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Revision 0

Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1995

United States
Department of Energy
Richland, Washington

Approved for Public Release

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Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1995

Earth and Environmental
Technical Services
Westinghouse Hanford Company

Date Published
February 1996

United States
Department of Energy
P.O. Box 550
Richland, Washington 99352

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EXECUTIVE SUMMARY

This report presents the annual hydrogeologic evaluation of 19 *Resource Conservation and Recovery Act of 1976* facilities and 1 nonhazardous waste facility at the U.S. Department of Energy's Hanford Site. Although most of the facilities no longer receive dangerous waste, a few facilities continue to receive dangerous waste constituents for treatment, storage, or disposal. The 19 *Resource Conservation and Recovery Act* facilities comprise 29 waste management units. Nine of the units are monitored under groundwater quality assessment status because of elevated levels of contamination indicator parameters. The impact of those units on groundwater quality, if any, is being investigated. If dangerous waste or waste constituents have entered groundwater, their concentration profiles, rate, and extent of migration are evaluated. Groundwater is monitored at the other 20 units to detect leakage, should it occur.

This report provides an interpretation of groundwater data collected at the waste management units between October 1994 and September 1995. Groundwater quality is described for the entire Hanford Site. Widespread contaminants include nitrate, chromium, carbon tetrachloride, tritium, and other radionuclides.

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11-DCA	1,1-dichloroethane
111-TCA	1,1,1-trichloroethane
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A-10 Crib	216-A-10 Crib
A-36B Crib	216-A-36B Crib
A-29 Ditch	216-A-29 Ditch
B-63 Trench	216-B-63 Trench
B Pond	216-B-3 Pond
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
CIP	contamination indicator parameter
CM	critical mean
CRQL	contractually required quantitation limit
CY	calendar year
DWS	drinking water standard
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERA	expedited response action
FY	fiscal year
LERF	Liquid Effluent Retention Facility
LLBG	Low-Level Burial Grounds
LLWMA	Low-Level Waste Management Area
LOD	limit of detection
LOQ	limit of quantitation
LWDF	Liquid Waste Disposal Facility
MDL	method detection limit
MEMO	Monitoring Efficiency Model
NCR	nonconformance report
NRDWL	Nonradioactive Dangerous Waste Landfill
PCE	tetrachloroethene
PUREX	Plutonium-Uranium Extraction (Plant)
QA	quality assurance
QC	quality control
RADE	request for analytical data evaluation
RCRA	*Resource Conservation and Recovery Act of 1976*
REDOX	Reduction-Oxidation (Plant)
RSU	retrievable storage unit
S-10 Facility	216-S-10 Pond and Ditch
SST	single-shell tank
SWL	Solid Waste Landfill

LIST OF TERMS (cont.)

TCE	trichloroethylene
TEDF	Treated Effluent Disposal Facility (200 Areas)
TOC	total organic carbon
TOX	total organic halogen
TSD	treatment, storage, and/or disposal
U-12 Crib	216-U-12 Crib
U Pond	216-U-10 Pond
WAC	*Washington Administrative Code*
WHC	Westinghouse Hanford Company
WMA	Waste Management Area
WP	Water Pollution
WS	Water Supply

METRIC CONVERSION CHART

<table>
<tr><th colspan="3">INTO METRIC</th></tr>
<tr><th>If you know</th><th>Multiply by</th><th>To get</th></tr>
<tr><td colspan="3">Length</td></tr>
<tr><td>inches</td><td>2.54</td><td>centimeters</td></tr>
<tr><td>feet</td><td>30.48</td><td>centimeters</td></tr>
<tr><td colspan="3">Volume</td></tr>
<tr><td>gallons</td><td>3.786</td><td>liters</td></tr>
<tr><td>cubic feet</td><td>0.02832</td><td>cubic meters</td></tr>
<tr><td colspan="3">Temperature</td></tr>
<tr><td>°Fahrenheit</td><td>Subtract 32°, then multiply by 5/9ths</td><td>°Celsius</td></tr>
<tr><td colspan="3">Pressure</td></tr>
<tr><td>inches water</td><td>1.87</td><td>mm Hg</td></tr>
<tr><td>inches water</td><td>249</td><td>pascal (Pa)</td></tr>
<tr><th colspan="3">OUT OF METRIC</th></tr>
<tr><td colspan="3">Length</td></tr>
<tr><td>centimeters</td><td>0.3937</td><td>inches</td></tr>
<tr><td>meters</td><td>3.28</td><td>feet</td></tr>
<tr><td colspan="3">Volume</td></tr>
<tr><td>milliliters</td><td>1.247 x 10^{-3}</td><td>cubic feet</td></tr>
<tr><td>liters</td><td>0.264</td><td>gallons</td></tr>
<tr><td>cubic meters</td><td>35.31</td><td>cubic feet</td></tr>
<tr><td colspan="3">Temperature</td></tr>
<tr><td>°Celsius</td><td>Multiply by 9/5ths, then add 32°</td><td>°Fahrenheit</td></tr>
<tr><td colspan="3">Pressure</td></tr>
<tr><td>mm Hg</td><td>0.5353</td><td>inches water</td></tr>
<tr><td>pascal (Pa)</td><td>4.02 x 10^{-3}</td><td>inches water</td></tr>
</table>

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ANNUAL REPORT FOR RCRA GROUNDWATER MONITORING PROJECTS AT HANFORD SITE FACILITIES FOR 1995

1.0 INTRODUCTION

M. J. Hartman
Westinghouse Hanford Company

This report presents the annual evaluation of 19 *Resource Conservation and Recovery Act of 1976* (RCRA) groundwater monitoring projects and 1 nonhazardous waste facility at the U.S. Department of Energy's (DOE) Hanford Site. It presents interpretations of groundwater monitoring data for samples collected between October 1, 1994 and September 30, 1995. These data were presented in the quarterly reports from October 1994 through September 1995 (DOE-RL 1995a, 1995b, 1995c, 1996). The reference list for this chapter includes a list of all quarterly and annual reports since RCRA groundwater monitoring began at the Hanford Site (Section 1.1.2).

DataChem Laboratories performed hazardous chemical analyses and Quanterra Environmental Services (formerly International Technologies Corporation) performed radiochemical analyses. These contracts were administrated by Pacific Northwest National Laboratory. Total organic halogen analyses were performed by Roy F. Weston Laboratories during the first part of the year and DataChem Laboratories during the remainder of the year.

The groundwater monitoring programs described in this document comply with the following *Washington Administrative Code* (WAC) regulations: (1) "Dangerous Waste Regulations," WAC 173-303-400, for hazardous waste; and (2) "Minimum Functional Standards for Solid Waste Handling," WAC 173-304-490, for nonhazardous waste. The projects meet the federal requirements for "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," 40 *Code of Federal Regulations* (CFR) 265, Subpart F; and "Criteria for Classification of Solid Waste Disposal Facilities and Practices," 40 CFR 257, for nonhazardous waste.

The RCRA projects are monitored under one of three programs: (1) a background monitoring program, (2) an indicator evaluation program, or (3) a groundwater quality assessment program. When a groundwater monitoring system has been installed, a background monitoring program begins. Samples and water levels from upgradient monitoring well(s) must be obtained and analyzed quarterly for at least 1 year to establish background concentrations in the groundwater. All of the RCRA sites at the Hanford Site have completed their background monitoring programs.

After background is established, the indicator evaluation program commences. Samples are collected semiannually to detect groundwater contamination. Data obtained through the indicator evaluation program are compared to background data; if a statistically significant change has occurred in a downgradient well, a groundwater quality assessment plan must be implemented. The objective of assessment monitoring is to determine if dangerous waste constituents have entered groundwater, and, if so, the concentration, rate, and extent of the constituents. Table 1-1 lists all of the RCRA facilities and waste management units and their monitoring program status. Figure 1-1 is an index map for locating all of the RCRA facilities on the Hanford Site.

One unit, 2101-M Pond, was clean-closed in October 1995 and groundwater monitoring is no longer required. It is included in this document but will not be included in future quarterly or annual reports.

The 183-H Solar Evaporation Basins are included in the Hanford Facility RCRA Permit and are now subject to final status regulation (Ecology 1994). However, the Basins were monitored under interim status regulations until September 1995, when a new, final-status monitoring program was implemented.

One additional facility, the 216-A-37-1 Crib, was originally excluded from the list of RCRA sites in the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1994). Later it was determined that regulated waste had been discharged to the crib and it is therefore subject to RCRA regulations. A groundwater monitoring plan is being prepared for the site and it will be monitored in the future.

The constituent lists for laboratory analyses are established in accordance with the requirements of 40 CFR 265.92. The contamination indicator parameters are specified in 40 CFR 265.92(b)(3). The parameters establishing groundwater quality are specified in 40 CFR 265.92(b)(2). The drinking water standards are specified in 40 CFR 265.92(b)(1), Appendix III. Site-specific parameters (including radionuclides) are determined from evaluation of the waste stream (or source) associated with the facility. Additional site-specific constituents may be included to aid in tracking groundwater movement and the influence of other facilities. In some cases, an Appendix IX list of constituents (40 CFR 264) is analyzed to establish a baseline for future comparisons and analyses.

The Solid Waste Landfill (SWL) is a solid waste disposal facility. It is not a RCRA hazardous waste site and is not addressed under the Tri-Party Agreement. The current operations of the SWL fall under the regulations of WAC 173-304. The SWL is included in this report for completeness. A permit application was submitted to the Benton-Franklin District Health Department in 1991 (DOE 1991). Responsibility for the site was subsequently assumed by the Washington State Department of Ecology (Ecology) and a revised permit application was submitted to Ecology in 1993 (DOE 1993).

40 CFR Part 265.94, "Recordkeeping and Reporting," requires that for indicator evaluation monitoring projects, concentrations and any changes in contamination indicator parameters for each groundwater monitoring well must be reported annually, and the locations of the monitoring wells must be shown to continue to satisfy regulatory criteria (265.94[a][2]). It must be identified separately if indicator parameter levels have changed significantly at an upgradient well since the initial background levels were established (265.94[a][2]). For assessment-level monitoring, the results of the groundwater quality assessment program must be submitted annually. The report must include the calculated (or measured) rate of migration of hazardous waste or hazardous waste constituents in the groundwater (40 CFR 265.94[b][2]). An annual report for solid waste landfills is required under WAC 173-304.

This report is organized by geographical area. Chapter 2.0 presents an overview of Hanford Site hydrogeology. Chapters 3.0, 4.0, 5.0, and 6.0 discuss the 100, 200, 600, and 300 Areas, respectively. For a description of the hydrogeologic setting of each area, see DOE-RL (1994). Appendix A provides a brief description of the quality control program and a summary of the year's activities. Appendix B describes the data evaluation process and activities during the year. Appendix C provides methods of statistical evaluation and summary tables for background conditions.

Each subsection describing an individual RCRA site begins with an overview of the facility, a summary of 1995 RCRA activities, and a summary of other activities related to the hydrogeology of the site. Next, the sampling and analysis program is described, including well locations, the constituent list, and sampling frequency. For sites in indicator evaluation monitoring, a section on groundwater chemistry discusses elevated constituents, their changes with time, and results of statistical evaluations. For sites in assessment monitoring, the groundwater chemistry section describes concentration histories of waste constituents and the rate and extent of contaminant migration. For all sites, the final subsections describe the direction of groundwater flow, the rate of flow, and provide an evaluation of the monitoring network.

Units of measurement are expressed in metric, with english equivalents following in parentheses. Water levels, drill depths, etc. were originally measured in feet and were converted to meters.

The drinking water standards referred to in this document have been updated from interim standards (as listed in 40 CFR 265, Appendix III) to final standards (40 CFR 141). The most notable changes are for chromium (changed from 50 to 100 ppb) and fluoride (changed from 1,400 to 2,000 ppb).

The constituent lists for most of the RCRA sites at Hanford were trimmed during the past year. Constituents were dropped if they are no longer required by regulations and are not constituents of interest at the RCRA site.

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1.1.1 Chapter References

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40 CFR 257, "Criteria for Classification of Solid Waste Disposal Facilities and Practices," *Code of Federal Regulations*, as amended.

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

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PNL, 1987b, *Ground-Water Monitoring Compliance Projects for Hanford Site Facilities: Progress Report for the Period April 1 to June 30, 1987*, PNL-6468, Pacific Northwest Laboratory, Richland, Washington.

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DOE-RL, 1991b, *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.

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1.1.2.7 Period 1992.

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1.1.2.8 Period 1993.

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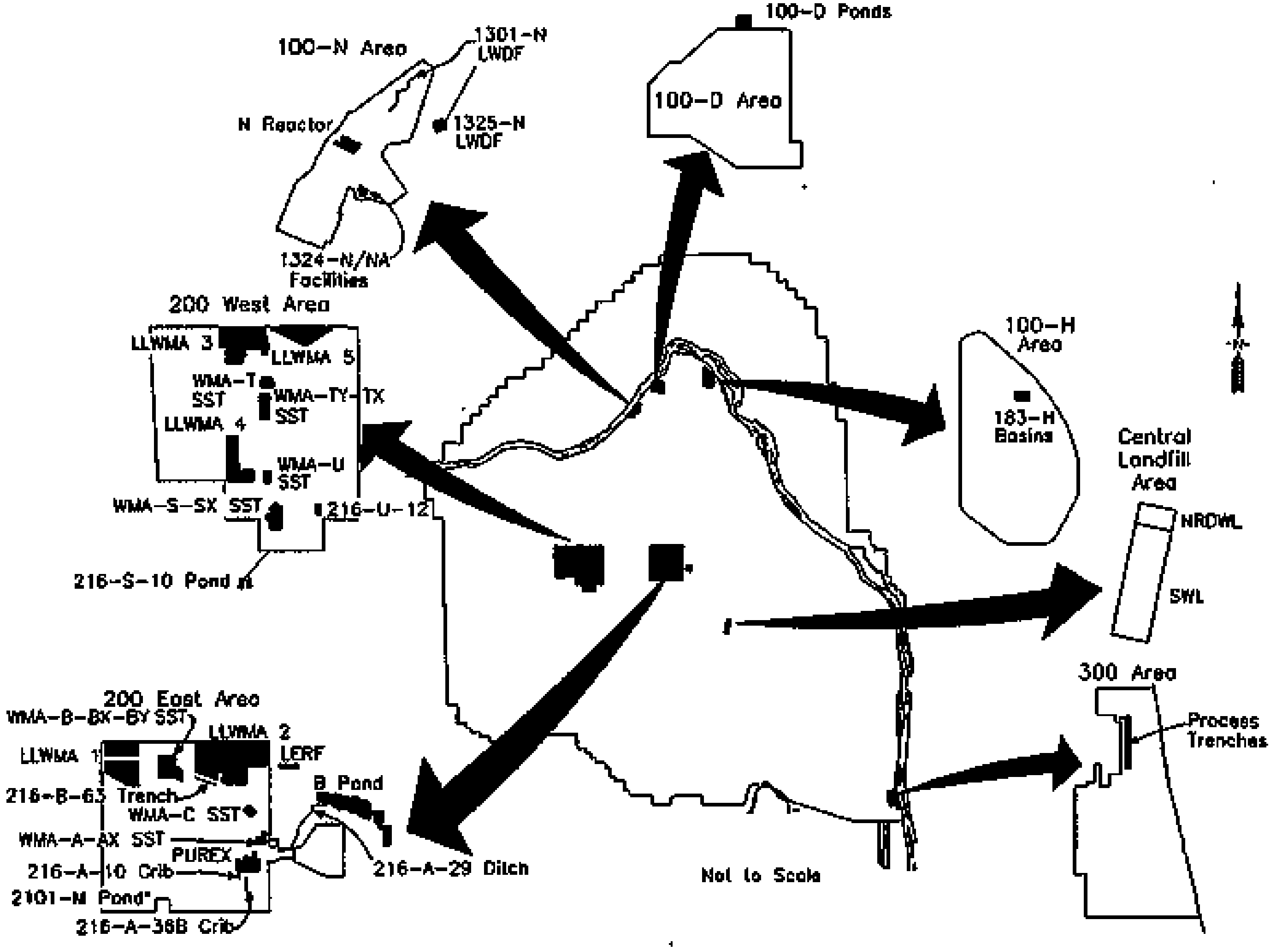

LERF	Liquid Effluent Retention Facility	PUREX	Plutonium-Uranium Extraction (Plant)
LLWMA	Low-Level Waste Management Area	SST	Single-Shell Tank
LWDF	Liquid Waste Disposal Facility	SWL	Solid Waste Landfill
NRDWL	Nonradioactive Dangerous Waste Landfill	WMA	Waste Management Area

SITEWIDE

Figure 1-1. Locations of the RCRA Groundwater Monitoring Projects and Landmarks on the Hanford Site.

Table 1-1. Status of Hanford Site RCRA Interim-Status Groundwater Monitoring Projects as of September 30, 1995. (3 sheets)

Project (date initiated)	Indicator parameter evaluation	GW quality assessment	Regulatory requirements
100-D Ponds (4/92)	X[a]		40 CFR 265.93(b) WAC 173-303-400
183-H Basin (6/85)		X[b] (9/95)	40 CFR 264.99 WAC 173-303-645
1301-N LWDF (12/87)	X		40 CFR 265.93(b) WAC 173-303-400
1324-N/NA Pond (12/87)		X (5/89) Spe cond, TOX	40 CFR 265.93(d) WAC 173-303-400
1325-N LWDF (12/87)	X		40 CFR 265.93(b) WAC 173-303-400
216-B-3 Pond (11/88)		X (5/90) TOX	40 CFR 265.93(d) WAC 173-303-400
216-A-29 Ditch (11/88)		X (6/90) Spe cond	40 CFR 265.93(d) WAC 173-303-400
216-A-36B Crib (5/88)	X		40 CFR 265.93(b) WAC 173-303-400
216-A-10 Crib (11/88)	X		40 CFR 265.93(b) WAC 173-303-400
216-B-63 Trench (8/91)	X		40 CFR 265.93(b) WAC 173-303-400
216-S-10 Pond (8/91)	X		40 CFR 265.93(b) WAC 173-303-400
216-U-12 Crib (9/91)		X (1/93) Spe cond	40 CFR 265.93(d) WAC 173-303-400
LERF (7/91)	X		40 CFR 265.93(b) WAC 173-303-400
2101-M Pond (8/88)	X		40 CFR 265.93(b) WAC 173-303-400

Table 1-1. Status of Hanford Site RCRA Interim-Status Groundwater Monitoring Projects as of September 30, 1995. (3 sheets)

Project (date initiated)	Indicator parameter evaluation	GW quality assessment	Regulatory requirements
LLBG			
WMA 1 (9/88)	X		40 CFR 265.93(b) WAC 173-303-400
WMA 2 (9/88)	X		40 CFR 265.93(b) WAC 173-303-400
WMA 3 (10/88)	X		40 CFR 265.93(b) WAC 173-303-400
WMA 4 (10/88)	X		40 CFR 265.93(b) WAC 173-303-400
WMA 5 (3/92)	X		40 CFR 265.93(b) WAC 173-303-400
SST			
WMA-A-AX (2/90)	X		40 CFR 265.93(b) WAC 173-303-400
WMA-B-BX-BY (2/90)	X		40 CFR 265.93(b) WAC 173-303-400
WMA-C (2/90)	X		40 CFR 265.93(b) WAC 173-303-400
WMA-S-SX (10/91)	X		40 CFR 265.93(b) WAC 173-303-400
WMA-T (2/90)		X (7/93) Spe cond	40 CFR 265.93(d) WAC 173-303-400
WMA-TX-TY (9-10/91)		X (7/93) Spe cond	40 CFR 265.93(d) WAC 173-303-400
WMA-U (10/9)	X		40 CFR 265.93(b) WAC 173-303-400

Table 1-1. Status of Hanford Site RCRA Interim-Status Groundwater Monitoring Projects as of September 30, 1995. (3 sheets)

Project (date initiated)	Indicator parameter evaluation	GW quality assessment	Regulatory requirements
300 Area Process Trenches (6/85)		X (6/85)	*Consent Agreement and Compliance Order*[c]
NRDWL (10/86)	X		40 CFR 265.93(b) WAC 173-303-400

Note: An X and date in the third column indicates the following: (1) the date that the assessment was initiated and (2) the indicator parameter that triggered assessment monitoring.

[a] Background conductivity is being reestablished.

[b] Final status compliance program implemented September 1995.

[c] Ecology and EPA (1986).

CFR = *Code of Federal Regulations*.
GW = groundwater.
LERF = Liquid Effluent Retention Facility.
LLBG = Low-Level Burial Grounds.
LWDF = Liquid Waste Disposal Facility.
NRDWL = Nonradioactive Dangerous Waste Landfill.
Spe cond = specific conductance.
SST = single-shell tanks.
TOX = total organic halogen.
WAC = *Washington Administrative Code*.
WMA = Waste Management Area.

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2.0 HANFORD SITE HYDROGEOLOGY

M. J. Hartman
Westinghouse Hanford Company

This chapter presents a summary of the geology and hydrology of the Hanford Site. Additional detail is available from Delaney et al. (1991) and DOE (1988).

2.1 SITE GEOLOGY

The information in this section is summarized from Delaney et al. (1991) and other sources as noted. The Hanford Site is underlain by Miocene-aged basalt of the Columbia River Basalt Group, and late Miocene to Pleistocene sediments.

The Columbia River Basalt Group comprises an assemblage of tholeiitic, continental flood basalts that cover an area of more than 160,000 km^2 (63,000 mi^2). Sediments of the Ellensburg Formation form interbeds between basalt flows. The Levey interbed is the uppermost unit of the Ellensburg Formation. It is tuffaceous sandstone to siltstone and, at the Hanford Site, it is found only beneath the 300 Area. The Rattlesnake Ridge interbed is the shallowest interbed beneath the rest of the Hanford Site. It is up to 33 m (108 ft) thick and includes clay, siltstone, and sandstone.

The suprabasalt sedimentary sequence beneath the Hanford Site is up to 230 m (750 ft) thick. It pinches out against areas where the basalt has been uplifted. The suprabasalt sediments are dominated by laterally extensive deposits assigned to the late Miocene to Pliocene-aged Ringold Formation and the Pleistocene-aged Hanford formation (informal name). The remainder of the sequence comprises localized strata assigned to the informally defined Plio-Pleistocene unit, early "Palouse" soil, and pre-Missoula gravels.

2.1.1 Stratigraphy of the Ringold Formation

The Ringold Formation comprises alternating fine- and coarse-grained, semi-indurated sediments. Lindsey (1991) designates fluvial sand and gravel-dominated sequences A (oldest) through E (youngest) (Figure 2-1). Not all of the fluvial sequences are continuous beneath the Hanford Site.

The lowest Ringold deposits consist of up to 46 m (150 ft) of fluvial gravel, designated unit A. Unit A is not found in the vicinity of the 300 and 1100 Areas or near the 100-H and 100-F Areas.

The lower mud unit, comprising overbank and lacustrine deposits, lies over unit A. The lower mud unit is up to 43 m (140 ft) thick.

Fluvial gravel unit B lies over the lower mud unit. Unit B is up to 25 m (82 ft) thick, but is not present beneath the 200 Areas.

Deposits typical of the overbank facies association overlie unit B throughout the Hanford Site. Where unit B is absent, these overbank deposits interfinger with the lower mud sequence.

Another fluvial gravel-dominated sequence, unit C, is present in a relatively narrow linear tract trending northwest to southeast trending across the Pasco Basin. It is up to 35 m (115 ft) thick near the 100-B/C Area, but it is absent north of the 100-N and 100-F Areas. In the Cold Creek syncline, the unit stretches from east of the 200 East Area to near the city of Richland.

Another sequence of fine-grained overbank deposits overlies unit C. Thin fluvial sands are present locally.

The uppermost fluvial gravel-dominated sequence in the Ringold Formation, unit E, is the most widespread of the gravel sequences. Unit E is up to 30 m (100 ft) thick near the 100-B/C Area, and pinches out north of the 100-D Area and east of Gable Gap. Laterally equivalent strata near the 100-F and 100-H Areas consist of overbank deposits with minor intercalated fluvial sand. Unit E is found throughout the Cold Creek syncline, forming a west-thickening wedge that is 30 to 40 m (98 to 130 ft) thick south and east of the 200 East Area, and 91 m (300 ft) thick south and west of the 200 West Area. Near the 300 Area the overbank deposits beneath unit E are absent and unit E overlies or truncates underlying coarse-grained sequences (unit C or B).

More interbedded fluvial sand and overbank deposits lie over unit E in some areas of the Hanford Site. Erosional remnants of these deposits are found south and east of the 200 East Area and near the 200 West Area. North of the 100-F and 100-N Areas, fluvial sands pinch out and overbank deposits dominate the sediments.

2.1.2 Post-Ringold, Pre-Hanford Deposits

Thin alluvial deposits between the Hanford and Ringold Formations are referred to informally as the: (1) Plio-Pleistocene unit, (2) pre-Missoula gravels, and (3) early "Palouse" soil.

The Plio-Pleistocene unit is laterally discontinuous and is up to 25 m (82 ft) thick. It is present in the vicinity of the 200 West Area. Pre-Missoula gravels, up to 25 m (82 ft) thick, are present east and south of the 200 East Area. It is unclear whether the pre-Missoula gravels overlie or interfinger with the early "Palouse" soil and Plio-Pleistocene unit. The early "Palouse" soil comprises up to 20 m (65 ft) of silt and fine-grained sand. It is present around the 200 West Area.

2.1.3 Stratigraphy of the Hanford Formation

The Hanford formation consists of gravel- and sand/silt-dominated deposits. It is up to 64 m (210 ft) thick near the 200 Areas.

The gravel-dominated deposits comprise coarse-grained sand and gravel with boulders. Matrix commonly is lacking in these gravels. Gravels dominate the formation in the 100 Areas, the northern part of the 200 East Area, and the eastern Hanford Site, including the 300 Area. The gravels generally become finer to the south in the 200 Areas. The gravel-dominated facies of the Hanford formation were deposited by high-energy glacial flood waters in or immediately adjacent to the main cataclysmic flood channels.

The sand/silt-dominated deposits comprise two facies: (1) laminated sand and (2) rhythmite. The laminated sand facies consists of fine- to coarse-grained sand that may contain small pebbles or pebble-gravel interbeds less than 20 cm (8 in.) thick. This facies is common in the 200 Areas. It was deposited adjacent to main flood channels where it spilled out of the channels. The rhythmite facies consists of silt and fine- to coarse-grained sand that commonly display normally graded rhythmites a few centimeters to tens of centimeters thick in outcrop. These sediments were deposited under slack water conditions. The facies is found within and south of the 200 Areas.

2.1.4 Holocene Surficial Deposits

Holocene surficial deposits form a thin (<5-m [<16-ft]) veneer across much of the Hanford Site. The deposits comprise silt, sand, and gravel.

2.1.5 Structural Geology of the Hanford Site

The Hanford Site is located in the Pasco Basin, one of the largest structural basins on the Columbia Plateau. The Pasco Basin is divided by the Gable Mountain anticline into the Wahluke and Cold Creek synclines (Figure 2-2).

The Cold Creek syncline is an asymmetric and relatively flat-bottomed structure. The 200 Areas lie on the northern flank and the bedrock dips gently to the south into the Cold Creek syncline. The 300 Area lies at the eastern end of the Cold Creek syncline.

The Wahluke syncline contains the 100 Areas. It is an asymmetric and relatively flat-bottomed structure similar to the Cold Creek syncline. The northern limb dips gently to the south; the steepest limb is adjacent to the Gable Mountain anticline.

The Umtanum Ridge-Gable Mountain structural trend is a segmented anticlinal ridge extending in an east-west direction between the 200 and 100 Areas. On the Hanford Site the Umtanum Ridge segment plunges eastward and joins the Gable Mountain-Gable Butte segment.

2.2 SITE HYDROLOGY

2.2.1 Surface Hydrology

Primary surface water features associated with the Hanford Site are the Columbia River and its tributary, the Yakima River. West Lake, about 4 ha

(10 acres) in size and less than 1 m (3 ft) deep, is the only natural lake on the Hanford Site.

The Columbia River flows through the northern part and along the eastern border of the Hanford Site. Flow along this section of the river, which is called the Hanford Reach, is controlled by Priest Rapids Dam upstream of the Hanford Site. River stage recorders, consisting of pressure transducers and data loggers, are operating at the 100-B/C, 100-N, 100-H, 100-F, and 300 Areas. The river drops 14 m (46 ft) between the 100 B/C and 300 Areas, in a distance of approximately 64 km (40 mi). The average gradient is 0.0002. Figure 2-3 shows the average weekly river stage for the past year. The river stage graphs are parallel, with some damping of amplitude further downstream (e.g., 300 Area).

Riverbank springs have been observed and sampled along the Hanford Reach (McCormack and Carlile 1984; Dirkes 1990; Peterson and Johnson 1992). Contaminants originating on the Hanford Site have been detected in spring water along the Hanford Reach. The type and concentrations of contaminants in the spring water are similar to those known to exist in the groundwater near the river.

Approximately one-third of the Hanford Site is drained by the Yakima River system. Cold Creek and its tributary, Dry Creek, are ephemeral streams within the Yakima River drainage system.

Table 2-1 lists the chemical composition of river water at the Hanford Site. Precipitation at the Hanford Site contains very few dissolved solids. Columbia River water is low in dissolved solids. Yakima River water contains higher concentrations of some constituents, which may be influenced by anthropogenic activity (DOE-RL 1992).

2.2.2 Hydrogeologic Units

Hydrogeologic units beneath the Hanford Site include: (1) the vadose zone, (2) an aquifer system in the suprabasalt sediments, and (3) a series of confined aquifers in the basalts and interbeds. This document will focus on the units above the basalts. The source of the following information is Delaney et al. (1991) unless otherwise indicated. Hydraulic properties of various hydrologic units are listed in Table 2-2.

The vadose zone at the Hanford Site includes Holocene surficial deposits, the Hanford formation and, in some areas, portions of the Ringold Formation. In the 100 Areas, the water table is located near the Hanford-Ringold contact and the vadose zone consists of poorly sorted gravel, sand, and silt. In the 200 Areas, unsaturated sediments include Ringold unit E and the units above it (see Section 2.1). Only the Hanford formation is continuous throughout the vadose zone in the 200 Areas. The vadose zone beneath the 300 and 1100 Areas is almost entirely in the Hanford formation. The vadose zone is less than 30 m (100 ft) thick near the Columbia River (i.e., the 100, 300, and 1100 Areas). The vadose zone beneath the 200 Areas is up to 104 m (340 ft) thick.

The saturated sediments of the Hanford and Ringold Formations make up a series of aquifers and aquitards that has been referred to as the *suprabasalt aquifer system*. The shallowest producing layer within the system at a given location is called the *uppermost aquifer*. In general, the sand- and gravel-dominated stratigraphic units (see Figure 2-1) form aquifers and the overbank/lacustrine deposits form aquitards.

The uppermost aquifer in the 100 Areas comprises unconfined sand and gravel of Ringold unit E or the Hanford formation. In the 200 West Area the uppermost aquifer is contained in the Ringold Formation under unconfined to locally confined conditions. In the 200 East Area the uppermost aquifer occurs in the Hanford and Ringold formations under unconfined to locally confined conditions. The aquifer pinches out north of the 200 East Area where the basalt is above the water table. The uppermost aquifer at the 300 and 1100 Areas is dominated by the fluvial gravels of the Ringold Formation.

Water enters the uppermost aquifer from precipitation, deeper aquifers, influent streams, and artificial sources such as liquid effluent disposal and irrigation.

Coarse-grained units deeper in the Ringold Formation are isolated beneath fine-grained units, forming a series of locally confined aquifers. Hydrologic data on these aquifers are limited. There is an upward gradient between these shallow, confined aquifers and the unconfined aquifer in the 100-H Area.

2.2.3 Groundwater Flow

Figure 2-4 is a water table map of the Hanford Site for June 1995. Groundwater flow in the unconfined aquifer is inferred to be generally from west to east, discharging to the Columbia River. Artificial recharge from liquid effluent disposal has locally altered groundwater flow and raised the water table. The most notable examples of this are in the 200 West Area and east of the 200 East Area.

The volume of water discharged in the 200 Areas has decreased and the location of the disposal facilities has changed in recent years. These changes have caused the water table to decline. During the past year this decline slowed, and water levels stabilized in many wells.

2.2.4 Groundwater Chemistry

Natural chemistry of unconfined groundwater on the Hanford Site is summarized in Table 2-3. The listed values were derived from wells located upgradient (to the west) of Hanford Site activities. These values are provided for general information only, and should not be used as a baseline to assess groundwater contamination.

Hanford Site operations have introduced chemical and radiological contaminants to the groundwater in the uppermost aquifer. Contaminant plumes originate in the operational areas. Contamination is also present from offsite sources, e.g., nitrate from agricultural practices.

Figures 2-5 through 2-10 are contour maps showing the distribution of the most widespread contaminants in the uppermost aquifer of the Hanford Site. The maps were constructed from data collected from shallow wells between January 1991 and September 1993. Anomalous data points were removed and values were averaged where more than one result existed. Groundwater chemistry data were retreived from the Hanford Environmental Information System, and include data from Pacific Northwest Laboratory sitewide monitoring as well as from Westinghouse Hanford Company's monitoring programs. Plume maps constructed from data collected in 1994 (Dresel et al. 1995) look very similar to the maps constructed of 1991-93 data.

Figure 2-5 shows the distribution of tritium in the uppermost aquifer. Sources of tritium contamination are, or have been, effluent storage or disposal sites in the reactor areas and the 200 Areas. Tritium contamination from the 200 Areas has moved in a widespread plume toward the east. It appears that tritium contamination also has moved northward between Gable Mountain and Gable Butte. Once through this "gap," the tritium contamination migrates toward the northwest.

Figure 2-6 illustrates gross beta activity in the uppermost aquifer. The highest observed activities are in the 200 Areas and in the 100-N Area. Like the tritium plume, the gross beta plume has moved from the 200 East Area through Gable Gap.

The gross beta plumes in the 200 Areas and the plume moving through Gable Gap coincide with the ^{99}Tc plume in those areas (see Figure 2-7). Technetium-99 is a beta emitter. A group of wells near the Columbia River due east of the 200 Areas also shows elevated ^{99}Tc. It is not known whether this plume is connected to contamination in the 200 Areas.

Figure 2-8 shows the distribution of ^{129}I in the uppermost aquifer. Contaminant plumes are moving east from the 200 Areas. Smaller areas of contamination are also observed near the 300 Area.

Figure 2-9 illustrates nitrate distribution in the uppermost aquifer. Nitrate contamination above the drinking water standard (45,000 ppb) is observed at locations throughout the Hanford Site.

Groundwater beneath most of the 200 West Area is contaminated with carbon tetrachloride (Figure 2-10). Discussion of potential sources of the contamination are contained in DOE (1991).

The concentrations of certain metals have been elevated in many unfiltered groundwater samples collected at the Hanford Site. The elevated metals are believed not to be representative of groundwater quality. Only filtered samples are now analyzed for metals at most of the RCRA sites, and filtered samples generally have much lower concentrations of metals.

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Figure 2-1. Generalized Stratigraphy of the Suprabasalt Sediments Beneath the Hanford Site (Delaney et al. 1991).

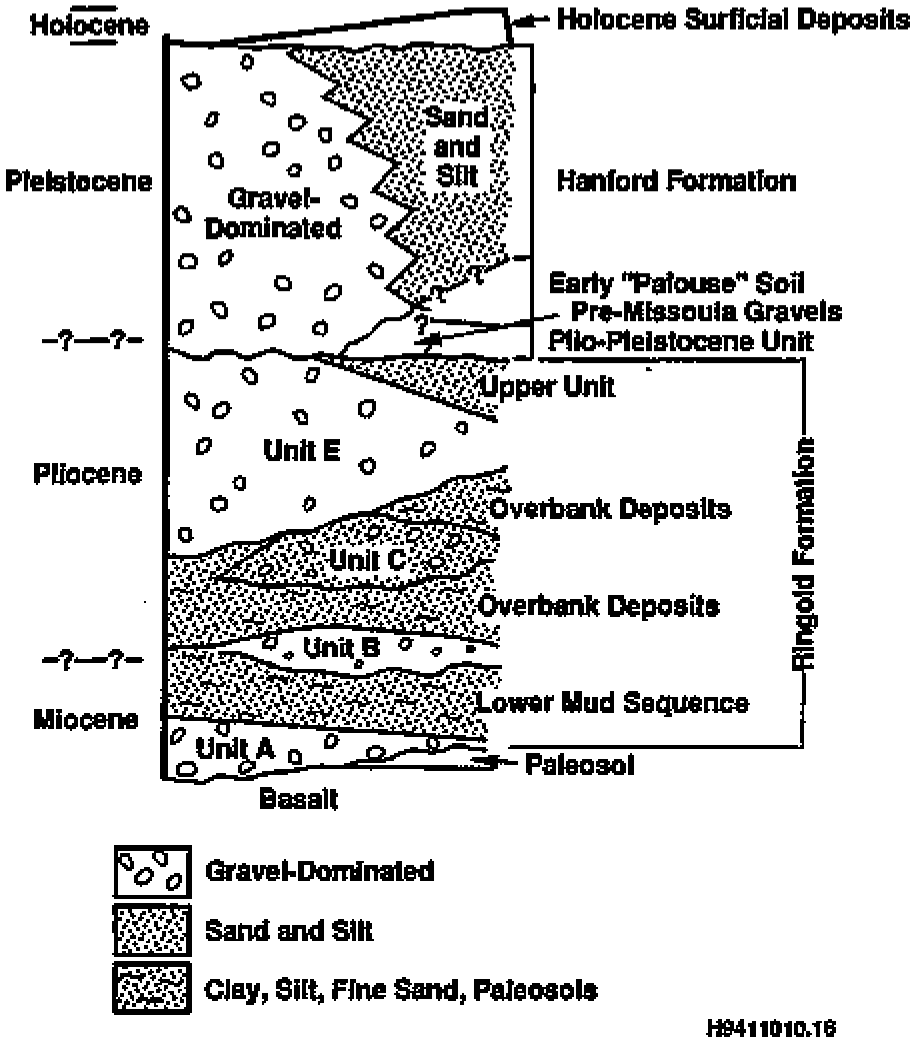
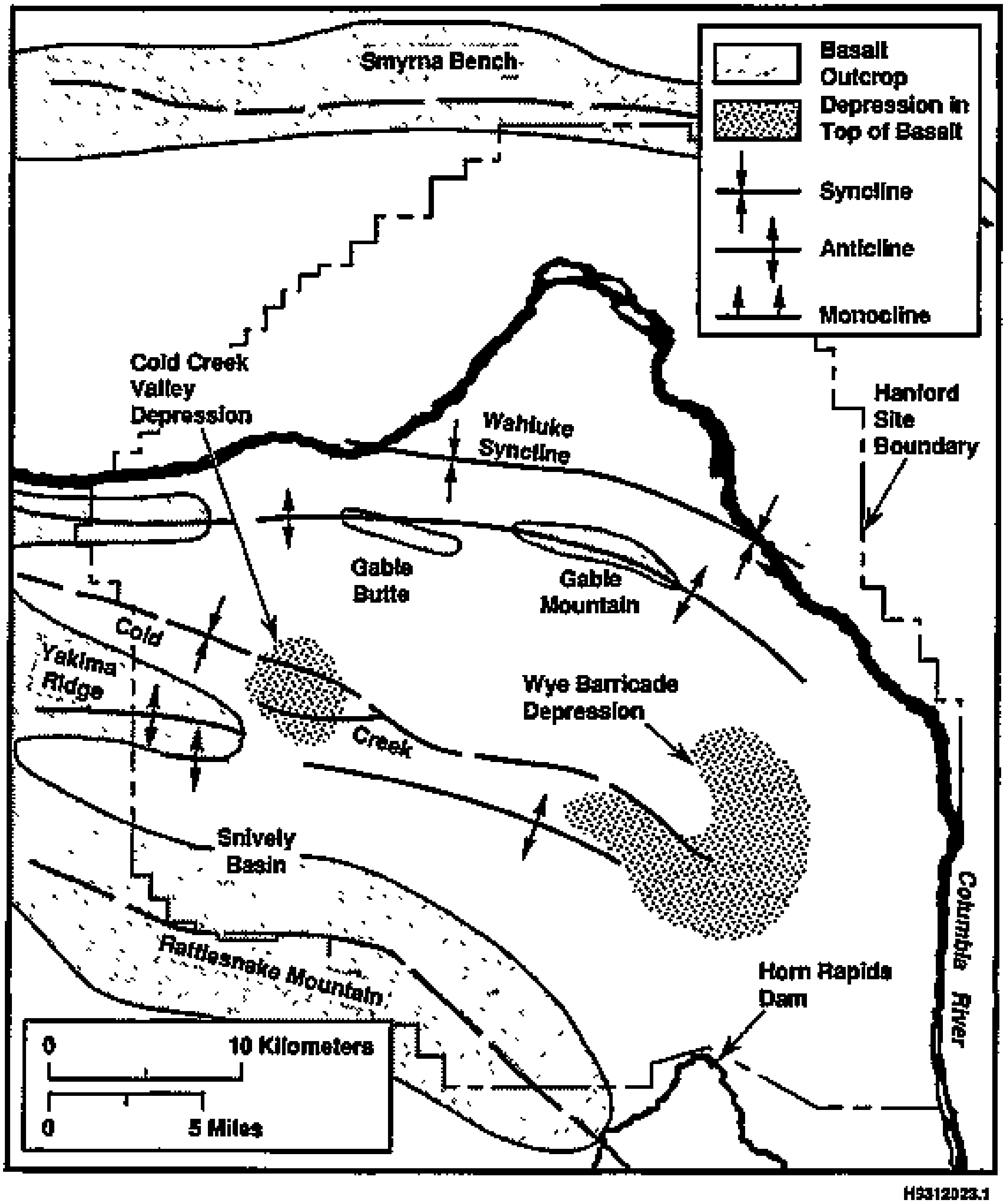


Figure 2-2. Geologic Structure of the Hanford Site (Delaney et al. 1991).



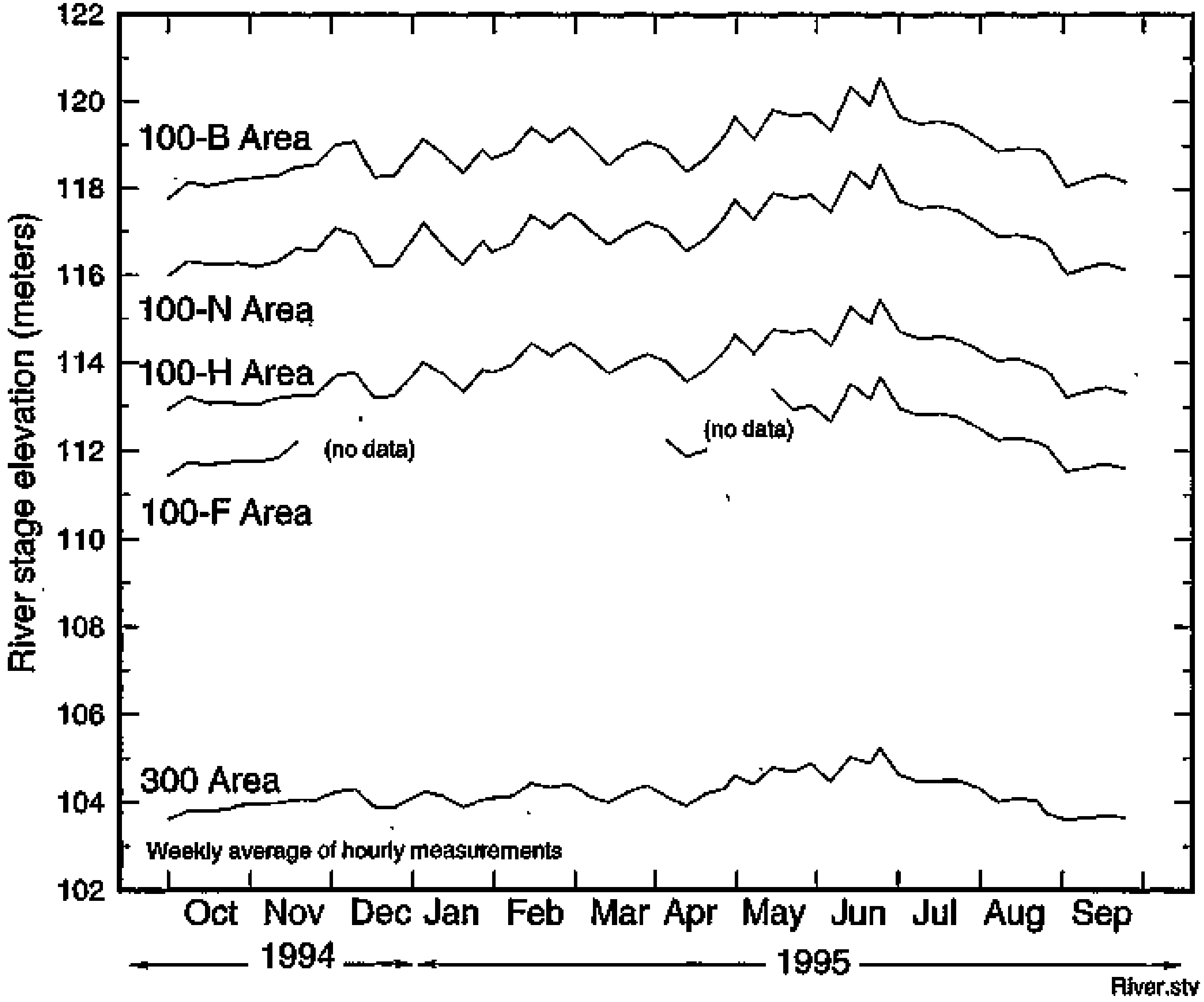
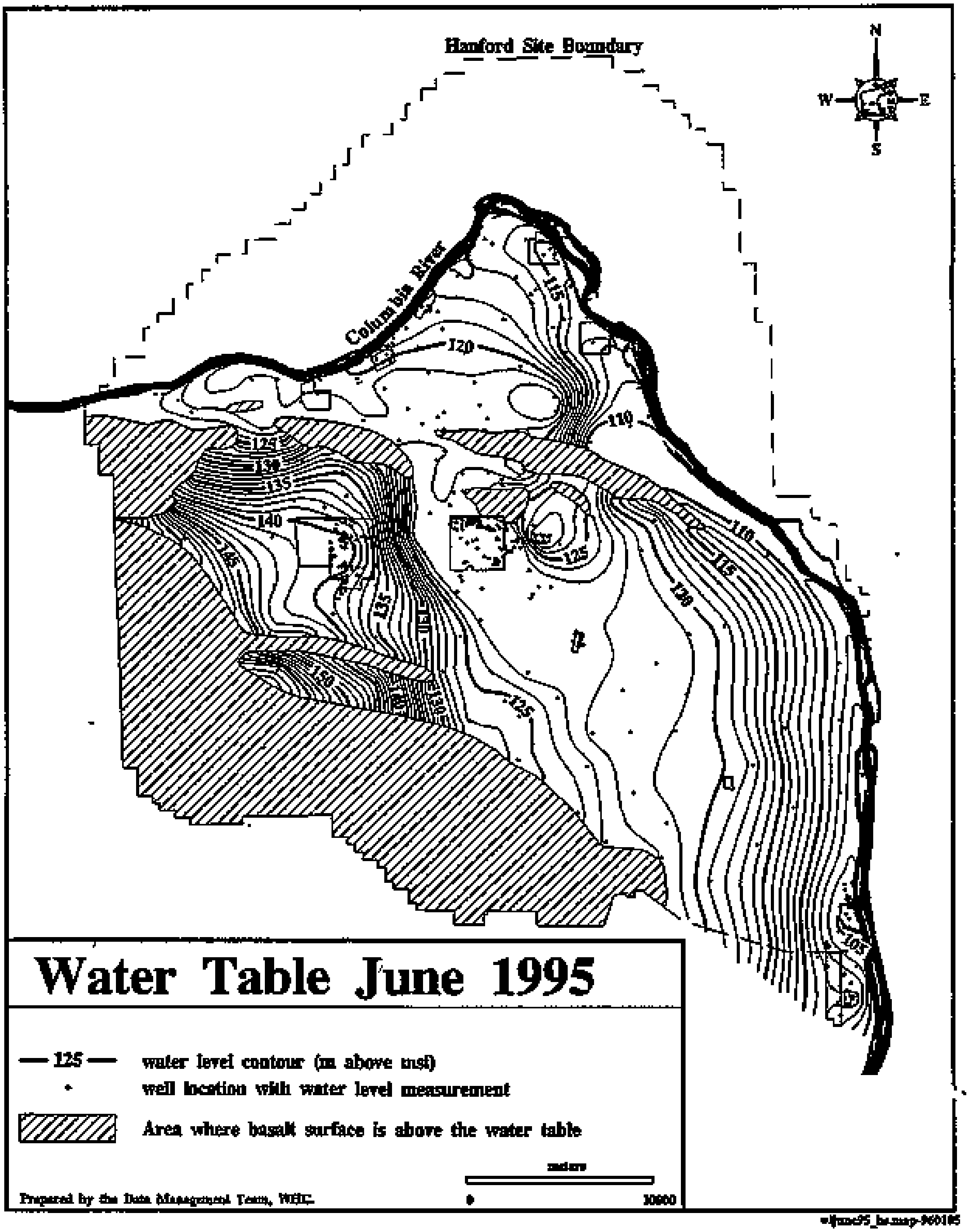


Figure 2-3. Weekly Average Columbia River Stage at the Hanford Site.

Figure 2-4. Hanford Site Water Table Map, June 1995.



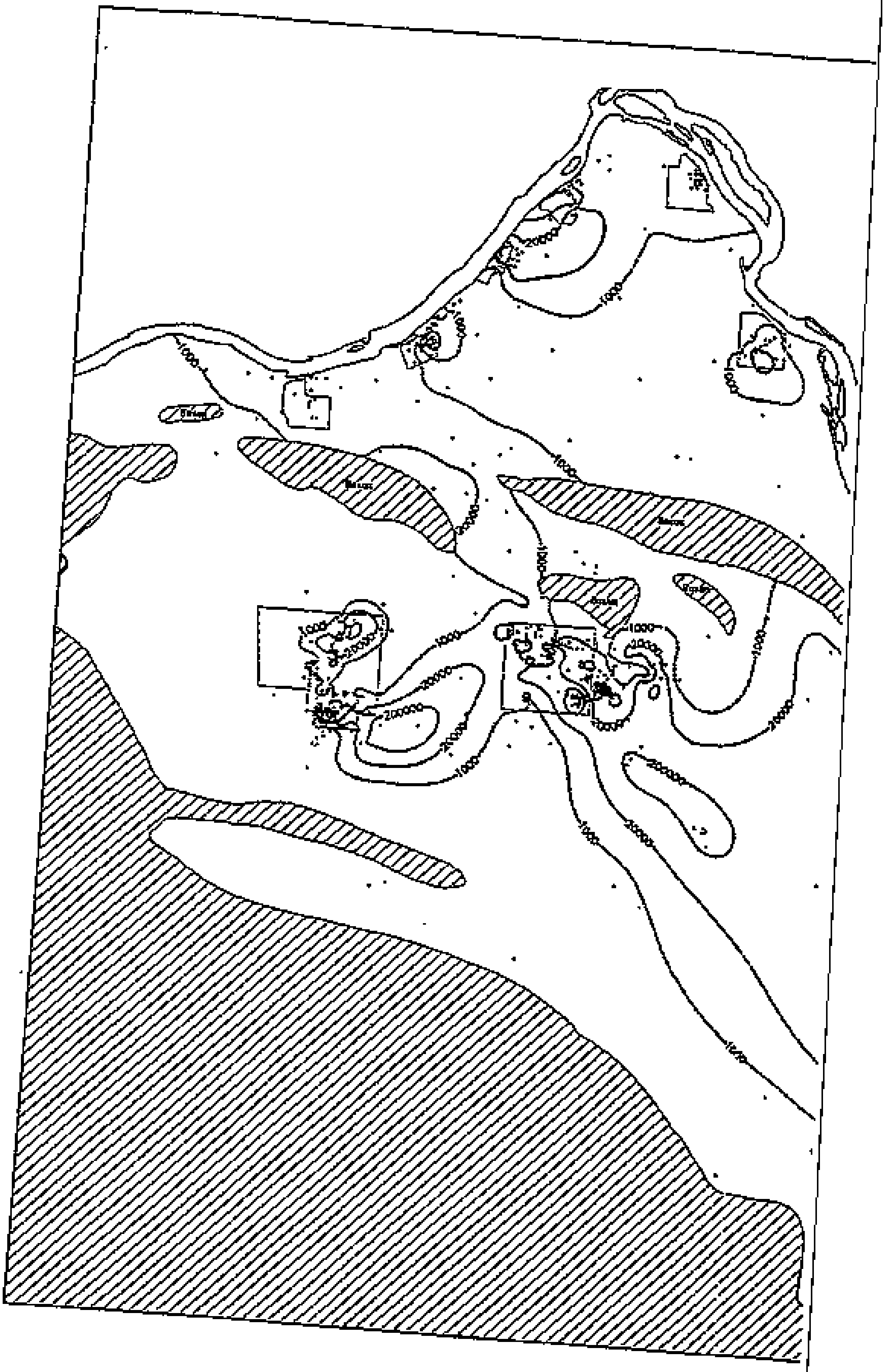

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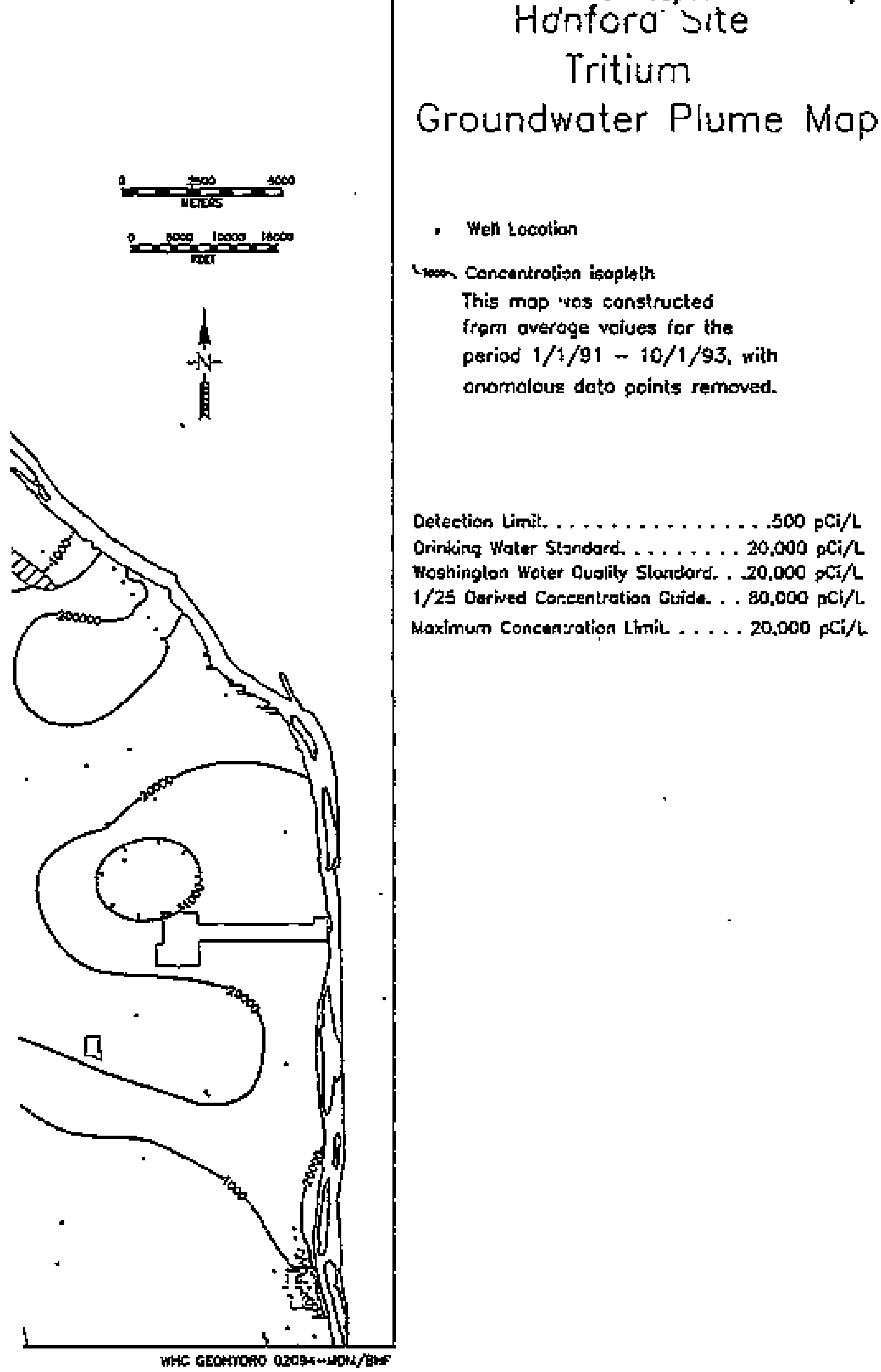
Figure 2-5. Tritium Distribution in the Uppermost Aquifer, Hanford Site, January 1991 through September 1993 (Hartman 1994).



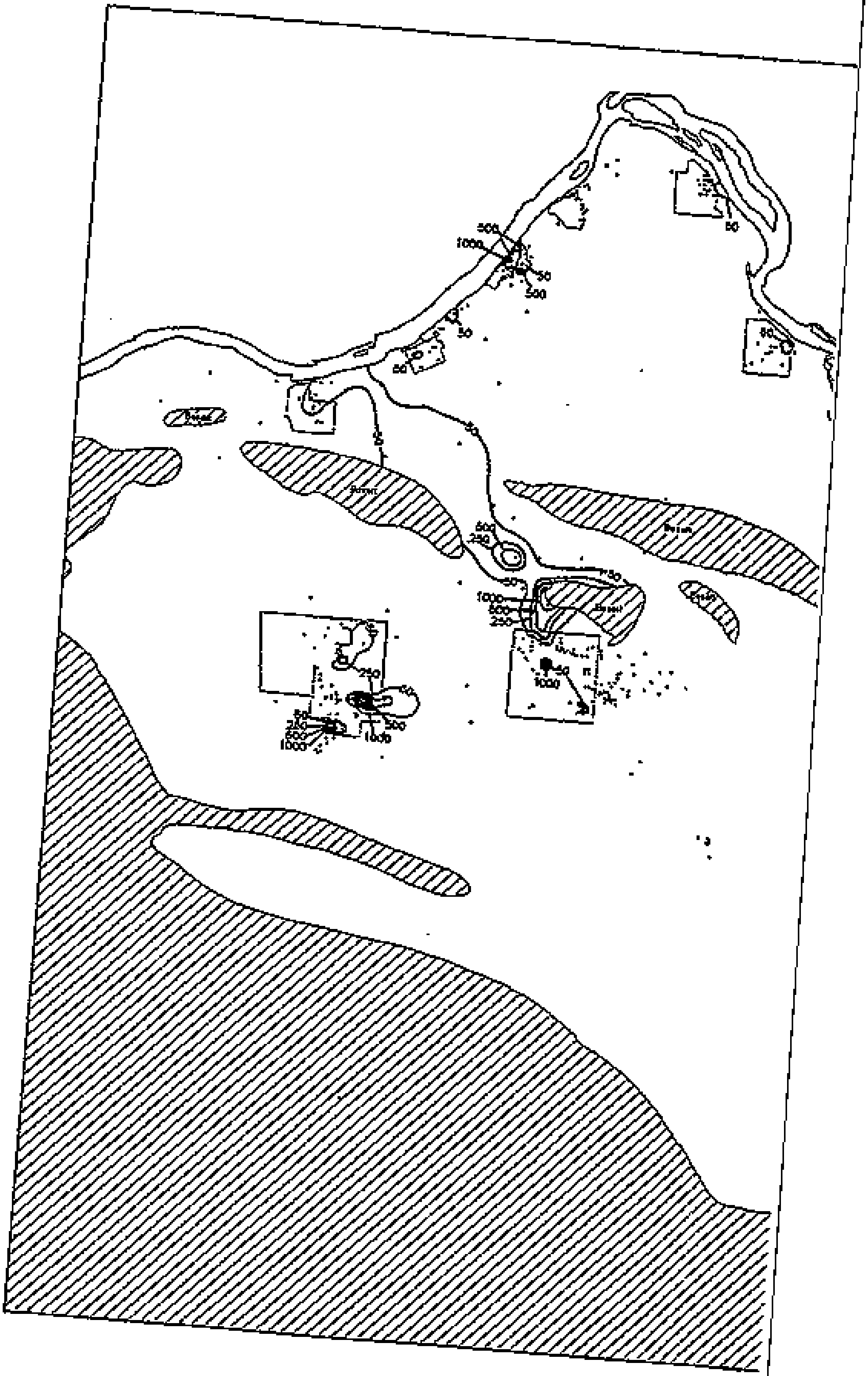

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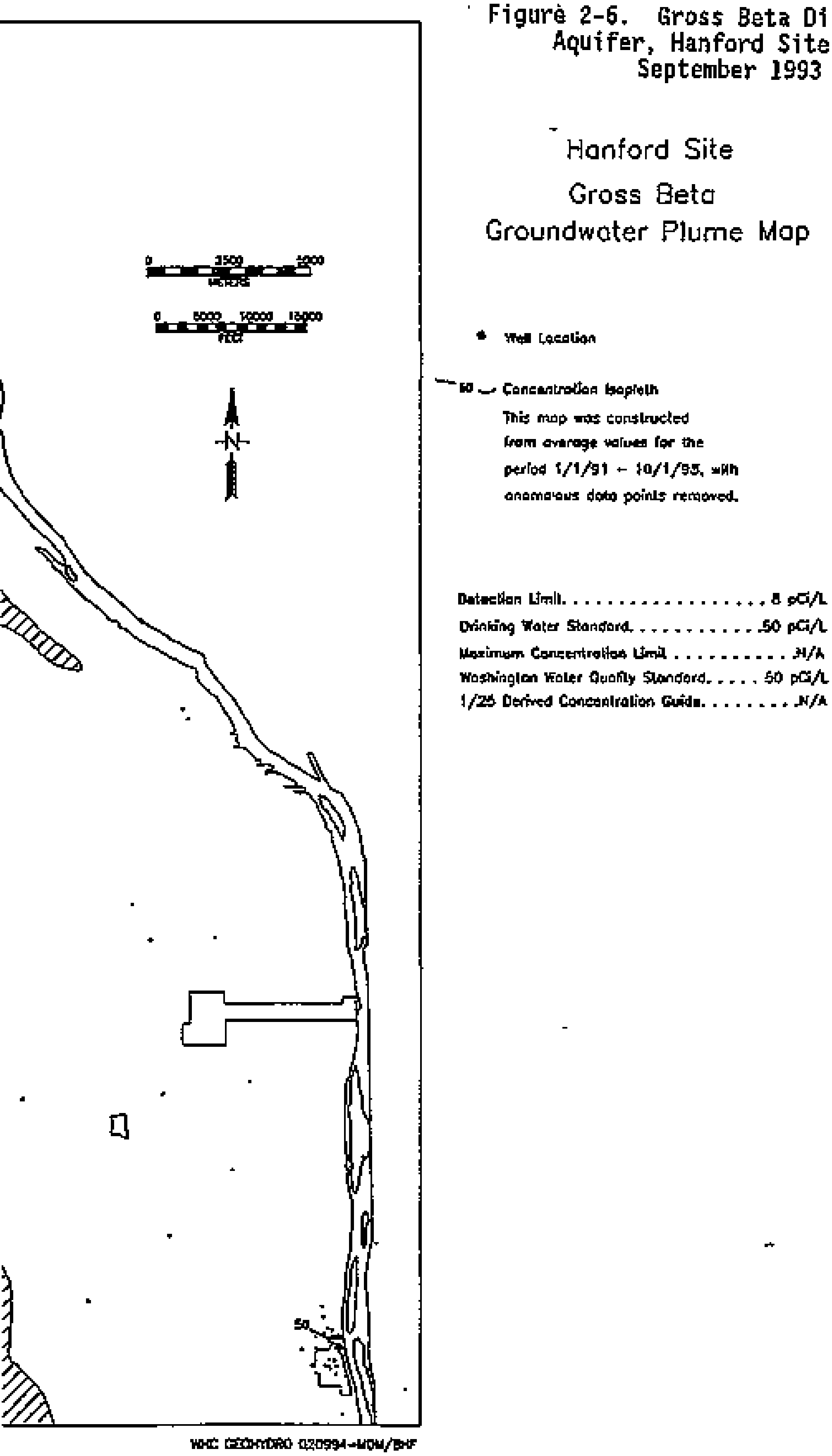
Figure 2-6. Gross Beta Distribution in the Uppermost Aquifer, Hanford Site, January 1991 through September 1993 (Hartman 1994).



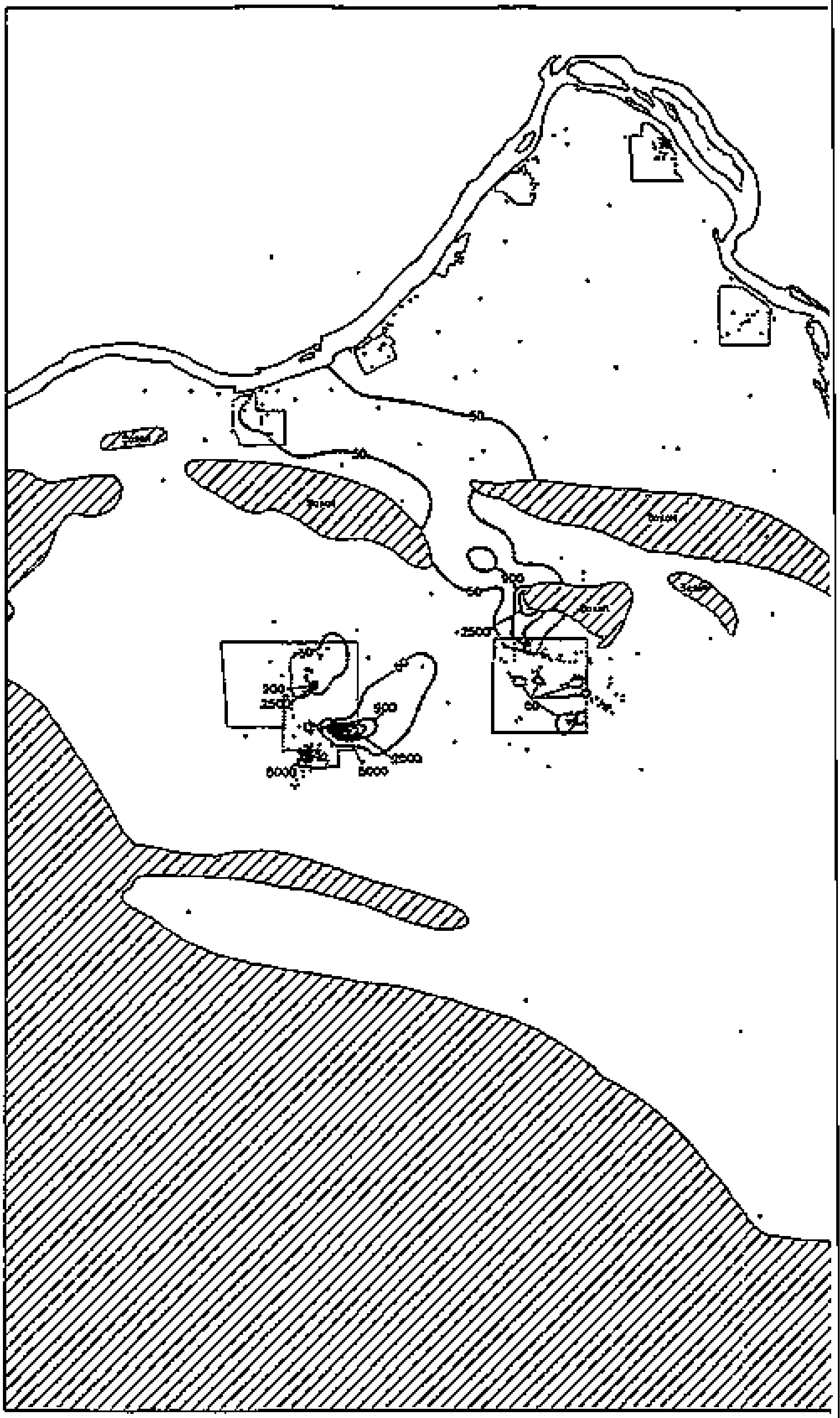

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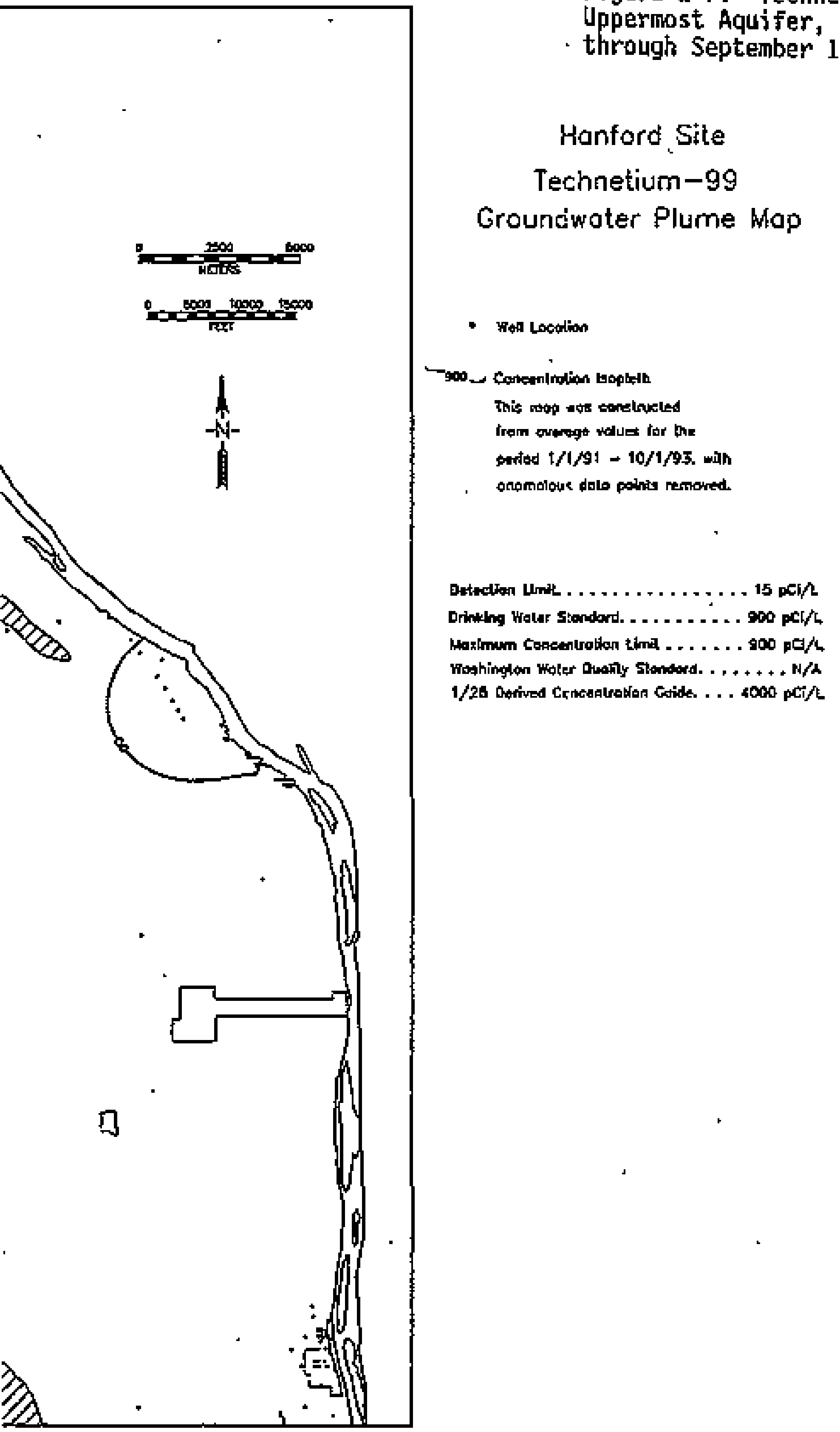
Figure 2-7. Technetium-99 Distribution in the Uppermost Aquifer, Hanford Site, January 1991 through September 1993 (Hartman 1994).



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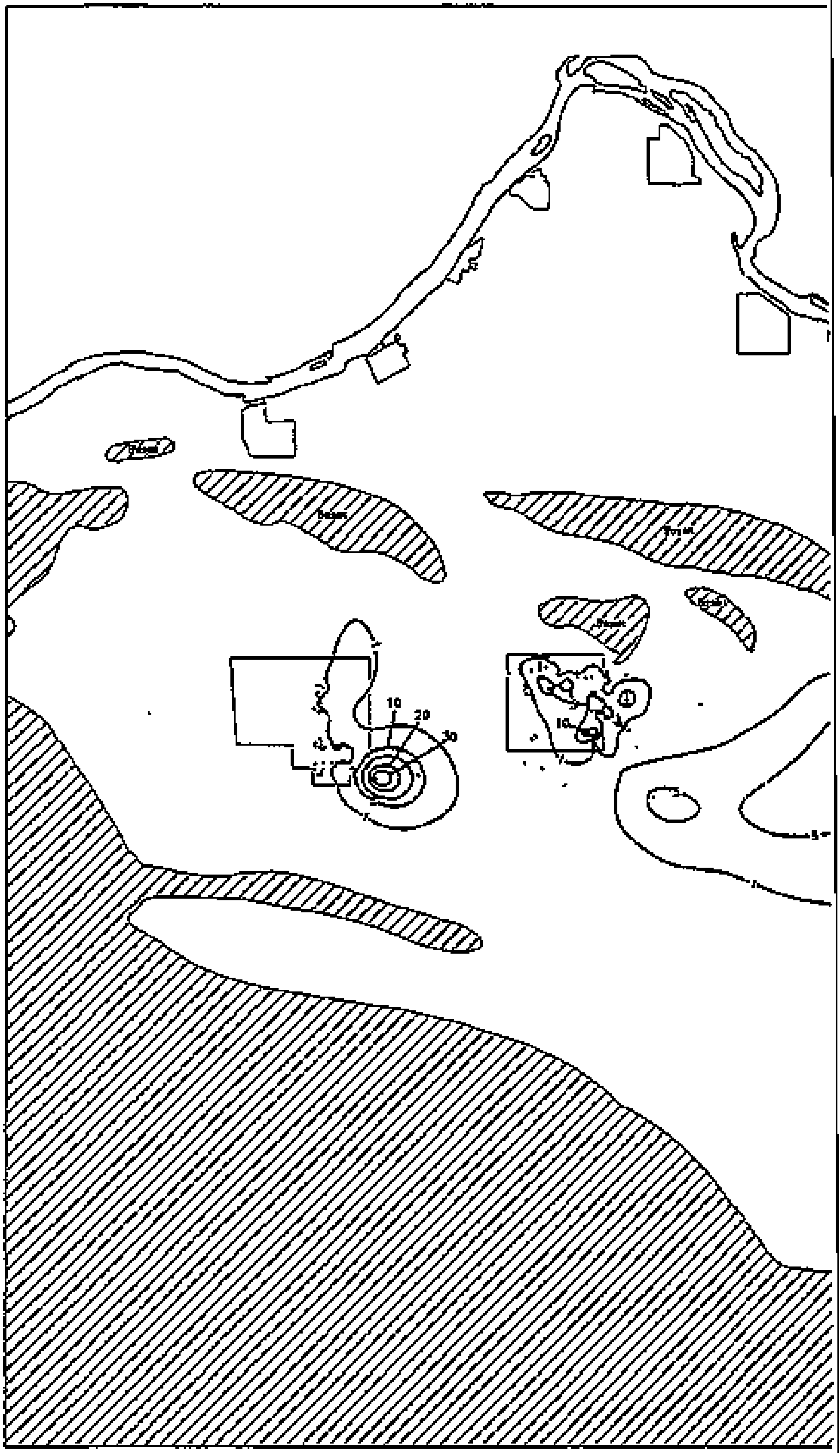
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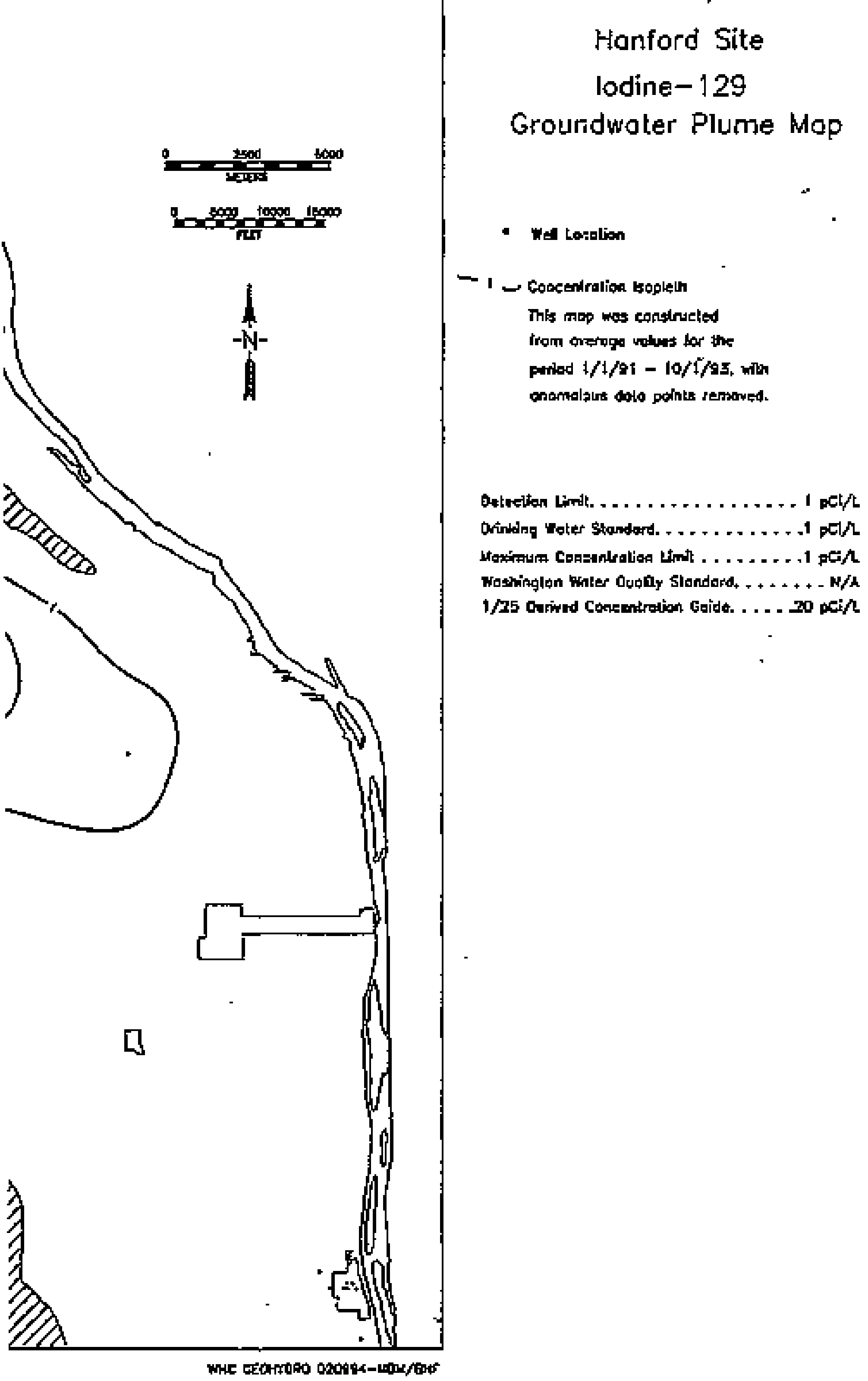
Figure 2-8. Iodine-129 Distribution in the Uppermost Aquifer, Hanford Site, January 1991 through September 1993 (Hartman 1994).



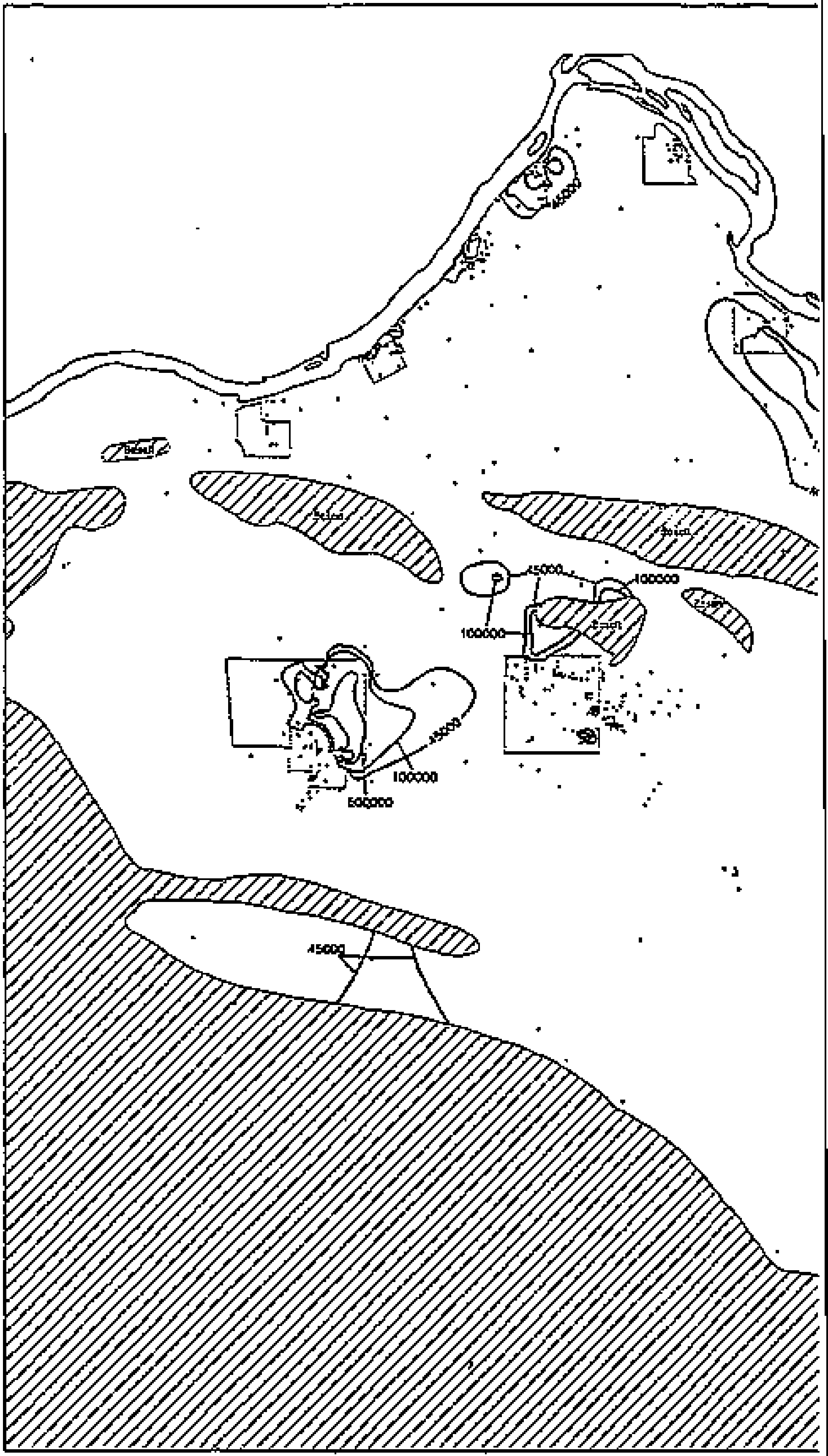

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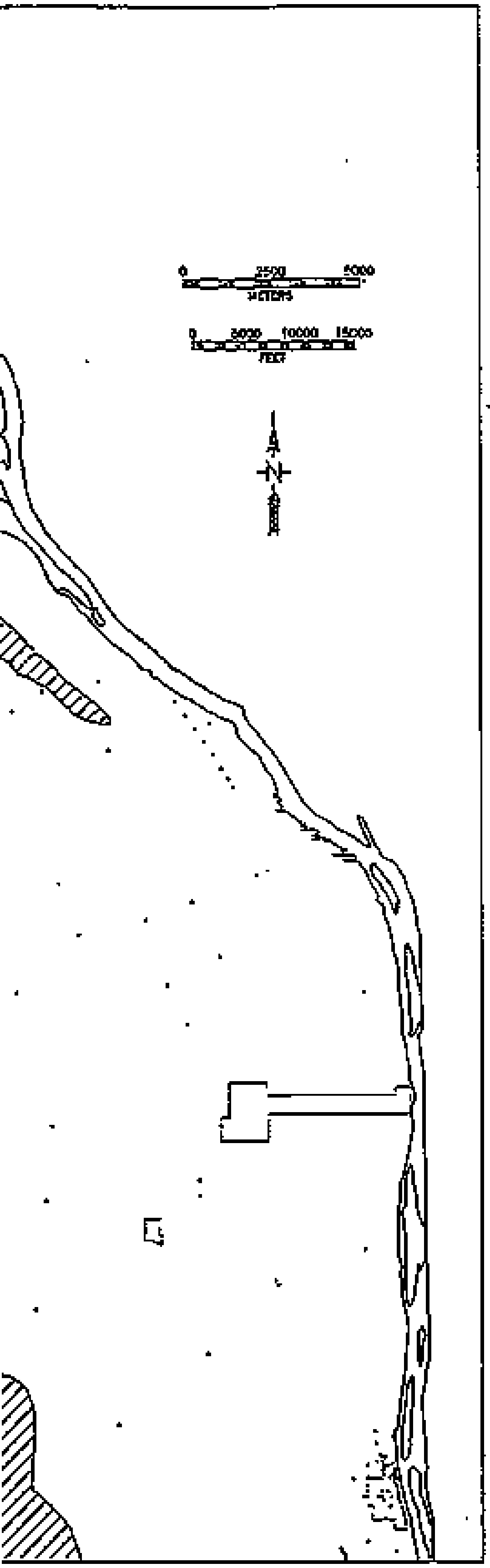
Figure 2-9. Nitrate Distribution in the Uppermost Aquifer, Hanford Site, January 1991 through September 1993 (Hartman 1994).



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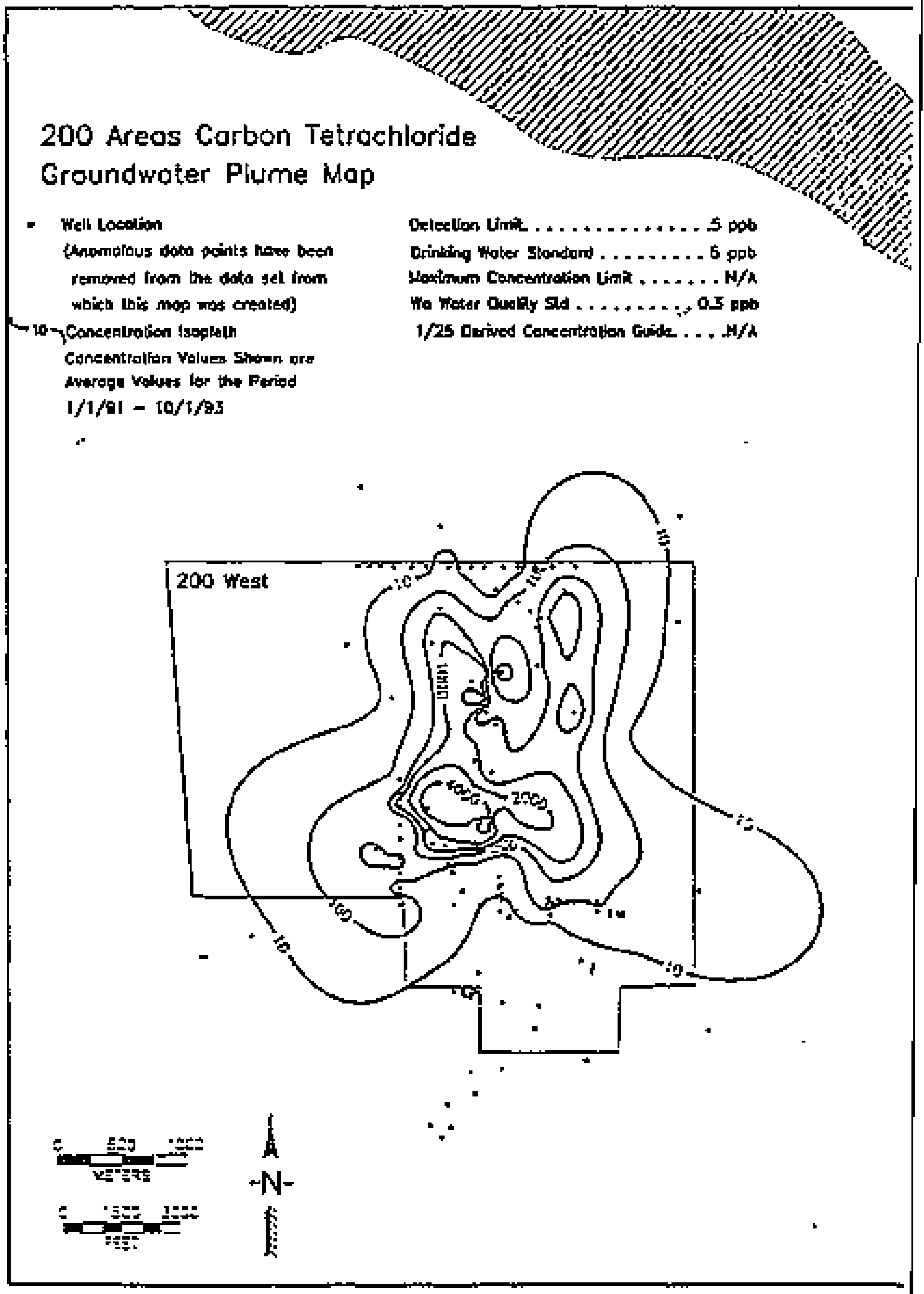

200 Areas Carbon Tetrachloride Groundwater Plume Map

- Well Location
  (Anomalous data points have been removed from the data set from which this map was created)

10 Concentration Isopleth
Concentration Values Shown are Average Values for the Period
1/1/91 – 10/1/93

Detection Limit................5 ppb
Drinking Water Standard.........5 ppb
Maximum Concentration Limit.......N/A
Wa Water Quality Std...........0.3 ppb
1/25 Derived Concentration Guide....N/A

Figure 2-10. Carbon Tetrachloride Distribution in the Uppermost Aquifer Beneath the 200 West Area (Trent 1994).

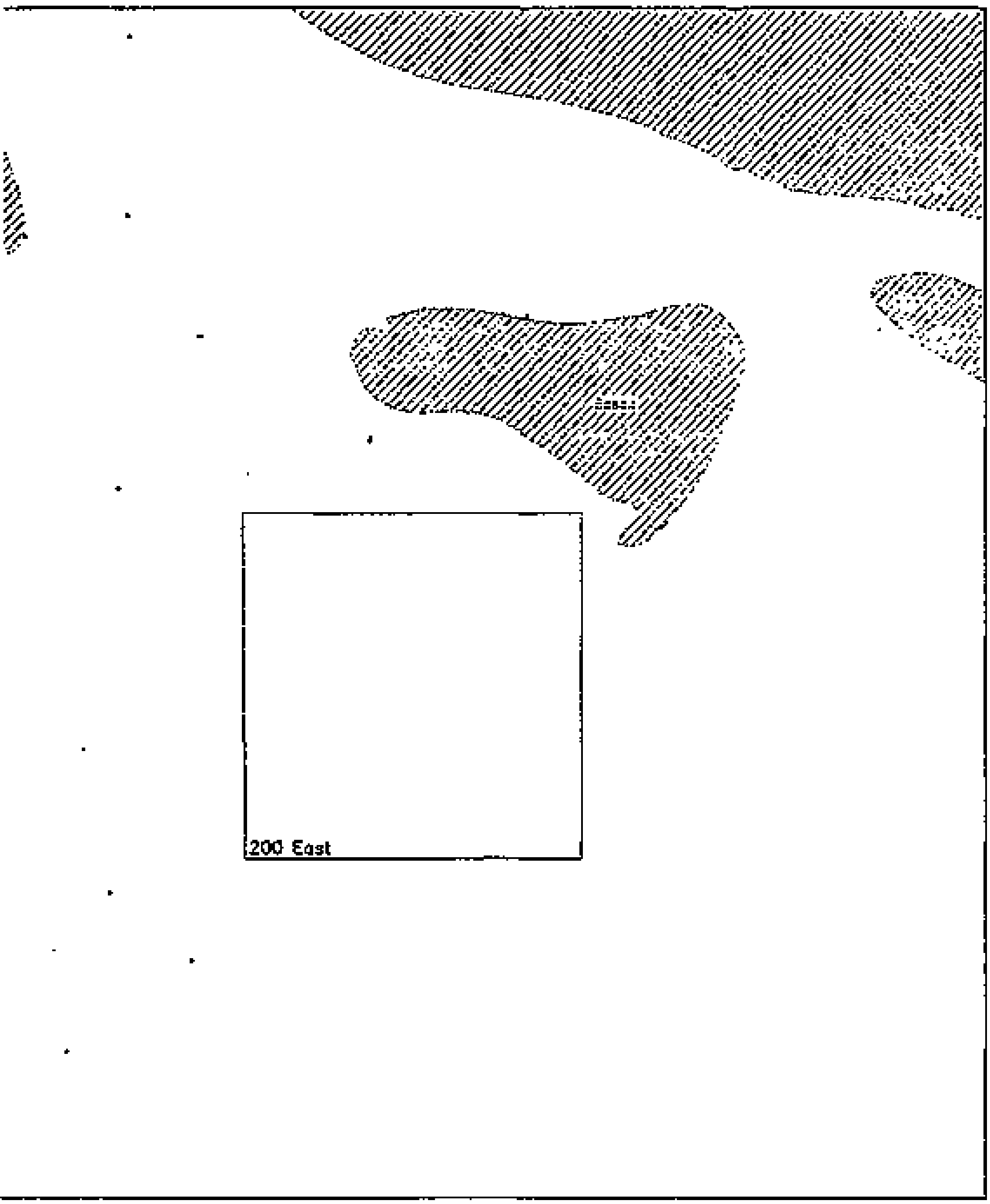

Table 2-1. Range of Chemical Constituents in Columbia and Yakima River Water (DOE 1988, pp. 3.4-3 and 3.4-4).

Parameter	Units	Range[a]	
		Columbia River at Vernita	Yakima River at Horn Rapids
Calcium	mg/L	17.3 - 22.2	12.7 - 30.3
Chlorine	mg/L	0.9 - 1.1	2.2 - 6.9
Fluorine	mg/L	0.13 - 0.32	0.18 - 0.22
Potassium	mg/L	0.42 - 0.91	1.3 - 3.0
Magnesium	mg/L	4.0 - 5.2	4.2 - 10.7
Sodium	mg/L	2.2 - 2.4	6.2 - 16.3
Nitrate (as NO_3)	mg/L	0.15[b]	0.4 - 4.0
Silicon	mg/L	1.8 - 2.1	8.0 - 10.7
Sulfate	mg/L	9.13 - 13.4	5.4 - 17.9
Total carbon	mg/L	13.9 - 16.3	14.9 - 29.5
Total organic carbon	mg/L	1.2 - 2.0	1.7 - 3.3
Tritium	pCi/L	81.1 - 96.3	40.4 - 45.2
pH	--	7.94 - 8.71	7.25 - 8.78
Turbidity	NTU	1.1 - 3.5	9.2 - 23.5
Alkalinity	mg/L	53.0 - 62.0	51 - 121
Conductivity	µmho/cm	123 - 152	122 - 291
Iron	mg/L	<0.03	<0.015 - 0.066
Manganese	mg/L	<0.01	0.012 - 0.028

[a] Samples were collected in April, July, and November 1985 and January and May 1986.

[b] Only one sample analyzed for nitrate.

NTU = nephelometric turbidity units.

Table 2-2. Hydraulic Parameters for Various Areas and Geologic Units at the Hanford Site (Delaney et al. 1991).

Location	Interval tested	Hydraulic conductivity (m/d) (ft/d)	Transmissivity (m^2/d) (ft^2/d)	Data source
100 Area	Rattlesnake Ridge interbed	0 - 30.5 (0 - 100)	--	Gephart et al. (1979)
100 Area	Ringold unit E	8.8 - 396 (29 - 1,300)	534 - 2,480 (5,750 - 26,700)	Liikala et al. (1988)
200 Area	Rattlesnake Ridge interbed	--	0.74 - 108 (8 - 1,165)	Graham et al. (1981, 1984)
200 West Area	Ringold unit E	0.18 - 61 (0.6 - 200)	--	Last et al. (1989)
1100 Area	Ringold units C and B	0.09 - 1.5 (0.3 - 5)	--	Lindberg and Bond (1979)
1100 Area	Ringold overbank deposits	0.00024 - 0.03 (0.0008 - 0.1)	--	Lindberg and Bond (1979)
300 Area	Levey interbed	0.003 - 305 (0.01 - 1,000)	--	DOE-RL (1990)
300 Area	Ringold Formation	0.58 - 3,050 (1.9 - 10,000)	--	DOE-RL (1990)
300 Area	Hanford formation	3,350 - 15,200 (11,000 - 50,000)	--	DOE-RL (1990)

Table 2-3. Inorganic Constituents in Unconfined Groundwater Unaffected by Hanford Site Operations (DOE-RL 1992, Tables 5-9 and 5-11). (2 sheets)

Parameter	Units	Mean ±1standard deviation (sample size)	Provisional threshold value[a]
Aluminum	ppb	<200[a] (50)	<200
Ammonium	ppb	<50 (18)	<120
Arsenic	ppb	<5 (14)	10
Barium	ppb	41 ±20 (53)	68.5
Beryllium	ppb	<5 (16)	<5
Bismuth	ppb	<5 (4)	<5
Boron	ppb	<100 (35)	<100
Cadmium	ppb	<10 (16)	<10
Calcium	ppb	38,542 ±11,023 (53)	63,600
Chloride-Low	ppb	5,032 ±1,774 (53)	8,690
Chloride-High	ppb	23,296 ±2,463 (14)	28,500
Chloride-All	ppb	8,848 ±7,723 (67)	Not calculated
Chromium	ppb	<30 (8)	<30
Copper	ppb	<30 (50)	<30
Fluoride	ppb	437 ±131[b] (47)	775[b]
Iron-Low	ppb	<50 (34)	86
Iron-Mid	ppb	115 ±52 (7)	291
Iron-High	ppb	494 ±118 (12)	818
Iron-All	ppb	149 ±199 (53)	Not calculated
Lead	ppb	<5 (15)	<5
Magnesium	ppb	11,190 ±2,578 (53)	16,480
Manganese-Low	ppb	<20 (33)	24.5
Manganese-High	ppb	118 ±17 (20)	163.5
Manganese-All	ppb	50 ±55 (53)	Not calculated
Mercury	ppb	<0.1 (14)	<0.1
Nickel	ppb	<30 (23)	<30
Nitrate	ppb	5,170 ±3,576 (78)	12,400
Phosphate	ppb	<1,000[c]	<1,000
Potassium	ppb	4,993 ±1,453 (53)	7,975

Table 2-3. Inorganic Constituents in Unconfined Groundwater Unaffected by Hanford Site Operations (DOE-RL 1992, Tables 5-9 and 5-11). (2 sheets)

Parameter	Units	Mean ±1 standard deviation (sample size)	Provisional threshold value[a]
Selenium	ppb	<5 (14)	<5
Silver	ppb	<10[d]	<10
Silicon	ppb	18,152 ±4,974 (35)	26,500
Sodium	ppb	15,774 ±6,784 (53)	33,500
Strontium	ppb	164 ±47 (43)	264.1
Sulfate	ppb	30,605 ±22,611 (67)	90,500
Uranium	ppb	1.7 ±1.2	3.43
Vanadium	ppb	9 ±4 (18)	15
Zinc-Low	ppb	<50 (36)	<50
Zinc-High	ppb	247 ±165 (17)	673
Zinc-All	ppb	95 ±140 (53)	Not calculated
Field alkalinity	ppb	137,758 ±33,656 (31)	215,000
Lab alkalinity	ppb	137,717 ±29,399 (52)	210,000
Field pH	--	7.57 ±0.29 (57)	[6.90, 8.24]
Lab pH	--	7.75 ±0.21 (52)	[7.25, 8.25]
Total organic carbon	ppb	519 ±367[b] (62)	1,610[b]
Field conductivity	µmho/cm	344 ±83 (22)	539
Lab conductivity	µmho/cm	332 ±93 (36)	530
Total organic halogen	ppb	<20[b] (14)	37.6[b]
Total carbon	ppb	31,772 ±7,022 (48)	50,100
Gross alpha	pCi/L	2.5 ±1.5[b] (36)	5.79[b]
Gross beta	pCi/L	7.1 ±2.6[b] (44)	12.62[b]
Radium	pCi/L	Not detected (10)	0.23

[a] Threshold value described in DOE-RL (1992). Estimate of the upper 95% confidence limit on the 95th percentile of the natural background.

[b] Potential outlier observation(s) were removed.

[c] From springs data (Early et al. 1986).

[d] From WHC (1990), based on inductively coupled plasma/mass spectrometer data.

[e] <X indicates constituent was not detected above detection limit X.

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3.0 100 AREAS

3.1 100 N AREA RESOURCE CONSERVATION AND RECOVERY ACT SITES

M. J. Hartman
Westinghouse Hanford Company

Four *Resource Conservation and Recovery Act of 1976* (RCRA) units are located in the 100 N Area: the 1301-N Liquid Waste Disposal Facility (LWDF), the 1324-N Surface Impoundment, the 1324-NA Percolation Pond, and the 1325-N LWDF (Figure 3.1-1). The 1324-N and 1324-NA units are monitored as a single site. Interim-status groundwater monitoring began at all of the sites in December 1987. The sites are located close together and have related effects on the groundwater hydrology of the 100 N Area. Therefore, they are discussed in a single section of this report.

The 1301-N and 1325-N LWDFs are monitored under indicator evaluation programs, as described in the groundwater monitoring plan (Hartman 1993a). The 1324-N/NA site is monitored under a groundwater quality assessment program, as described in the assessment plan (Hartman 1993b).

3.1.1 Facility Overview

The 1301-N LWDF was the primary liquid waste disposal facility for the N Reactor from 1963 until 1985. Discharges to the 1301-N LWDF were primarily radioactive fission and activation products. Minor amounts of dangerous waste also were discharged, including the following: hydrazine, ammonium hydroxide, diethylthiourea, sodium dichromate, morpholine, phosphoric acid, lead, and cadmium. The 1301-N LWDF consists of a concrete basin with an unlined, zig-zagging extension trench, covered with concrete panels.

The 1325-N LWDF was constructed in 1983, and N Reactor effluent was discharged to it and to the 1301-N LWDF. In 1985, discharge to the 1301-N LWDF ceased, and all effluent was sent to the 1325-N LWDF. All discharge to the 1325-N LWDF ceased in late 1991. The 1325-N LWDF consists of a concrete basin with an unlined extension trench, covered with concrete panels.

The 1324-N Surface Impoundment was a treatment facility that was in service from May 1986 to November 1988. This facility is a double-lined pond that was used to neutralize high- and low-pH waste from a demineralization plant. The 1324-NA Percolation Pond is an unlined pond that was used to treat waste from August 1977 to May 1986, and to dispose of treated waste from May 1986 to August 1990. The effluent to both facilities contained sulfuric acid and sodium hydroxide, and its pH was occasionally high or low enough to be classified as a dangerous waste.

The RCRA sites in the 100 N Area are part of the 100-NR-1 source operable unit, under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) program. Groundwater is addressed by the 100-NR-2 operable unit. Groundwater sampling and analysis are coordinated between the RCRA and CERCLA programs.

Hartman and Lindsey (1993) describe the hydrogeology of the 100 N Area. The uppermost aquifer beneath the 100 N Area is a sand and gravel unit in the Ringold Formation. The base of the aquifer is believed to be a clay-rich unit approximately 12 m (40 ft) beneath the water table.

Hydraulic conductivity estimates for the uppermost aquifer are highly variable. Gilmore et al. (1992) used several methods to derive a representative range. Horizontal hydraulic conductivity is estimated to range from 6 to 37 m/d (20 to 120 ft/d) beneath most of the area.

3.1.2 Summary of 1995 Activities

The 1301-N and 1325-N LWDF remained in indicator evaluation programs during the past year, and monitoring wells were sampled semiannually. The results of the first phase of the TOX assessment program at 1324-N/NA were presented by Hartman (1995d). The 1324-N/NA network wells were sampled quarterly during the past year.

3.1.3 Other Activities in 1995

The ERC sampled wells in the 100-NR-2 monitoring network twice in the past year, in conjunction with RCRA sampling.

An expedited response action was undertaken to reduce the amount of ^{90}Sr entering the Columbia River through riverbank springs in the 100 N Area (N Springs). The Environmental Restoration Contractor (ERC) attempted to install a grouted-hinge sheet pile barrier in the aquifer along the shoreline, but they were unsuccessful. A pump-and-treat system was installed to remove ^{90}Sr from groundwater in the 1301-N contaminant plume and reinject the treated water into wells near the 1325-N LWDF. The system began to operate in August 1995, but had no noticeable effects on groundwater quality or water levels in RCRA wells sampled in August and September. As the system continues to operate, groundwater flow direction will change, especially around the 1301-N LWDF. The RCRA monitoring networks will need to be reevaluated to account for the changes.

The ERC maintains a network of pressure transducers and data loggers in 20 wells and in the Columbia River at 100 N Area.

3.1.4 Sampling and Analysis Program

Sampling and analysis for the 1301-N, 1325-N, and 1324-N/NA sites are described by Hartman (1993a, 1993b). Wells in the sampling networks are listed in Tables 3.1-1, 3.1-2, and 3.1-3; constituents analyzed are listed in Tables 3.1-4 and 3.1-5.

The 1301-N and 1325-N networks are sampled semiannually. The 1324-N/NA network is sampled quarterly under an assessment program. Well locations for the 100 N Area are shown in Figure 3.1-1.

Low water levels in some wells hamper sample collection. Wells N-57[1] and N-67 of the 1301-N network, and well N-59 of the 1324-N/NA network have often pumped dry in the past. Low-flow bladder pumps are now used to sample these wells, but well N-59 can be sampled only when water levels are seasonally high.

Water levels and results of laboratory analyses of 100 N Area groundwater were reported in quarterly reports (Hartman 1995a, 1995b, 1995c, 1996).

3.1.5 Groundwater Chemistry: 1301-N and 1325-N LWDFs

This section describes results of chemical analyses of groundwater samples and defines the constituents of concern for the 1301-N and 1325-N LWDF sites. The sites are discussed together because they are close together, their effluents were virtually identical, and their contaminant plumes overlap.

3.1.5.1 Constituents of Concern: 1301-N and 1325-N LWDF. The indicator parameters at the 1301-N and 1325-N LWDFs are specific conductance, pH, total organic carbon (TOC), and TOX (40 *Code of Federal Regulations* [CFR] 265.92[b][3]). Groundwater is also analyzed for other constituents that were discharged to the 1301-N and 1325-N LWDFs during their use (see Section 3.1.1). These analytes include nitrate, chromium, phosphate, lead, and cadmium. Phosphate, chromium, lead, and cadmium have not been detected in filtered samples from 1301-N or 1325-N LWDF groundwater in significant concentrations. Nitrate has increased in some wells near 1301-N and 1325-N during the past year, exceeding the drinking water standard in wells N-2 and N-3 (Figure 3.1-2). Well N-26, southwest of 1301-N, also had nitrate above the standard. The source of nitrate is unknown.

While the 1301-N and 1325-N LWDFs were in use, they introduced radioactive constituents, primarily tritium and ^{90}Sr, to the groundwater. Figure 3.1-3 illustrates ^{90}Sr in the uppermost aquifer. This map, constructed of an average of data from September 1994 through September 1995, includes data from new wells installed for the N Springs expedited response action. ^{90}Sr is elevated around the 1301-N and 1325-N LWDF, with the highest activities (over 5,000 pCi/L) in new wells along the shoreline downgradient from the 1301-N LWDF.

Figure 3.1-4 illustrates recent trends in gross beta activity in selected 1301-N and 1325-N wells. ^{90}Sr is the primary beta-emitter in the 100 N Area. Gross beta in 1301-N downgradient well N-75 has remained relatively stable since late 1992. Gross beta activity is relatively low in some wells that had very high ^{90}Sr activity in the 1980s (e.g., wells N-2 and N-29). As the water table dropped in the vicinity of these wells, the higher concentrations of ^{90}Sr may have sorbed onto the sediments and remained in what is now the unsaturated zone.

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[1] Well numbers in this section are abbreviated by removing the 199- prefix (e.g., well 199-N-57 is written N-57).

Figure 3.1-5 shows tritium in the uppermost aquifer. Like ^{90}Sr, tritium is elevated around the 1301-N and 1325-N LWDF. Tritium-contaminated water from the 100 N Area appears to have migrated northward to the 100 D Area (see Figure 2-5). It also migrated to the south, toward what is now the upgradient well (N-74) for the 1325-N LWDF site. Tritium is declining in 1325-N wells and is stable in 1301-N wells (Figure 3.1-6).

Specific conductance is relatively low and stable in most of the downgradient wells in the 1301-N network (Figure 3.1-7). It is higher in upgradient well N-57. The position of this well and the chemical composition of the water indicate that the source of the elevated specific conductance is the 1324-N/NA site (Hartman 1992).

When the 1325-N site was in use, specific conductance of groundwater was low because of artificial recharge with low-conductivity water. After discharge to the 1325-N LWDF ceased, specific conductance of groundwater gradually increased. Specific conductance in the upgradient well, N-74, was elevated (possibly because of the influence of 1324-N/NA), but has declined in the past 4 years (see Figure 3.1-7). Specific conductance in the downgradient wells may continue to increase gradually as the higher conductivity water moves northward.

The pH of groundwater beneath the 1301-N and 1325-N LWDFs ranged from 7.5 to 8.8 in the past year. There are no clear upward or downward trends. Replicate averages of TOC have been at or below the contractually required quantitation limit during the past year in most wells, but was detected at approximately 600 ppb in wells N-3 and N-57. TOX also is usually less than its contractually required quantitation limit but has been detected at 10 to 15 ppb in upgradient well N-74. There is no apparent pattern to TOC or TOX detections in 1301-N or 1325-N LWDF wells.

Tritium and ^{90}Sr have been consistently above their drinking water standards in many of the 1301-N and 1325-N LWDF wells during the past year. Nitrate concentrations were higher than the drinking water standard in August/September 1995 in wells N-2 and N-3.

3.1.5.2 Statistical Evaluations: 1301-N and 1325-N LWDFs. New critical mean values were established for the indicator parameters at 1301-N because of a change in upgradient wells. Comparisons between upgradient and downgradient wells were performed for the 1301-N and 1325-N sites. All values of specific conductance, pH, TOX, and TOC in the downgradient wells in the past year were below the upgradient/downgradient comparison values except one set of pH measurements from well N-81. Verification sampling indicated the original values (around 5.9) were erroneous. Statistical analyses are discussed in more detail in the following paragraph.

Statistical analyses required by 40 CFR 265.93(b) and *Washington Administrative Code* (WAC) 173-303-400 were performed on the samples collected from the upgradient wells. Results are presented in Tables 3.1-6 and 3.1-7. These tables list the background average, standard deviation, critical mean (or critical range, in the case of pH), and upgradient/downgradient comparison values for the contamination indicator parameters. The comparison value is the value to which current and future averages of indicator parameters are compared. The comparison value is generally the critical mean or critical range. The limit of quantitation is used as the comparison value for TOC at 1325-N instead of the critical mean because most of the upgradient concentrations were below the contractually required quantitation limit (see Appendix C).

3.1.6 Groundwater Chemistry: 1324-N/NA

3.1.6.1 Concentration Histories of Waste Indicators. Groundwater beneath the 1324-N/NA site is characterized by high specific conductance, primarily because of elevated sulfate and sodium. Specific conductance increased in wells N-72, N-73, and N-77 in the past few years, but leveled off in 1995 (Figure 3.1-8). Sulfate and sodium concentrations follow the same pattern. The pH in 1324-N/NA wells generally is between 8 and 8.2.

TOX was slightly elevated in some of the 1324-N/NA downgradient wells in 1992-93, but has decreased in the past 4 years and is nearly the same as in the upgradient well (see Figure 3.1-8). A revised assessment program is investigating the elevated TOX (Hartman 1993c). Results of the first phase of assessment indicate that chloroform is the cause of the TOX. A French drain, used to dispose of nondangerous chlorinated water, is located near the 1324-NA pond, and may be the cause of the chloroform (i.e., chlorine interacting with organic material). Results of the first phase of the TOX assessment are presented by Hartman (1995d).

3.1.6.2 Distribution of Waste Constituents: 1324-N/NA. The 1324-NA Percolation Pond has introduced nondangerous constituents, primarily sulfate and sodium, to the groundwater. The distribution of specific conductance is illustrated in Figure 3.1-9.

As discussed in Section 3.1.6.1, TOX and chloroform were elevated in wells N-72 and N-77. Concentrations of these parameters have declined to near local background and there is no evidence of a widespread plume.

3.1.7 Groundwater Flow

This section describes the direction and rate of groundwater flow beneath the 1301-N, 1325-N, and 1324-N/NA sites. The water table in the 100 N Area is no longer elevated from artificial recharge, but it is affected by fluctuations in the Columbia River stage (Figure 3.1-10, see Figure 2-3). Data presented in this section were collected by an automated system using pressure transducers and data loggers. Water levels are measured hourly; monthly averages were calculated from the hourly data.

3.1.7.1 Groundwater Flow Direction. During most of the year, groundwater flowed toward the north and northwest beneath the 100 N site, under a gradient that is typified by the March 1995 water table map (Figure 3.1-11). Figure 3.1-12 shows the water table beneath the 100 N Area in June 1995, when the river level was high and there was a potential for water to flow out of the river into the aquifer.

Groundwater is more strongly influenced by river stage near the 1301-N LWDF than near the other RCRA sites, because the 1301-N site is closest to the river. In June, groundwater near the river may have flowed toward the northeast. During the rest of the year, groundwater is inferred to flow toward the river (i.e., toward the northwest) beneath the 1301-N LWDF. The average horizontal gradient for March 1995 was calculated between wells N-34 and N-76:

difference in head = 0.68 m (2.2 ft)
horizontal distance = 460 m (1,500 ft)
gradient = 1.5×10^{-3}.

Groundwater flows primarily toward the north beneath the 1325-N LWDF, as inferred from the water table. River stage did not affect the direction of groundwater flow at the 1325-N site during the past year. The average horizontal gradient for March 1995 was calculated between wells N-28 and N-50:

difference in head = 0.92 m (3.0 ft)
horizontal distance = 820 m (2,690 ft)
gradient = 1.1×10^{-3}.

The general direction of groundwater flow beneath the 1324-N/NA site is toward the northwest. The average horizontal gradient for March 1995 was calculated between wells N-72 and N-25:

difference in head = 0.75 m (2.5 ft)
horizontal distance = 344 m (1130 ft)
gradient = 2.2×10^{-3}.

Vertical gradients are not well known in the 100 N Area. Wells adjacent to the Columbia River show an upward gradient in the uppermost aquifer (Hartman and Lindsey 1993). Further inland there is no significant difference in head between wells completed at the water table and wells completed at the base of the aquifer, which are approximately 6 m (20 ft) deeper. Limited data prevent a clear comparison of vertical heads in the unconfined and shallowest confined Ringold aquifers.

3.1.7.2 Rate of Flow. The rate of groundwater flow can be estimated by using a form of the Darcy equation with a range of input parameters.

$$v = \frac{Ki}{n_e} \tag{1}$$

where:

v = Average linear velocity of groundwater
K = Horizontal hydraulic conductivity
i = Hydraulic gradient
n_e = Effective porosity of the aquifer.

The following input parameters were used:

K = 6.1 to 36.6 m/d (20 to 120 ft/d) (Gilmore et al. 1992)
$i = 1.5 \times 10^{-3}$ (1301-N); 1.1×10^{-3} (1325-N); 2.2×10^{-3} (1324-N/NA)
n_e = 0.1 to 0.3.

Resulting estimates of groundwater velocity are as follows:

1301-N LWDF: 0.03 to 0.50 m/d (0.1 to 1.6 ft/d)
1325-N LWDF: 0.02 to 0.40 m/d (0.07 to 1.3 ft/d)
1324-N/NA: 0.04 to 0.80 m/d (0.13 to 2.6 ft/d).

3.1.7.3 Evaluation of Monitoring Well Networks. The monitoring networks for the 1301-N, 1325-N, and 1324-N/NA sites are considered adequate under current flow conditions. However, pump-and-treat activities will change groundwater flow and chemistry beneath the 1301-N and 1325-N LWDF and the RCRA networks may need to be modified at these sites. Westinghouse Hanford Company, the ERC, and other contractors that conduct groundwater monitoring in the 100 N Area are working to coordinate and streamline sampling and analysis.

3.1.8 References

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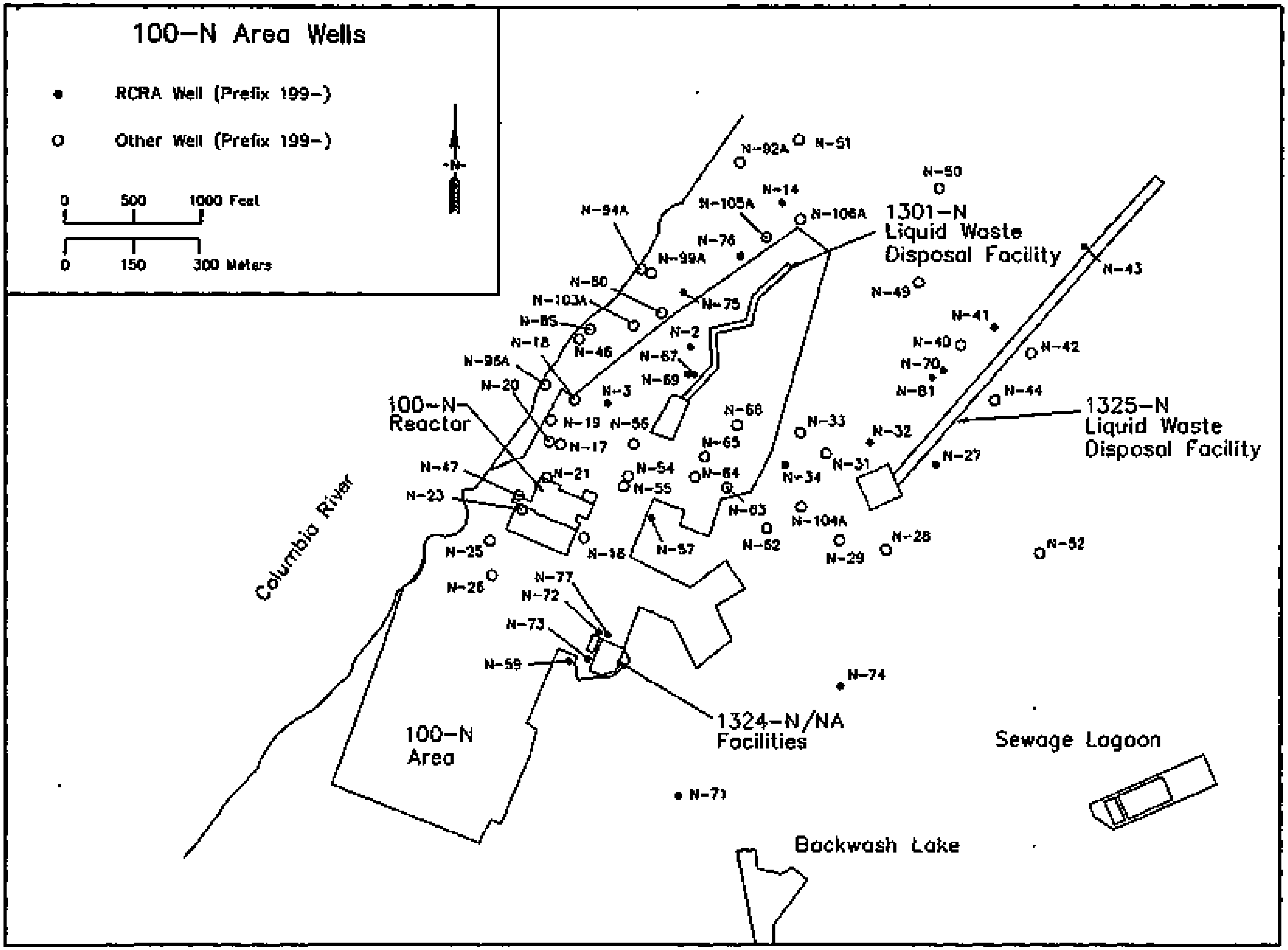

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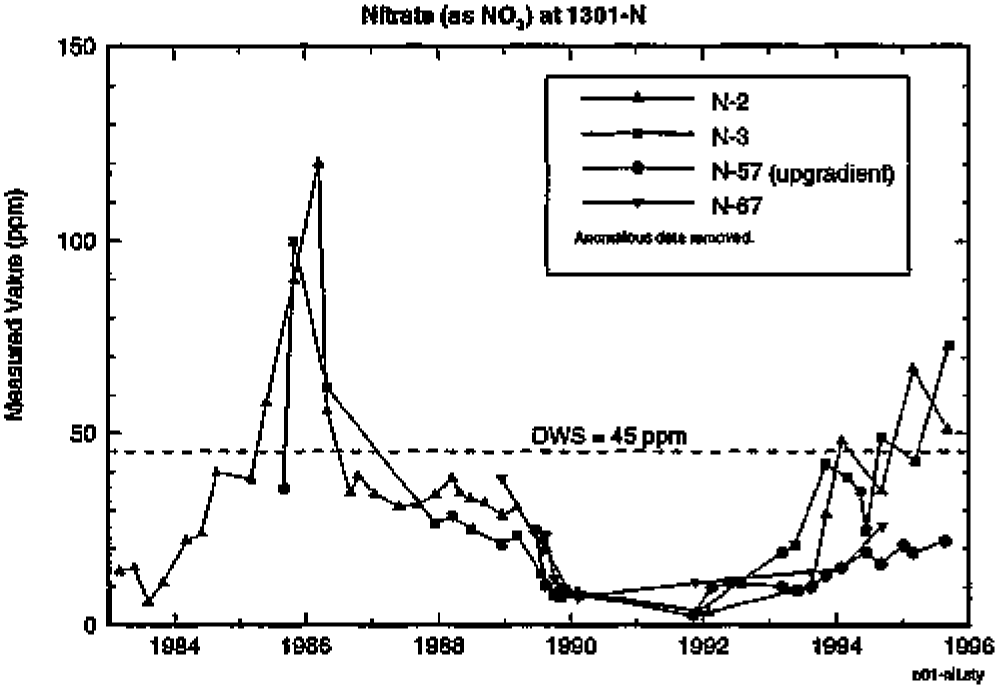
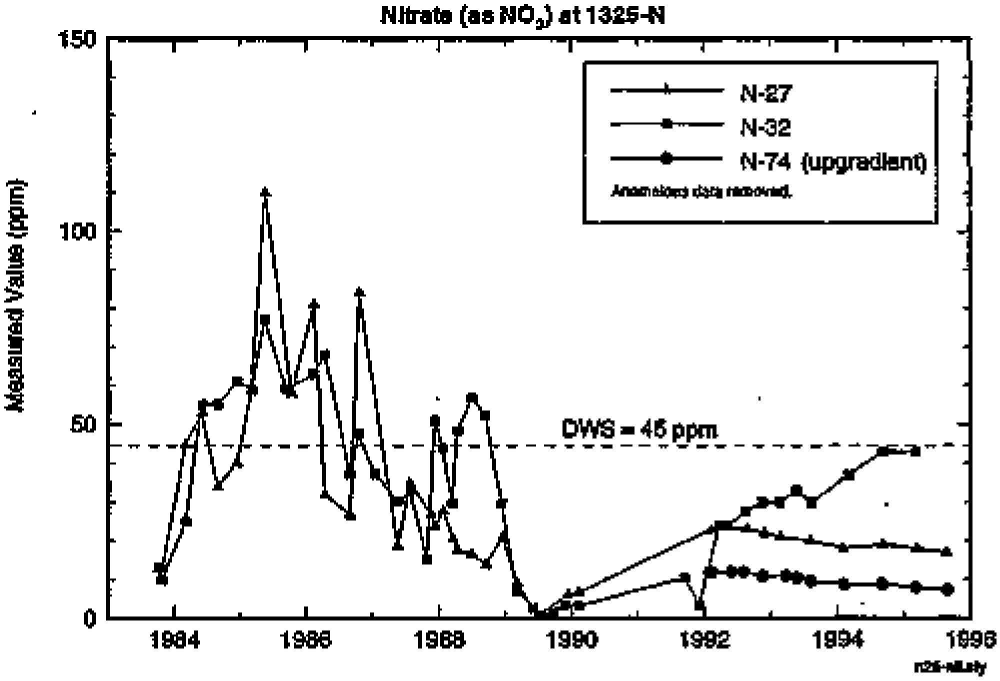
Figure 3.1-1. Locations of 100 N Area RCRA Sites and Groundwater Monitoring Wells.

Figure 3.1-2. Nitrate Versus Time in 1301-N and 1325-N Wells.





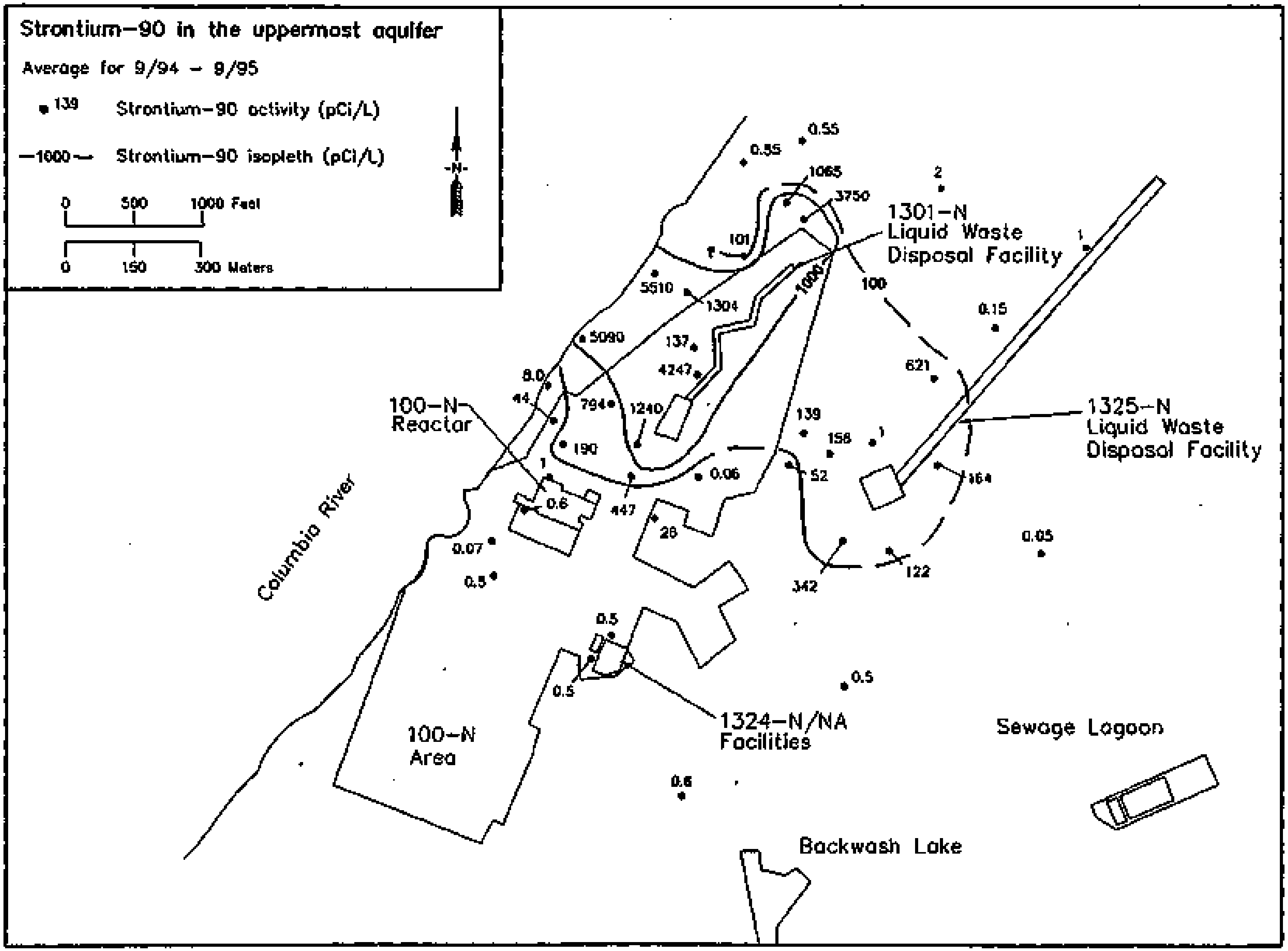


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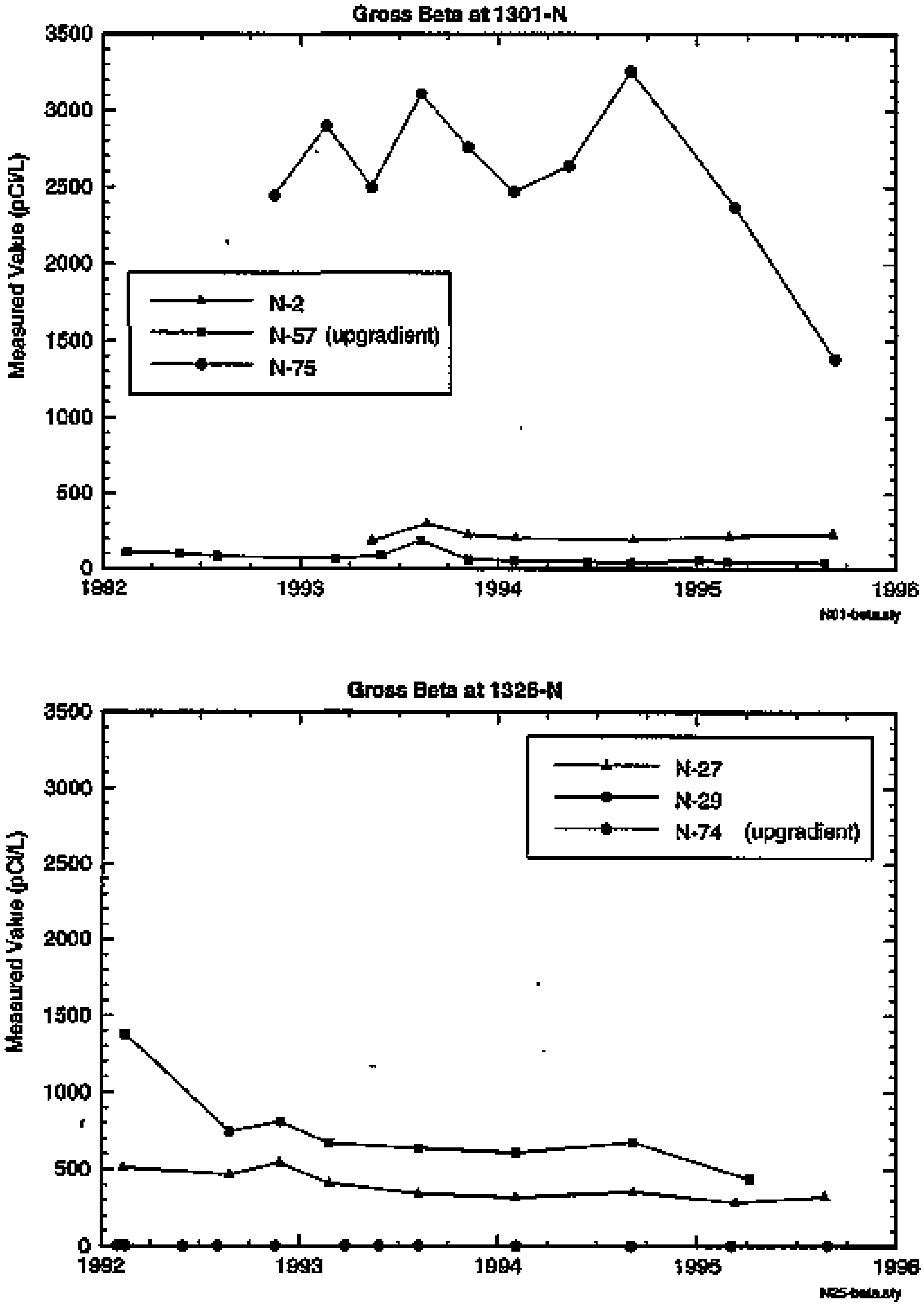
Figure 3.1-3. Strontium-90 in the Uppermost Aquifer Beneath the 100 N Area, Average of 1995 Data.

Figure 3.1-4. Gross Beta Versus Time in 1301-N and 1325-N Wells.



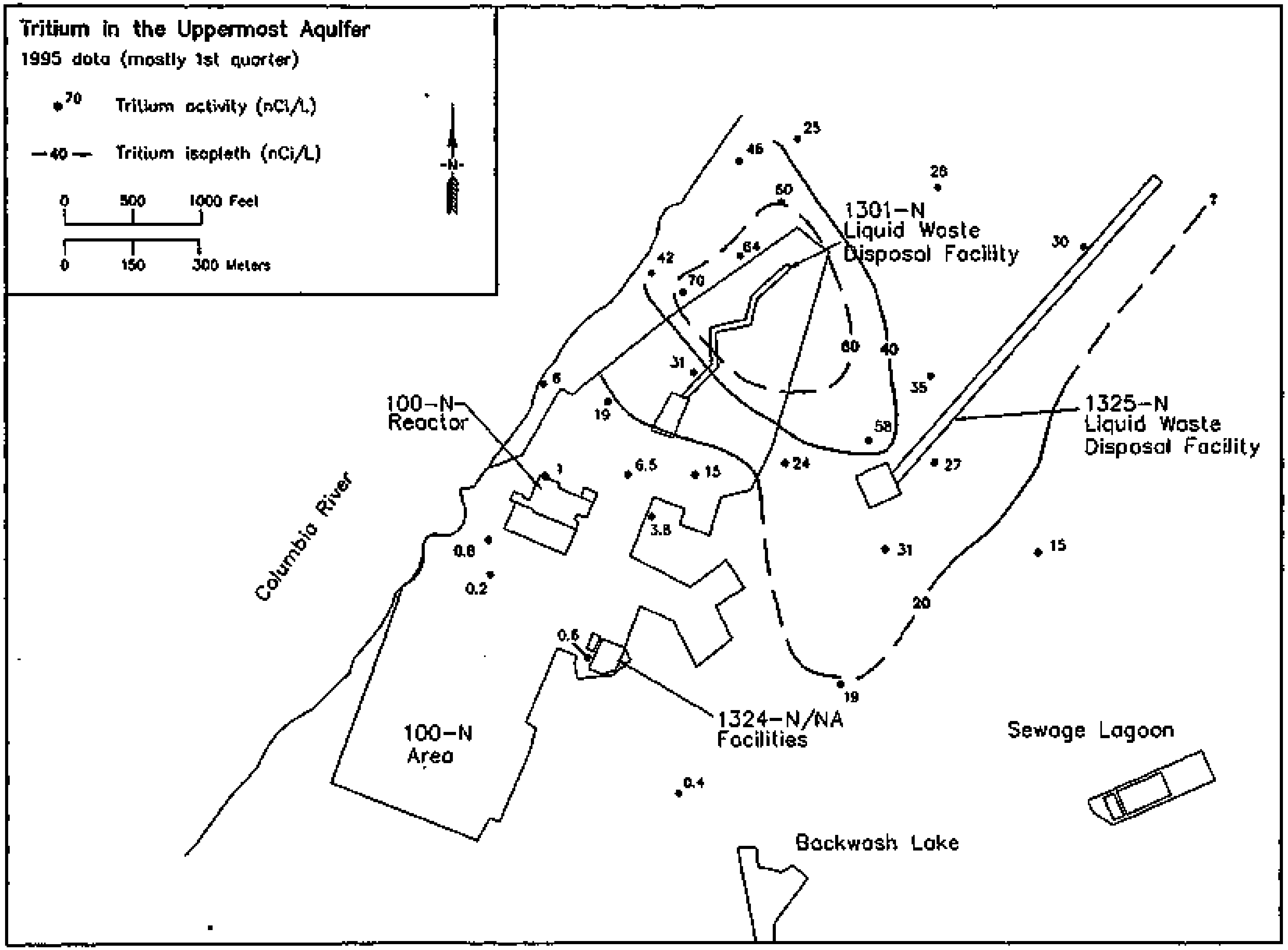


Figure 3.1-5. Tritium in the Uppermost Aquifer Beneath the 100 N Area, 1995.

Figure 3.1-6. Tritium Versus Time in 1301-N and 1325-N Wells.

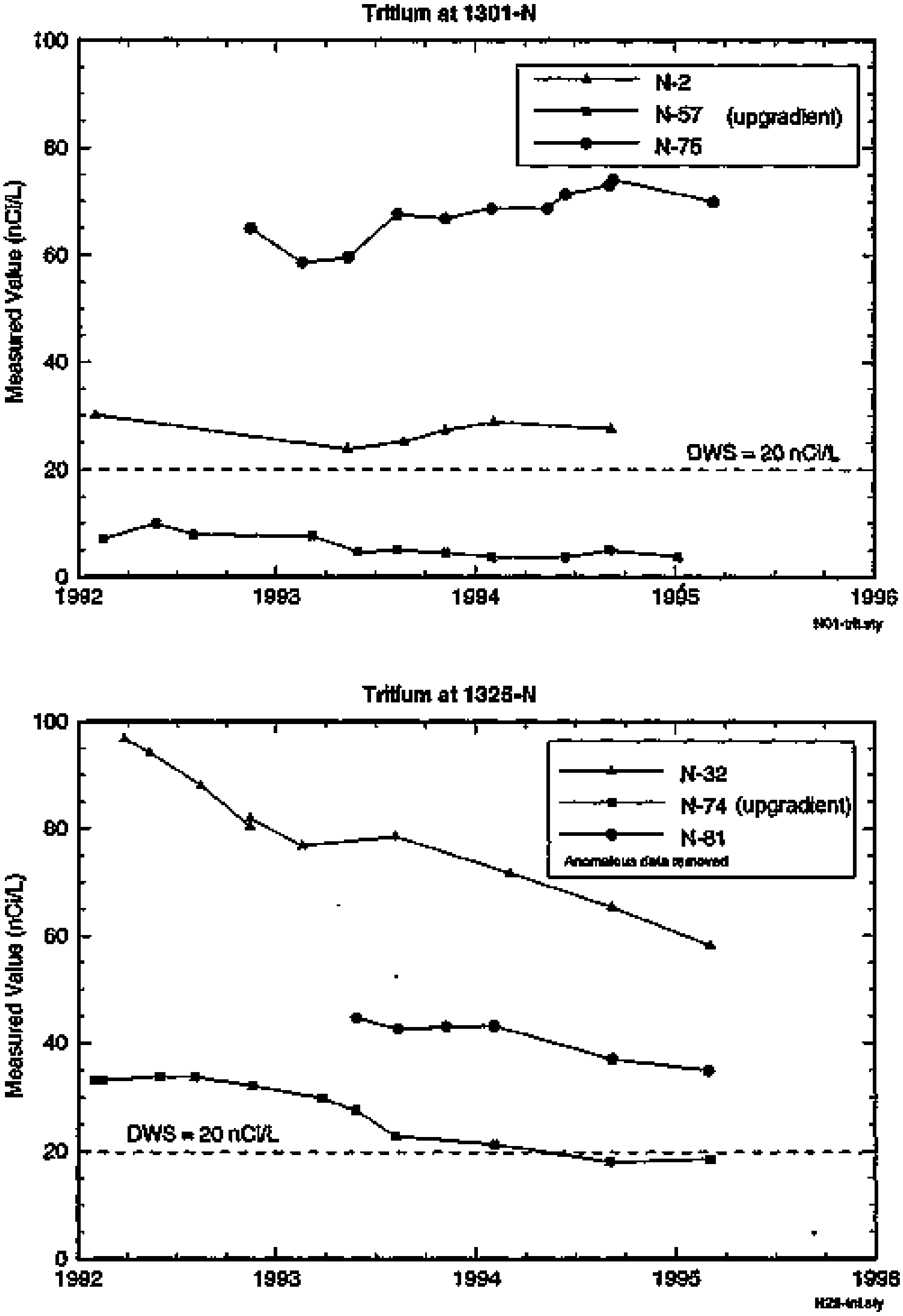


Figure 3.1-7. Specific Conductance Versus Time in 1301-N and 1325-N Wells.

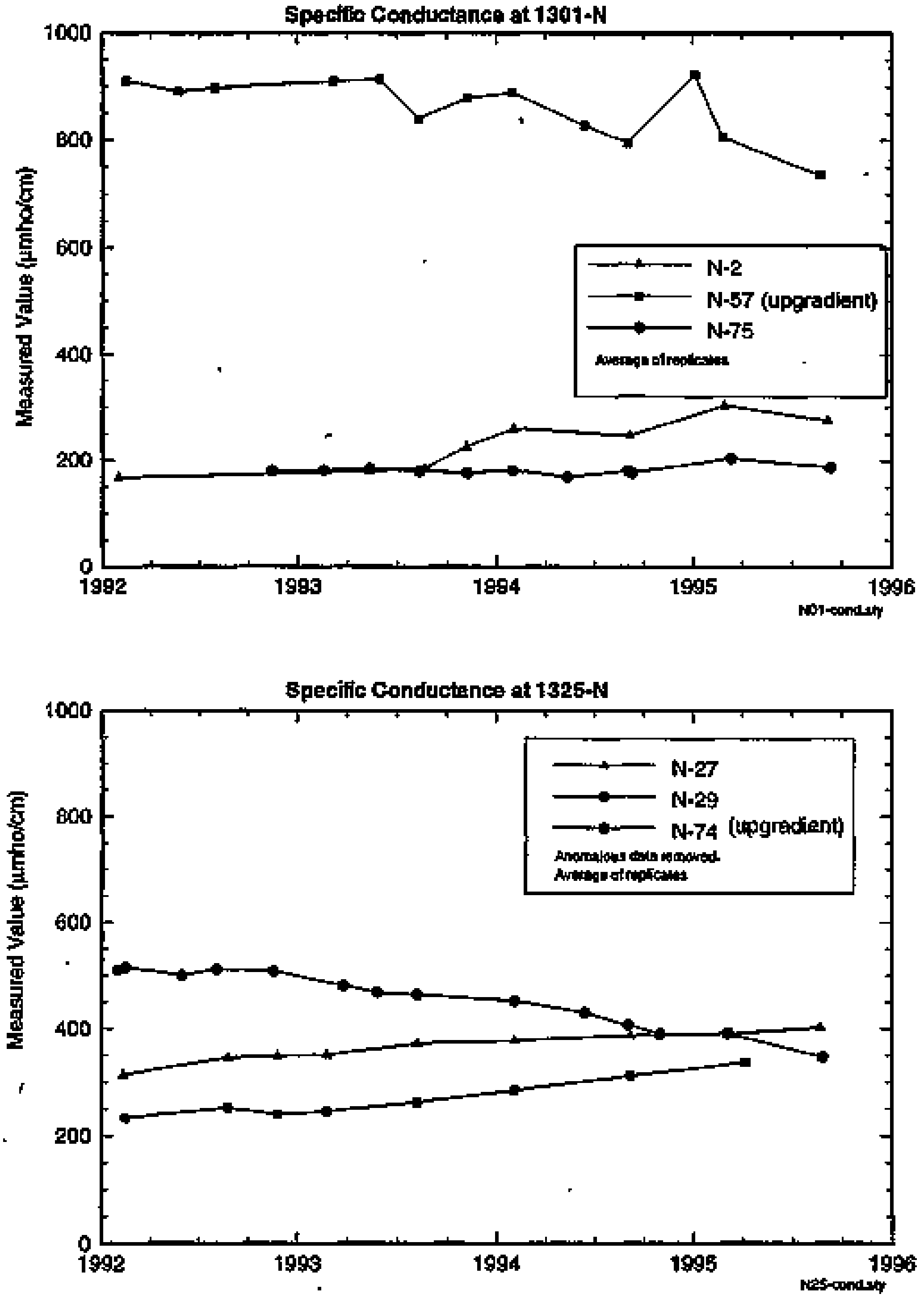
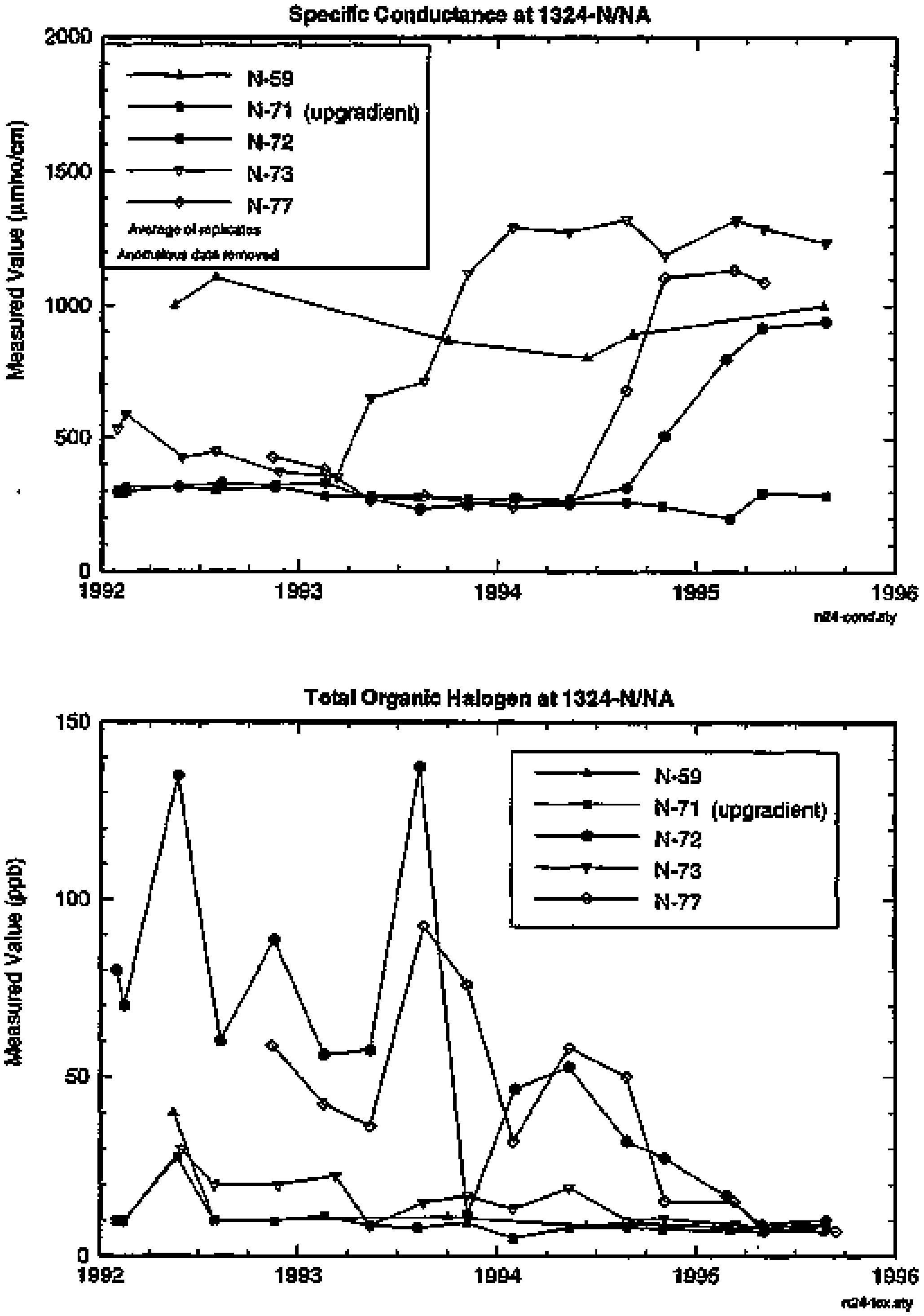


Figure 3.1-8. Specific Conductance and Total Organic Halogen Versus Time in 1324-N/NA Wells.



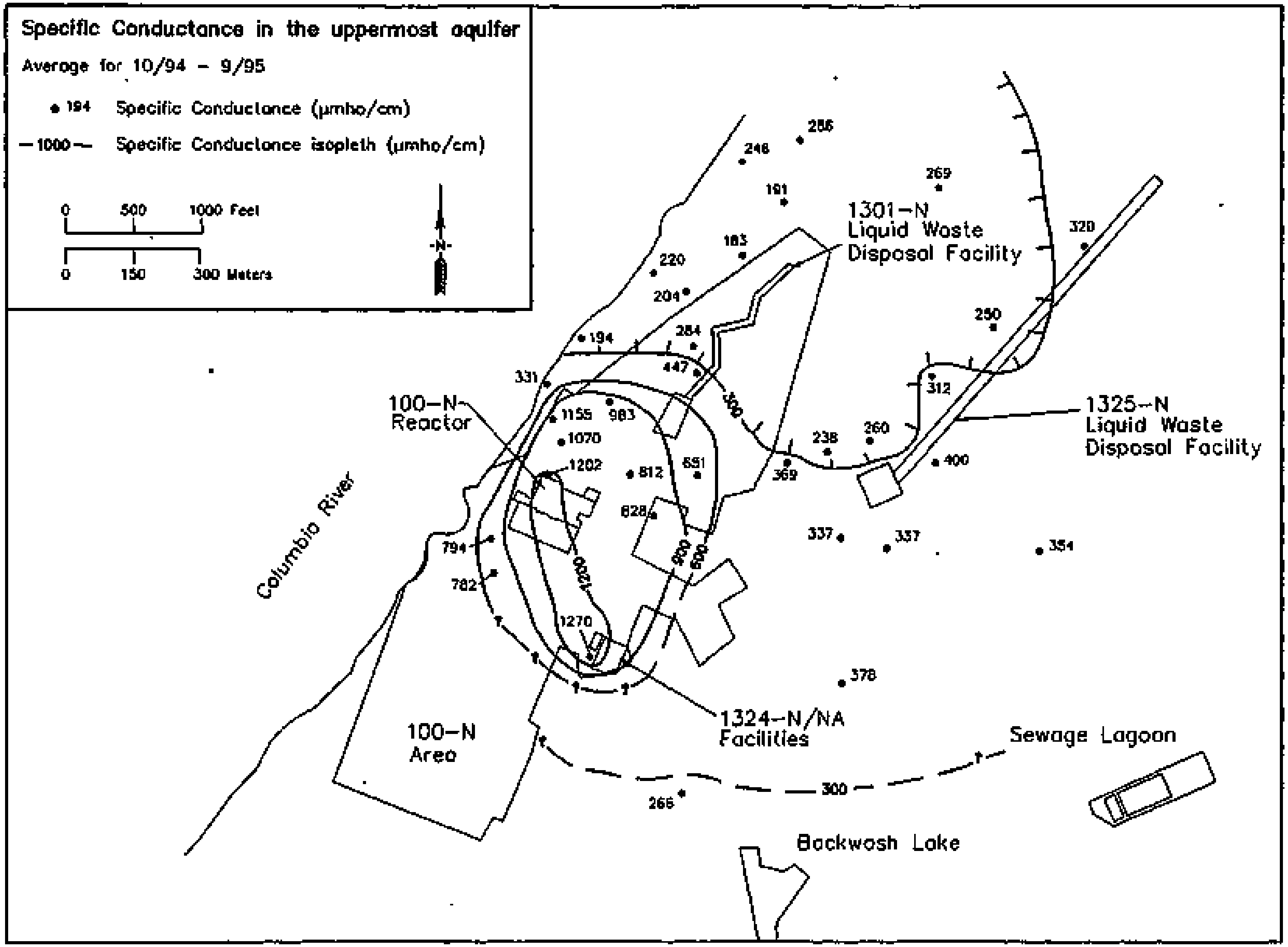


Figure 3.1-9. Specific Conductance in the Uppermost Aquifer Beneath the 100 N Area, 1995.

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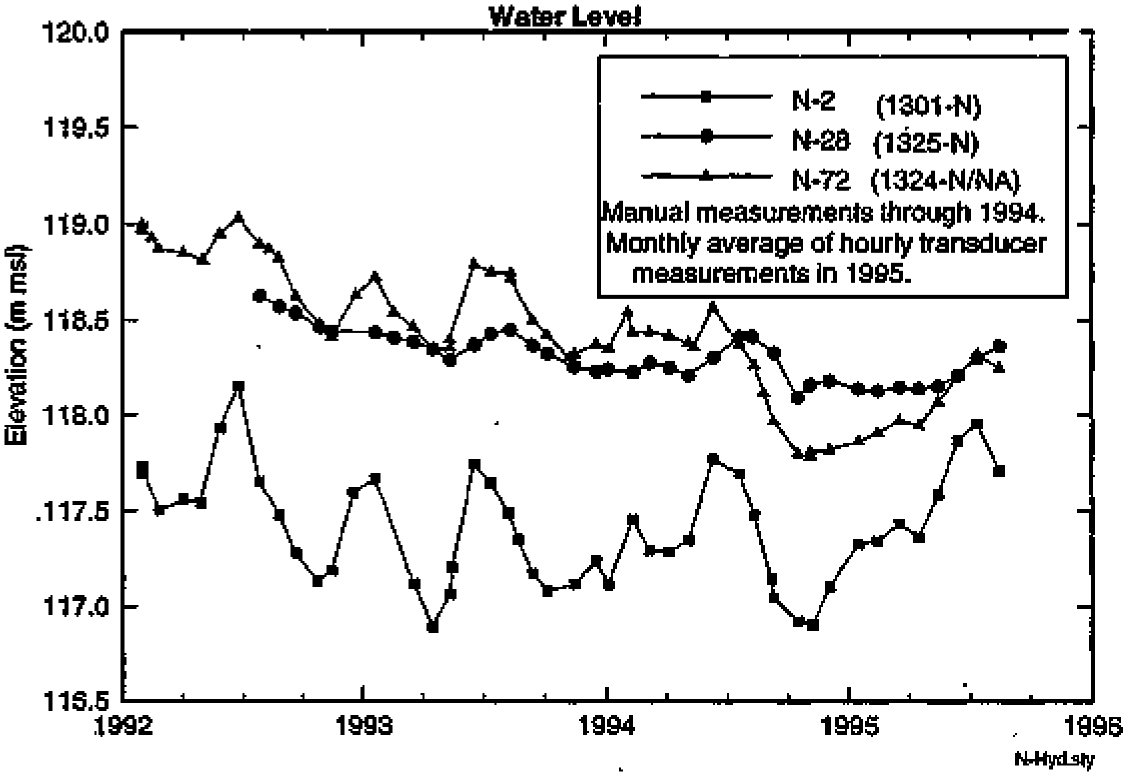
Figure 3.1-10. Water Levels Versus Time in the 100 N Area.



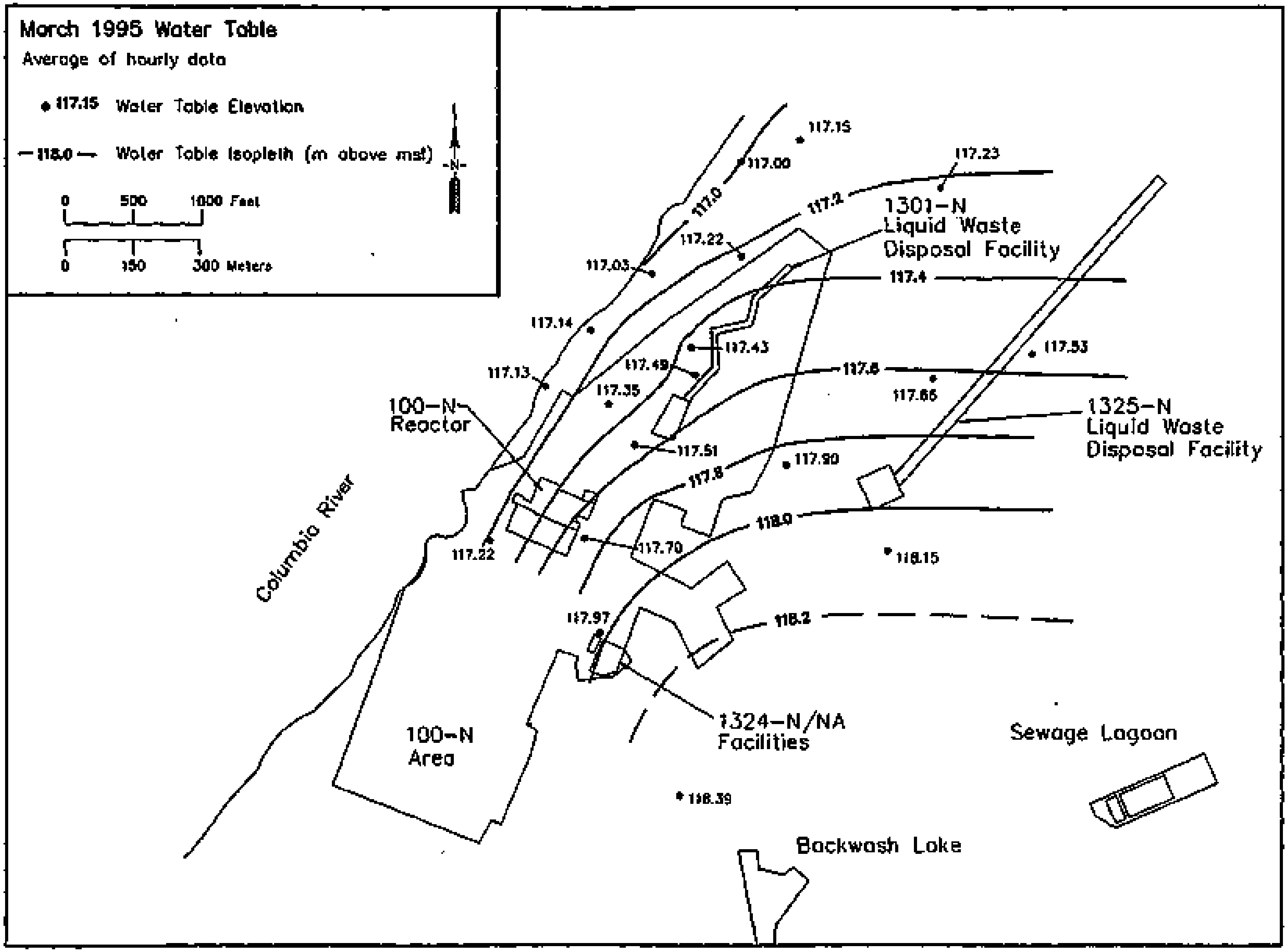


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Figure 3.1-11. Water Table in the 100 N Area, March 1995.

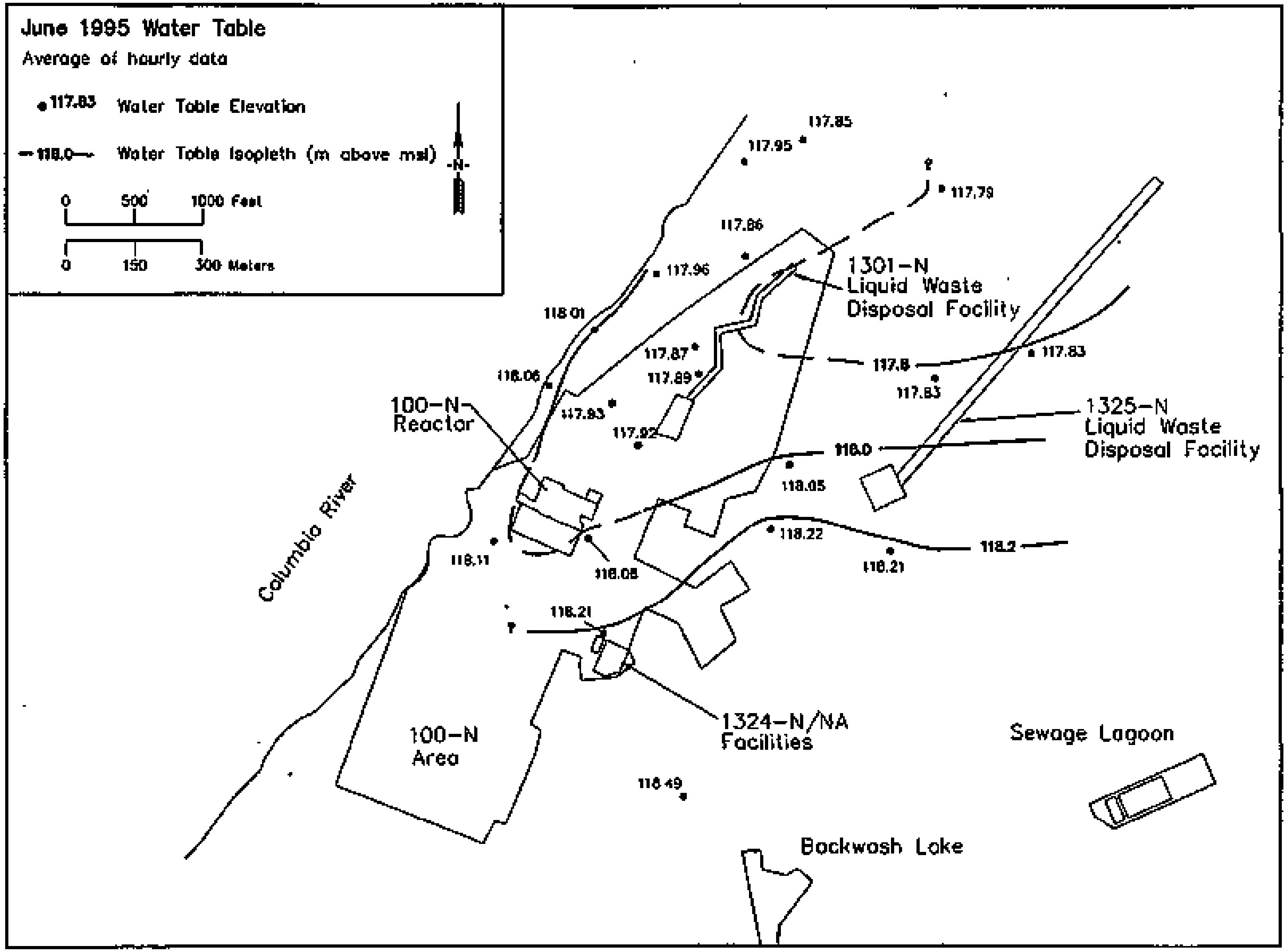

Figure 3.1-12. Water Table in the 100 N Area, June 1995.

Table 3.1-1. Wells Used to Monitor Groundwater Chemistry for the 1301-N Liquid Waste Disposal Facility.

Well	Aquifer	Sampling frequency	Well standard	Other networks
199-N-2^{64}	Top of unconfined	SA	PRE	--
199-N-3^{64}	Top of unconfined	SA	PRE	100-NR-2, Sitewide
199-N-14^{69}	Top of unconfined	SA	PRE	N Springs
199-N-34^{83}	Top of unconfined	SA	PRE	--
199-N-57^{87}	Top of unconfined	SA	RCRA	--
199-N-67^{88}	Top of unconfined	SA	RCRA	100-NR-2, Sitewide
199-N-69^{88}	Bottom unconfined	SA	RCRA	Sitewide
199-N-75^{92}	Top of unconfined	SA	RCRA	100-NR-2, N Springs
199-N-76^{92}	Top of unconfined	SA	RCRA	100-NR-2, N Springs

Notes: Shading denotes upgradient wells. Superscript following well number denotes the year of installation.

PRE = well is not constructed to RCRA standards.
SA = frequency on a semiannual basis.
RCRA = well is constructed to RCRA standards.

Table 3.1-2. Wells Used to Monitor Groundwater Chemistry for the 1325-N Liquid Waste Disposal Facility.

Well	Aquifer	Sampling frequency	Well standard	Other networks
199-N-27^{83a}	Top of unconfined	SA	PRE	Sitewide
199-N-29^{83a,b}	Top of unconfined	SA	PRE	N Springs
199-N-32^{83}	Top of unconfined	SA	PRE	100-NR-2, Sitewide
199-N-41^{84}	Top of unconfined	SA	PRE	--
199-N-43^{84}	Top of unconfined	SA	PRE	--
199-N-70^{88}	Bottom unconfined	SA	RCRA	100-NR-2
199-N-74^{91}	Top of unconfined	SA	RCRA	100-NR-2
199-N-81^{93}	Top of unconfined	SA	RCRA	Sitewide

Notes: Shading denotes upgradient well. Superscript following well number denotes the year of installation.

[a] Although wells N-27 and N-29 are currently upgradient of the 1325-N LWDF, they were downgradient when the facility was active. The groundwater chemistry at these wells is still affected by the facility, so they are monitored as downgradient wells.

[b] Well N-29 was dropped from the 1325-N network before the September 1995 sampling because it is an injection well for the ERC's pump and treat program.

PRE = well is not constructed to RCRA standards.
RCRA = well is constructed to RCRA standards.
SA = frequency on a semiannual basis.

Table 3.1-3. Wells Used to Monitor Groundwater Chemistry for the 1324-N/NA Facilities.

Well	Aquifer	Sampling frequency	Well standard	Other networks
199-N-59^{87}	Top of unconfined	Q	RCRA	--
199-N-71^{91}	Top of unconfined	Q	RCRA	100-NR-2
199-N-72^{91}	Top of unconfined	Q	RCRA	--
199-N-73^{91}	Top of unconfined	Q	RCRA	100-NR-2
199-N-77^{92}	Bottom of unconfined	Q	RCRA	100-NR-2

Notes: Shading denotes upgradient well. Superscript following well number denotes the year of installation.

Q = frequency on a quarterly basis.
RCRA = well is constructed to RCRA standards.

Table 3.1-4. Constituent List for 1301-N and 1325-N LWDFs in 1995.

Contamination indicator parameters		
pH (field) Specific conductance (field)	Total organic carbon Total organic halogen	
Other parameters		
Turbidity	ICP metals (filtered)	Gross alpha
Alkalinity	Lead (filtered)	Gross beta
Phenols	Anions	

Table 3.1-5. Constituent List for 1324-N/NA Assessment Monitoring.

Contamination indicator parameters		
pH (field) Specific conductance (field)	Total organic carbon Total organic halogen	
Other parameters		
Turbidity	ICP metals (filtered)	Gross alpha
Alkalinity	Anions	Gross beta
TDS	Volatile organics[a]	

[a] Wells N-72 and N-77 only.

Table 3.1-6. Critical Means Table for 32 Comparisons--Background Contamination Indicator Parameter Data for the 1301-N Liquid Waste Disposal Facility[a,b]

Constituent (Unit)	n	df	tc	Average background	Standard deviation	Critical mean	Upgradient/ downgradient comparison value
Specific Conductance (μmho/cm)	10	9	5.1241	592.70	272.527	2,057.3	2,057.3
Field pH[c]	9	8	6.0313	7.855	0.248	[6.28, 9.43]	[6.28, 9.43]
TOC (ppb)	10	9	5.1241	377	205.037	1,478.9	1,478.9
TOX (ppb)	10	9	5.1241	10.742	5.087	38.1	38.1

[a] Data collected from February 1994 to February 1995 for upgradient wells N-57 and N-34. Values calculated based on 32 comparisons.

[b] The following notations are used in this table:
df = degrees of freedom (n-1).
n = number of background replicate averages.
t_c = Bonferroni critical t-value for appropriate df and 32 comparisons.

[c] Excluding suspect pH data collected on 9/6/94 from well N-57.

N. C. = not calculated.

Table 3.1-7. Critical Means Table for 24 Comparisons--Background Contamination Indicator Parameter Data for the 1325-N Liquid Waste Disposal Facility[a,b]

Constituent (Unit)	n	df	tc	Average background	Standard deviation	Critical mean	Upgradient/ downgradient comparison value
Specific Conductance (μmho/cm)	4	3	13.745	501.75	14.046	729.1	717.6
Field pH	4	3	17.358	7.991	0.129	[5.27, 10.55]	[6.50, 9.12][d]
TOC[c] (ppb)	4	3	13.745	500	N.C.	N.C.	976
TOX (ppb)	4	3	13.745	11.185	2.952	59.0	56.6

[a] Data collected from May 1992 to March 1993 for upgradient well N-74 except for TOX which was collected from June 1994 to March 1995. Values calculated based on 24 comparisons (well N-29 was not sampled in 1995).

[b] The following notations are used in this table:
df = degrees of freedom (n-1).
n = number of background replicate averages.
t_c = Bonferroni critical t-value for appropriate df and 24 comparisons.

[c] Critical mean cannot be calculated due to lack of an estimate of background standard deviation. The upgradient/downgradient comparison value for TOC is the limit of quantitation (see Appendix A).

[d] Upgradient/downgradient comparison values for pH were calculated using data collected from May 1992 to November 1994 (well N-74) because the critical range calculated using only four quarters of data is too large to be meaningful.

N. C. = not calculated.

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3.2 100 D PONDS

M. J. Hartman
Westinghouse Hanford Company

This chapter describes groundwater monitoring at the 100 D Ponds, a *Resource Conservation and Recovery Act of 1976* (RCRA) disposal unit located in the 100 D Area of the Hanford Site (see Figure 1-1, Chapter 1.0). The 100 D Ponds monitoring program began in 1991 and the four wells in the network were sampled for the first time in 1992. The groundwater monitoring program is described by Hartman (1991). The site is monitored in an indicator evaluation program.

3.2.1 Facility Overview

The 100 D Ponds facility was constructed in 1977 for disposal of nonradioactive effluents derived from 100 D Area operating facilities. The 100 D Ponds are located in the former 188 D Ash Disposal Basin. The 100 D Ponds include a settling pond and a percolation pond, separated by a dike (Figure 3.2-1).

Effluent to the 100 D Ponds originated from two sources: the 183D Filter Plant and the 189D Building engineering testing laboratories. Some past discharges contained hydrochloric acid, sulfuric acid, and sodium hydroxide. Before 1986, the effluent may have had a pH of greater than 12.5 or less than 2.0 and, thus, may have been dangerous waste. Also, up to 2.3 kg (5 lb) of mercury may have been discharged to the 100 D Ponds. Effluent discharge ceased in 1994. Between 1986 and 1994 the effluent included chlorine and flocculating agents such as aluminum sulfate.

In addition to being a RCRA facility, the 100 D Ponds are regulated under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) program. Groundwater beneath the 100 D Area is considered part of the 100-HR-3 operable unit. The 100 D Ponds themselves are located in the 100-DR-1 source operable unit. Hydrogeologic data from CERCLA wells were interpreted in this section along with data from the 100 D Ponds RCRA wells to better understand the hydrogeology of the 100 D Area.

The uppermost aquifer beneath the 100 D Ponds is a sand-and-gravel unit in the Ringold Formation (Figure 3.2-2), approximately 3 to 9 m (10 to 30 ft) thick. This unit corresponds to Ringold unit E (see Section 2.1). The base of the aquifer is a fine-grained overbank interval, which is approximately 15 m (50 ft) thick elsewhere in the 100 D Area (DOE-RL 1993).

3.2.2 Summary of 1995 RCRA Activities

The downgradient wells in the 100 D Ponds network were sampled twice during the past year. The upgradient well was sampled four times to reestablish background specific conductance, which is increasing. Water levels were measured monthly.

3.2.3 Other Activities in 1995

Several activities were conducted for the 100-HR-3 groundwater operable unit during the past year. Wells in the 100 D Area were sampled twice. A pump-and-treat system, which began operation in August 1994, continued to operate during the past year. The system is designed to remove chromium from groundwater. Water is withdrawn from wells D5-14[1], D5-15, and D5-16; treated in an ion exchange column; and injected into wells D5-18 and D5-19 (Figure 3.2-3).

3.2.4 Sampling and Analysis Program

The monitoring program for the 100 D Ponds is described by Hartman (1991). Four wells are sampled for the 100 D Ponds and additional wells are used to monitor water levels. Table 3.2-1 lists the wells monitored for water levels and/or chemistry for the 100 D Ponds RCRA program. The locations of the wells are shown in Figure 3.2-1.

The RCRA sampling network consists of one upgradient well (D5-13) and three downgradient wells. Two of the downgradient wells (D8-4 and D8-6) are located adjacent to the 100 D Ponds. The remaining well (D8-5) is located farther from the facility, outside of the ash mounds, and nearer to the river. The location of this well was determined in discussions with the Washington State Department of Ecology. The well's location was chosen to provide more information on river/aquifer relationships.

Samples are analyzed for the constituents listed in Table 3.2-2. Water levels are measured monthly in most of the wells in the 100 D Area and its vicinity (see Table 3.2-1 and Figure 3.2-3). Water levels and results of chemical analyses are presented in quarterly reports (Hartman 1995a, 1995b, 1995c, 1996).

3.2.5 Groundwater Chemistry

3.2.5.1 Constituents of Concern. The indicator parameters for the 100 D Ponds are: pH, specific conductance, total organic carbon (TOC), and total organic halogen (TOX) (40 *Code of Federal Regulations* [CFR] 265.92[b][3]). TOC was below the contractually required quantitation limit in all wells except upgradient well D5-13 (approximately 800 ppb in August 1995). TOX was less than 15 ppb in all wells. The pH tends to be higher in the wells immediately adjacent to the ponds (D8-4 and D8-6) than in the upgradient well (D5-13) or the well further downgradient (D8-5) (Figure 3.2-4). The change in pH may be caused by reactions with lime and periclase in the ash beneath the ponds (Alexander 1993). Specific conductance is lower in the wells nearest the ponds (see Figure 3.2-4). This is likely because of dilution by artificial recharge from the ponds.

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[1] Well numbers in this section are abbreviated by removing the 199- prefix, e.g., well 199-D5-14 is written D5-14.

Specific conductance in the upgradient well, D5-13, which had increased in 1994, stabilized at approximately 500 μmho/cm during the past year (see Figure 3.2-4). The elevated specific conductance is believed to be caused by an influx of higher conductivity groundwater from upgradient sources. Nitrate and sulfate also are elevated in well D5-13 (Figure 3.2-5). This well is sampled quarterly to establish a new background value for specific conductance.

Mercury is a dangerous waste constituent that was potentially discharged to the 100 D Ponds (DOE-RL 1993). No mercury has been detected in the 100 D Ponds downgradient wells.

Nitrate, chromium, and tritium are elevated in the 100 D Area from sources other than the 100 D Ponds (Figures 3.2-6, 3.2-7, and 3.2-8). Each of these constituents is lowest in the area surrounding the 100 D Ponds. As with specific conductance, this is likely because pond effluent has diluted local groundwater. This dilution effect is expected to disappear gradually now that effluent disposal has ceased.

3.2.5.2 Statistical Evaluation. Indicator parameter data from upgradient well D5-13 were statistically evaluated as required by 40 CFR 265.93(b) and *Washington Administrative Code* (WAC) 173-303-400. Table 3.2-3 lists background averages, standard deviations, critical mean values, and upgradient/downgradient comparison values for the indicator parameters. Statistical methods are described in Appendix C. The upgradient/downgradient comparison value is the value to which current and future averages of indicator parameters are compared. The comparison value is generally the critical mean or critical range. The limit of quantitation is used as the comparison value for TOC instead of the critical mean because most of the upgradient concentrations were below the contractually required quantitation limits (see Appendix C).

Specific conductance, pH, TOX, and TOC values for the downgradient wells were compared to the upgradient/downgradient comparison values. No downgradient values exceeded the comparison values, except pH in well D8-6 in August 1995. Verification samples from the well had pH within the critical range. The original values (around 9.3) were determined to be nonrepresentative.

Specific conductance has increased in upgradient well D5-13. A new critical mean will be established in the future.

3.2.6 Groundwater Flow

Water levels were measured in wells in and near the 100 D Area each month during the past year. The water table currently lies approximately 24 m (80 ft) beneath land surface at the 100 D Ponds, within Ringold Formation gravel. Interpretations of groundwater flow are based on water table maps constructed from the measured water levels.

3.2.6.1 Groundwater Flow Direction. Groundwater levels in the 100 D Area fluctuate with the stage of the Columbia River (Figure 3.2-9; see Figure 2-3). Seasonal changes of up to 1 m (3 ft) were observed during the past year in the

100 D Ponds wells. When river stage is high, water levels in downgradient wells D8-4 and D8-6 can be slightly higher than in upgradient well D5-13.

Figure 3.2-10 shows the water table in the 100 D Area in February 1995 when the river stage was relatively low. Groundwater is inferred to flow northwest toward the river beneath the 100 D Ponds. The river stage was high in June 1995, and the gradient between the river and 100 D Ponds was flat or perhaps reversed (Figure 3.2-11).

Hartman (1994) estimated an upward vertical gradient ranging from 7×10^{-3} to 2×10^{-2} between wells D8-54A and D8-54B. Well D8-54A is completed across the water table. Well D8-54B is completed 22.6 m (74 ft) deeper than well D8-54A in a thin layer of silty sand that is confined beneath 15 m (50 ft) of clay.

3.2.6.2 Rate of Flow. The horizontal hydraulic gradient was calculated between wells D5-13 and D8-4 using data from February 1995:

difference in head:	0.07 m (0.23 ft)
horizontal distance:	161 m (530 ft)
gradient:	4.3×10^{-4}.

The rate of groundwater flow can be estimated by using a form of the Darcy equation with a range of input parameters.

$$v = \frac{Ki}{n_e} \tag{1}$$

where:

v = Average linear velocity of groundwater
K = Horizontal hydraulic conductivity
i = Hydraulic gradient
n_e = Effective porosity of the aquifer.

The following input parameters were used:

K = 1.2 to 40 m/d (3.9 to 130 ft/d) (slug withdrawal; Hartman 1992)
i = 4.3×10^{-4}
n_e = 0.1 to 0.3.

The resulting estimate of groundwater velocity ranges from 2×10^{-3} to 0.2 m/d (6×10^{-3} to 0.6 ft/d).

3.2.6.3 Evaluation of Monitoring Well Network. When the 100 D Ponds were in use, recharge from the ponds diluted groundwater, apparently affecting even the upgradient well. With the cessation of effluent discharge to the 100 D Ponds, contaminated water from elsewhere in the 100 D Area can be expected to flow beneath the ponds. The pump-and-treat system currently operating in the 100 D Area and another planned system may also have an effect on groundwater flow and chemistry in the 100 D Ponds monitoring network.

3.2.7 References

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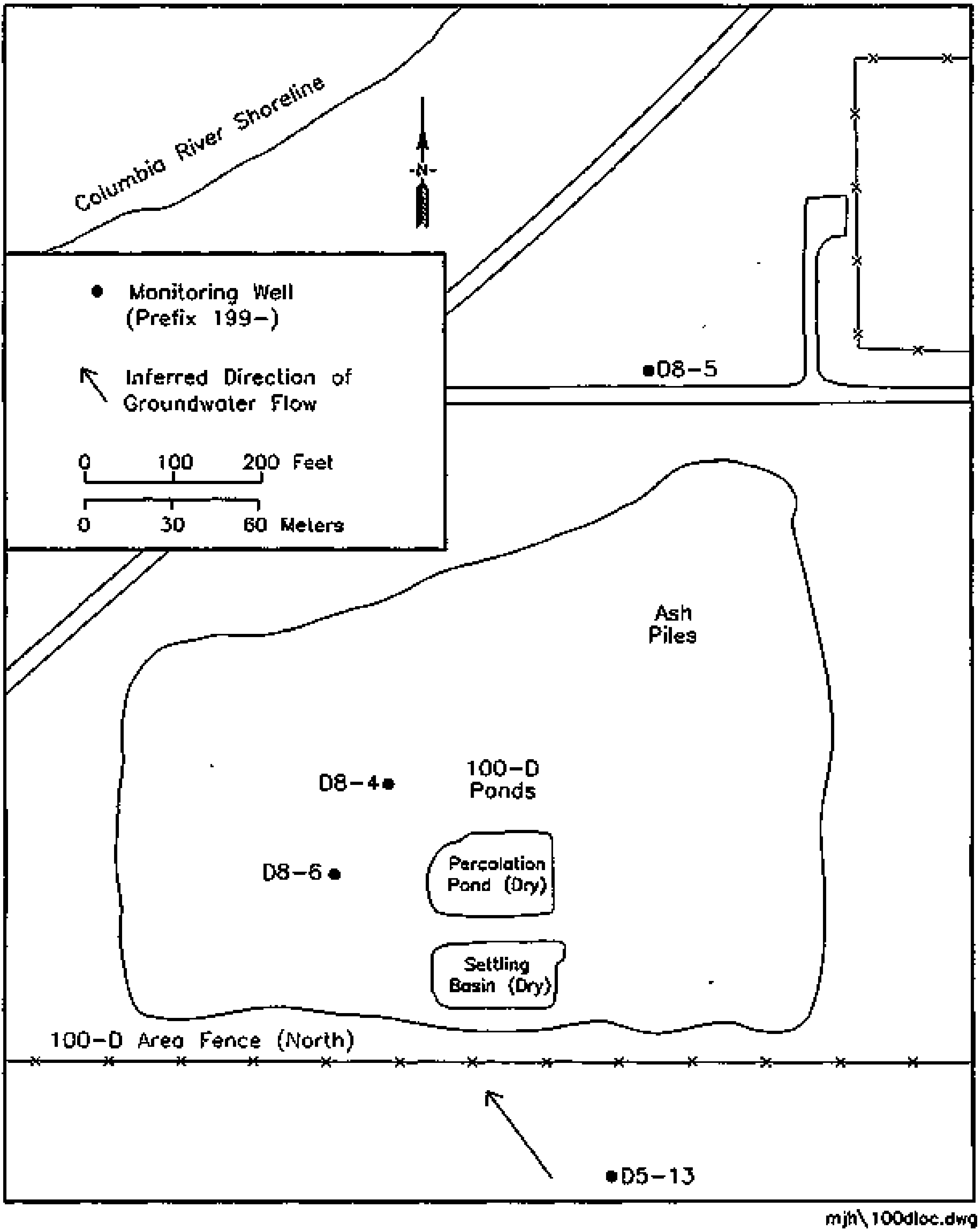
Resource Conservation and Recovery Act of 1976, 42 USC 6901 et seq.

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

Figure 3.2-1. Groundwater Monitoring Wells Located Near the 100 D Ponds.



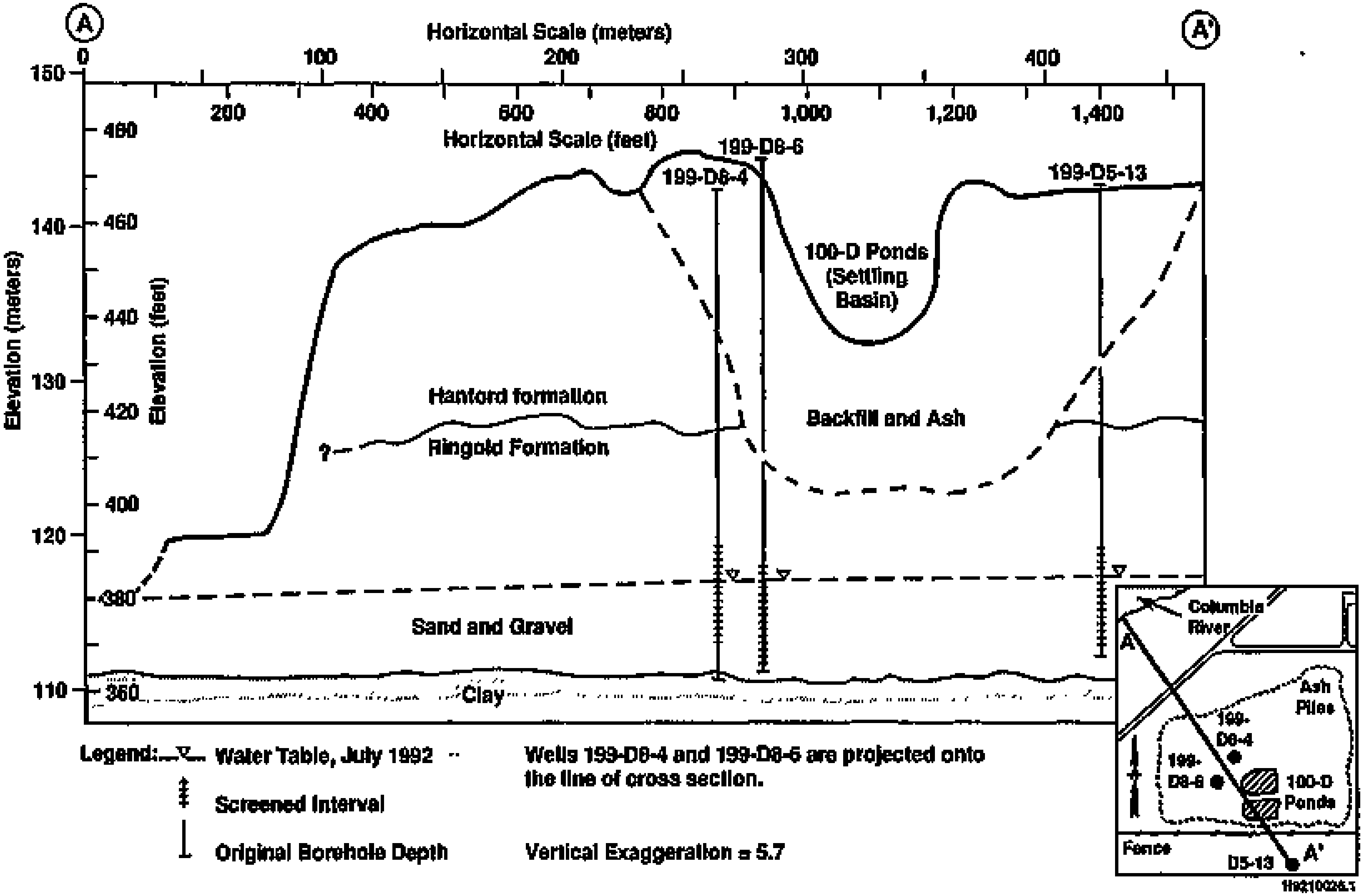


Figure 3.2-2. Geologic Cross Section Through the 100 D Ponds (DOE-RL 1993).

Figure 3.2-3. Groundwater Monitoring Wells in and Near the 100 D Area.

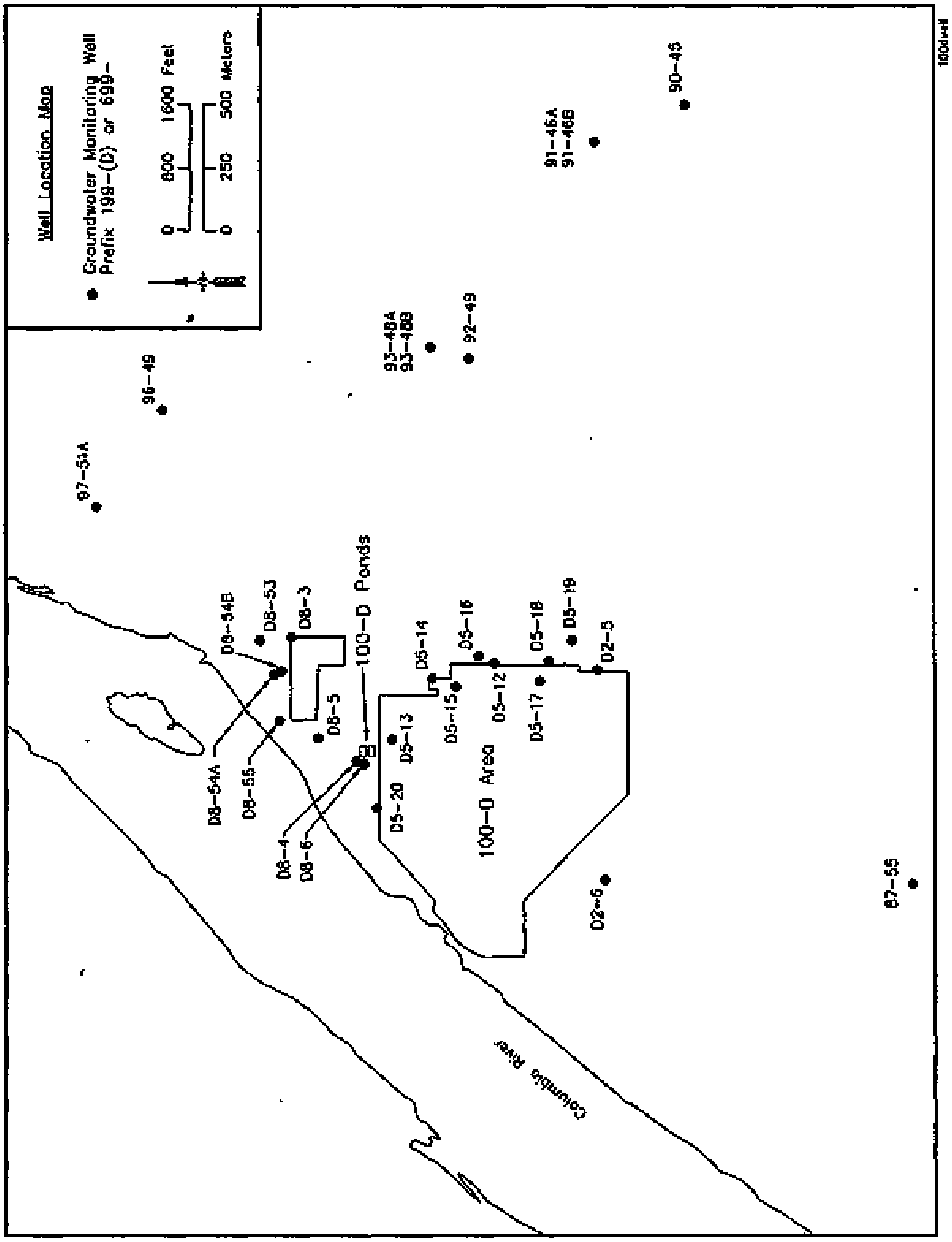


Figure 3.2-4. Specific Conductance and pH Versus Time in 100 D Ponds Wells.

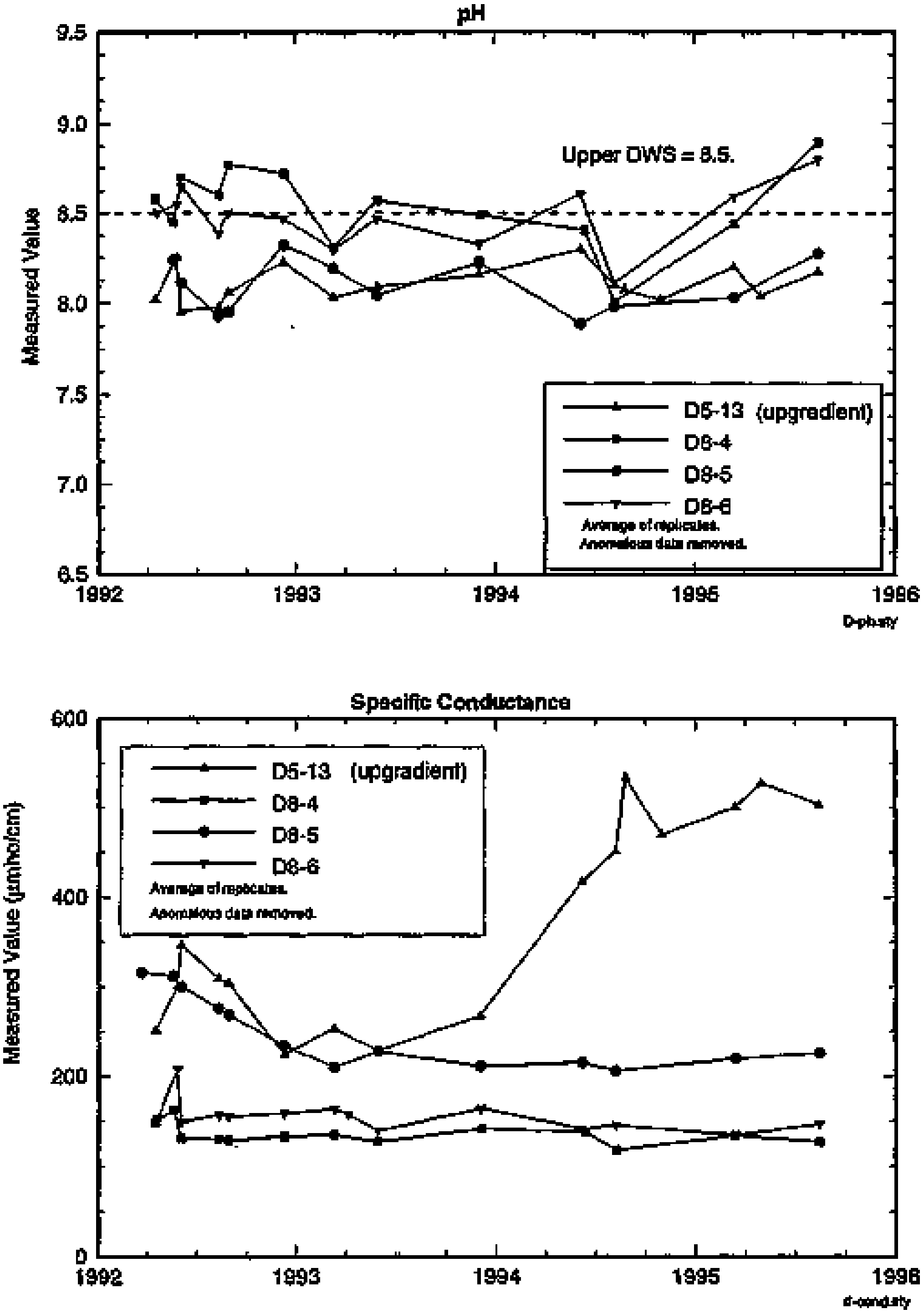
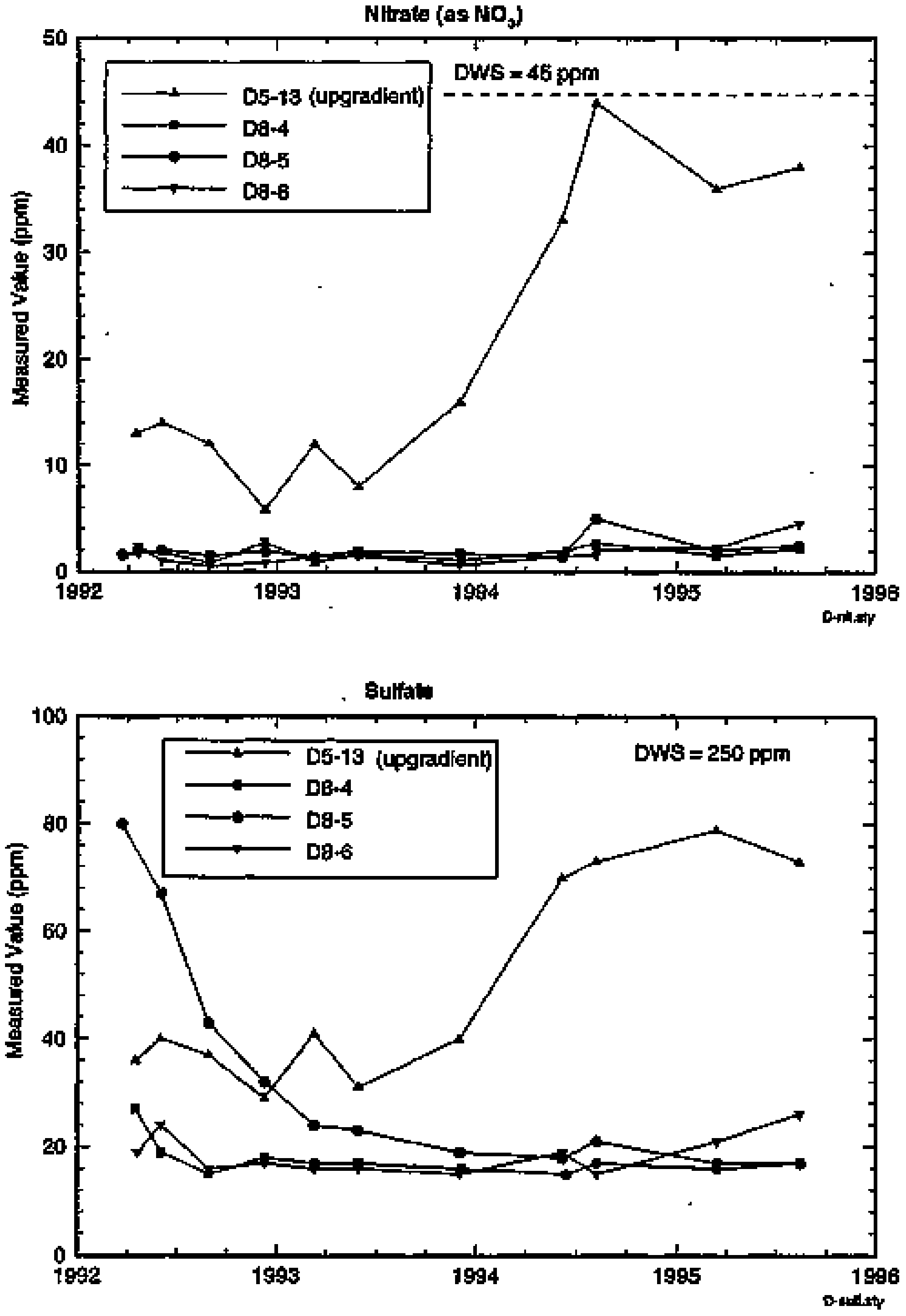


Figure 3.2-5. Nitrate and Sulfate Versus Time in 100 D Ponds Wells.



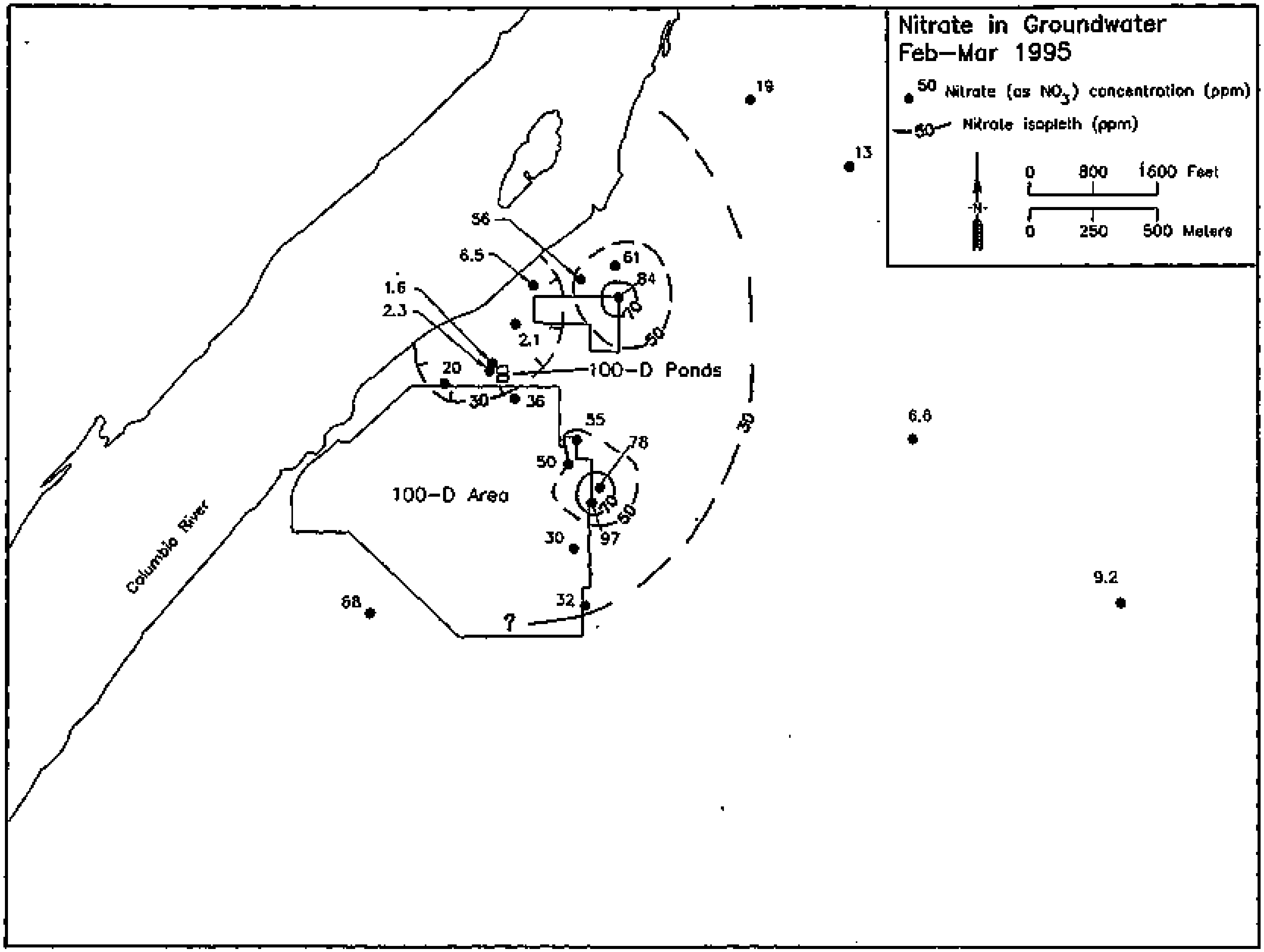
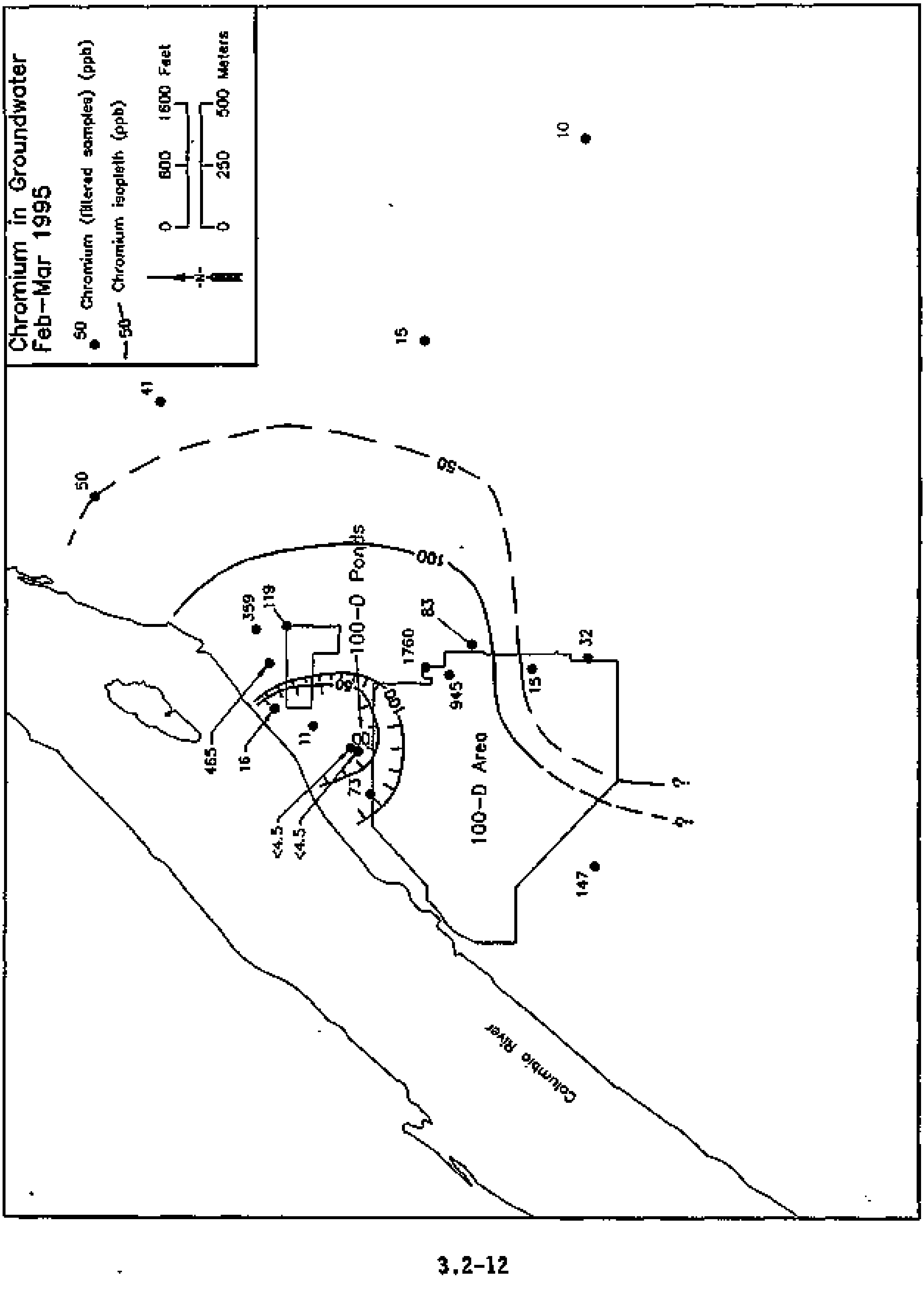


Figure 3.2-6. Nitrate in the Uppermost Aquifer, 100 D Area, February-March, 1995.

Figure 3.2-7. Chromium in the Uppermost Aquifer, 100 D Area, February-March, 1995.



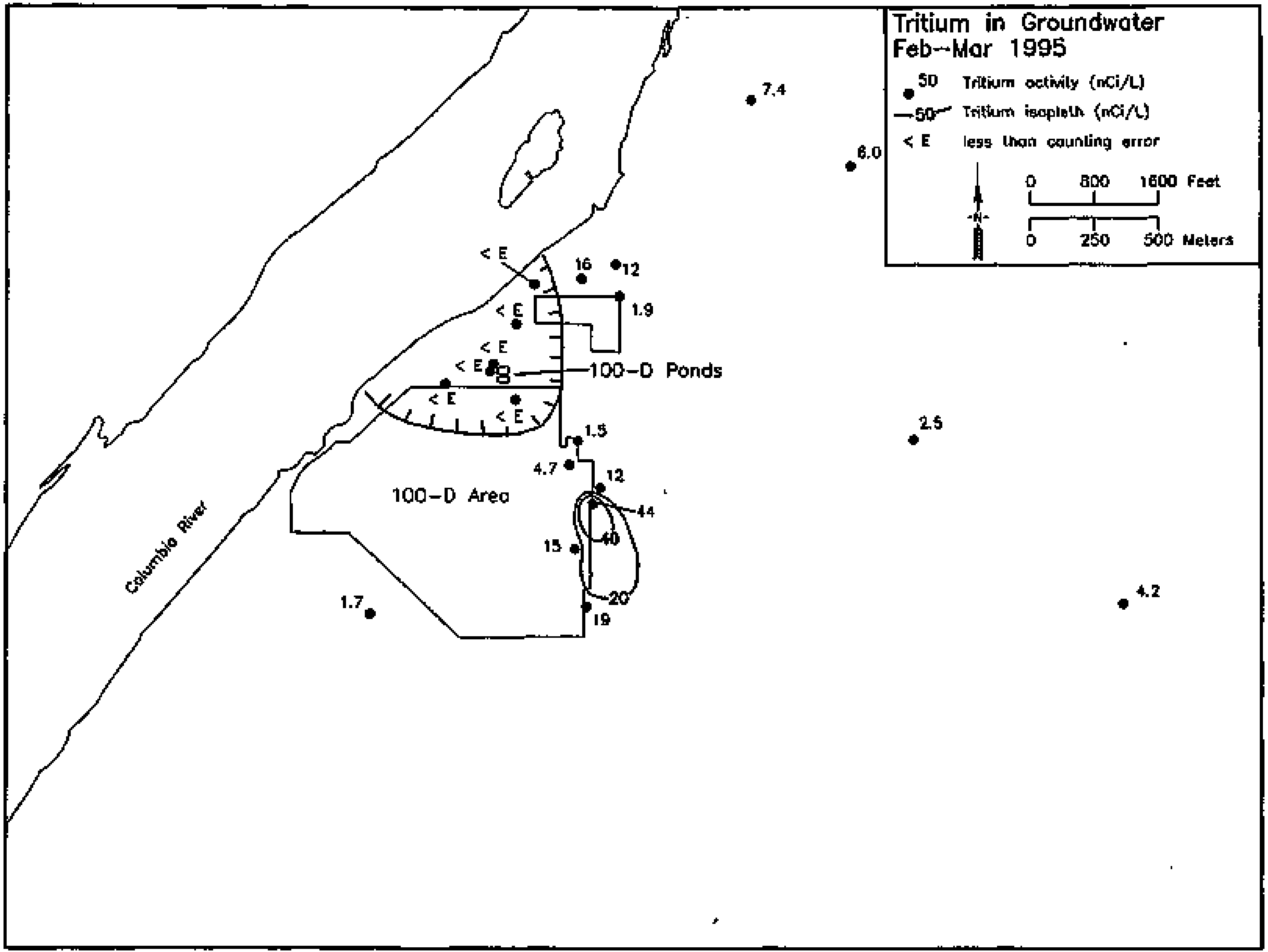


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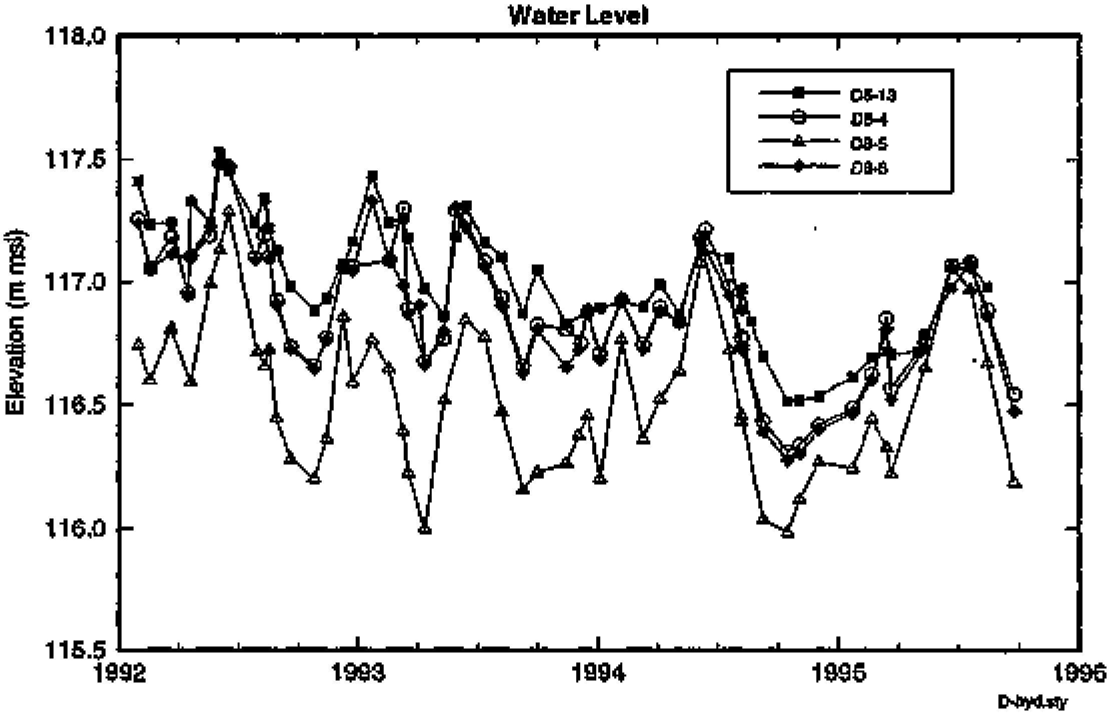
Figure 3.2-8. Tritium in the Uppermost Aquifer, 100 D Area, February-March, 1995.

Figure 3.2-9. Water Level Versus Time in 100 D Ponds Wells.



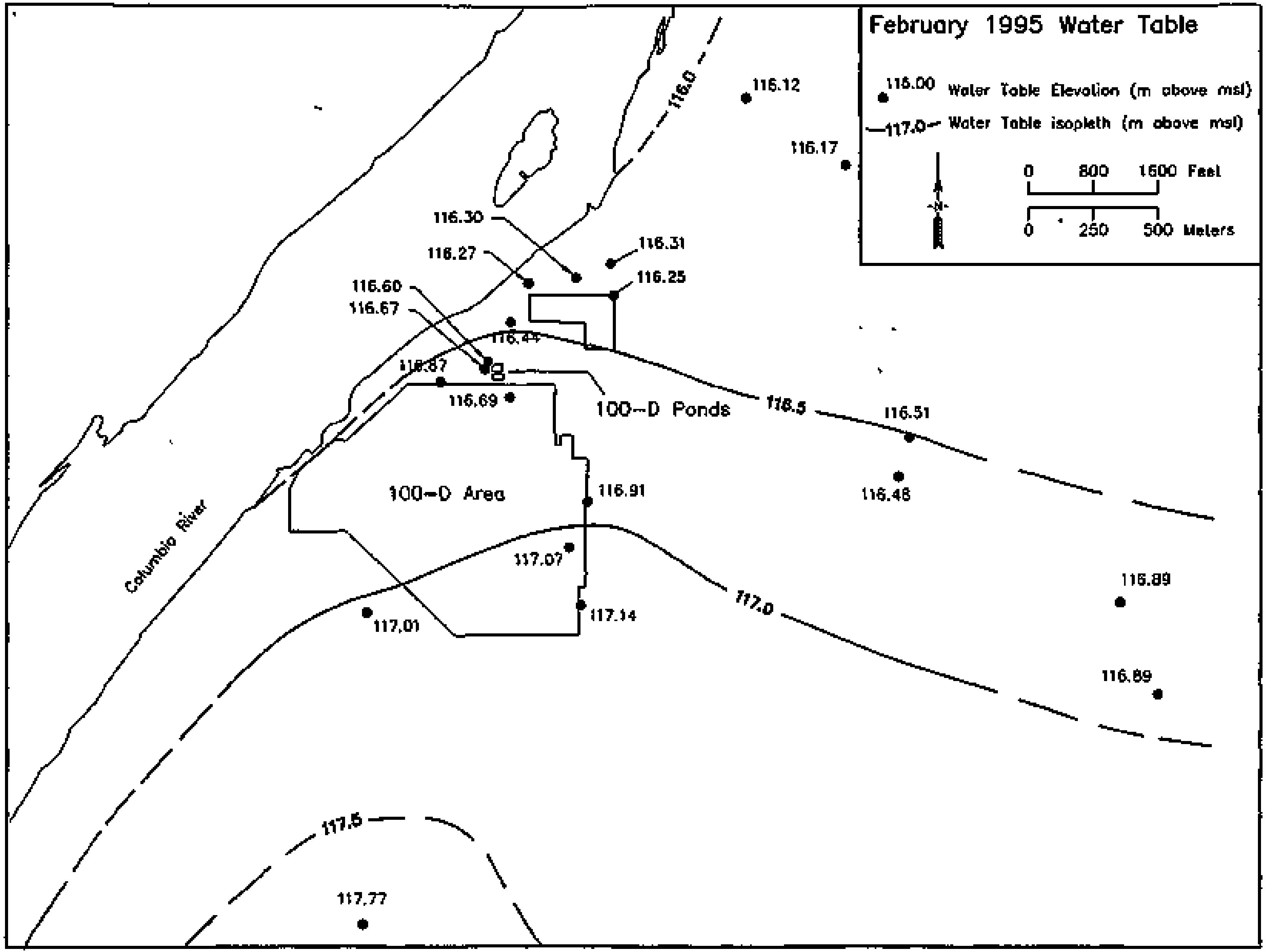


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Figure 3.2-10. Water Table in the 100 D Area, February, 1995.

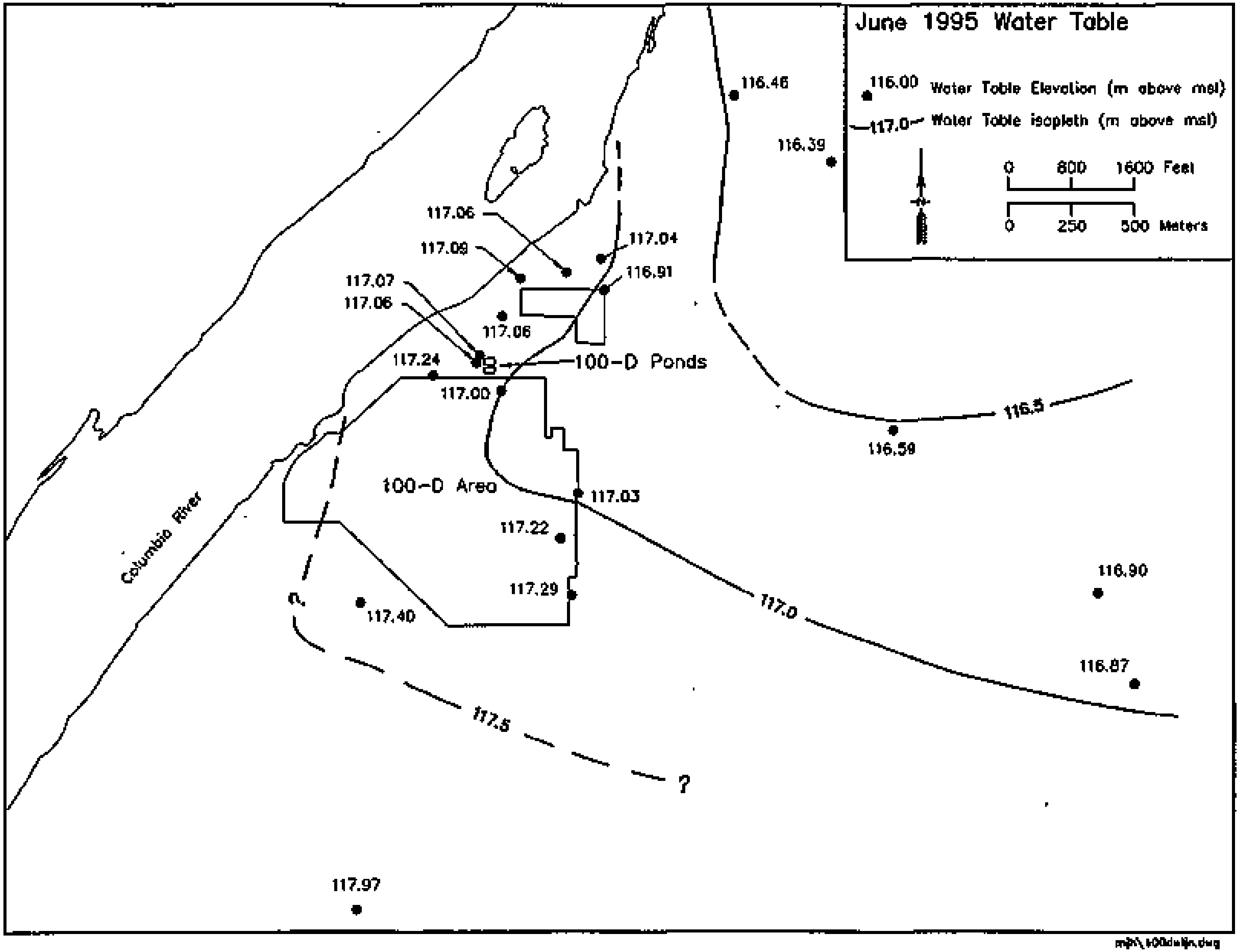

Figure 3.2-11. Water Table in the 100 D Area, June, 1995.

Table 3.2-1. Wells Monitored for Chemistry or Water Levels for the 100 D Ponds. (2 sheets)

Well	Aquifer	RCRA sampling frequency	Water levels	Well standards	Other networks
199-D2-5^{60}	Top of unconfined	--	M	PRE	--
199-D2-6^{92}	Top of unconfined	--	M	RCRA	100-HR-3
199-D5-12^{60}	Top of unconfined	--	M	PRE	100-HR-3
199-D5-13^{91}	Top of unconfined	Q	M	RCRA	100-HR-3
199-D5-14^{92}	Top of unconfined	--	M	RCRA	100-HR-3
199-D5-15^{92}	Top of unconfined	--	M	RCRA	100-HR-3
199-D5-16^{92}	Top of unconfined	--	M	RCRA	100-HR-3
199-D5-17^{92}	Top of unconfined	--	M	RCRA	100-HR-3
199-D5-18^{92}	Top of unconfined	--	M	RCRA	100-HR-3
199-D5-19^{92}	Top of unconfined	--	M	RCRA	100-HR-3
199-D5-20^{92}	Top of unconfined	--	M	RCRA	100-HR-3
199-D8-3^{52}	Top of unconfined	--	M	PRE	100-HR-3
199-D8-4^{91}	Top of unconfined	SA	M	RCRA	--
199-D8-5^{91}	Top of unconfined	SA	M	RCRA	--
199-D8-6^{91}	Top of unconfined	SA	M	RCRA	--
199-D8-53^{92}	Top of unconfined	--	M	RCRA	100-HR-3
199-D8-54A^{92}	Top of unconfined	--	M	RCRA	100-HR-3
199-D8-54B^{92}	Top of unconfined	--	M	RCRA	100-HR-3
199-D8-55^{92}	Shallow confined	--	M	RCRA	100-HR-3
699-87-55^{a}	Top of unconfined	--	M	PRE	--
699-90-45^{a}	Top of unconfined	--	M	PRE	--
699-91-46A^{92}	Top of unconfined	--	M	RCRA	--
699-92-49^{a}	Top of unconfined	--	M	PRE	--

Table 3.2-1. Wells Monitored for Chemistry or Water Levels for the 100 D Ponds. (2 sheets)

Well	Aquifer	RCRA sampling frequency	Water levels	Well standards	Other networks
699-93-48A^{92}	Top of unconfined	--	M	RCRA	100-HR-3
699-96-49^{62}	Top of unconfined	--	M	PRE	--
699-97-51A[a]	Top of unconfined	--	M	PRE	100-HR-3

Notes: Shading denotes upgradient well in sampling network. Superscript following well number denotes the year of installation.

[a] The year of well completion is unknown.
M = frequency on a monthly basis.
PRE = well was not constructed to RCRA standards.
Q = frequency on a quarterly basis.
RCRA = well is in compliance with RCRA standards.
SA = frequency on a semiannual basis.

Table 3.2-2. Constituent List for 100 D Ponds.

Contamination indicator parameters		
pH (field)	Total organic carbon	
Specific conductance (field)	Total organic halogen	
Other parameters		
ICP metals (filtered)	Gross alpha	Phenols
Mercury (filtered)	Gross beta	Alkalinity
Anions	Tritium	Turbidity (field)

Table 3.2-3. Critical Means Table for 16 Comparisons--Background Contamination Indicator Parameter Data for the 100-D Pond.[a,b]

Constituent (Unit)	n	df	tc	Average background	Standard deviation	Critical mean	Upgradient/ downgradient comparison value
Specific Conductance (μmho/cm)	5	4	8.122	275.90	48.976	711.6	711.6
Field pH	5	4	9.729	8.070	0.101	[6.99, 9.15]	[6.99, 9.15]
TOC[c] (ppb)	5	4	8.122	500	N.C.	N.C.	976
TOX (ppb)	4	3	11.984	11.7	2.697	47.8	47.8

[a] Data collected from April 1992 to March 1993 for upgradient well D5-13 except for TOX which was collected from June 94 to March 95. Values calculated based on 16 comparisons.

[b] The following notations are used in this table:
df = degrees of freedom (n-1).
n = number of background replicate averages.
t_c= Bonferroni critical t-value for appropriate df and 16 comparisons.

[c] Critical mean cannot be calculated due to lack of an estimate of background standard deviation. The upgradient/downgradient comparison value for TOC is the limit of quantitation (see Appendix A).

N. C. = not calculated.

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3.3 183-H SOLAR EVAPORATION BASINS

M. J. Hartman
Westinghouse Hanford Company

The 183-H Solar Evaporation Basins (183-H Basins) have been monitored under an interim-status assessment program since 1986 (Ecology and EPA 1986). This report presents results of interim-status groundwater monitoring during the fourth quarter of 1994 and the first three quarters of 1995.

3.3.1 Facility Overview

The 183-H Basins are located beside the Columbia River in the northern portion of the Hanford Site (see Figure 1-1, Figure 3.3-1). The facility comprised four separate concrete basins surrounded by an earthen berm. Each basin measured approximately 16 by 39 m (52 by 128 ft). Originally, the concrete basins were part of a water treatment facility that provided coolant water to the 105-H Reactor, which was shut down in 1965. Between 1973 and 1985, the 183-H Basins were used to store liquid waste that resulted primarily from nuclear fuel fabrication activities conducted in the 300 Area. Volume reduction occurred by solar evaporation. The waste was predominantly acid-etch solutions that had been neutralized with sodium hydroxide before being discharged into the 183-H Basins (DOE-RL 1991a). The acid solutions included nitric, sulfuric, hydrofluoric, and chromic acids. The waste solutions, described as supersaturated, contained various metallic and radioactive constituents (e.g., chromium, uranium, technetium).

By the end of 1990, essentially all of the waste had been removed from the 183-H Basins. The walls of all four basins have been decontaminated, and the walls from Basins 3 and 4 have been demolished. Decontamination and demolition of the remaining walls and the basin floors are planned for 1996.

The 183-H Basins are located within two operable units regulated under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA). Operable unit 100-HR-1 addresses surface sources of contamination and 100-HR-3 addresses groundwater contamination.

A comprehensive description of 100-H Area stratigraphy is presented by Lindsey (1992, 1993). The uppermost portion of the unconfined aquifer in the 100-H Area resides in cataclysmic flood deposits. The saturated portion of these deposits ranges in thickness from 2 to 6 m (6 to 18 ft) (Peterson and Connelly 1992). It consists of unconsolidated sands and gravels, referred to as the Hanford formation (Figure 3.3-2). An erosional unconformity separates this hydrogeologic unit from the more consolidated fluvial sands and overbank deposits of the underlying Ringold Formation.

3.3.2 Summary of 1995 RCRA Activities

Routine monitoring of groundwater continued during 1995. Three wells directly in the 183-H contaminant plume were sampled monthly until April 1995, when they were switched to a quarterly schedule. These wells were sampled monthly to provide more information on groundwater closest to the basins.

Four wells not directly affected by the plume were sampled once, in June. The remaining wells, including upgradient wells and wells on the margins of the plume, were sampled quarterly. Water levels were measured quarterly in most of the wells in the 100-H Area.

Over the past several years, the 183-H groundwater monitoring program was streamlined from what was described in the monitoring plan, which was included in the Closure Plan (DOE 1991). This resulted in the program being out of compliance with the monitoring plan. The groundwater monitoring program was revised in the spring of 1995 to bring it back into compliance with the monitoring plan. Several wells that had been dropped were added back to the network, and three wells that had been sampled monthly were switched to quarterly. These changes were temporary, because a new, final-status monitoring program was designed and initiated in September 1995 (Hartman and Chou 1995). The final-status program includes eight wells sampled twice per year.

Decontamination and demolition of the 183-H Basins proceeded in 1995. The concrete walls of the basins were sampled and tested for dangerous and radioactive waste. The walls were decontaminated where waste was found; the walls of Basins 3 and 4 were demolished.

3.3.3 Other Activities in 1995

In addition to RCRA groundwater monitoring activities, several other groundwater investigations were under way during 1995 in the 100-H Area. Semiannual sampling of selected wells continued under the CERCLA remedial investigation for the 100-HR-3 operable unit.

Pacific Northwest National Laboratory completed characterization activities at a field test site in the 100-H Area. Sixteen wells were installed within the uppermost unconfined aquifer beneath the test site. Characterization activities focused on sediment physical properties, geochemical properties, microbiologic population data, and aquifer hydraulic properties (Vermeul et al. 1995).

Approximately 40 gallons of oil leaked from a backhoe hydraulic system into a shallow pit ("clearwell") adjacent to the 183-H Basins in June 1995. The ERC sampled wells near the spill in July; no hydrocarbons were detected. The wells were sampled again in December 1995; results were not available at the time of this writing.

3.3.4 Sampling and Analysis Program

The initial interim-status RCRA groundwater monitoring plan for the 183-H Basins was prepared by the Pacific Northwest National Laboratory (PNL 1986). A revised program was described in the Closure Plan (DOE 1991). That program had been revised in practice in recent years by dropping some wells that were not in the flow path beneath the basins. However, in early 1995 those wells were added back to the network until the monitoring plan could be formally revised.

The 183-H Basins are included in the Hanford Facility RCRA Permit and are now subject to final-status regulations (Ecology 1994). A new, final-status monitoring plan was released in 1995 (Hartman and Chou, 1995). Monitoring under the new plan began in September. This annual report will focus on the interim-status program that was in place for 11 months of the past year.

Twenty-three groundwater monitoring wells were monitored for RCRA in FY95 (Table 3.3-1). Many are jointly used by other programs, including the 100-HR-3 remedial investigation and the Sitewide Environmental Surveillance program.

The sampling schedule for the past year included quarterly sampling of wells that are used to define the extent of contamination and upgradient conditions. Monthly sampling was conducted in selected wells located immediately downgradient of the 183-H Basins until April 1995, when they were switched to a quarterly schedule. Quarterly sampling is sufficient to meet the objectives of the monitoring program. Annual sampling of wells in the vicinity of, but not directly in the flowpath under the 183-H Basins, was conducted to provide 100-H Area baseline data. The constituent list is summarized in Table 3.3-2.

Water levels were measured quarterly with a steel tape. Water levels also were recorded before each well was sampled. Pressure transducers measure water levels in the river and in several wells monitored under the CERCLA program. The data from these efforts are used to help explain the temporal variability observed in 100-H Area groundwater quality, particularly in wells near the river. They can also be useful in helping to determine the transport of contaminants in groundwater toward the river.

Water level and chemistry data for the past year were presented in quarterly reports (Hartman 1995b, 1995c, 1995d, 1996).

3.3.5 Groundwater Chemistry

The primary constituents of concern in groundwater downgradient of the 183-H Basins are nitrate, chromium, uranium, and ^{99}Tc (Hartman and Chou 1995). Sulfate and sodium are also elevated in groundwater, but are not dangerous or radioactive contaminants. Gross alpha and gross beta activities are monitored as indicators of uranium and technetium, respectively.

3.3.5.1 Concentration Histories of Waste Indicators. Concentrations of waste constituents in groundwater have generally declined in the past 10 years, with several exceptions. Figure 3.3-3 illustrates the trends for gross alpha and nitrate in well H4-3[1]. During the last half of 1990 and first half of 1991, the sampling and analysis program was interrupted by analytical laboratory problems. When sampling resumed, concentrations of waste indicators in wells within the contaminant plume were higher than the previously established trends. The cause for this may have been an atypically high water table during that period (Peterson 1993).

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[1] Well numbers in this section are abbreviated by dripping the 199- prefix, e.g., well 199-H4-3 is written H4-3.

Concentrations of 183-H waste constituents increased in some wells in 1993 and remained elevated in 1994. Figures 3.3-4 through 3.3-6 illustrate the trend for gross alpha, gross beta, nitrate, sulfate, and chromium in wells H4-3, H4-4, and H4-12, which lie directly in the 183-H contaminant plume. The increases in concentration were most noticeable in well H4-3, which is adjacent to the 183-H Basins on the downgradient side. Gross alpha and chromium declined in 1995. Gross beta, nitrate, and sulfate remained elevated in 1995 and showed large seasonal fluctuations.

3.3.5.2 Distribution of Waste Constituents. The 183-H Basins have contaminated groundwater between the basins and the river. Maps showing the concentrations of gross alpha, gross beta, nitrate, and chromium for June 1995 are presented in Figures 3.3-7 through 3.3-10. The river stage was high in June, and contaminants were diluted in wells near the river. When the river stage is lower, the contaminant plume from 183-H extends in a narrow band from the basins straight eastward to the river (Hartman 1995a).

No conclusive evidence of downward migration of 183-H Basins waste constituents has been found. Well H4-12A is screened at the water table. Adjacent well H4-12C is screened at mid-depth in the Ringold Formation. Waste constituents in the two wells are plotted in Figures 3.3-11 and 3.3-12. Gross alpha, gross beta, and nitrate are low in the deeper well. Chromium is the only 183-H waste indicator elevated in well H4-12C. The source of the chromium is unknown.

3.3.6 Groundwater Flow

3.3.6.1 Groundwater Flow Direction. Groundwater in the 100-H Area flows toward the river, as inferred from plume configurations and the average water table. Figure 3.3-13 is a water table map of the 100-H Area constructed from September 1995. The contours indicate that flow is toward the east-northeast beneath the 183-H Basins, approximately perpendicular to the river channel. The shape of the gross alpha and gross beta plumes (Hartman 1995a) indicates that these constituents have migrated toward the east from the 183-H Basins.

Daily, weekly, and seasonal river level changes affect water levels and flow patterns in the 100-H Area. Seasonally high river levels temporarily reverse the hydraulic gradient near the river. Figure 3.3-14 shows the water table in June 1995 when the river stage was high. Water apparently flowed from the river into the aquifer during that time (see Section 3.3.5). When the river level falls, the river water stored in the bank flows back towards the river, and groundwater resumes its flow towards the river under a more typical gradient.

Well pairs such as H4-12A and H4-12B indicate that the vertical gradient within the uppermost unconfined aquifer system is generally upward, although the direction can be reversed at the shallowest levels in response to changes in river stage. At mid-depths in the Ringold Formation, the potential for flow is upward, as indicated by data from well H4-15CR. Vertical flow from the confined aquifers near the base of the Ringold Formation and upper Columbia River basalt units is upward. Evidence for this comes from flowing wells H4-2 and H4-15CP, both of which are completed in the uppermost basalt aquifer.

3.3.6.2 Rate of Flow. The rate of migration of waste constituents has been estimated using the following methods: numerical flow models, analyzing time delays in the downgradient migration of waste indicator "pulses," directly measuring speed and direction using an instrument lowered into a well, and calculations using the Darcy equation. A representative range of estimates is 0.3 to 3 m/d (1 to 10 ft/d).

Computer modeling based on an initial, limited water level data set indicated an average velocity of 0.31 m/d (1.0 ft/d) (Liikala et al. 1988). An estimate based on the migration of a single nitrate pulse suggested a value of 0.6 m/d (2 ft/d) (Hall 1989). Analysis of the migration rate of nitrate pulses in two pairs of wells downgradient from 183-H Basins over a 3-year interval suggested rates of 2.56 to 4.82 m/d (8.4 to 15.8 ft/d) (Peterson 1992). Nitrate travels at essentially the same rate as groundwater flow because that constituent is not sorbed onto sediments or reduced appreciably by chemical reactions.

Three devices designed to measure groundwater flow velocity directly have been used in the 100-H Area: the *In Situ* Permeable Flow Sensor (a permanently installed device), the Colloidal Borescope, and the K-V Associates Geoflow Meter. The in situ flow sensor did not produce meaningful results near the 183-H Basins. Results of the colloidal borescope and the K-V flow meter are summarized in Table 3.3-3. Results indicate that local flow directions are quite variable. Many measurements indicate a more northward flow than expected based on the water table map and plume configuration. Flow rates ranged from 0.65 to 4.92 m/d (2.1 to 16.1 ft/d).

The horizontal hydraulic gradient was calculated between wells H3-2A and H4-12A using data from September 1995:

difference in head:	0.83 m (2.7 ft)
horizontal distance:	417 m (1370 ft)
gradient:	2.0×10^{-3}.

The rate of groundwater flow can be estimated by using a form of the Darcy equation with a range of input parameters.

$$v = \frac{Ki}{n_e} \qquad (1)$$

where:

v = Average linear velocity of groundwater
K = Horizontal hydraulic conductivity
i = Hydraulic gradient
n_e = Effective porosity of the aquifer.

The following input parameters were used:

K = 15 to 130 m/d (50 to 430 ft/d) (PNL 1987 and Liikala et al. 1988)
i = 2×10^{-3}
n_e = 0.1 to 0.3.

The resulting estimate of groundwater velocity ranges from 0.1 to 2.6 m/d (0.3 to 9 ft/d), which is in general agreement with the estimates discussed earlier.

3.3.6.3 Evaluation of Monitoring Network. A final-status groundwater monitoring program was designed and implemented in September 1995 (Hartman and Chou, 1995). The network includes six downgradient wells and two upgradient wells (see Table 3.3-1). These wells will be monitored for ^{99}Tc, uranium, chromium, and nitrate.

A pump-and-treat system for chromium is being planned for the 100-HR-3 Operable Unit. Pumping wells will be located in the most concentrated part of the chromium plume, which is downgradient of the 183-H Basins. The system will change groundwater flow and chemistry and the RCRA network will probably no longer be adequate. A new approach to monitoring will be developed in the future.

3.3.7 References

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Figure 3.3-1. Monitoring Well Locations for the 100-H Area.

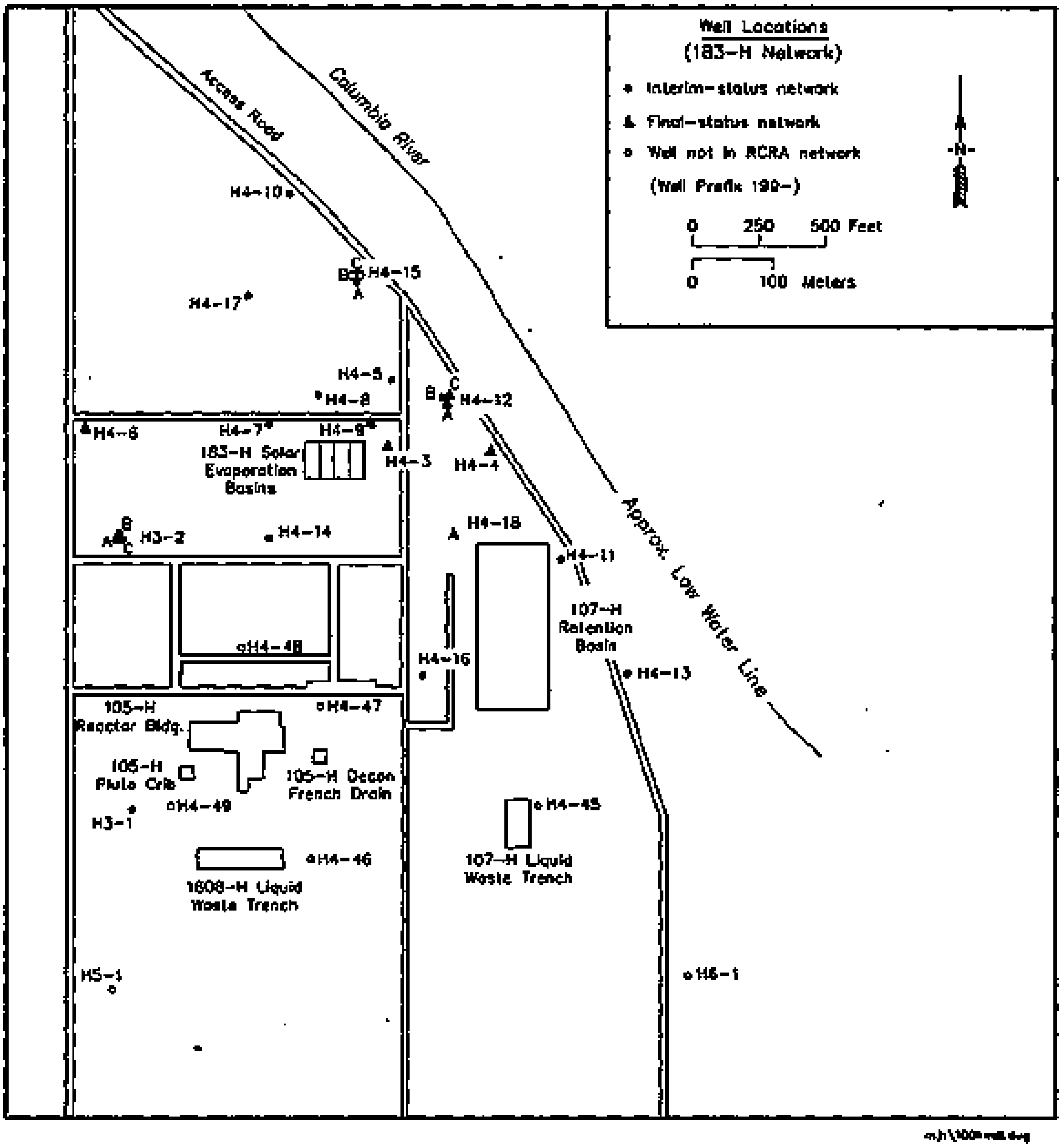


Figure 3.3-2. Generalized Hydrogeology of the 100-H Area (Lindsey 1993).

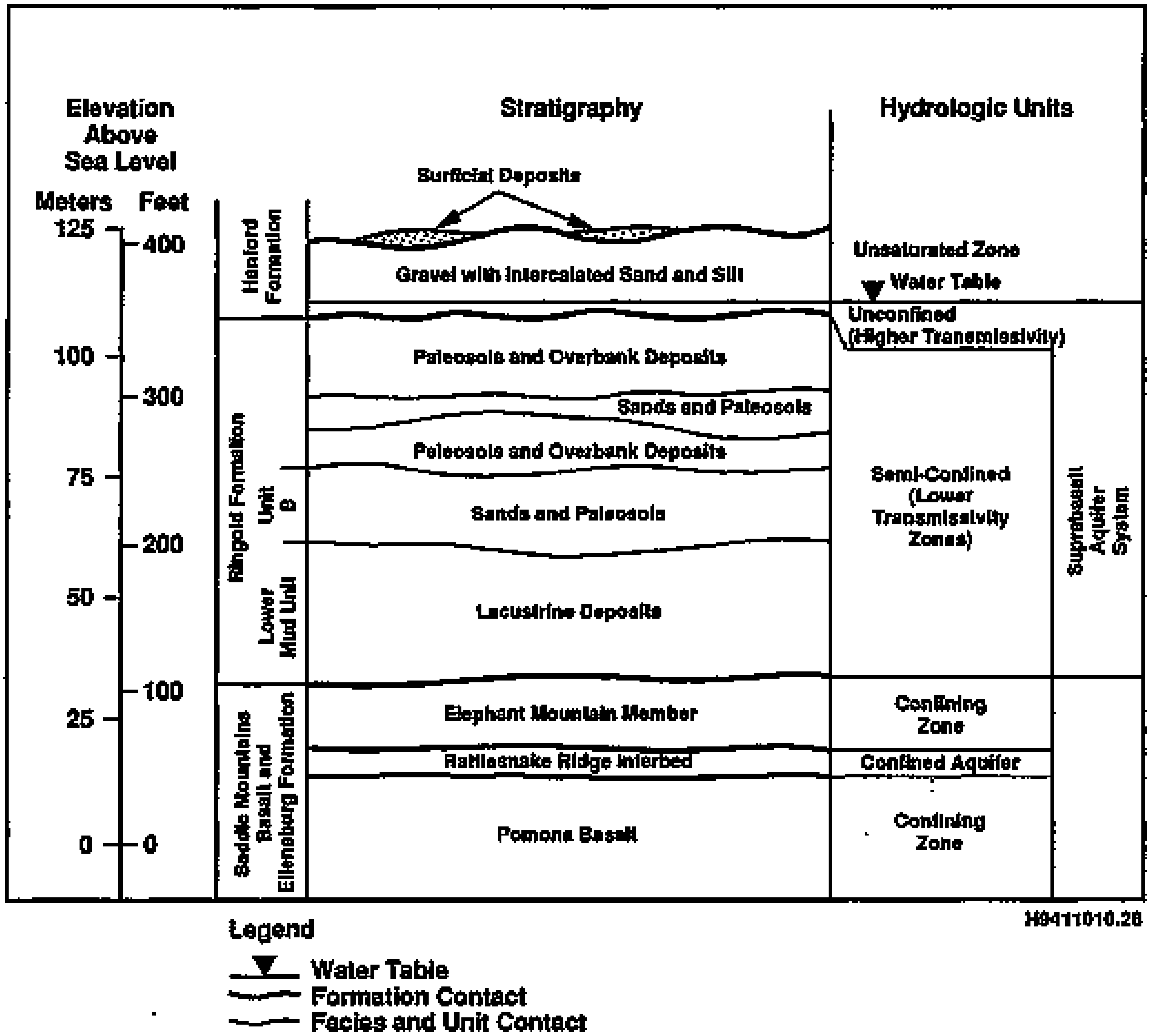
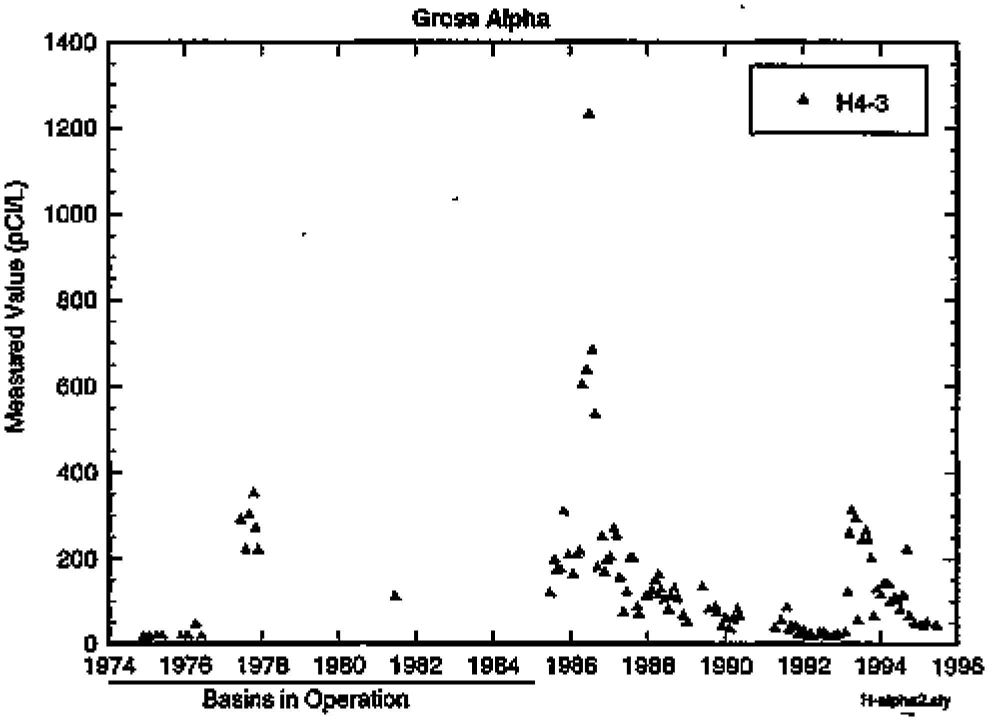


Figure 3.3-3. Gross Alpha and Nitrate in Well H4-3.



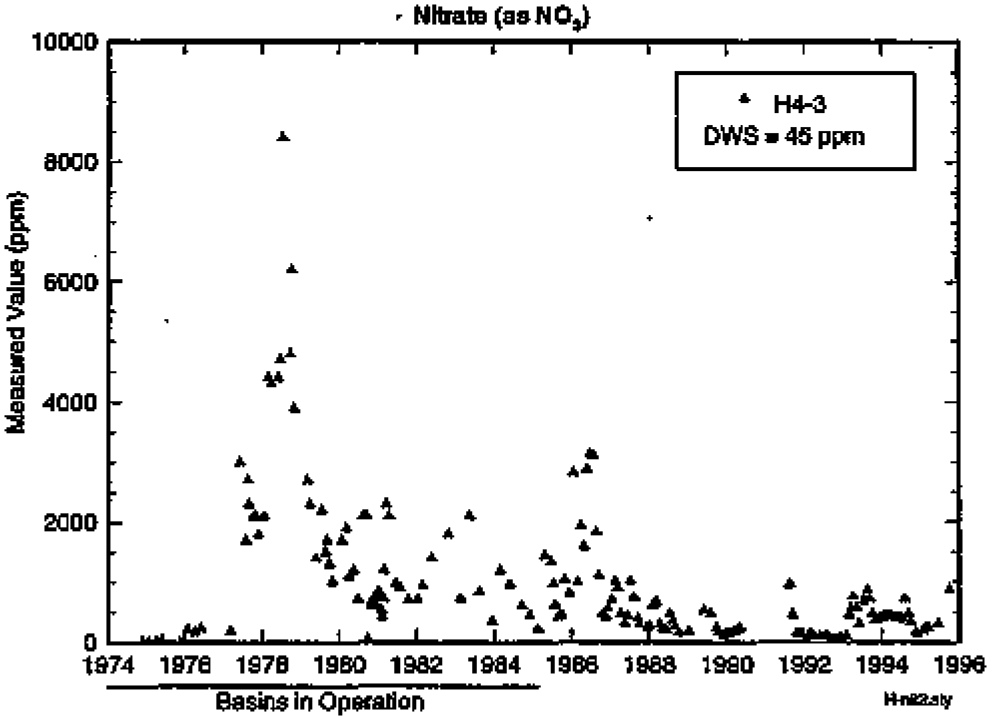


Figure 3.3-4. Gross Alpha and Gross Beta Versus Time in 183-H Solar Evaporation Basins Plume Wells.

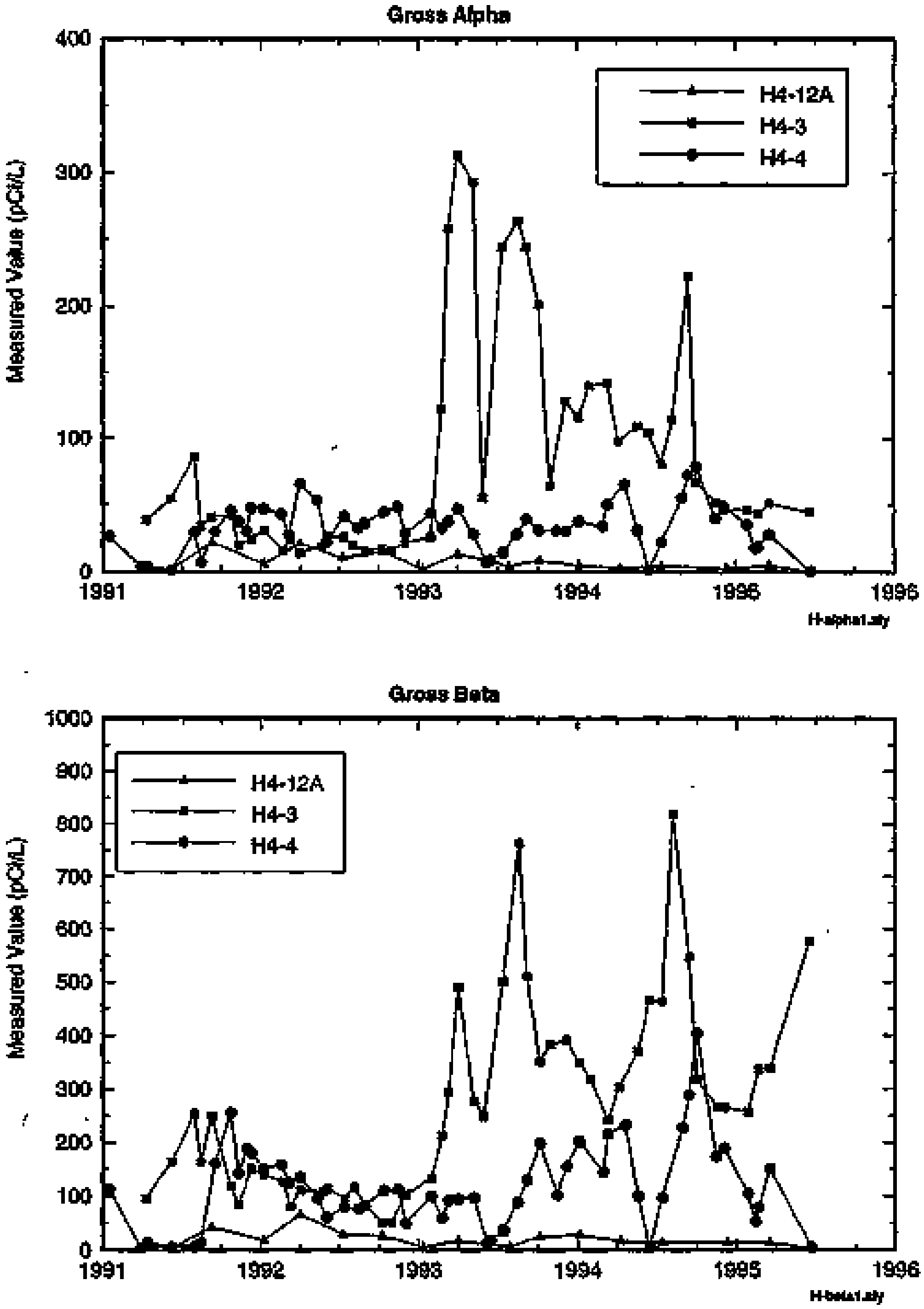


Figure 3.3-5. Nitrate and Sulfate Versus Time in 183-H Solar Evaporation Basins Plume Wells.

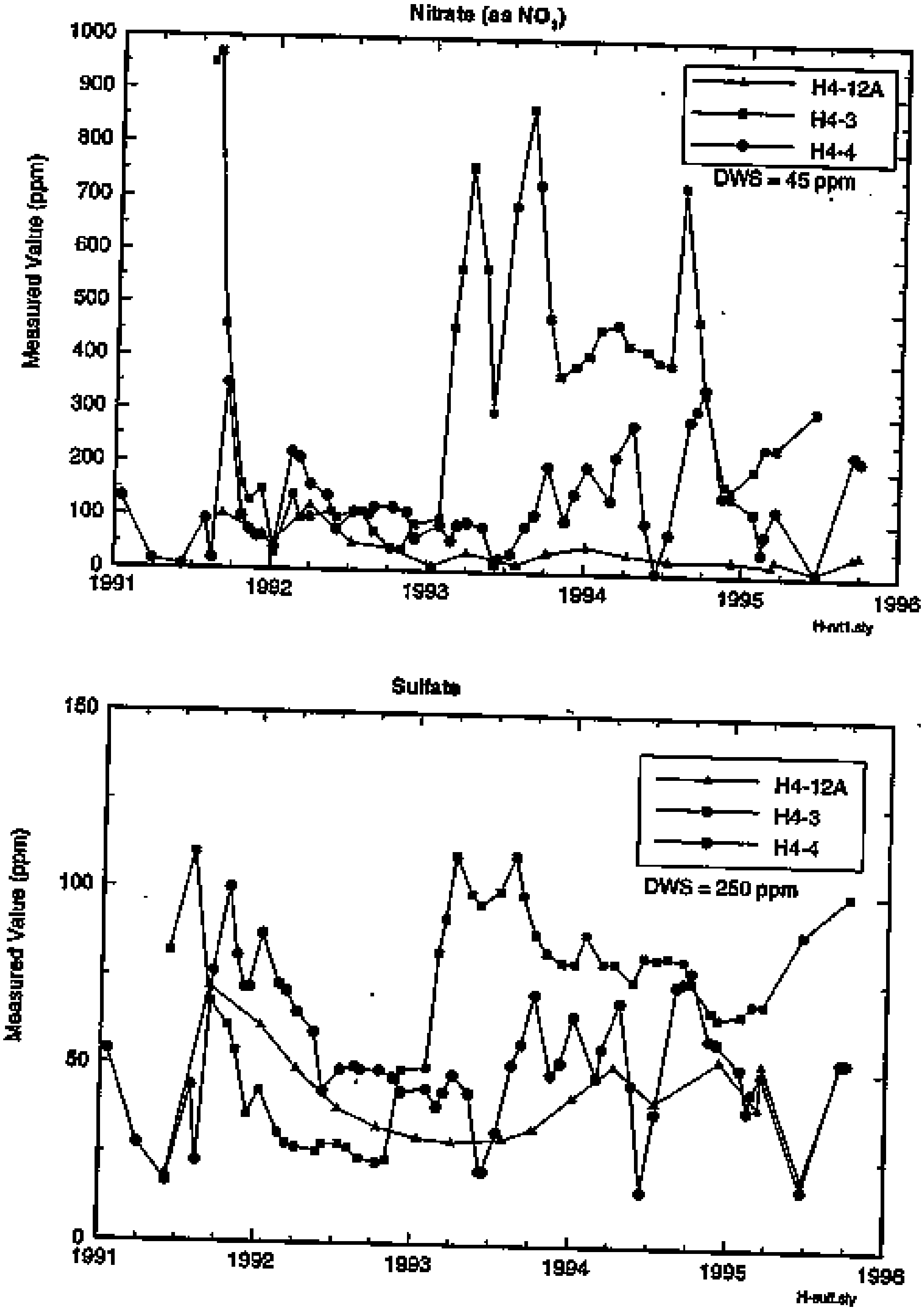


Figure 3.3-6. Chromium Versus Time in 183-H Solar Evaporation Basins Plume Wells.

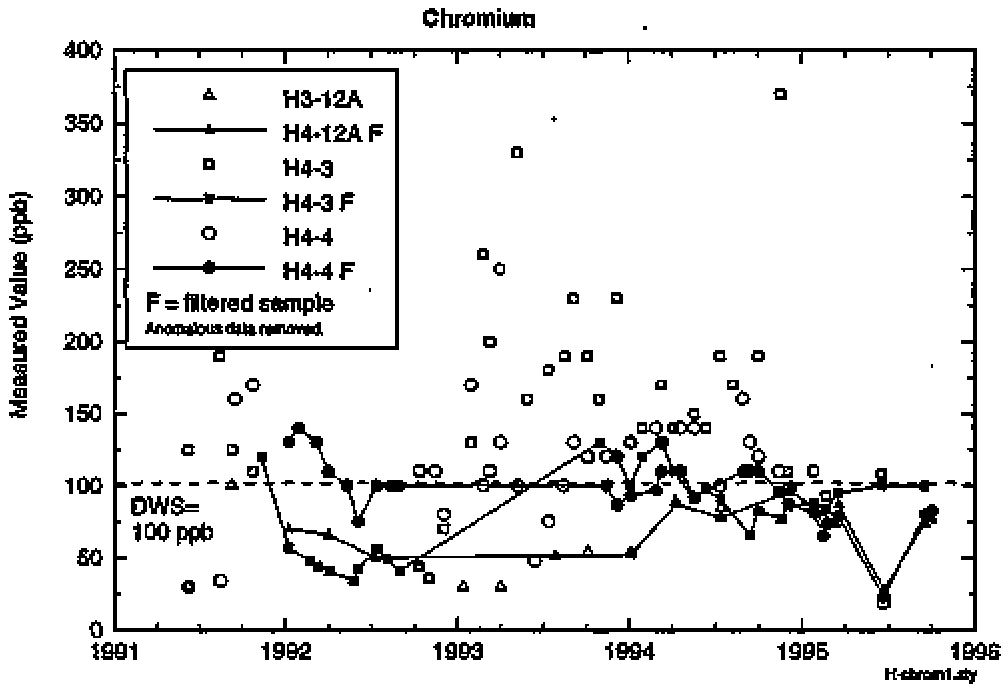


Figure 3.3-7. Gross Alpha in the Uppermost Aquifer Beneath the 100-H Area, June 1995.

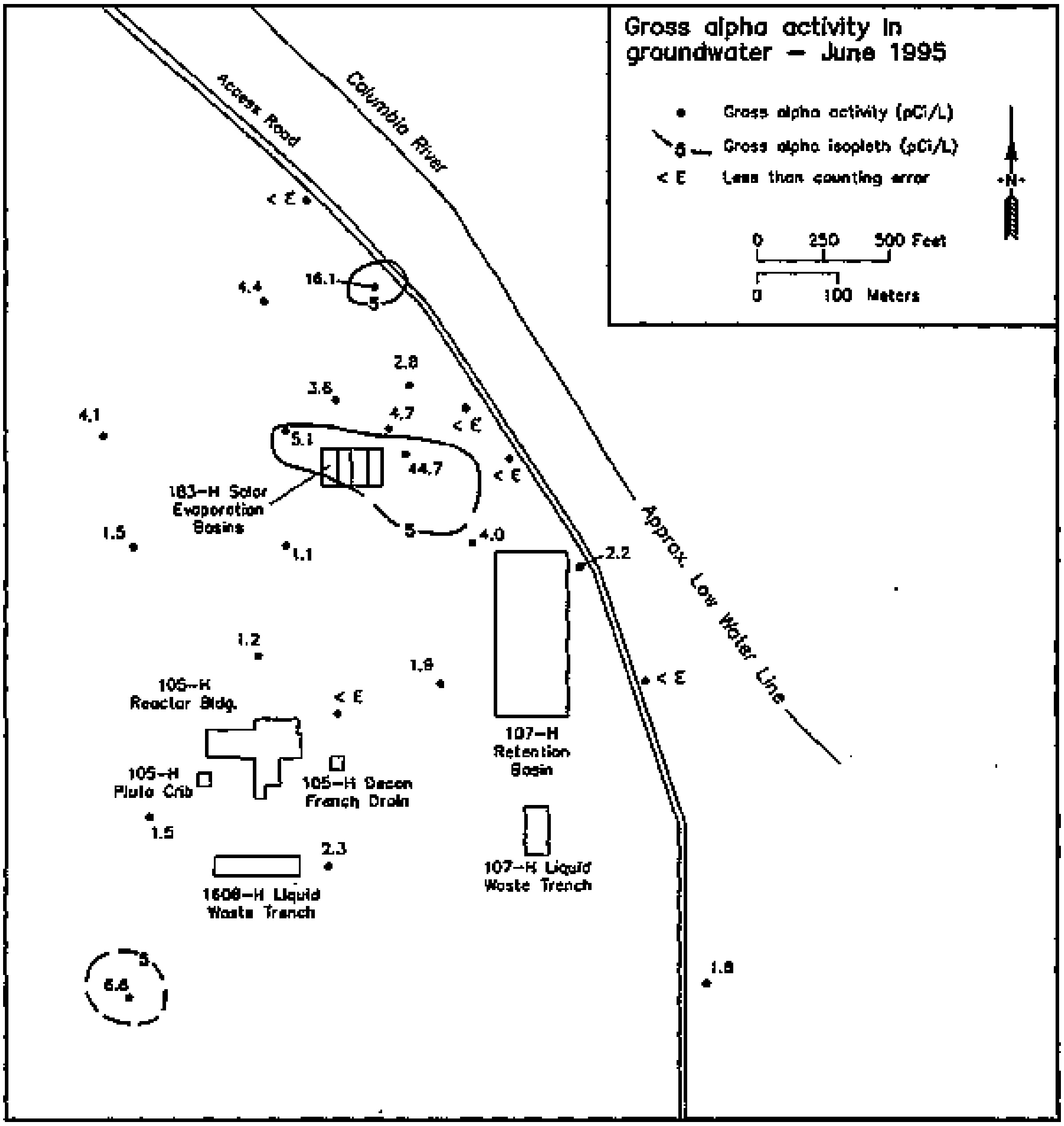


Figure 3.3-8. Gross Beta in the Uppermost Aquifer Beneath the 100-H Area, June 1995.

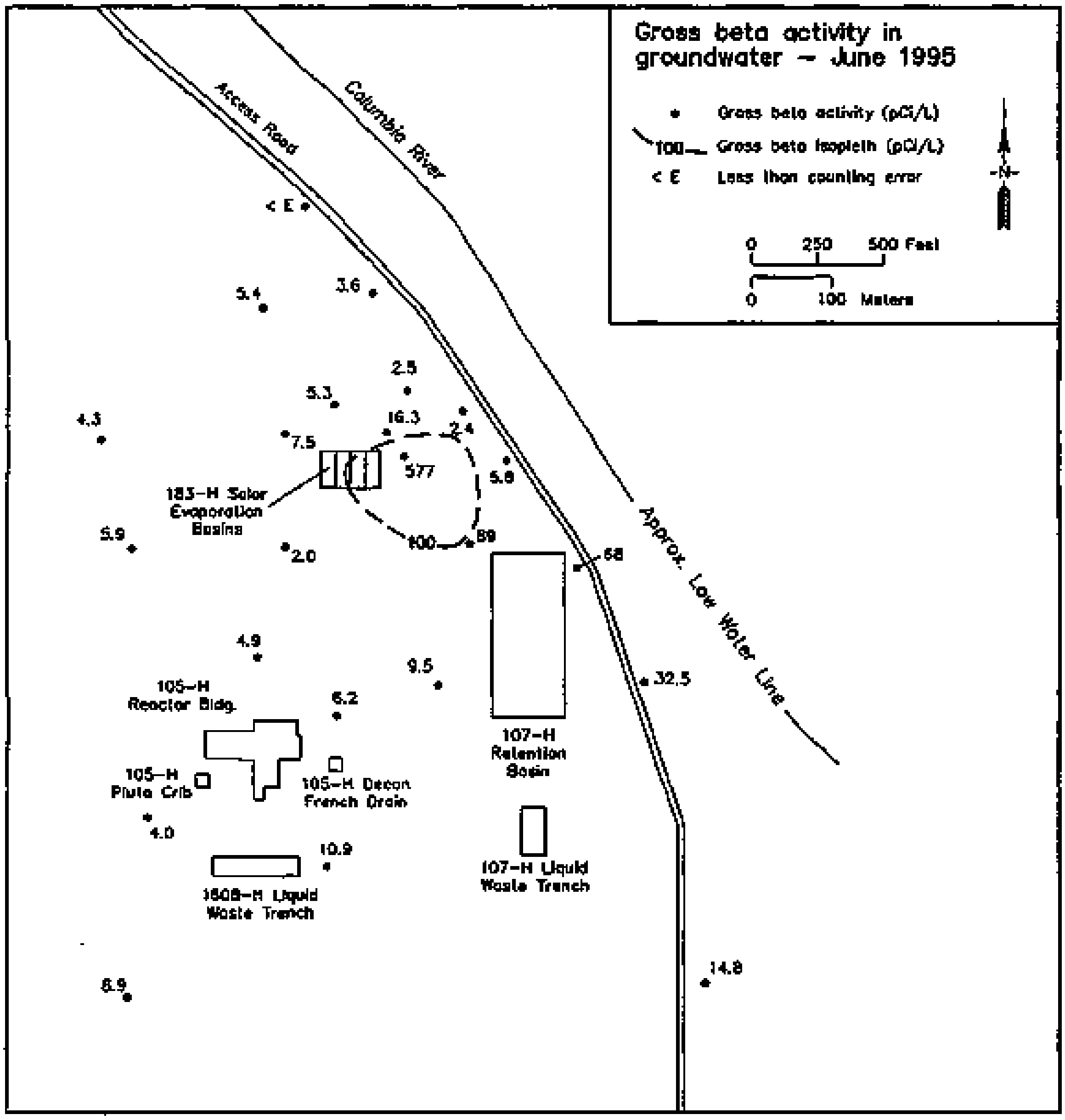


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Figure 3.3-9. Nitrate in the Uppermost Aquifer Beneath the 100-H Area, June 1995.

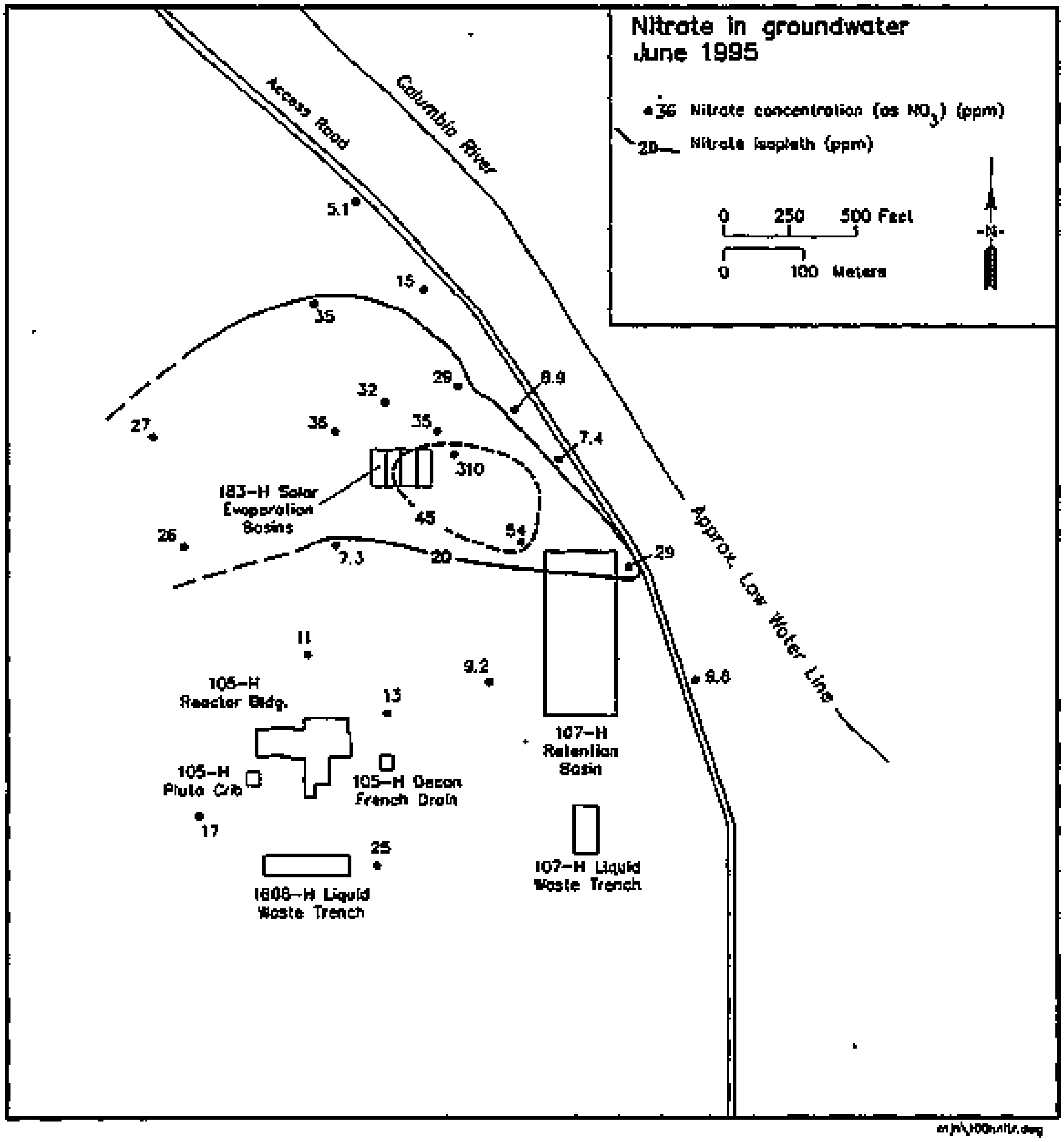


Figure 3.3-10. Chromium in the Uppermost Aquifer Beneath the 100-H Area, June 1995.

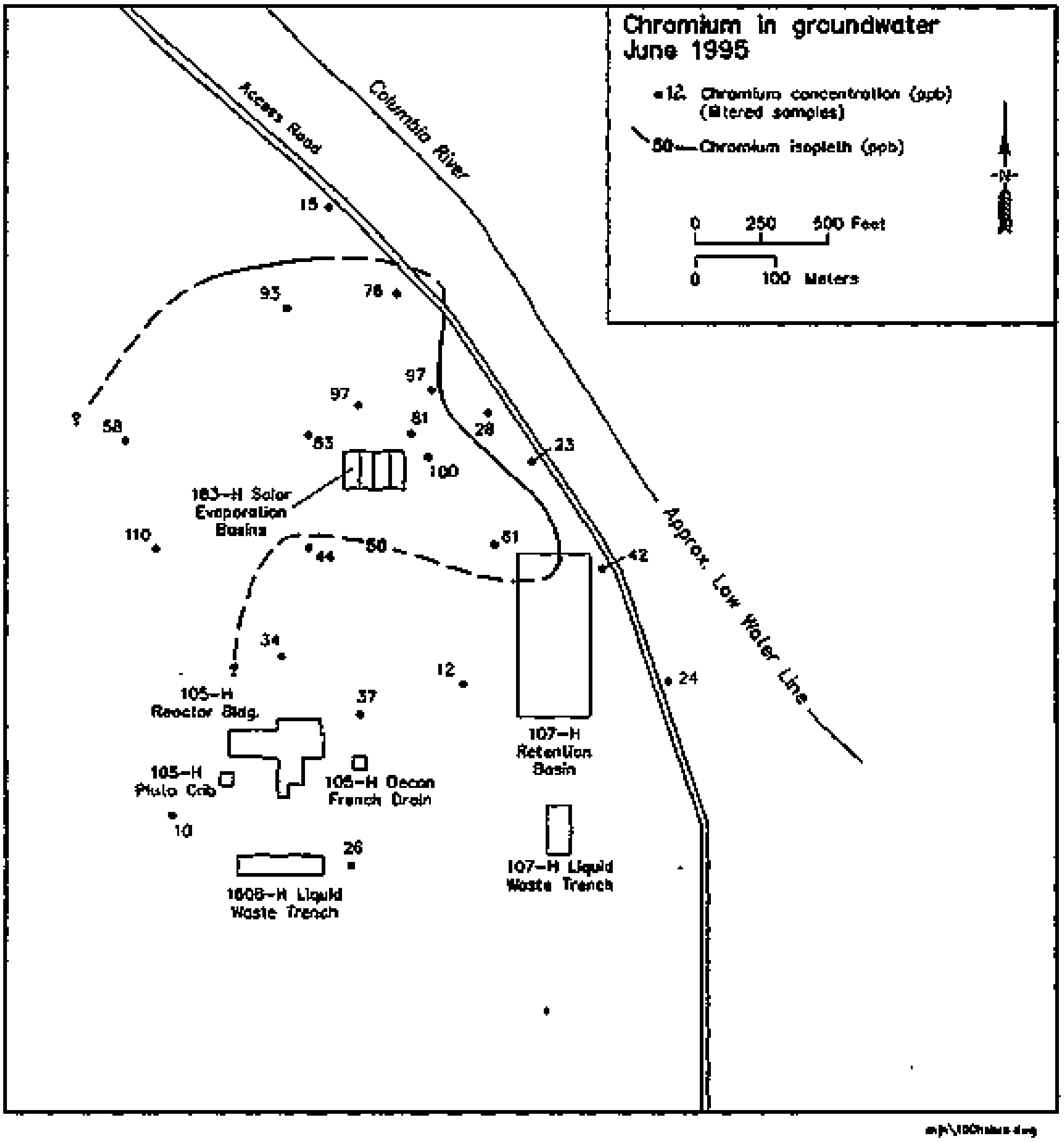


Figure 3.3-11. Gross Alpha and Gross Beta Versus Time in Wells H4-12A and H4-12C.

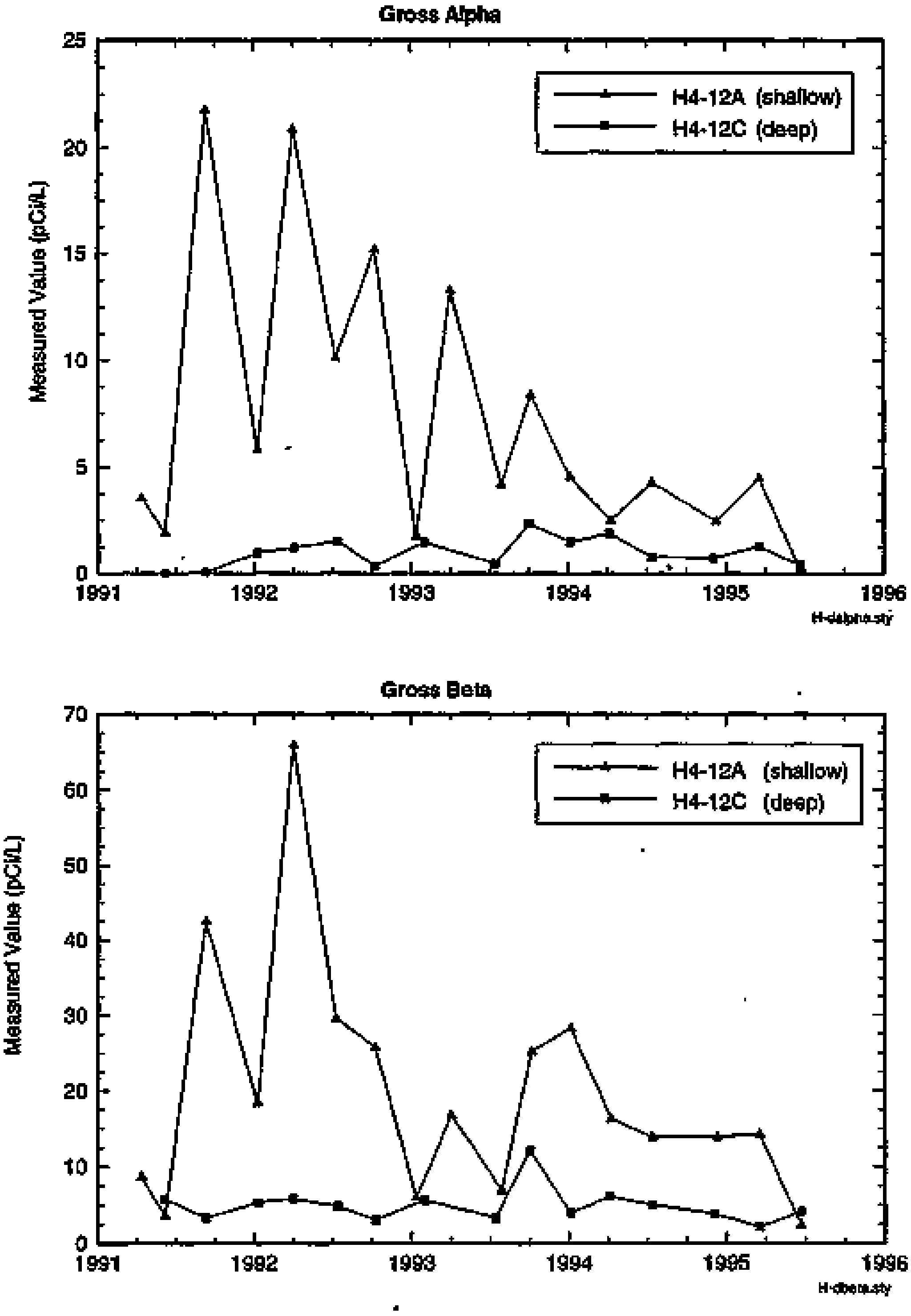


Figure 3.3-12. Nitrate and Chromium Versus Time in Wells H4-12A and H4-12C.

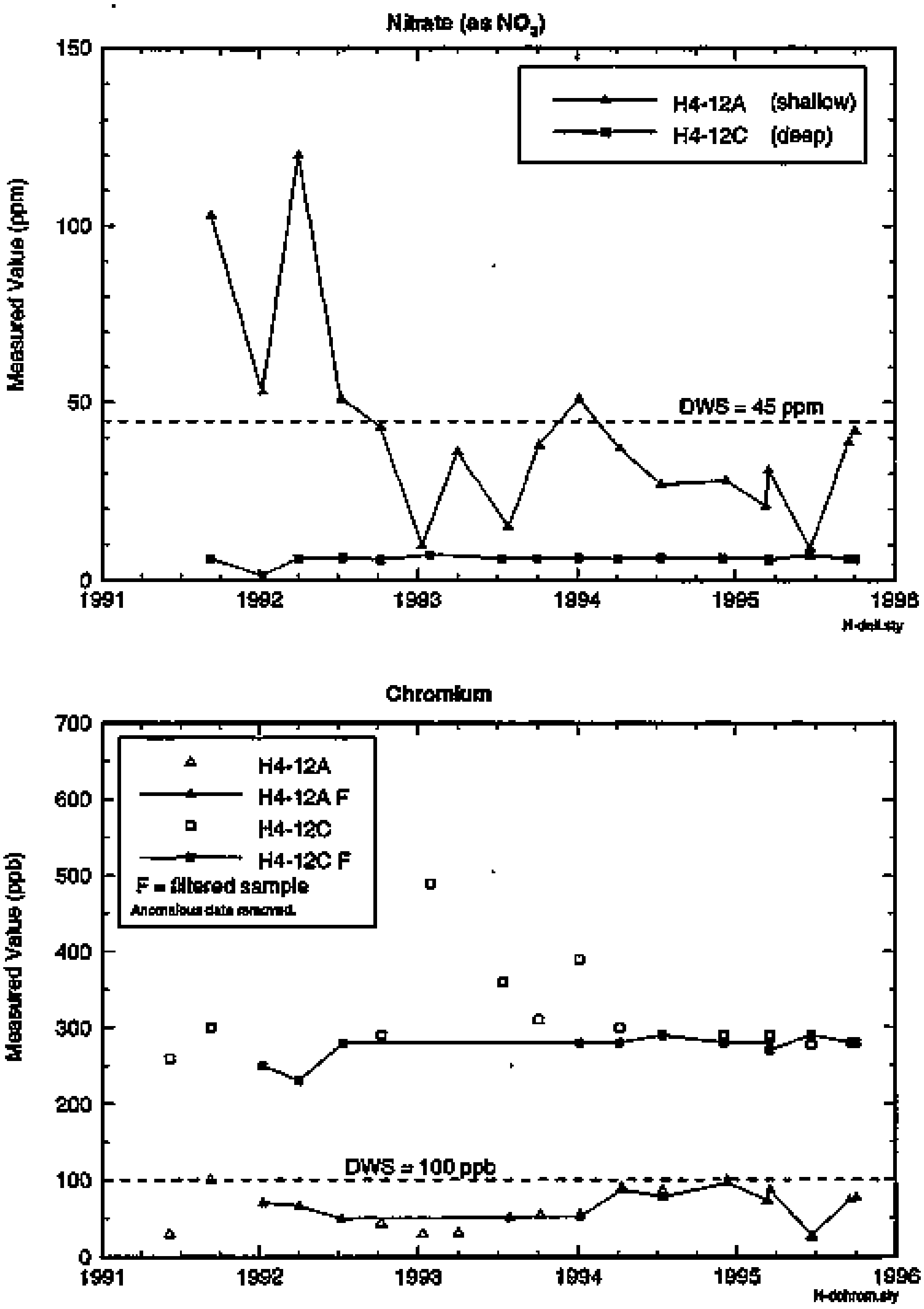


Figure 3.3-13. Water Table in the 100-H Area, September 1995.

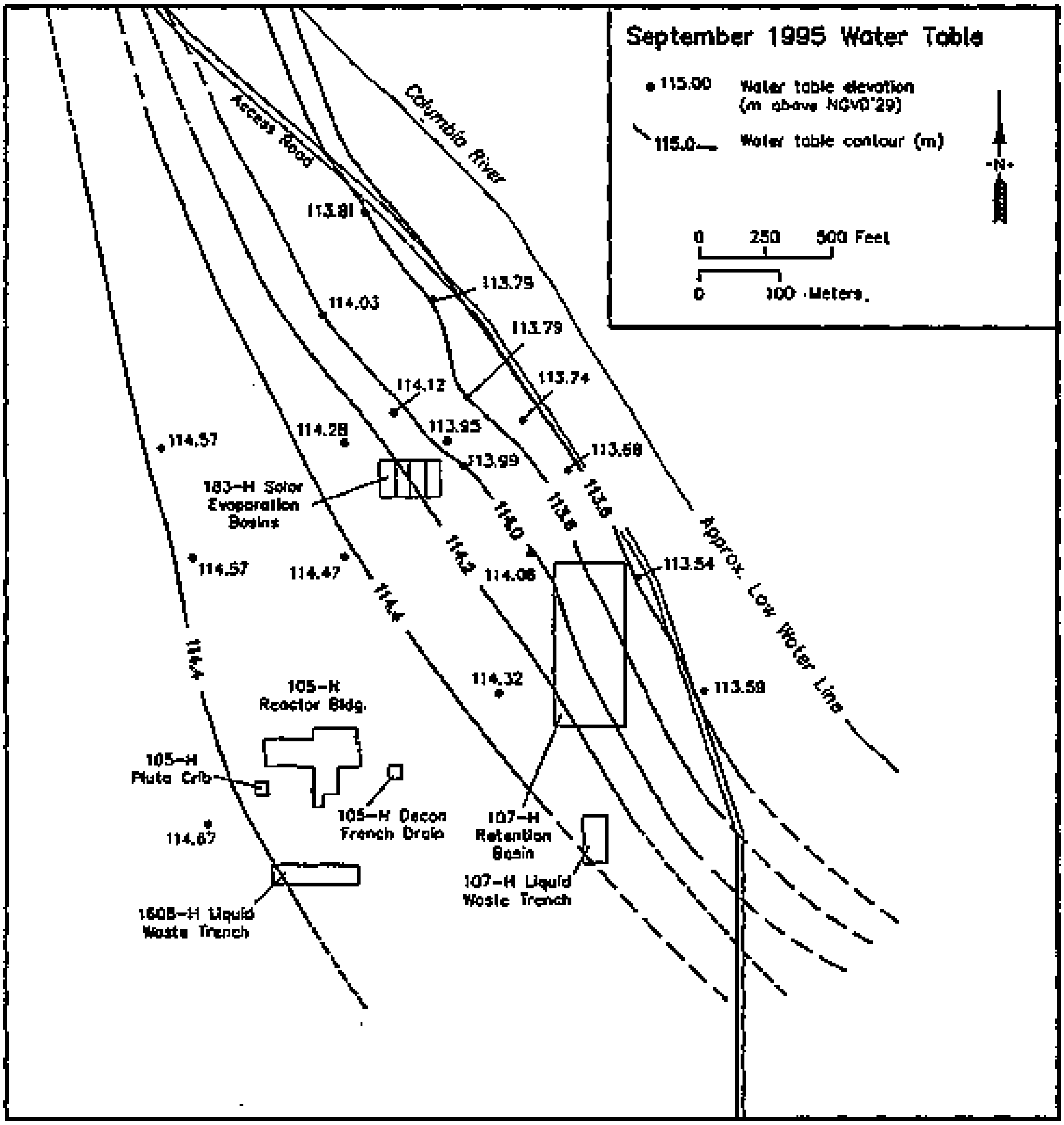
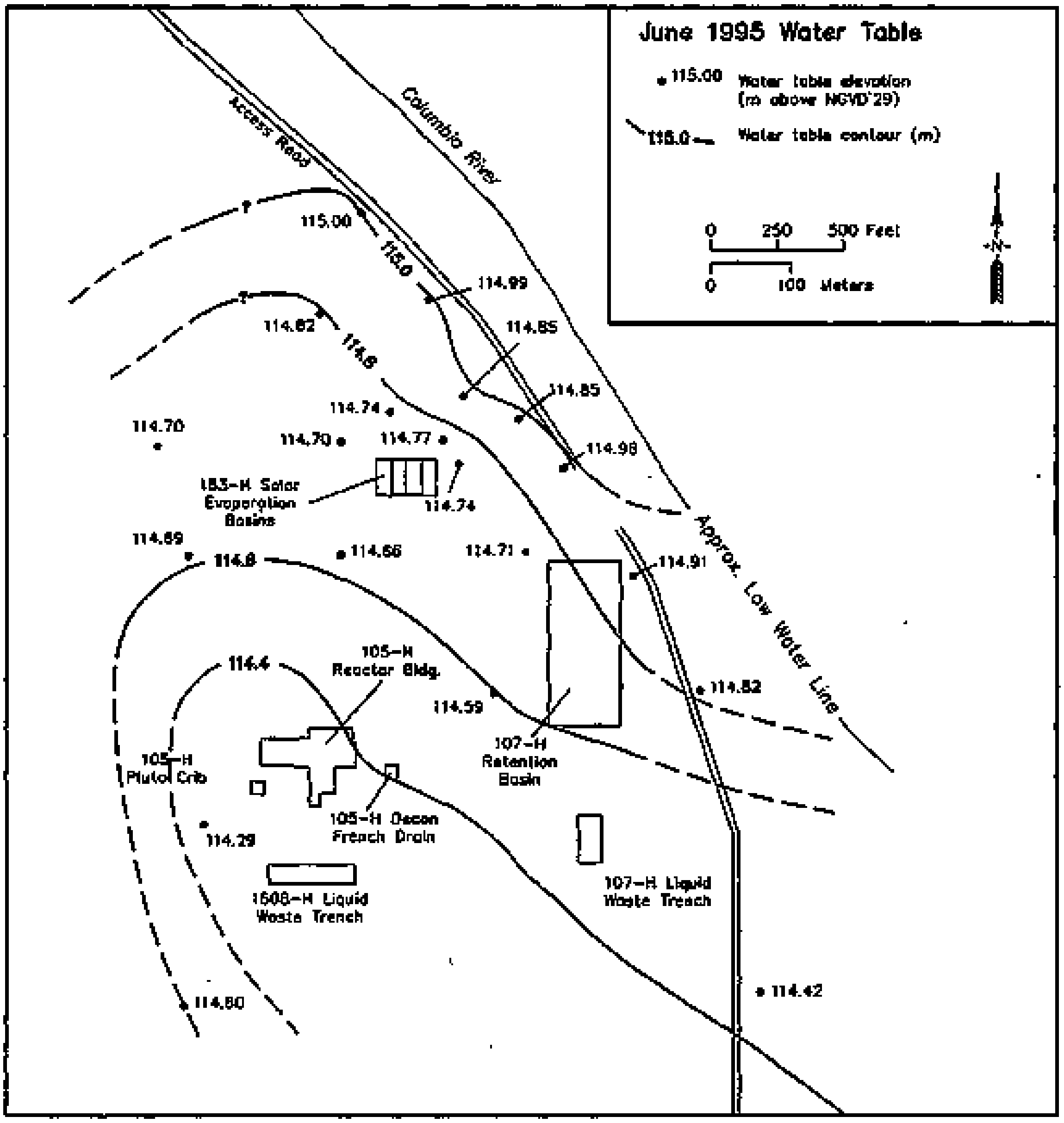


Figure 3.3-14. Water Table in the 100-H Area, June 1995.



m/h\100hwtjn.dwg

Table 3.3-1. Monitoring Wells in 183-H Solar Evaporation Basins Network.

Well no. (199-)	Hydrologic unit monitored	Sampling frequency[a]	Well standards	Other networks
H3-1^{1960}	Top of unconfined	Annually	PRE	HR3, Sitewide
H3-2A^{1986}	Top of unconfined	Quarterly	RCRA	Sitewide
H3-2B^{1986}	Top of unconfined	Annually	RCRA	Sitewide
H3-2C^{1986}	Mid-depth unconfined	Quarterly	RCRA	--
H4-10^{1986}	Top of unconfined	NS	RCRA	HR3
H4-11^{1986}	Top of unconfined	Quarterly	RCRA	--
H4-12A^{1986}	Top of unconfined	Quarterly	RCRA	Sitewide
H4-12B^{1986}	Top of unconfined	Annually	RCRA	Sitewide
H4-12C^{1986}	Mid-depth unconfined	Quarterly	RCRA	Sitewide
H4-13^{1986}	Top of unconfined	NS	RCRA	HR3
H4-14^{1986}	Top of unconfined	Quarterly	RCRA	--
H4-15A^{1986}	Top of unconfined	Quarterly	RCRA	HR3
H4-15B^{1986}	Top of unconfined	NS	RCRA	Sitewide
H4-15Cq^{1986}	Bottom of unconfined	NS	RCRA	--
H4-15Cr^{1986}	Mid-depth unconfined	NS	RCRA	--
H4-15Cs^{1986}	Mid-depth unconfined	NS	RCRA	--
H4-16^{1987}	Top of unconfined	Annually	RCRA	HR3, Sitewide
H4-17^{1987}	Top of unconfined	Annually	RCRA	HR3, Sitewide
H4-18^{1987}	Top of unconfined	Quarterly	RCRA	Sitewide
H4-3^{1974}	Top of unconfined	Monthly[b]	PRE	--
H4-4^{1983}	Top of unconfined	Monthly[b]	PRE	Sitewide, DOH
H4-5^{1983}	Top of unconfined	Quarterly	PRE	--
H4-6^{1983}	Top of unconfined	Quarterly	PRE	--
H4-7^{1986}	Top of unconfined	Quarterly	RCRA	Sitewide
H4-8^{1986}	Top of unconfined	Quarterly	RCRA	Sitewide
H4-9^{1986}	Top of unconfined	Monthly[b]	RCRA	Sitewide

Notes: This table represents interim-status network, which was in place prior to September 1995. Thick outlines denote wells in the final-status network, which will be sampled semiannually. Superscript following well number denotes year installed. Shading denotes upgradient well.

[a] Water levels are measured quarterly in all wells.
[b] Monthly until April 1995; quarterly remainder of year.

DOH = Washington State Department of Health.
HR3 = 100-HR-3 groundwater operable unit.
NS = not sampled (piezometer).
PRE = constructed before RCRA standards.
RCRA = in compliance with RCRA construction standards.
Sitewide = Sitewide Environmental Surveillance Program.

Table 3.3-2. Constituent List for the 183-H Solar Evaporation Basins (interim status, before September 1995).

Specific conductance	Total organic carbon	Gross alpha
(field)	Total organic	Gross beta
pH (field)	halogen Alkalinity	Uranium
Turbidity	ICP metals (filtered)	^{99}Tc
	Anions	

Table 3.3-3. Groundwater Flow Estimates from Direct Methods.

Device	Depth below top of casing	Average direction	Average flow rate
Well H4-7			
K-V flow meter	14 m	N 10° E	0.65 m/d
Colloidal borescope	14 m	N 8° W	4.32 m/d
Well H3-2A			
K-V flow meter	12.8 m	S 62° E	1.38 m/d
	14.9 m	N 23° W	4.92 m/d
Colloidal borescope	12.8 m	N 9° W	2.42 m/d
	14.9 m	swirling flow	swirling flow
Well H4-48			
K-V flow meter		NE (not quantified)	1 m/d

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4.1 216-S-10 POND AND DITCH

J. W. Lindberg
Westinghouse Hanford Company

4.1.1 Facility Overview

A *Resource Conservation and Recovery Act of 1976* (RCRA) groundwater monitoring network has been established according to the RCRA Interim-Status Groundwater Monitoring Plan (WHC 1990) for the 216-S-10 Pond and Ditch (referred to as the S-10 Facility). This facility operates under RCRA interim-status regulations (40 *Code of Federal Regulations* [CFR] 265). The site is currently in the indicator parameter evaluation program. The site is also within the 200-UP-1 operable unit of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*.

The S-10 Facility is located south-southwest of the 200 West Area, directly outside the perimeter fence (see Figure 4.1-1). Initially the S-10 Facility consisted of an open, unlined ditch that was 1.82 m (6 ft) deep, 1.21 m (4 ft) wide at the bottom, and 685.8 m (2,250 ft) long. An open, unlined percolation pond, constructed at the southwest end of the 216-S-10 Ditch and approximately 2.0 ha (5 acres) in size, also was active during part of the time that the ditch was receiving waste (S-10 Pond).

The 216-S-10 Ditch began receiving wastewater from the Reduction-Oxidation (REDOX) Plant in August 1951. The 216-S-10 Pond was excavated and placed in service in February 1954. In October 1985, the 216-S-10 Pond and portions of the 216-S-10 Ditch were decommissioned, backfilled, and interim stabilized. The remaining portion of the 216-S-10 Ditch received nondangerous, nonregulated wastes from the 202-S Building chemical sewer. The waste stream comprised cooling water, steam condensate, water tower overflow, and drain effluent. From 1985 to October 1991, physical controls and operating procedures were modified to avoid inadvertent discharge of hazardous chemicals to the wastewater stream. The effluent stream to the S-10 Facility was permanently deactivated in October 1991. The S-10 Facility will not receive additional dangerous substances but will be closed in final status pursuant to the authorized State Dangerous Waste Program in accordance with *Washington Administrative Code* (WAC) 173-303-610 (Ecology et al. 1994).

Releases of dangerous materials and constituents to the S-10 Facility are poorly documented. Radioactive waste was reportedly disposed to the S-10 Facility as a result of contaminated floor and sewer drains at the REDOX Plant. Hazardous chemical releases were documented in 1954 and 1983 and included $Al(NO_3)_3$, $NaNO_3$, NaOH, Na_3PO_4, NaF, NaCl, and $K_2Cr_2O_7$.

Stratigraphy at the S-10 Facility includes the following (from upper to lower):

- About 52 m (171 ft) of Hanford formation consisting of silt and sand
- 1.8 m (6 ft) of Plio-Pleistocene unit composed of silty sandy gravel capped with a 0.3-m (1-ft) layer of caliche

- 14 m (45 ft) of upper Ringold unit sand
- 61 m (199 ft) of Ringold Formation unit E composed of sandy gravel
- Approximately 15 m (50 ft) of the lower mud unit of the Ringold Formation.

The top of the lower mud unit is the base of the uppermost aquifer system at the S-10 Facility. Most of the uppermost aquifer is within gravel unit E of the Ringold Formation. However, the water table is approximately 2 m (7 ft) above unit E in the upper Ringold unit. Depth to water varies from 55 m (180 ft) toward the southwestern end of the S-10 Facility to about 67 m (220 ft) toward the northeastern end because of topography (drainage).

In 1991 approximately 1.89 x 10^8 L (5.0 x 10^7 gal) of effluent were discharged to the 216-S-10 Ditch. This and previous discharges created a local recharge mound and an associated perched water table directly below the receiving end of the 216-S-10 Ditch. In 1990 well 299-W26-11 was installed to monitor the perched aquifer. Perching occurred on the silt and fine sand within the lower portion of the Hanford formation or possibly the caliche layer at the top of the Plio-Pleistocene unit. Depth to water in the perched zone was about 38 m (125 ft). However, when surface water discharges ceased in 1991, the perched water began receding. The water level within the well installed in this perched zone (299-W26-11) dropped below the level of the well screen shortly after the surface water discharges ceased at the S-10 Facility.

4.1.2 Summary of 1995 Activities

Sampling and analysis were performed for the wells in the monitoring network according to the RCRA Interim-Status Groundwater Monitoring Plan (WHC 1990). The facility now has two upgradient and four downgradient monitoring wells (Figure 4.1-1). This monitoring network will be used to monitor groundwater levels and water quality before and after closure of the facility. During FY 1995 the wells of the monitoring network were sampled semiannually and water levels were measured quarterly (except for well 299-W27-2, which was measured semiannually) under the indicator parameter evaluation program. The sampling dates were December 7, 1994, and June 13-15, 1995. In addition, well 299-W27-2 was not sampled with the others on December 7, 1994, but was sampled January 20, 1995.

4.1.3 Sampling and Analysis Program

The groundwater monitoring plan for the S-10 Facility (WHC 1990) establishes the justification and requirements for the monitoring network. The current monitoring well network consists of six wells as shown in Figure 4.1-1 and listed in Table 4.1-1. Five monitor the upper portion of the unconfined aquifer, and one (299-W27-2) monitors the base of the unconfined aquifer. The wells in the monitoring network were sampled for contamination indicator parameters, some drinking water standards (DWS) (40 CFR 265, Appendix III), groundwater quality parameters, and site-specific parameters, as identified in Table 4.1-2. Site-specific parameters were selected based on a history of waste disposed of at this site and in surrounding cribs.

4.1.4 Groundwater Chemistry

A brief discussion of the analytical data available for 1995 is provided in Sections 4.1.4.1 and 4.1.4.2. Tables summarizing the available analytical data for the year can be found in the RCRA quarterly reports (Lindberg 1994, 1995a, 1995b, and 1996).

4.1.4.1 Constituents of Concern

Groundwater quality parameters, drinking water parameters, and site-specific parameters did not exceed DWS during 1995 except for chromium, iron, manganese, and carbon tetrachloride (tetrachloromethane). The exceedances for chromium, iron, and manganese were in wells 299-W26-7, -8, -10, and -12 and were for unfiltered samples except for one sample from 299-W26-7. The highest chromium result was 340 ppb (DWS 100 ppb) in well 299-W26-8. The highest iron result was 5,000 ppb (DWS 300) in well 299-W26-10, as was the highest manganese result (100 ppb) (DWS 50 ppb). Wells 299-W26-7 and -8 are upgradient wells suggesting that the elevated concentrations of these metals may not be caused by wastewater from the 216-S-10 Facility. High levels of these metals also have been reported in the past in Hanford Site wells and are assumed to be artifacts of well construction or the use of stainless steel screens. A concentration of 5.3 ppb of carbon tetrachloride (DWS 5.0 ppb) was discovered in well 299-W27-2 for one sample taken January 20, 1995. The occurance of carbon tetrachloride above the DWS correlates well with the elevated TOX in that well at the same time (TOX 11.7-17.5 ppb). The elevated carbon tetrachloride and TOX are probably caused by upgradient sources (Figure 2-10). Well 299-W27-2 is screened at the bottom of the unconfined aquifer, and there are no upgradient wells corresponding to the same depth at the 216-S-10 Facility.

Well 299-W26-8 continues to show slightly elevated levels of gross alpha (Figure 4.1-2). The cause of the elevated gross alpha is probably uranium, which also is in higher concentrations in well 299-W26-8 (Figure 4.1-3). Because this well is upgradient of the 216-S-10 Facility, the source of the uranium concentrations may be from the area of the 216-U-10 Pond, which is known to have received radioactive wastewater (DOE-RL 1992).

There were a few anomalous exceedances of indicator parameters. In the December 1994 sampling, pH exceeded the critical range (6.74-9.04) with field results of 4.51 and 4.11 in wells 299-W26-8 and -10, respectively. These results do not fit the historical trend for these wells, and laboratory results do not corroborate these results. A RADE was submitted. Results of subsequent verification sampling confirmed that these pH exceedances were caused by errors in the field measurements. Results for pH exceeded the DWS (8.5) in well 299-W26-8 for the June 1995 sampling, but did not exceed the critical range for pH. These high pH results are typical of this upgradient well.

Well 299-W27-2, which monitors the base of the unconfined aquifer, continues to have high specific conductance and, in the sample collected in January 1995, showed elevated TOX levels (11.7 to 17.5 ppb). Specific conductance is typically in the range of 330 to 360 μmhos/cm for this well. Because well 299-W27-2 monitors a different portion of the aquifer than the other wells of the network, it is inappropriate to compare the analytical results with the critical mean. Results from well 299-W27-2 are used as supplemental information only.

4.1.4.2 Statistical Evaluation. Statistical evaluations of data for the past year at the S-10 Facility consisted of the required comparisons of indicator parameters between upgradient and downgradient wells for any indication of contamination in the groundwater underlying the facility. Statistical methods are described in Appendix C. The contamination indicator parameters for the S-10 Facility include field specific conductance, field pH, total organic carbon (TOC), and total organic halogen (TOX). Statistical analyses required by 40 CFR 265.93(b) and WAC 173-303-400 were performed on the samples collected from August 1991 to June 1992 for upgradient wells 299-W26-7 and 299-W26-8. Results are presented in Table 4.1-3. This table lists the background average, background standard deviation, and critical mean (or critical range, in the case of pH) for the four contamination indicator parameters. The critical mean (or critical range) is the value to which future averages of quadruplicate measurements are compared. The upgradient/downgradient comparison value is generally the critical mean or critical range. The limit of quantitation is used instead of the critical mean as the comparison value for TOC because most of the upgradient concentrations were below the contractually required quantitation limits (see Appendix C).

If the average from a downgradient well for a parameter exceeds the upgradient/downgradient comparison values listed in Table 4.1-3, that parameter is considered statistically different from background. If this is confirmed by subsequent verification sampling and analysis, the regulatory program is triggered into assessment. Except for the error (false positive) in measuring pH at wells 299-W26-8 and -10, none of the samples collected during the last year for the upper portion of the unconfined aquifer had indicator parameters that exceeded the critical means (or in the case of pH, critical range). However, field specific conductance for well 299-W27-2 ranged from 339 to 354 μmho/cm. The critical mean for field-specific conductance is 301.1 μmho/cm. Although groundwater samples collected from well 299-W27-2 exceed the critical mean for field-specific conductance, it is inappropriate to compare these analytical results with the critical mean because well 299-W27-2 samples the bottom of the unconfined aquifer. [Furthermore, the average specific conductance background value for the Hanford Site is 332 ±93 (Johnson 1993).] The critical means were calculated from samples and analytical results corresponding to the upgradient wells (299-W26-7 and 299-W26-8) that sample groundwater in the upper portion of the unconfined aquifer.

4.1.5 Groundwater Flow

4.1.5.1 Groundwater Flow Direction. Tables summarizing available water level data are reported in the RCRA quarterly reports (Lindberg 1994, 1995a, 1995b, and 1996). Figure 4.1-4 depicts the contoured water table elevations for the unconfined aquifer for June 1995. This figure indicates that the flow direction is toward the east to southeast beneath the S-10 Facility. This general flow direction coincides with the regional groundwater map (see Figure 2-4). Vertical groundwater flow (June 1995) in the vicinity of wells 299-W27-2 and 299-W26-12 is slightly upward [i.e., head in well W27-2 (138.54 m) is slightly higher than in well W26-12 (138.42 m)]. Well hydrographs (Figure 4.1-5) show the continued declines in water table elevations with time at the S-10 Facility.

4.1.5.2 Rate of Flow. The rate of horizontal groundwater flow can be estimated by using a form of the Darcy equation with a range of input parameters.

$$v = \frac{Ki}{n_e} \qquad (1)$$

where:

v = Average linear velocity of groundwater
K = Horizontal hydraulic conductivity
i = Hydraulic gradient
n_e = Effective porosity of the aquifer.

The following input parameters were used:

K = 10 m/d (34 ft/d) (Williams and Barnett 1993); 12 to 152 m/d (40 to 500 ft/d) (Kipp and Mudd 1973)
i = 0.0014 to 0.0022 (from June 1995 water table map)
n_e = 0.1 to 0.3.

Resulting estimates of groundwater velocity range from 0.05 to 3.34 m/d (0.16 to 10.96 ft/d).

The most recent aquifer testing in network wells was done in November 1992 when a constant discharge test was performed (at the water table in well 299-W27-2) with an observation well (299-W26-12) (Williams and Barnett 1993). The interpreted hydraulic conductivity is 10 m/d (34 ft/d). Slug tests in the same well provided similar results (6 to 10 m/d [21 to 34 ft/d] hydraulic conductivity). These results have a much smaller range than the results reported by Kipp and Mudd (1973) (12 to 152 m/d [40 to 500 ft/d]). If the more recent estimates of hydraulic conductivity are used, the resulting estimates of groundwater velocity would fall more closely to the lower end of the originally estimated range (0.028 to 0.22 m/d [0.092 to 0.72 ft/d]).

4.1.5.3 Evaluation of Monitoring Well Network. Based on the MEMO model (Jackson et al. 1991) and the hydrogeology of the site, the existing network should provide a monitoring efficiency of approximately 85% for the S-10 Facility. Presently, the network is judged to be adequate for the indicator parameter evaluation program. There are no plans to drill additional wells or to modify the existing ones in the near future unless groundwater sampling results indicate a significant change in groundwater chemistry or there is a significant change in groundwater flow conditions.

The water table in the vicinity of the 216-S-10 Facility is dropping at an average rate of 0.43 m per year. Assuming the rate continues, wells 29-W26-8, -9, and -10 will be completely dry in 4 to 6 years (2000 to 2001) and well 299-W26-12 in about 7 years (2002). In approximately 3.4 years, well 299-W26-8 will not have enough water to sample with the installed Hydrostar[1] pump. [The minimum amount of water needed in a well with a Hydrostar pump is approximately 0.61 m (2.0 ft), assuming there is no draw-down.] With increasingly greater amounts of draw-down, a larger column of water is needed, which means that the well will need to be replaced sooner.

4.1.6 References

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

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Williams, B. A., and D. B. Barnett, 1993, *Borehole Completion Data Package for the 216-S-10 Facility, CY 1992*, WHC-SD-EN-DP-052, Westinghouse Hanford Company, Richland, Washington.

Figure 4.1-1. Monitoring Well Locations for the 216-S-10 Facility.

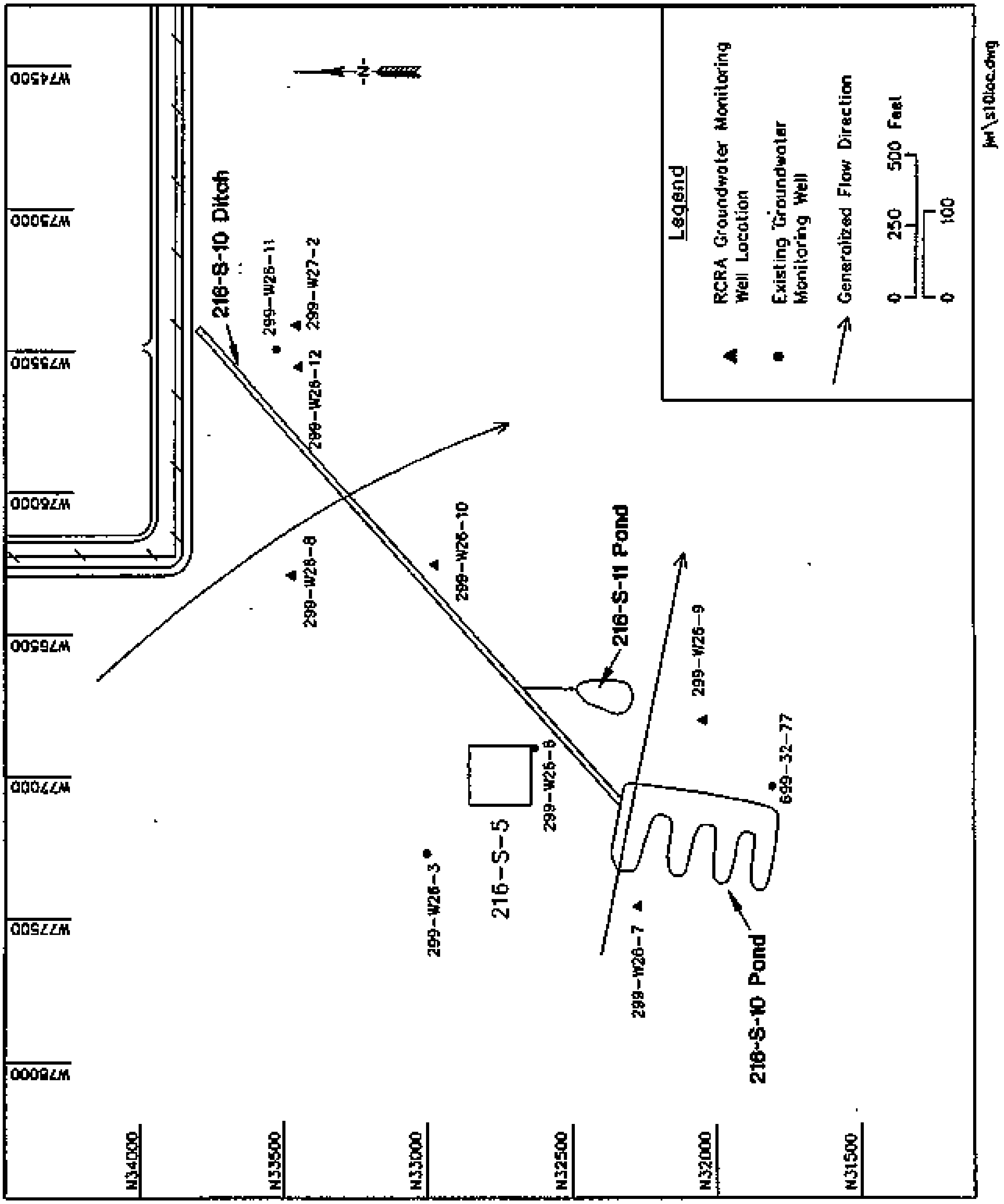


Figure 4.1-2. Gross Alpha Concentration Plot for the 216-S-10 Facility Monitoring Wells.

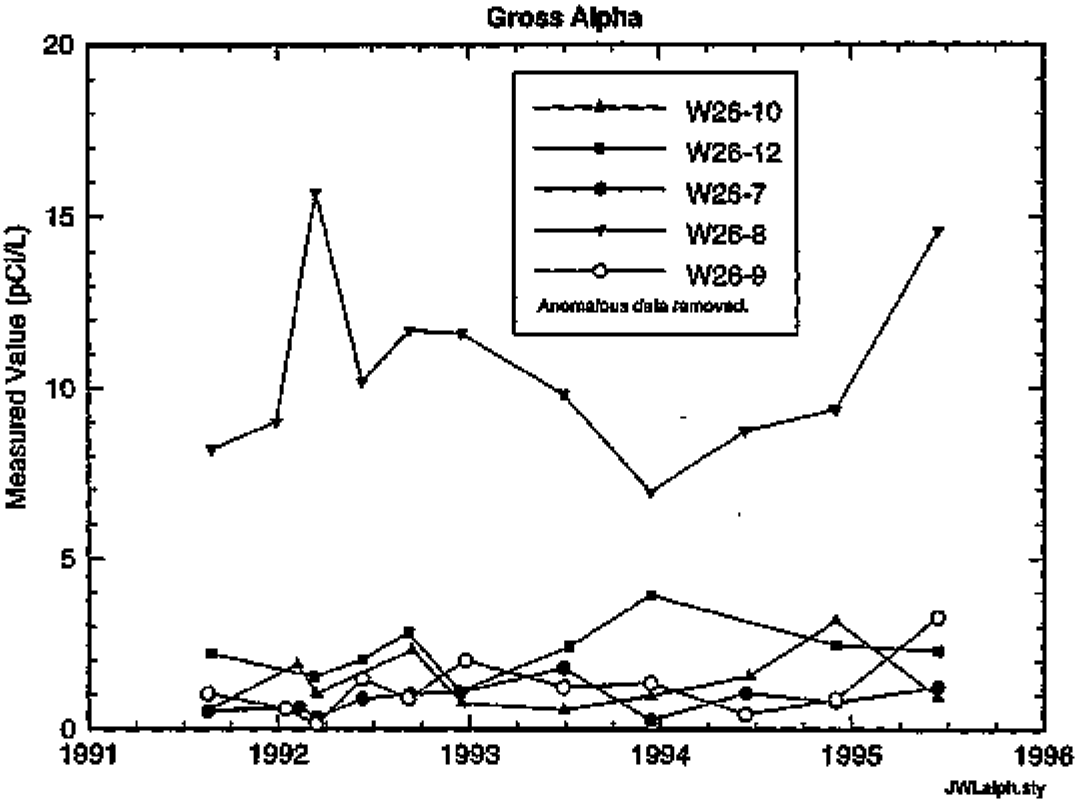
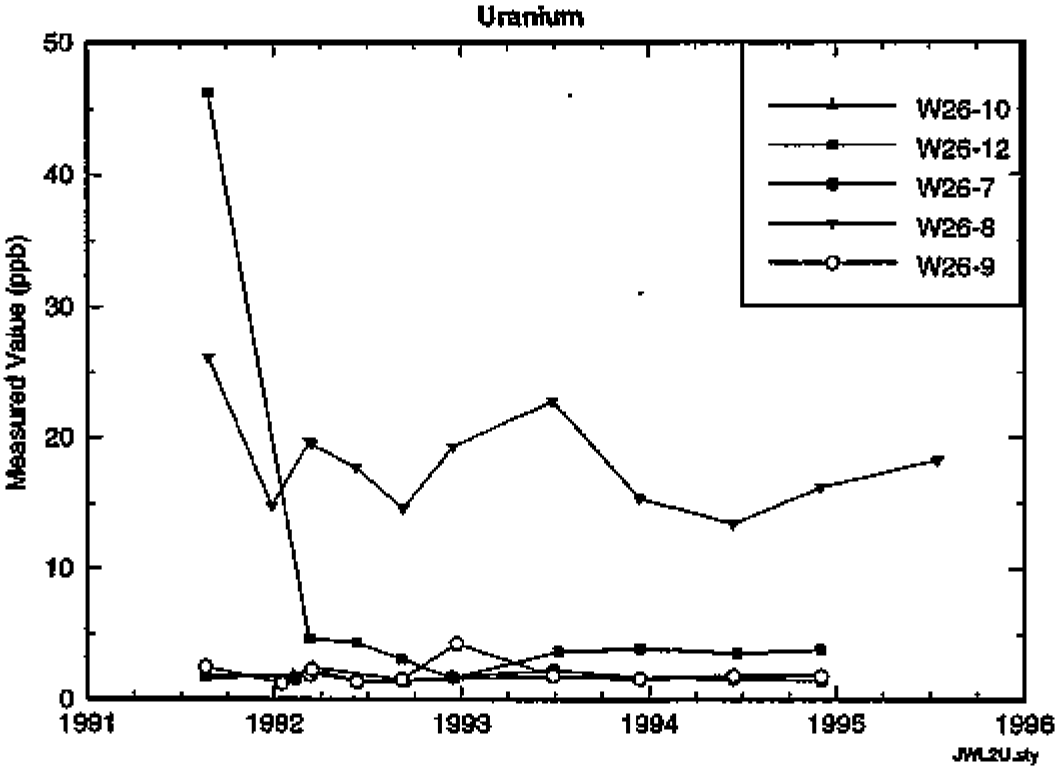
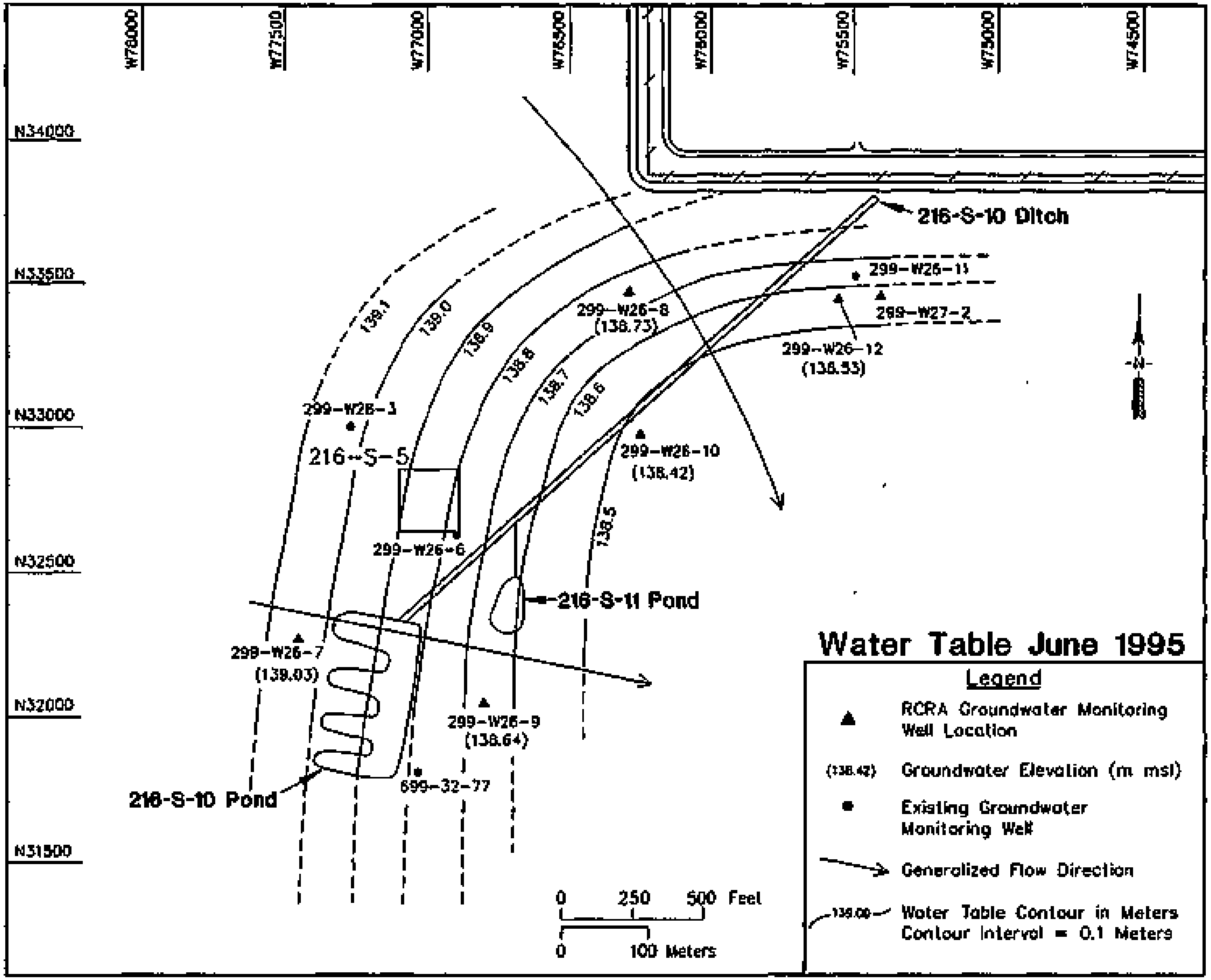


Figure 4.1-3. Uranium Concentration Plot for the 216-S-10 Facility Monitoring Wells.





jwl\s1041-4.dwg

Figure 4.1-4. 216-S-10 Facility Water Table Map, June 1995.

Figure 4.1-5. Hydrograph of the 216-S-10 Facility Unconfined Aquifer Monitoring Wells.

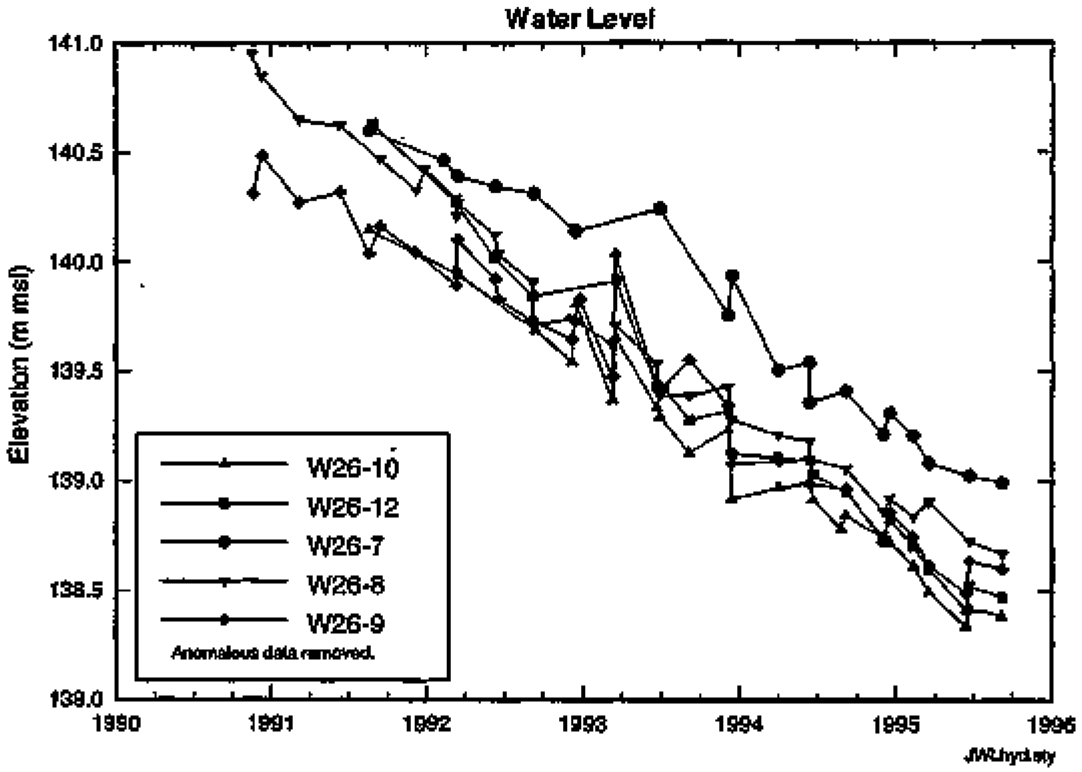


Table 4.1-1. 216-S-10 Facility Groundwater Monitoring Network.

Well	Aquifer	Sampling frequency	Water levels	Well standards
299-W26-7^{91}	Top of unconfined	S	Q	RCRA
299-W26-8^{90}	Top of unconfined	S	Q	RCRA
299-W26-9^{90}	Top of unconfined	S	Q	RCRA
299-W26-10^{91}	Top of unconfined	S	Q	RCRA
299-W26-12^{91}	Top of unconfined	S	Q	RCRA
299-W27-2^{92}	Base of unconfined	S	S	RCRA

Notes: Shading denotes upgradient wells. Superscript following well number denotes the year of installation.

Q = frequency on a quarterly basis.
RCRA = well is constructed to RCRA-specified standards.
S = frequency on a semiannual basis.

Table 4.1-2. Constituents Analyzed at the 216-S-10 Facility.

<table>
<tr><th colspan="3">Groundwater Contamination Indicator Parameters</th></tr>
<tr><td>pH SA</td><td>Total organic carbon SA</td><td></td></tr>
<tr><td>Specific conductance SA</td><td>Total org. halogen SA</td><td></td></tr>
<tr><th colspan="3">Groundwater quality parameters</th></tr>
<tr><td>Chloride A</td><td>Manganese A</td><td>Sodium A</td></tr>
<tr><td>Iron A</td><td>Phenols A</td><td>Sulfate A</td></tr>
<tr><th colspan="3">Drinking water parameters</th></tr>
<tr><td>2,4-D *</td><td>Endrin *</td><td>Methoxychlor *</td></tr>
<tr><td>2,4,5-TP Silvex *</td><td>Fluoride A</td><td>Nitrate A</td></tr>
<tr><td>Arsenic *</td><td>Gross alpha SA</td><td>Radium *</td></tr>
<tr><td>Barium A</td><td>Gross beta SA</td><td>Selenium *</td></tr>
<tr><td>Cadium A</td><td>Lead *</td><td>Silver A</td></tr>
<tr><td>Chromium A</td><td>Lindane *</td><td>Toxaphene *</td></tr>
<tr><td>Coliform bacteria *</td><td>Mercury *</td><td>Turbidity SA</td></tr>
<tr><th colspan="3">Site-specific parameters</th></tr>
<tr><td>Technetium-99 *</td><td>Uranium *</td><td>Alkalinity ** SA</td></tr>
<tr><td>Tritium *</td><td>Volatile organic analysis *</td><td></td></tr>
</table>

* - Discontinued after 4th quarter of 1994.
** - Added 2nd quarter of 1995.
SA - Sampled semi-annually after the 4th quarter of 1994.
A - Sampled annually after the 4th quarter of 1994.

Table 4.1-3. Critical Means Table for 20 Comparisons--
Background Contamination Indicator Parameter
Data for the 216-S-10 Facility.[a,b]

Constituent (unit)	n	df	t_c	Average background	Standard deviation	Critical mean	Upgradient/ downgradient comparison value
Specific conductance (µmho/cm)	8	7	5.4079	248.375	9.186	301.1	301.1
Field pH	8	7	6.0818	7.888	0.178	[6.74, 9.04]	[6.74, 9.04]
Total organic carbon[c] (ppb)	7[e]	6	5.9588	500	NC	NC	976
Total organic halogen[d] (ppb)	NC	NC	NC	NC	NC	NC	13.6

[a] Data collected from August 1991 to June 1992 for upgradient wells 2-W26-7 and 2-W26-8. Values calculated based on 20 comparisons.

[b] The following notations are used in this table:

df = degrees of freedom (n-1)
n = number of background replicate averages
t_c = Bonferroni critical t-value for appropriate df and 20 comparisons.

[c] Critical mean cannot be calculated because of lack of an estimate of background standard deviation. The upgradient/downgradient comparison value for TOC is the limit of quantitation (see Appendix A).

[d] Critical mean cannot be calculated because of problems associated with data quality for samples analyzed aby OCL. The upgradient/downgradient comparison value for TOX is the limit of quantitation (see Appendix A).

[e] Excluding total organic carbon values collected on 2/11/92 from well 2-W26-7 because of Nonconformance Report.

NC = not calculated.

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4.2 216-U-12 CRIB

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4.2.1 Facility Overview

This section summarizes data collected and analyzed in fiscal year (FY) 1995 to define the distribution and concentration profiles of waste constituents in groundwater at the 216-U-12 Crib (referred to as the U-12 Crib). Groundwater monitoring was elevated from a *Resource Conservation and Recovery Act of 1976* (RCRA) detection-level to an assessment-level groundwater monitoring program in 1993 because of elevated concentrations of specific conductance in two of the downgradient wells. An *Interim-Status Ground-Water Quality Assessment Plan for the 216-U-12 Crib* (WHC 1993) was submitted to the Washington State Department of Ecology. This plan was developed to present a program to determine whether the U-12 Crib is the source of contamination and if so, the concentration, flow rate, and extent of the contaminant plumes. Elevated concentrations of nitrate, technetium-99, tritium, and iodine-129 are being investigated under the assessment monitoring program. The U-12 Crib is also part of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) 200-UP-1 groundwater operable unit. The closure of this facility will be coordinated with the CERCLA past-practice cleanup process.

The U-12 Crib is located approximately 610 m (2,000 ft) south of the U Plant in the 200 West Area (see Figure 4.2-1). The U-12 Crib is an unlined, gravel-bottomed, percolation crib that has bottom dimensions of 3.05 m (10 ft) wide, 30.5 m (100 ft) long, and 4.3 m (14 ft) deep. The U-12 Crib has a plastic barrier cover and is backfilled with the original excavated soil. A vitrified clay distributor pipe buried in gravel dispersed the effluent across the bottom of the U-12 Crib.

The U-12 Crib received wastewater from the U Plant in the 200 West Area from April 1960 until February 1988, when the crib was permanently retired and replaced by the 216-U-17 Crib. The wastewater disposed of to the U-12 Crib contained dangerous waste and radioactive materials. Specifically, the waste was composed of effluent from the U Plant and included drainage from the 291-U-1 Stack and process condensate from the 224-U Building. The U-12 Crib received this waste stream from April 1960 until 1972, when it was deactivated. The U-12 Crib was reactivated in November 1981, and received U Plant waste until it was permanently retired in February 1988. An average of over 1.33×10^8 L/yr (3.5×10^7 gal/yr) of effluent was discharged to the U-12 Crib during its active life. The U-12 Crib has received low-level radioactive waste that is known to have included chemicals such as nitric acid, in addition to plutonium, strontium, ruthenium, and uranium. In 1985, physical controls and operating procedures were modified to avoid inadvertent discharge of hazardous chemicals to the wastewater stream.

Vadose zone investigations below the U-12 Crib reveal radioactive contamination at various depths. An investigation in 1983 indicated radioactive contamination to a depth of at least 42.7 m (140 ft); investigations in 1993 detected radioactive contamination to a depth of 19.5 m

(64.5 ft) (DOE-RL 1993f). A CERCLA vadose zone limited field investigation (BHI 1993) supporting the 200-UP-2 operable unit reported ^{238}U at a depth of about 6.1 m (20 ft). The unsaturated interval (vadose) is approximately 64 m (210 ft) thick and is composed of unconsolidated sandy gravel and sand of the Hanford formation, and sandy silt and gravelly sand of the Plio-Pleistocene unit. The unconfined aquifer lies below and within the silty, sandy gravels of the middle Ringold unit.

4.2.2 Summary of 1995 RCRA Activities

The U-12 Crib continued in a groundwater quality assessment monitoring program during 1995. Wells in the network (Figure 4.2-1 and Table 4.2-1) were sampled quarterly during December 1994 and January, March, June, and September of 1995.

To meet *Hanford Federal Facility Agreement and Consent Order* Milestone M-24-33 (Ecology et al. 1994), one assessment well was constructed during late FY 1994-early FY 1995 and was sampled quarterly starting in January 1995. This well, 699-36-70A, was constructed to provide hydrogeologic characterization data for the entire upper unconfined aquifer, to delineate groundwater contaminants in the unconfined aquifer, and to monitor the uppermost portion of the aquifer. Results of the drilling, construction, and hydrogeologic characterization are reported in a borehole completion data package (Williams 1995). It also supports the Environmental Restoration Disposal Facility as an upgradient monitoring well.

Water level measurements were recorded at least once a month and during sampling.

The summary and interpretation of quarterly monitoring results (groundwater chemistry) are presented in Section 4.2.4. The U-12 Crib groundwater analyte list and assessment monitoring schedule were revised and modified in 1995 to reflect more accurately the intent of the assessment groundwater monitoring program at the U-12 Crib. These changes are defined in a supplemental change notice (No. 618170) to the groundwater assessment plan (WHC 1993). The U-12 Crib assessment sampling and analysis program will still meet the analytical requirements found in 40 CFR 265.

4.2.3 Sampling and Analysis Program

Sampling and analysis activities are conducted based on requirements set forth in the U-12 Crib groundwater monitoring plan (WHC 1990) and as modified in the assessment plan (WHC 1993). Currently the monitoring network consists of five shallow monitoring wells (one upgradient and four downgradient) completed at the top of the unconfined aquifer (Figure 4.2-1 and Table 4.2-1). Wells installed for the U-12 Crib RCRA network in 1990 were first sampled in September 1991. The first full year of quarterly sampling was completed by CY 1993. The site was immediately shifted into assessment evaluation monitoring status (DOE-RL 1994a) and network wells are sampled quarterly for constituents listed in Table 4.2-2 (40 CFR 265). Site-specific parameters were selected based on evaluations of the history of waste disposed of to the site and surrounding cribs, and groundwater monitoring results. Additional analyses associated with a particular analytical method are also included in the data tables.

As a result of contamination detected in wells 299-W22-41 and 299-W22-42, two wells were added to the network in CY 1993 to provide more detailed information for plume evaluation and source determination. These two wells, 299-W22-22 and 299-W22-23, were sampled for only one year. Deteriorating casing conditions and substandard construction materials in these wells caused questionable results, so both wells were dropped from the 1995 sampling schedule.

Based on data associated with the Phase I assessment program at the U-12 Crib, well 699-36-70A was added to the network to determine the extent of contaminant migration. Well 699-36-70A was installed approximately 914 m (3,000 ft) downgradient of the U-12 Crib just beyond the 200 West Area fence boundary. Well construction information, including as-built diagrams, geologic and geophysical data, and aquifer test results, is documented in Williams (1995).

All RCRA-compliant wells in the network have been sampled at least once for the complete 40 CFR 264, Appendix IX list of constituents. All available data results are presented in the quarterly reports for RCRA groundwater monitoring data (DOE-RL 1995a, 1995b, 1995c, and 1995d).

4.2.4 Groundwater Chemistry

The groundwater below the U-12 Crib has been monitored and analyzed as part of the RCRA program since September 1991. The site-specific waste parameters selected for the U-12 Crib are listed in Table 4.2-2 and include tritium, ^{99}Tc, and ^{129}I. Nitrate, ^{99}Tc, ^{129}I, and tritium have been detected repeatedly and are being investigated to determine if the U-12 Crib is the source.

Summary and interpretation of the chemical and radiological results are being completed for all past data results and are evaluated with time-concentration plots found in Section 4.2.4.1. Only those constituents that may have a significant impact on the quality of the groundwater are discussed. A final assessment report originally scheduled for September 1995 has been deferred until CY 1996.

4.2.4.1 Concentration Histories of Waste Indicators. Specific conductance has exceeded the critical mean (457.8 µmho/cm) in downgradient wells 299-W22-41, 299-W22-42, and later in 699-036-70A since groundwater monitoring began (Figure 4.2-2). Nitrate is the only constituent with significantly consistent and elevated concentrations in the downgradient wells (Figure 4.2-3) and is probably the source of the elevated specific conductance. Initial data evaluation suggests that the U-12 Crib may be a source of this contamination. Documented releases of nitric acid waste to the U-12 Crib during its operation substantiate this interpretation.

Nitrate concentrations have continued to exceed the 45,000-ppb DWS and are more than 10 times above the average background value. The elevated concentration trends (see Figures 4.2-2 and 4.2-3) in the four downgradient wells have been changing since monitoring began. Vadose zone modeling and studies have shown that liquid travel times to the aquifer could take many years. Therefore, it is possible that effluent disposed of during the last years of active crib life (effluent disposal ceased in 1983) is still seeping into the aquifer, but at a slower rate than when a driving head was available. These slugs and seeps of effluent are believed to still be moving downward and may be contaminating the aquifer. The fluctuations in concentration are a result of this noncontinuous effluent migration and of heterogeneities within the aquifer. Concentration trends are expected to remain the same in the short term and eventually decline as the vadose zone drains.

Gross beta contamination has also been detected in downgradient wells 299-W22-41, 299-W22-42, and new assessment well, 699-36-70A since monitoring began (Figure 4.2-4). Technetium-99 is the only specific beta-emitting radionuclide with concentrations above background (Figure 4.2-5). Gross beta is a weak indicator of ^{99}Tc (a 1:5 activity relationship). Comparison of the concentration trends reveals this relationship and substantiates ^{99}Tc as the primary source of the elevated beta values. Concentration trends of both beta and ^{99}Tc throughout the monitoring life have fluctuated somewhat but appear to be relatively stable. As with the nitrate plume, the concentrations are expected to decrease over time.

Concentrations of tritium in well 299-W22-42 indicate that it could be a contaminant released from the U-12 Crib. However, data collected last year in remediated well 299-W22-23 (upgradient) suggest that there may also be an upgradient source for this constituent (Figure 4.2-6). Tritium will also be evaluated as part of the U-12 Crib assessment. Tritium is a documented (WHC 1990) component of the effluent disposed of at the facility. The new assessment well, 699-36-70A, has tritium values that are over 300,000 pCi/L, well over background and DWS. These new data will be useful in updating the tritium plume map and will provide another point of control.

The concentration trends for ^{129}I in wells 299-W22-23 and 699-36-70A relative to the trends for the other wells indicate that these wells are probably detecting ^{129}I released from an upgradient source southwest of the U-12 Crib (Figures 4.2-7 and 4.2-13). This constituent is also evaluated as part of the U-12 Crib assessment. Iodine-129 is not a documented component of the effluent disposed of at the facility.

Carbon tetrachloride concentrations have predominantly exceeded the DWS (5 ppb) in all network wells since RCRA monitoring began. Because this constituent is not a contaminant emanating from the U-12 Crib and is being sampled in support of other CERCLA programs, it was dropped from the 1995 RCRA sampling schedule.

4.2.4.2 Distribution of Waste Constituents. It is possible that significantly higher undetected levels of nitrate contamination lie downgradient of the current U-12 Crib monitoring network, given the history and timing of effluent volumes that have been disposed of at the facility (see Section 4.2.1). Preliminary contaminant transport modeling indicates that a significant portion of the nitrate plume may be located beyond the three downgradient point-of-compliance wells. Current downgradient well spacing is very limited and the spatial coverage available for accurate plume mapping in the area may be inadequate. It is possible that the U-12 Crib contributed a significant portion of nitrate to the groundwater and the concentrations are mixed with and indistinguishable from the regionally extensive nitrate plume (see Figure 4.2-10). Data from well 699-36-70A support this interpretation and will be used to identify future groundwater monitoring well locations as necessary. All groundwater and contaminant modeling results will be presented in the U-12 Crib assessment report.

Monitoring at downgradient well 299-W22-40 has not detected any nitrate contamination; the well is most likely outside the flow path of the U-12 Crib nitrate plume. This is supported by mapping flow lines on the water table map. The spatial relationship of the monitoring network, with respect to the detected contamination, indicates that the current source is restricted and of relatively low volume and high concentration.

One full year's worth of data (four quarters) has now been collected from assessment well 699-36-70A. This well was installed to determine the extent of contaminants migrating downgradient from the U-12 Crib. Specific conductance has been above the critical mean, averaging over 640 μmhos/cm during 1995. Nitrate was consistently elevated above the DWS, averaging 150,000 ppb. These data substantiate preliminary travel time estimates for a plume emanating from the U-12 Crib. These estimates will be presented in detail in the assessment report. This new well provides data that change the earlier interpretation of the nitrate plume. The areas within the 100-pCi/L contour are much greater than previously mapped (Figure 4.2-10). The ^{99}Tc plume map, presented in Figure 4.2-11, will be modified in the future to incorporate the new data provided by well 699-36-70A. The area of the plume, like that for the nitrate plume, will likely be enlarged. These constituents will be monitored and evaluated as part of the assessment investigation.

Technetium-99 exhibits a distribution similar to nitrate. Time/concentration plots (Figure 4.2-5) reflect a consistent, low-volume source emanating from below the U-12 Crib. A review of the regional technetium plume (see Figure 4.2-11) reveals an asymmetrical plume shaped similarly to the nitrate plume. The skewed portion in the plume is toward the U-12 Crib, which may hint at a larger plume downgradient of the current monitoring system.

Review of the tritium plume map, Figure 4.2-12, reveals that a regionally extensive plume exists southeast and adjacent to the groundwater flow paths from the U-12 Crib. The skewed nature of this plume, which encompasses the U-12 Crib, the elevated tritium activity in well 299-W22-42 (Figure 4.2-6), and documented tritium disposal (WHC 1990) to the crib indicate that the U-12 Crib may also be contributing tritium to the groundwater that is mixing with the larger plume.

4.2.5 Groundwater Flow

4.2.5.1 Groundwater Flow Direction. Figure 4.2-8, the hydrograph of the U-12 Crib groundwater monitoring network, depicts the drop in the water table beneath the crib since the start of RCRA monitoring. The groundwater below the U-12 Crib has declined over 0.45 m (1.5 ft) since the last annual report. This indicates a slight increase in the rate of decline over last year (DOE-RL 1994a). Water levels are reported in previous quarterly reports. Figure 4.2-9 depicts the contoured water table elevations for June 1995. The groundwater gradient indicates a flow direction to the east-southeast that coincides with the regional groundwater map presented in Figure 2-4. This flow direction remains unchanged from 1994 to 1995. Based on this information, the wells are appropriately located to detect continuing contaminant discharges from the U-12 Crib. The expected high values of nitrate and ^{99}Tc detected in the new assessment well, 699-36-70A, are indicative of plumes that have migrated from the site. This supports the conclusion that groundwater flow at the U-12 Crib has not changed significantly. This well will support the location of additional assessment wells, as needed, in the future.

4.2.5.2 Groundwater Flow Rate. The rate of groundwater flow beneath the U-12 Crib is about the same as last year. The upper aquifer is composed of silty, sandy gravel that exhibits variable or heterogeneous flow conditions. Evaluation of the hydraulic gradient over the past several years reveals a slight decrease in the decline rate. The average gradient measured across the U-12 Crib in 1995 was 0.0021.

Based on Trent (1992), the upper unconfined aquifer in the area surrounding the U-12 Crib is characterized by relatively low hydraulic conductivities (K) ranging from to 1 to 12 m/d (5 to 40 ft/d). The range of K for the U-12 Crib wells (Goodwin 1990) is from 2 to 13 m/d (8 to 44 ft/d).

Groundwater velocity can be calculated based on the Darcy average linear groundwater flow equation

$$V = \{K\ (i)\}/n_e$$

where:

V = average linear velocity
K = geometric mean value of hydraulic conductivity
i = hydraulic gradient
n_e = effective porosity.

The geometric mean value of conductivity (K) calculated for the network is 6.2 m/d (20.2 ft/d). Effective porosity is estimated at 0.2 and the hydraulic gradient is calculated to be 0.0021 from June 1995 water table results. The calculated average velocity for the U-12 Crib is 0.07 m/d (0.21 ft/day). This is a slight decrease in the groundwater velocity compared to last year.

Average groundwater velocities have also been estimated based on plume transport velocities. The ^{99}Tc plume has a calculated average velocity of 0.1 m/d (0.32 ft/d). This velocity is within the reported range and supports the groundwater velocity determination at the U-12 Crib, which is corroborated by the new assessment well (699-36-70A) results and by calculated contaminant arrival times.

4.2.5.3 Evaluation of Monitoring Well Network. Because the groundwater flow direction is unchanged, the wells are appropriately located to monitor releases and assess contaminant discharges from the U-12 Crib. The original detection monitoring network at the U-12 Crib was designed based on the Monitoring Efficiency Model (Jackson et al. 1991) to provide leak detection monitoring efficiency of 90 percent.

Water levels are measured regularly and the adequacy of the existing monitoring network is evaluated according to the ability of the downgradient wells to detect contamination at the point of compliance. Declining water levels at the U-12 Crib are not expected to jeopardize the ability to sample the network wells this year.

Continued assessment at the U-12 Crib will require the use of the groundwater flow meter to confirm flow directions before completing the assessment report. Additional well installations or network modifications may be required as a result of the flow meter testing. These will be planned and integrated with the CERCLA remediation activities in the area.

4.2.6 References

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

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Trent, S. J., 1992, *Hydrologic Model for the 200 West Groundwater Aggregate Area*, WHC-SD-EN-TI-014, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC, 1990, *Interim-Status Ground-Water Monitoring Plan for the 216-U-12 Crib*, WHC-SD-EN-AP-019, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC, 1993, *Interim-Status Ground-Water Quality Assessment Plan for the 216-U-12 Crib*, WHC-SD-EN-AP-103, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Williams, B. A., 1995, *Borehole Data Package for the 216-U-12 Crib Well 699-36-70A, Calendar Year 1994*, WHC-SD-EN-DP-091, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Figure 4.2-1. Well Location Map for the 216-U-12 Crib.

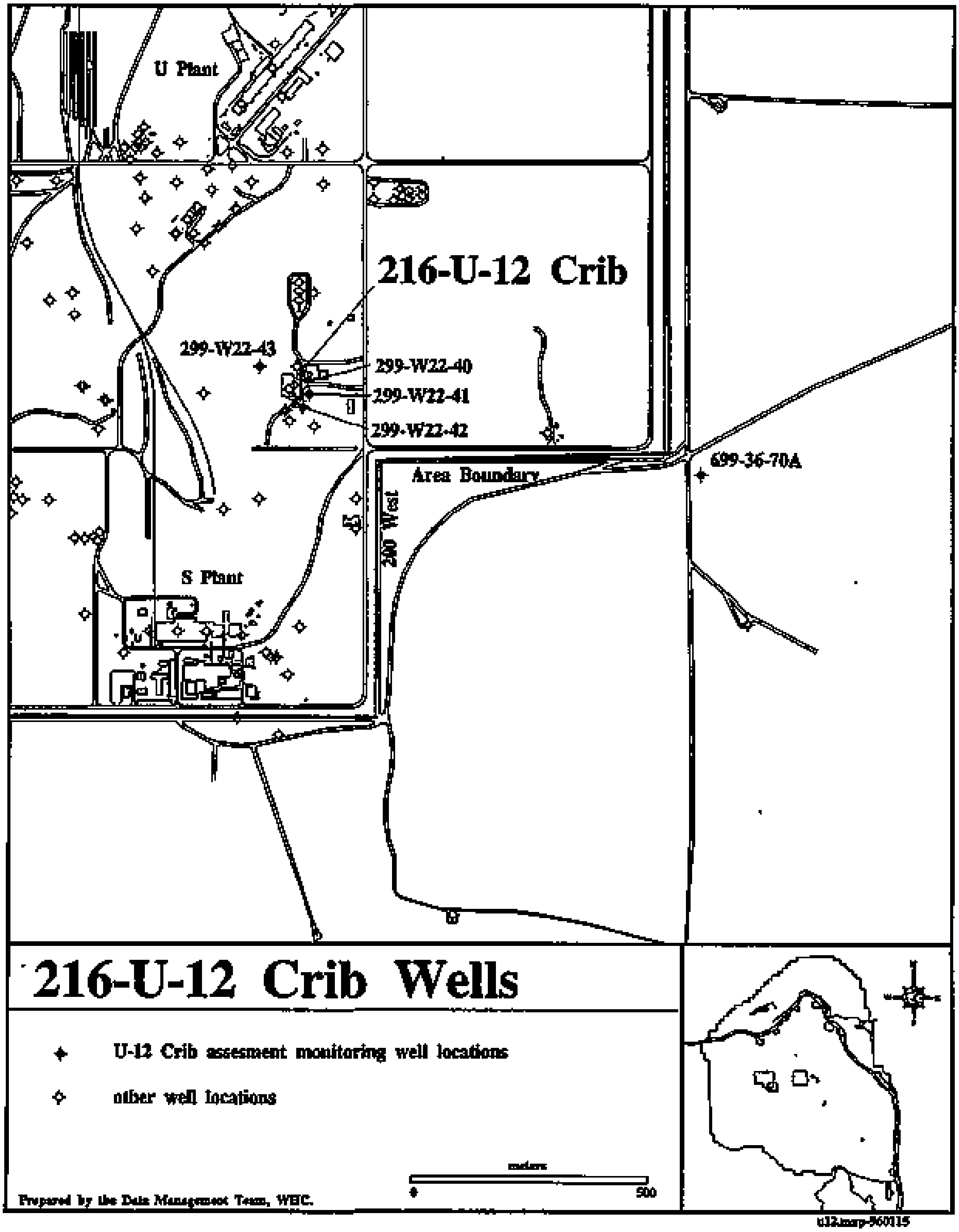


Figure 4.2-2. Specific Conductivity at the 216-U-12 Crib.

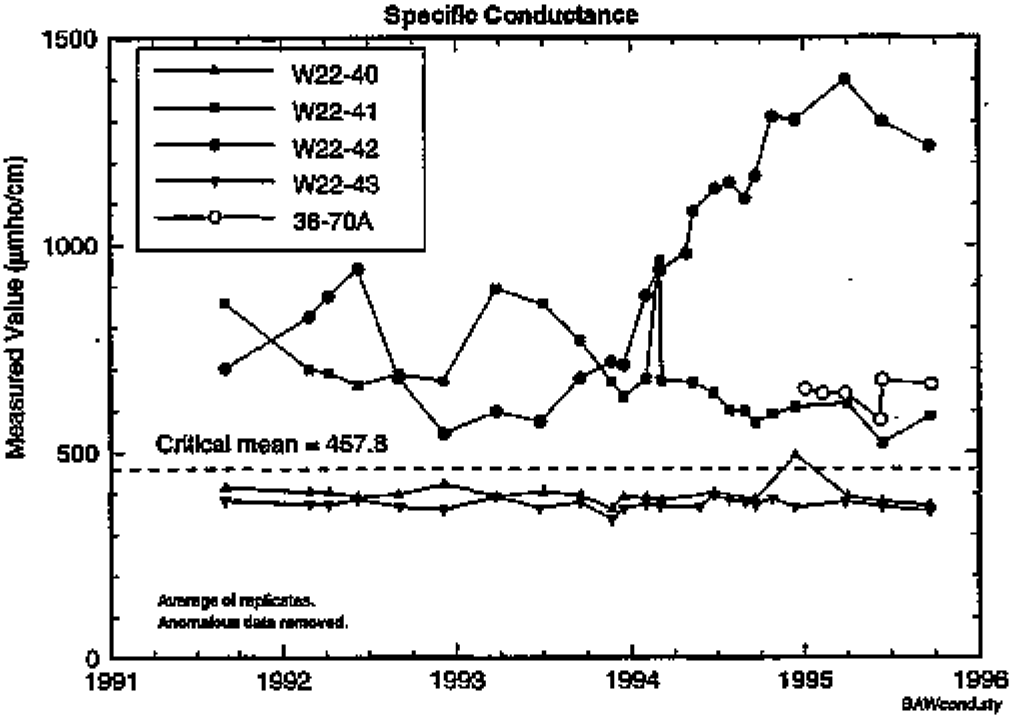


Figure 4.2-3. Nitrate Concentrations at the 216-U-12 Crib.

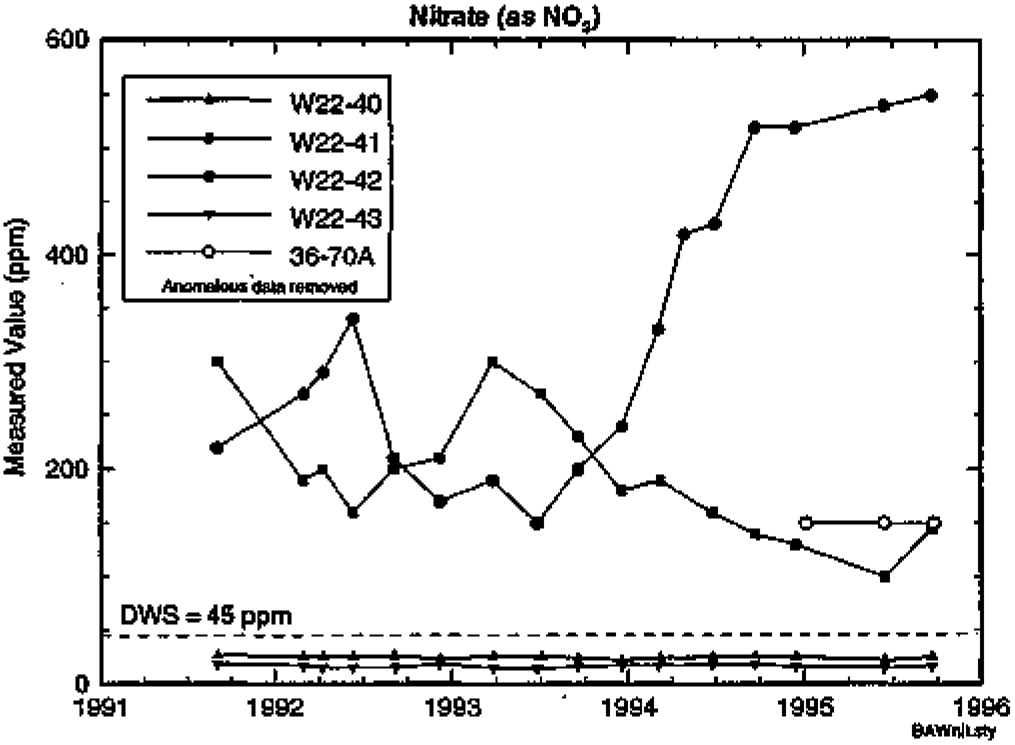


Figure 4.2-4. Gross Beta Activity at the 216-U-12 Crib.

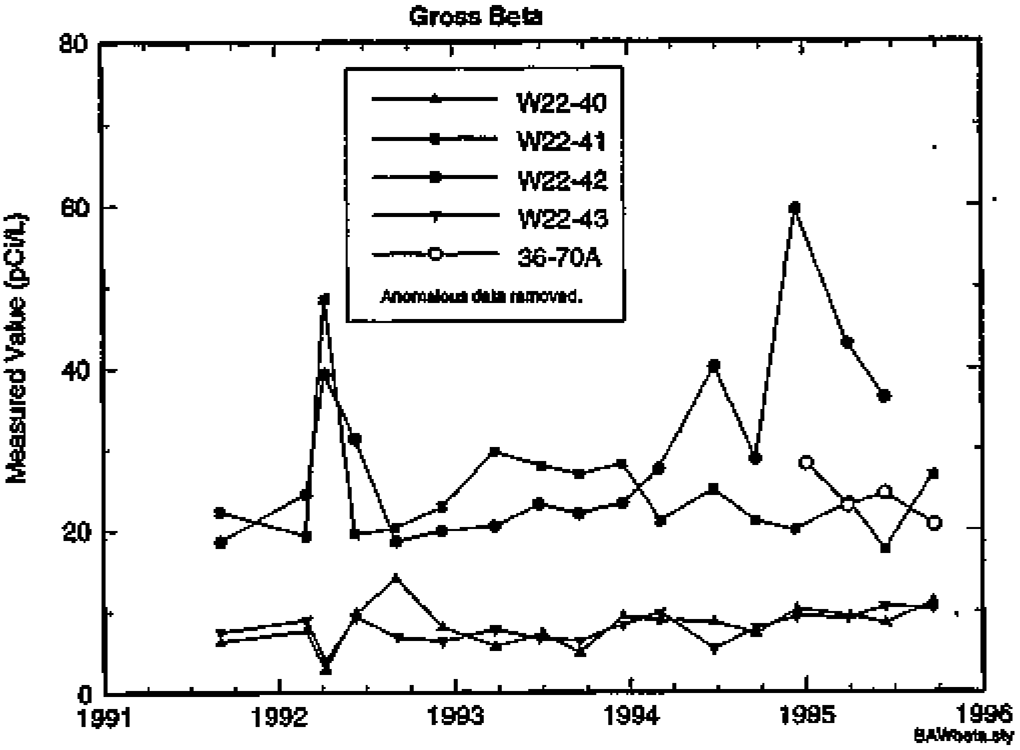


Figure 4.2-5. Technetium-99 Activity at the 216-U-12 Crib.

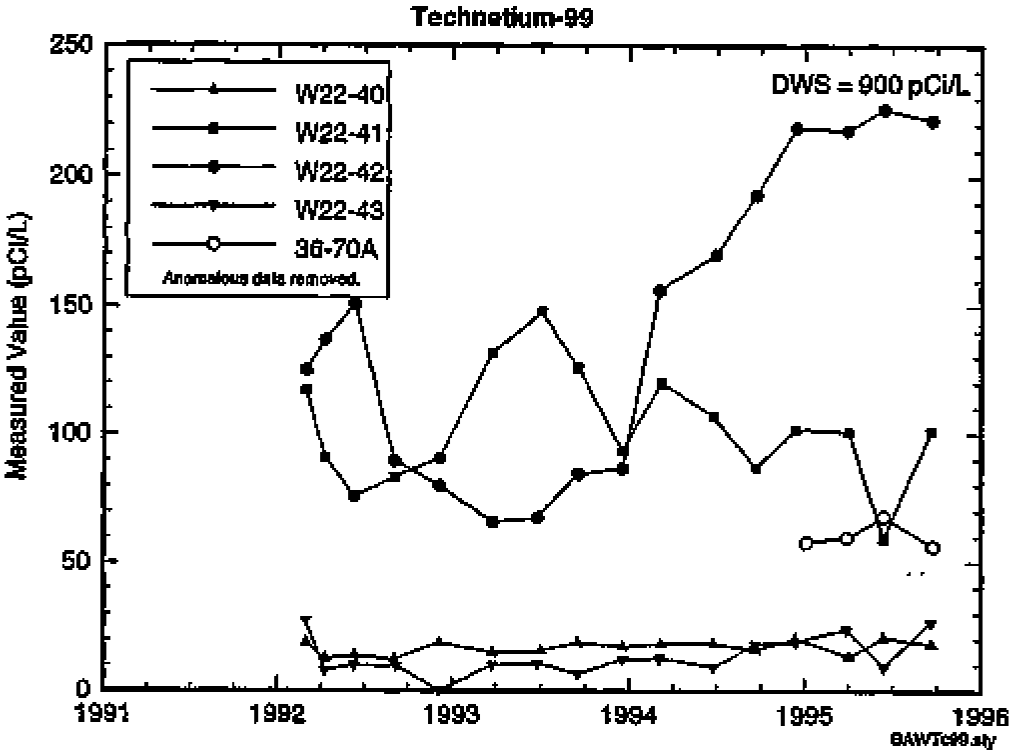


Figure 4.2-6. Tritium Activity at the 216-U-12 Crib.

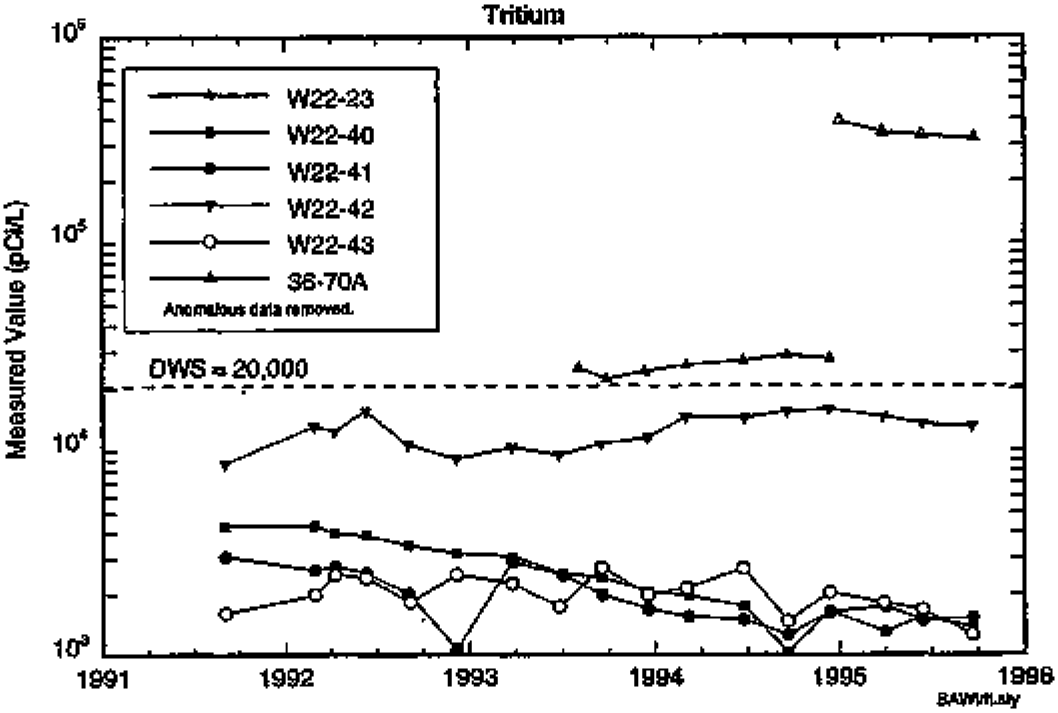


Figure 4.2-7. Iodine-129 Concentrations at the 216-U-12 Crib.

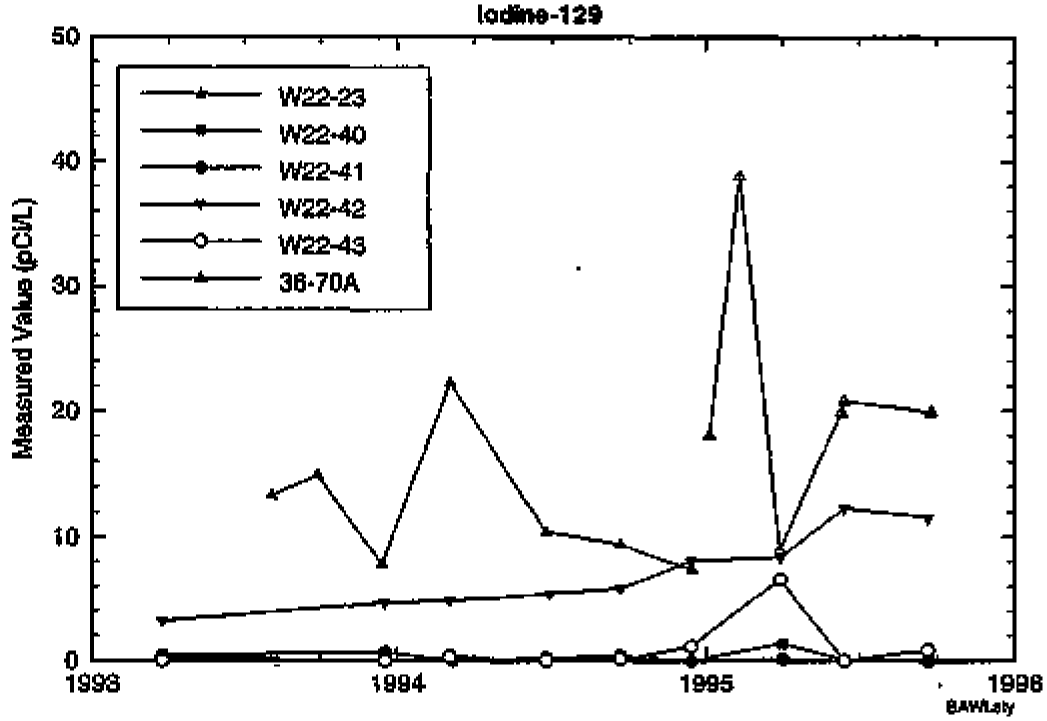


Figure 4.2-8. Composite Hydrograph of Quarterly Water Level Measurements (feet above sea level) at the 216-U-12 Facility.

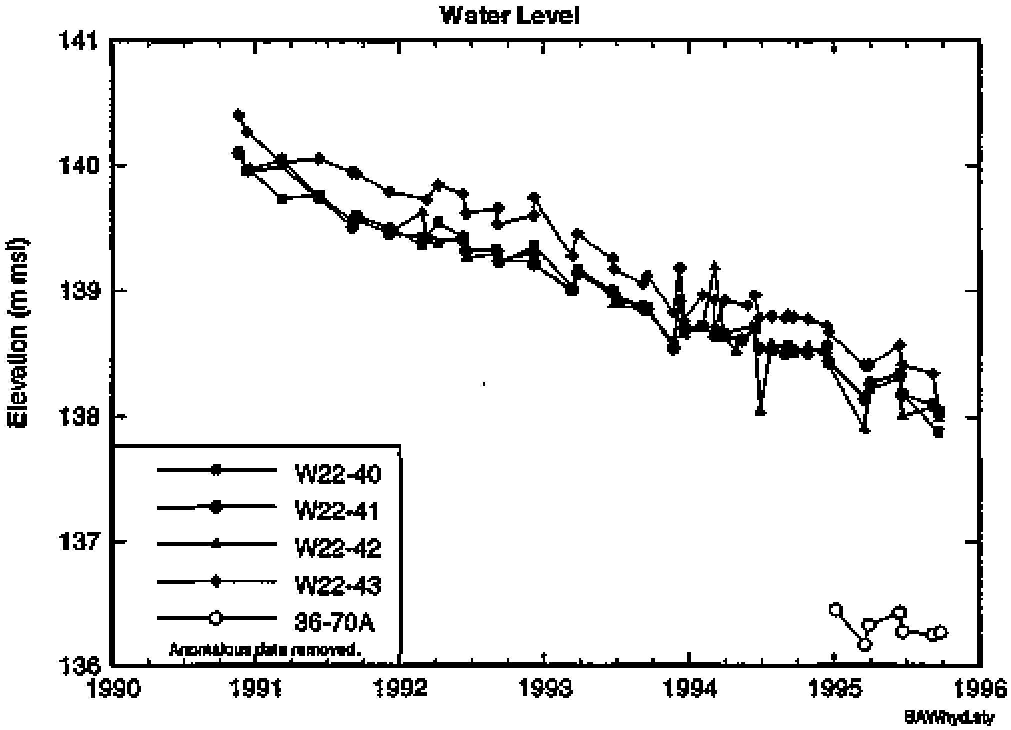


Figure 4.2-9. Contour Map of the 216-U-12 Crib, June 1995.

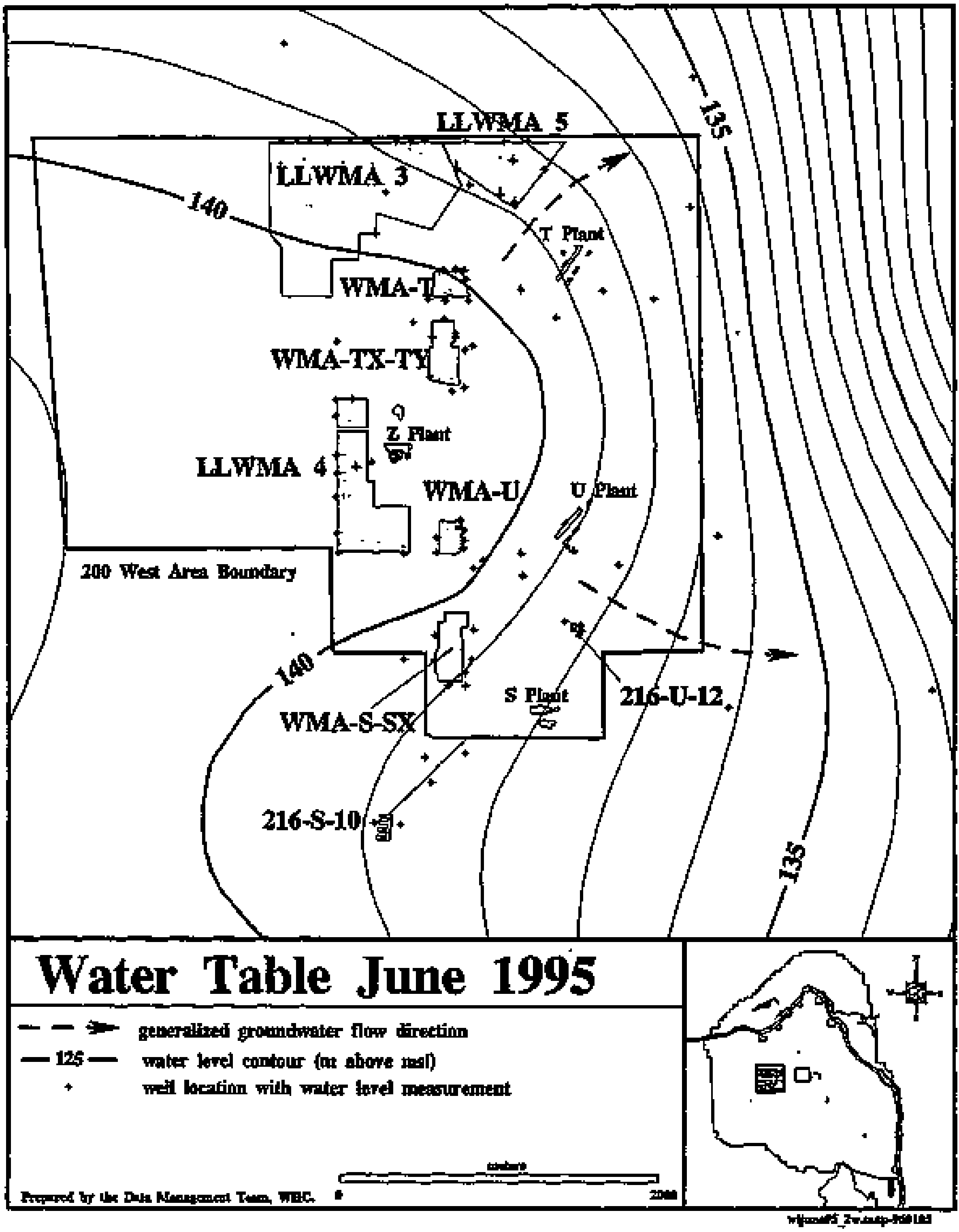


Figure 4.2-10. Nitrace Distribution in the Uppermost Aquifer, 200 West Area, 1994.

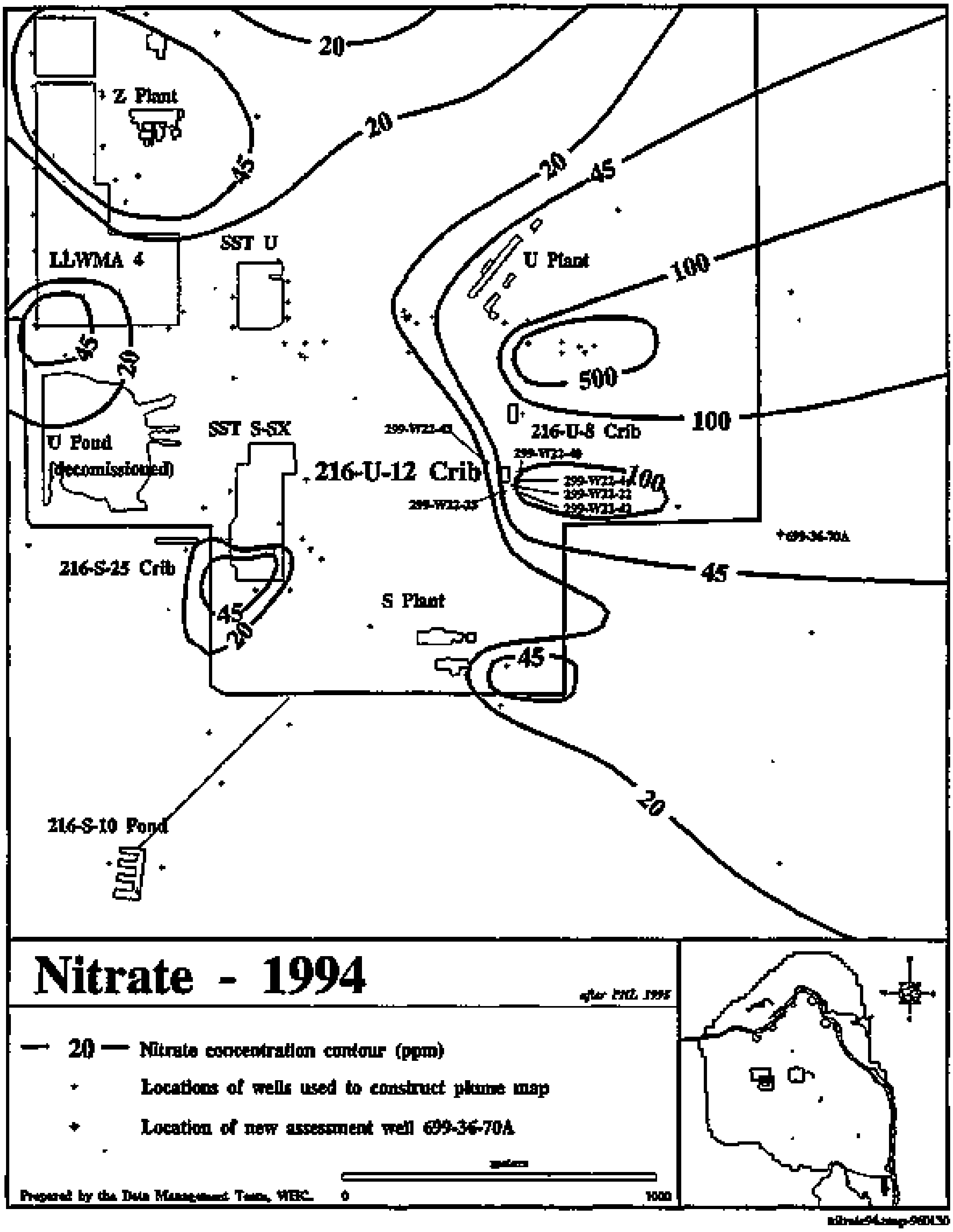


Figure 4.2-11. Technetium-99 Distribution in the Uppermost Aquifer, 200 West Area, 1994.

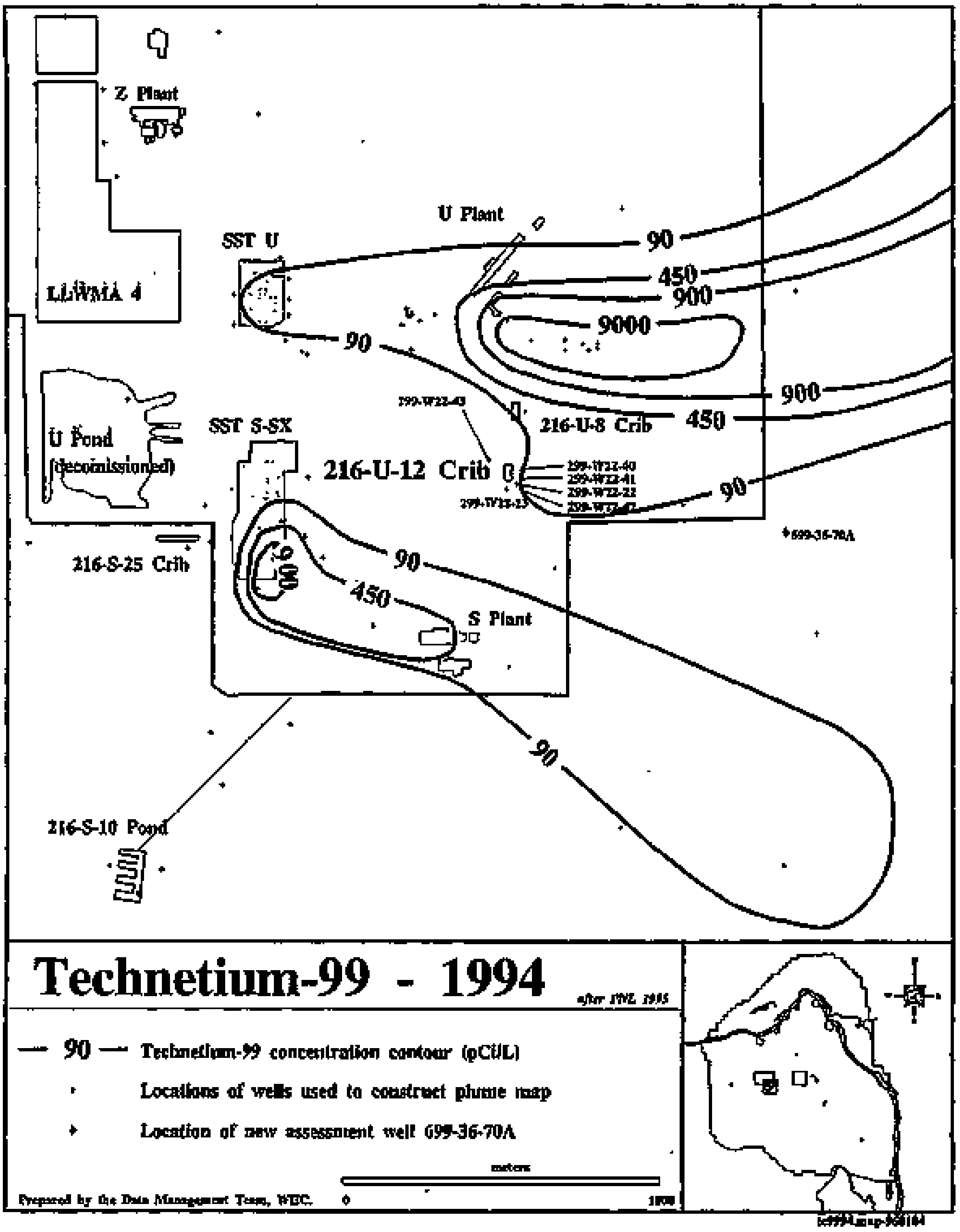
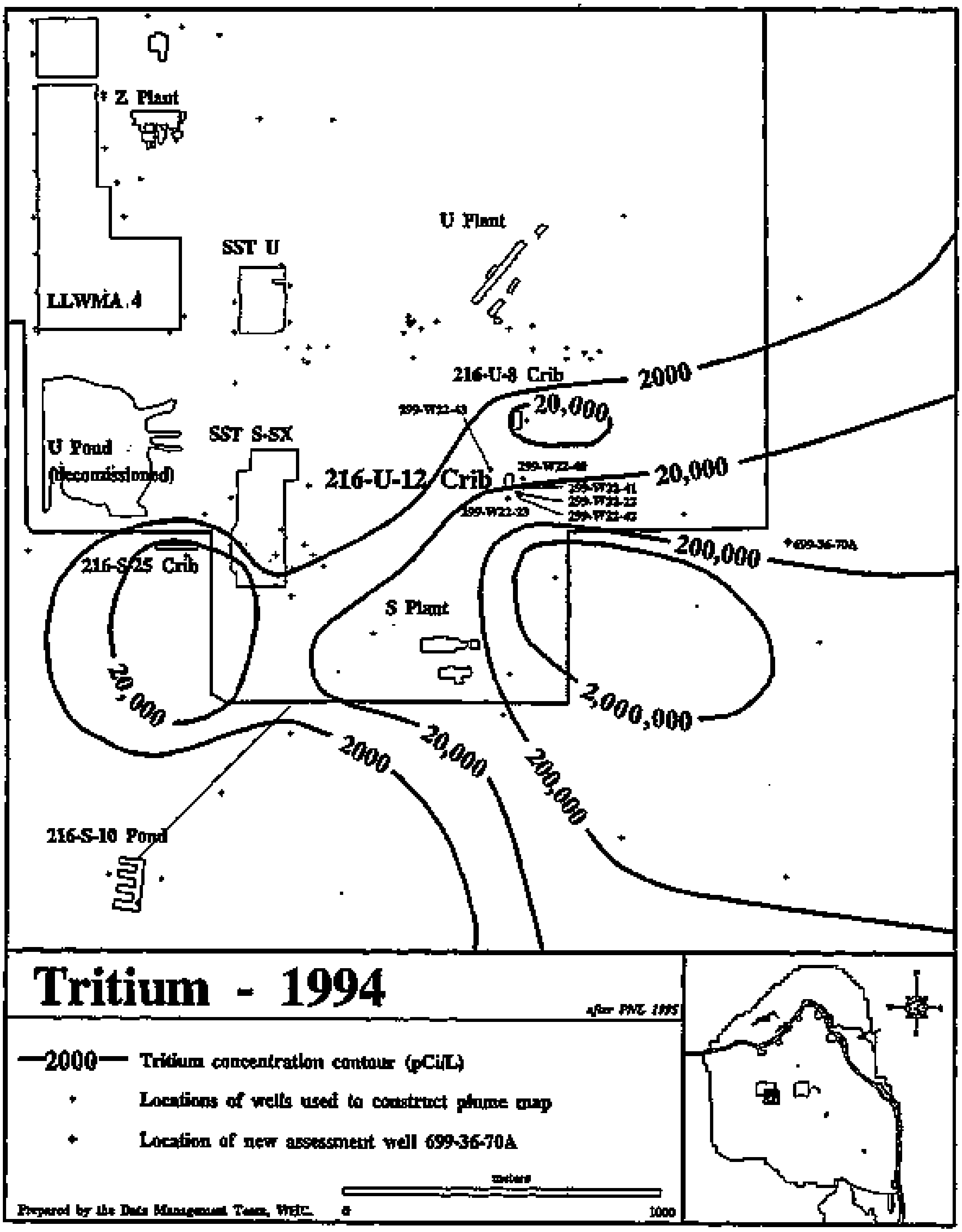


Figure 4.2-12. Tritium Distribution in the Uppermost Aquifer, 200 West Area, 1994.



tritium94.map-960130

Figure 4.2-13. Iodine-129 Distribution in the Uppermost Aquifer, 200 West Area, 1994.

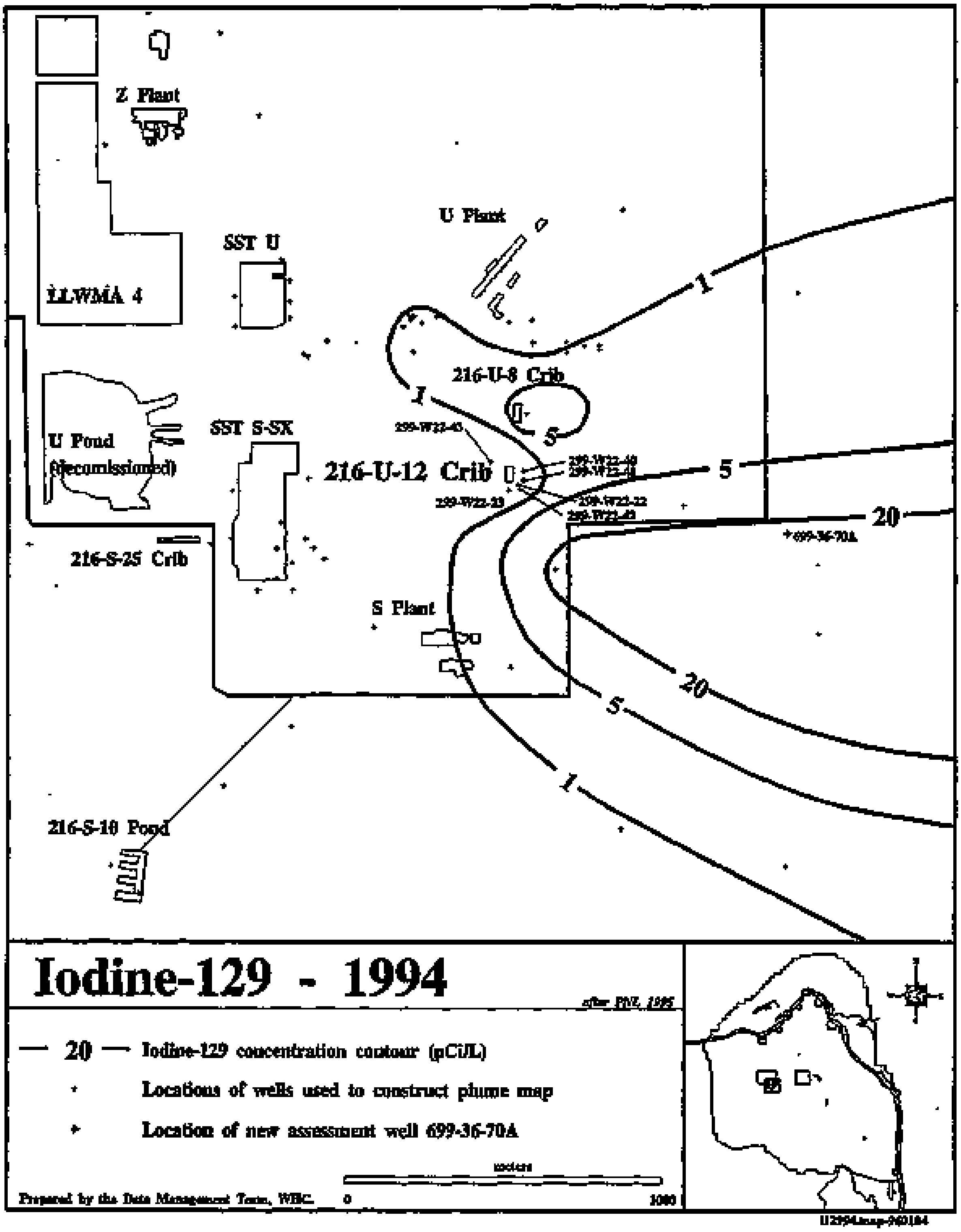


Table 4.2-1. Groundwater Monitoring Network.

Well	Aquifer	Sampling frequency	Water levels	Well standards	Other networks
299-W22-43^{90}	Top of unconfined	Q	M	RCRA	Operational and Sitewide
299-W22-40^{90}	Top of unconfined	Q	M	RCRA	Operational and Sitewide
299-W22-41^{90}	Top of unconfined	Q	M	RCRA	Operational and Sitewide
299-W22-42^{90}	Top of unconfined	Q	M	RCRA	Operational and Sitewide
699-36-70A^{94}	Top of unconfined	Q	M	RCRA	Operational and Sitewide

Notes: Shading denotes upgradient wells. Superscript following well number denotes the year of installation.

M = frequency on a monthly basis.
Q = frequency on a quarterly basis.
RCRA = well is constructed to RCRA-specified standards.

Table 4.2-2. Constituents Analyzed at the 216-U-12 Crib.

Contamination indicator parameters		
pH	Total organic carbon	
Specific conductance	Total organic halogen	
Site-specific parameters		
Anions	Alkalinity[1]	Turbidity
ICP metals	^{129}I	DWS[2]
Alpha	^{99}Tc	GWQP[2]
Beta	^{3}H	TDS[1]

[1] Only analyzed in 299-W22-42, 299-W22-43, and 699-36-70A.

[2] Only analyzed for in 699-36-70A.

DWS = drinking water standards.
GWQP = groundwater quality parameters.
TDS = total dissolved solids.

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4.3 216-B-3 POND SYSTEM

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4.3.1 Facility Overview

This section summarizes information collected and analyzed in fiscal year 1995 to describe distribution and concentration of waste constituents in groundwater beneath the 216-B-3 Pond (B Pond) system. The B Pond system is a regulated wastewater disposal facility for past operations in the 200 East Area of the Hanford Site. Groundwater monitoring under the *Resource Conservation and Recovery Act of 1976* (RCRA) was changed from a detection-level program to an assessment program in 1990 because of elevated levels of total organic halogen (TOX) in two downgradient wells. The *Ground Water Quality Assessment Plan for the 216-B-3 Pond System* was submitted to Ecology as part of the original groundwater monitoring plan (Harris 1990). The assessment plan was later supplemented by the *Interim-Status Groundwater Monitoring Plan for the 216-B-3 Pond* (Sweeney 1995) and the closure/post-closure plan (DOE-RL 1994). The B Pond system is also part of the 200-BP-11 operable unit and the BP-5 and PO-1 groundwater operable units, which are regulated under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) program.

The B Pond system is located east of the 200 East Area and consists of a main pond and three expansion ponds constructed for wastewater disposal. The main pond, which began receiving effluent in 1945, was located in a natural topographic depression, diked on the eastern margin, covered approximately 14.2 ha (35 acres), and had a maximum depth of about 6.1 m (20 ft). The 216-B-3A (3A), 216-B-3B (3B), and 216-B-3C (3C) Expansion Ponds were placed into service in 1983, 1984, and 1985, respectively. The 3A and 3B Expansion Ponds are about 4.5 ha (11 acres) in size, and the 3C Expansion Pond is approximately 16.6 ha (41 acres). Water discharged to these ponds infiltrated into the ground and artificially recharged the underlying aquifer. Details of the operation of these ponds are presented in DOE-RL (1994).

During 1994, the main pond and 216-B-3-3 Ditch were filled with clean soil, and all vegetation was removed from the perimeter as part of interim stabilization activities. Three ditches (no longer in use) leading to the ponds are included in the system for groundwater monitoring purposes (Figure 4.3-1). Beginning in April 1994, discharges to the main pond ceased, and all effluents were rerouted to the 3C Expansion Pond via the Project X-009 bypass pipeline. Only the 3C Expansion Pond now receives wastewater.

Currently, the 3C Expansion Pond receives wastewater primarily from the Plutonium-Uranium Extraction (PUREX) Plant and B Plant. Specifically, these streams consist of B Plant cooling water, the 242-A Evaporator (cooling water and steam condensate), 241-A-702 vessel ventilation system (cooling water), 283-E Water Treatment Facility (filter backwash), and the 284-E Powerhouse (liquid effluent). These streams will continue to discharge to the 3C Expansion Pond until October 1997. At that time, they will be rerouted to the 200 Areas TEDF (see Section 4.3.3).

In the past, the B Plant steam condensate and chemical sewer and the PUREX plant chemical sewer were also discharged to the B Pond system (primarily the main pond). Potential contaminants that were contained in past waste streams, which may have entered the groundwater, are discussed in DOE-RL (1994). During 1994, the volume of effluent discharged to the B Pond system averaged approximately 11,000 L/min (3,000 gal/min) or 16,000,000 L/day (4,000,000 gal/day). From January 3 1995 through October 4 1995, discharges to the 3C pond averaged 11,836 L/min (3,127 gal/min) or 17,043,400 L/day (4,502,880 gal/day). The greatest volumes of the 1995 discharges occurred during campaigns of the 242-A Evaporator, and were not evenly spread over the January-October time period.

RCRA groundwater monitoring for the B Pond system began in 1988 with an indicator-evaluation program and was elevated from a detection-level to an assessment-level program following review of the analytical chemistry results from the first and second quarters of 1990. Concentrations of TOX were above the allowable background concentrations in two of the B Pond wells (see Section 4.3.5). The *Ground Water Quality Assessment Plan for the 216-B-3 Pond System* (Harris 1990) was prepared and submitted to Ecology in May 1990.

The uppermost aquifer beneath the B Pond system occurs primarily within sediments of the Ringold Formation, with the Hanford formation comprising the vadose zone under most of the facility. Ringold Formation sediments here consist of the unit A gravel and lower mud sequence (see Chapter 2.0). The Hanford formation consists of coarse sand and gravel of the lower gravel unit as described by Lindsey et al. (1992).

The Ringold unit A gravel ranges in thickness from about 12 m (40 ft), in the northwest part of the facility, to approximately 30 m (100 ft) in the southern portion. The Ringold lower mud sequence is not present in the northwest part of the facility, but is approximately 24 m (80 ft) thick near the southern end of the 3C Expansion Pond. The Hanford formation ranges in thickness from 40 m (120 ft) beneath the 3C Expansion Pond to approximately 50 m (160 ft) at the northwest corner of the main pond (Davis et al. 1993).

4.3.2 Summary of FY 1995 RCRA Activities

The B Pond system continued in a groundwater quality assessment monitoring program during FY 1995. Wells in the network were sampled during October, January, and April for the first three quarters of FY 1995, and during August and July for the final quarter. Water levels in all wells were measured four times each quarter, once a month and once during each quarterly sampling event for the first three quarters of FY 1995. Thereafter, water levels were measured once a quarter and during sampling. Beginning with the July-through-September sampling event, the monitoring well network was reduced by 11 downgradient wells. This action was taken to reduce redundancy in the B Pond network and to reassign administration of the three wells near the TEDF to that facility (Also see Section 4.3.4).

In late CY 1994, the RCRA Part A permit application was modified to distinguish the three expansion ponds (3A, 3B, and 3C) from the main pond and the 216-B-3-3 Ditch. This change allowed clean closure of the expansion ponds to meet Tri-Party Agreement Milestone M-17-10 (Ecology et al. 1994). The clean closure did not include radioactive contaminants included in the 200-BP-11 Operable Unit. Therefore, the expansion ponds may be included in an upcoming RCRA facility investigation/corrective measures study for the 200-BP-11 operable unit (DOE-RL 1994). The decision on whether to proceed with this characterization will be rendered during FY 1996.

Closure of the main pond and the 216-B-3-3 Ditch is also being coordinated with the closure of the 200-BP-11 operable unit, but as a separate effort from closure of the expansion ponds. Interim stabilization activities for the main pond concluded in September 1994. The main pond was backfilled with clean soil and vegetation was removed from the perimeter. Stabilization and backfilling of the 216-B-3-3 Ditch also was completed in August 1994.

4.3.3 Other Activities in 1995—Project W-049H

As mandated by Tri-Party Agreement Milestone M-17-08, the Project W-049H TEDF was built to provide an infiltration site for treated liquid effluent from the generating facilities in the 200 Areas. The TEDF allows infiltration of treated (cleaned) water to the soil column. Operation of the facility began in June 1995. Some of the streams formerly discharged to the 3C Expansion Pond were rerouted to the TEDF. Because of its proximity to the B Pond system, information from the TEDF site also enhances knowledge of B Pond hydrogeology and groundwater chemistry. The TEDF and its three monitoring wells are within the area of influence of the groundwater mound from the B Pond system (Figure 4.3-2). A groundwater monitoring plan for the TEDF was submitted to Ecology in May 1995 (Barnett et al. 1995) as a condition of the State Waste Discharge Permit (WAC 173-216) required to operate the TEDF.

4.3.4 Sampling and Analysis Program

The monitoring well network for the B Pond system consists of 2 upgradient and 12 downgradient monitoring wells, as shown in Figure 4.3-1 and listed in Table 4.3-1. Although the three monitoring wells for the nearby TEDF have been reassigned administratively to that program, results of groundwater chemistry analyses will still be evaluated as pertinent information for the B Pond network. The groundwater monitoring program for the B Pond System is described in the groundwater monitoring plan (Sweeney 1995).

The upgradient wells, in the western portion of the 200 East Area, were constructed in 1987 and 1988. These two wells and most of the downgradient wells were constructed to monitor the top 4.6 m (15 ft) of the uppermost aquifer. Four of the downgradient wells (699-40-40A, 699-42-39B, 699-42-42B, and 699-43-41G) are screened to monitor a lower horizon within the uppermost aquifer, approximately 7.6 to 15.2 m (25 to 50 ft) below the top of the saturated zone.

The three wells around the W-049H Treated Effluent Disposal Basin are monitored to extend coverage of the B Pond network to the east. These wells monitor the upper portion of the uppermost aquifer, which is confined at these locations. All three wells are screened within the Ringold Formation unit A, just below the Ringold lower mud sequence confining layer (see Section 4.3.1).

All 12 of the downgradient monitoring wells for the B Pond System and the three wells at the TEDF meet the regulatory criteria for location downgradient from the facility because of a radial groundwater flow pattern directed away from the pond system. This pattern is induced by groundwater mounding from past operations (see Section 4.3.6). Because of this condition, no upgradient well, in the strict sense, could be placed within the immediate vicinity of the B Pond facility. Upgradient wells 299-E18-1 and 299-E32-4 were selected to represent groundwater chemistry unaffected by B Pond. The wells are located as near to B Pond as possible, but remain outside the influence of the B Pond groundwater mound, as indicated by regional contaminant plume maps (e.g., Law et al. 1987, Johnson 1993).

As a result of the past several years of groundwater monitoring at the B Pond System, several wells in the network were determined to be redundant or no longer critical to adequate monitoring. Thus, the number of downgradient wells sampled was reduced from 23 to 12. Also, several constituents that were regularly sought in analyses were deleted from the constituent list. The constituents that were eliminated were determined to occur in insignificant quantities, were not a result of contamination, or were recognized as occurring in a predictable trend (e.g., tritium) that can be reevaluated on a less frequent schedule. The constituent list also was amended to include some constituents that may provide insight on the occurrence of elevated TOX in some wells (Sweeney 1995).

Four quarters of sampling were completed at the B Pond during 1995. Because of the elevated TOX and total organic carbon (TOC) detected in several wells from 1990 to 1993 (699-43-41E, 699-43-41F, 699-42-40A, and 699-43-42J), semivolatile organic compounds were sampled in all the downgradient wells. These analyses were chosen to identify the particular chemical species that may be causing the elevated TOX results and to evaluate the overall groundwater chemistry of the site. Analytical results of the groundwater sampling for B Pond are presented in quarterly reports (Barnett 1995a, 1995b, 1995c, and 1996).

All wells in the network were sampled quarterly during 1995, and have been sampled at least once for the Appendix IX constituents. The current list of constituents sought in groundwater analyses at B Pond is given in Table 4.3-2.

4.3.5 Groundwater Chemistry

4.3.5.1 Concentration Histories of Waste Indicators. Chemistry data for the groundwater contamination indicator parameters (TOX, TOC, pH, and specific conductance) from the two upgradient wells for B Pond have been used to establish background concentration limits not to be exceeded in the downgradient wells. The B Pond system was elevated to assessment-level monitoring in 1990 because of elevated concentrations of TOX in downgradient well 699-43-41E. During 1990, well 699-43-41F also exhibited high concentrations of TOX and TOC.

4.3.5.1.1 TOX. Following the change in monitoring status to assessment in 1990, TOX in wells 699-43-41E and 699-43-41F continued to be above established background limits during 1991. During the past year, well 699-40-40B has exhibited elevated TOX results. Although this well was removed from the network as a regularly scheduled sampling point, it is still sampled for TOX and semivolatile organic compounds.

Attempts to isolate a specific constituent(s) that may account for elevated TOX results remain inconclusive. Analyses for semivolatile organic constituents have revealed 11 low-level detections of the compound tris-2-chloroethyl phosphate in 5 wells since April 1993. The highest result was 44 ppb in well 699-40-40A. Comparing results for this compound and TOX results (from corresponding sampling events and wells) does not reveal a defensible correlation between the two constituents. Further data accumulation and comparison is needed to confirm or disprove this connection. Thus far, however, levels of this contaminant have been so low that it is difficult to justify further research.

4.3.5.1.2 TOC. The highest reported averaged results for TOC were from well 699-42-41 (1,000 ppb in July 1995). This value was slightly above the limit of quantitation (976 ppb). No definitive trends were evident in any of the network wells for this parameter.

4.3.5.1.3 Specific Conductance. No trends in specific conductance were observed during FY 1995. Specific conductance (field measurements) ranged from a high average of 507 μmho/cm in upgradient well 299-E18-1, in June 1995, to a low average of 148 μmho/cm in well 699-42-41 in October 1994.

4.3.5.1.4 pH. The average of replicates for well 699-43-41G in April was the highest averaged field pH results for the year (8.82). However, the laboratory result for the same sample (8.1) does not agree with the field results. The lowest replicate average for the year (6.23) in well 699-44-42 also disagrees with the comparison laboratory result of 8.1. This average is the only result that fell below the lower drinking water standard (DWS) for pH. Four wells exceeded the upper limit of DWS for pH during 1994.

4.3.5.1.5 Site-Specific Constituents. Until mid 1995, tritium was monitored quarterly in each well in the network. The trends in these wells over several years indicated a general decline for tritium levels in groundwater at the B Pond System.

Although nine wells produced tritium results above drinking water standards during 1994, a consistently downward trend for this constituent has been established for all these wells. Results of tritium analyses from the first half of CY 1995 indicate no change in this trend. Tritium levels will be monitored and reported annually at this site through the Groundwater Surveillance Project groundwater monitoring program (e.g., Dresel et al. 1995).

4.3.5.1.6 Other Constituents. Additional drinking water and groundwater quality parameters are measured at all downgradient wells for comparison with established DWSs, and other components, such as turbidity, that are indicators of groundwater or sample quality.

The number of metal analyses performed for the B Pond System in 1995 was significantly reduced from the number in 1994. Chromium in unfiltered samples, iron in unfiltered samples, and manganese in filtered and unfiltered samples, as in years past, remain the most common constituents exceeding DWSs in the B Pond system wells (see discussion in Section 2.2.4).

Although the turbidity DWS applies only to surface water analyses (40 CFR 265), this property is monitored in groundwater at B Pond to provide insight into occurrences of other constituents. High turbidity levels are most obviously correlated to concentrations of certain metals. During 1995, purging and sampling rates were reduced in six wells to decrease turbidity. These wells are 699-40-39, 699-40-40B, 699-41-40, 699-42-40A, 699-43-40, and 699-43-41E. As predicted, reduced pumping rates during purging and sampling in these wells significantly lowered turbidity levels and resulted in lower levels of metals, particularly iron and manganese, in unfiltered samples. Turbidity also is monitored at the time of sampling to prevent excessive turbidity interference with analyses.

4.3.5.2 Distribution of Waste Constituents. Groundwater beneath the B Pond system contains elevated levels of tritium from past wastewater disposal to the facility. Monitoring wells that have been in place around the B Pond system for several years show a consistent decline in tritium activities since the late 1980's. The observed decline is likely a result of the dilution of older, more contaminated water by recent tritium-free effluent, and decay of the tritium radionuclide (half-life = 12.3 years). The most recent depictions of tritium distribution in groundwater at the B Pond System are presented by Barnett (1995a) and Dresel et al. (1995).

4.3.6 Groundwater Flow

The sediments of the Ringold Formation comprise the bulk of the uppermost aquifer beneath the B Pond system. Specifically, groundwater flows mostly within the Ringold unit A gravel sequence and somewhat within the Ringold lower mud sequence. Section 4.3.1 discusses stratigraphy and hydrogeology in the vicinity of the B Pond system. Hydrogeology of the B Pond system and vicinity is discussed in more detail by Davis et al. (1993), DOE-RL (1994), and Johnson et al. (1995).

During 1995, water table elevations were measured at least quarterly in all wells in the monitoring network, and monthly for most wells as part of the groundwater assessment program.

4.3.6.1 Groundwater Flow Direction. Groundwater flow in the B Pond area is dominated by the groundwater mound created by large volumes of wastewater recharging the uppermost aquifer (see Figure 4.3-2). This hydraulic feature has altered the original groundwater flow pattern of the area. In the past, the mound was even more extensive because larger volumes of effluent were discharged to the system than at present (see Section 4.3.1). As the rate of effluent discharge has decreased, water levels in wells within the influence of the mound are also generally decreasing.

The horizontal component of groundwater flow at the B Pond system is radially outward from the center of the groundwater mound. Horizontal head gradient, as determined by water level measurements taken in June 1995, is estimated at roughly 0.003 just east of the 3C Expansion Pond, to 0.005 immediately west of the former location of the main pond.

4.3.6.2 Rate of Groundwater Flow. Estimates of groundwater flow rates near the B Pond system are mostly based on numerical modeling, and by tracking tritium migration from the 200 East Area operations to the Columbia River (Freshley and Graham 1988, Freshley and Thorne 1992). Average horizontal groundwater flow rate determined by these methods is estimated at 0.2 to 2.7 m/d (0.6 to 9.0 ft/d).

The horizontal component of groundwater flow rate may also be estimated by the relationship:

$$v = \frac{Ki}{n_e} \qquad (1)$$

where:

v = Average linear groundwater velocity (rate)
K = Hydraulic conductivity
i = Head gradient (horizontal)
n_e = Effective porosity.

For the B Pond system, K has been approximated at 640 m/d (2,100 ft/d) for the Hanford formation, and 1.5 m/d (5 ft/day) for the Ringold Formation; estimated effective porosity ranges were from 0.1 to 0.3 for both the Hanford and the Ringold Formations (WHC 1990). However, Thorne et al. (1993, 1994) estimated horizontal hydraulic conductivity of the Hanford formation in some areas around B Pond at no more than 1 m/d (3 ft/d). This is because of the mud content of the Hanford formation sediments at this location.

Estimates of average linear flow velocity based on head gradients observed in May 1989 and aquifer properties (K and n) yielded rates from 0.009 to 0.03 m/d (0.03 to 0.1 ft/d) for the Ringold Formation, and 15 to 46 m/d (50 to 150 ft/d) for the Hanford formation (WHC 1990). Performing this calculation with head gradients observed for June 1995 and using the extreme values known for hydraulic conductivity, gradient, and effective porosity, groundwater flow velocities are estimated to range between 0.02 and 0.09 m/d (0.07 to 0.3 ft/d) for the Ringold Formation, and 0.01 to 38.4 m/d (0.03 to 126.0 ft/d) for the Hanford formation.

Groundwater flow velocities estimated at the W-049H Treated Effluent Disposal Basin site have ranged from 0.002 to 0.02 m/d (0.005 to 0.08 ft/d) within the Ringold Formation unit A. Hydraulic conductivities used to calculate these estimates were derived from constant-discharge pumping tests conducted in early 1993 (Davis et al. 1993). Effective porosities are laboratory estimates from borehole samples.

In February 1994, groundwater flow velocities (direction and rate) were measured directly within the three wells at the W-049H site using a heat-pulse flowmeter. The details of this investigation are presented in Barnett et al. (1994) and Barnett et al. (1995). Groundwater velocities determined by this method ranged from an estimated average of 0.07 m/d (0.23 ft/d) (±17%) at 181° (±12°) azimuth in well 699-40-36, to 0.57 m/d (1.88 ft/d) (±17%) at 92° (±11°) azimuth in well 699-42-37. All three of these wells are screened within the Ringold unit A gravel.

4.3.6.3 Evaluation of the Monitoring Well Network. Currently, the monitoring well network is adequate to detect contamination originating from the B Pond site. As discussed in Section 4.3.4, eight wells were dropped from the regular sampling list during 1995 to eliminated duplication of effort. Because of the radial flow from the apex of the groundwater mound, a constituent introduced at this apex should theoretically be detectable at any selected point within the mound, barring heterogeneities in the geologic structure of the aquifer. As known from drilling, heterogeneities do exist at this site, but they are not predictable to a level of detail that would justify siting wells at specific locations. Hydraulic head measurements do indicate, however, that groundwater most likely flows with the greatest ease in an east-to-southeasterly direction. In the future, particular attention will be focused in that area to ensure adequate coverage and well integrity.

Figure 4.3-3 is a composite hydrograph of wells at the B Pond system network showing typical patterns of water level decline. Beginning in late 1993 and early 1994, water levels in some wells in the network actually began to rise. This rise was probably in response to a series of temporary increases in discharges to the facility during that period (Davis et al. 1995; Johnson et al. 1995), and may also have been enhanced by the rerouting of discharges in early 1994. The trend was reversed again in late CY 1994. In 1995 these wells have apparently resumed their declining-water-level trend. Distal portions of the groundwater mound are relatively unaffected by these changes, as noted in well 699-40-36 at the TEDF.

During 1993 the network was evaluated to determine whether any wells were on the verge of going dry and becoming incapable of producing a groundwater sample. The evaluation determined that wells 699-42-41, 699-43-45, 699-44-42, and 699-44-43B may be going dry. Comparing the 1993 water levels in these wells with levels measured in November 1995 showed that water levels had fallen by as much as 0.6 m (2 ft). However, only well 699-44-42 was in immediate danger of going dry, with the water level approaching the pump intake level. This well was recently eliminated from the sampling schedule because it is not essential to the network.

Redirection of discharges from the main pond to the 3C Expansion Pond that began in early 1994 is possibly introducing wastewater into the parts of the Hanford formation (i.e., above the Ringold lower mud sequence) that were formerly dry. Concomitantly, the original mound beneath the B Pond system will diminish. Wurstner and Freshley (1994) predict that as many as seven wells in the network (mostly around the main pond) will be dry by the year 2000. The monitoring network will be periodically assessed for adequacy of coverage.

4.3.7 References

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200-East Area

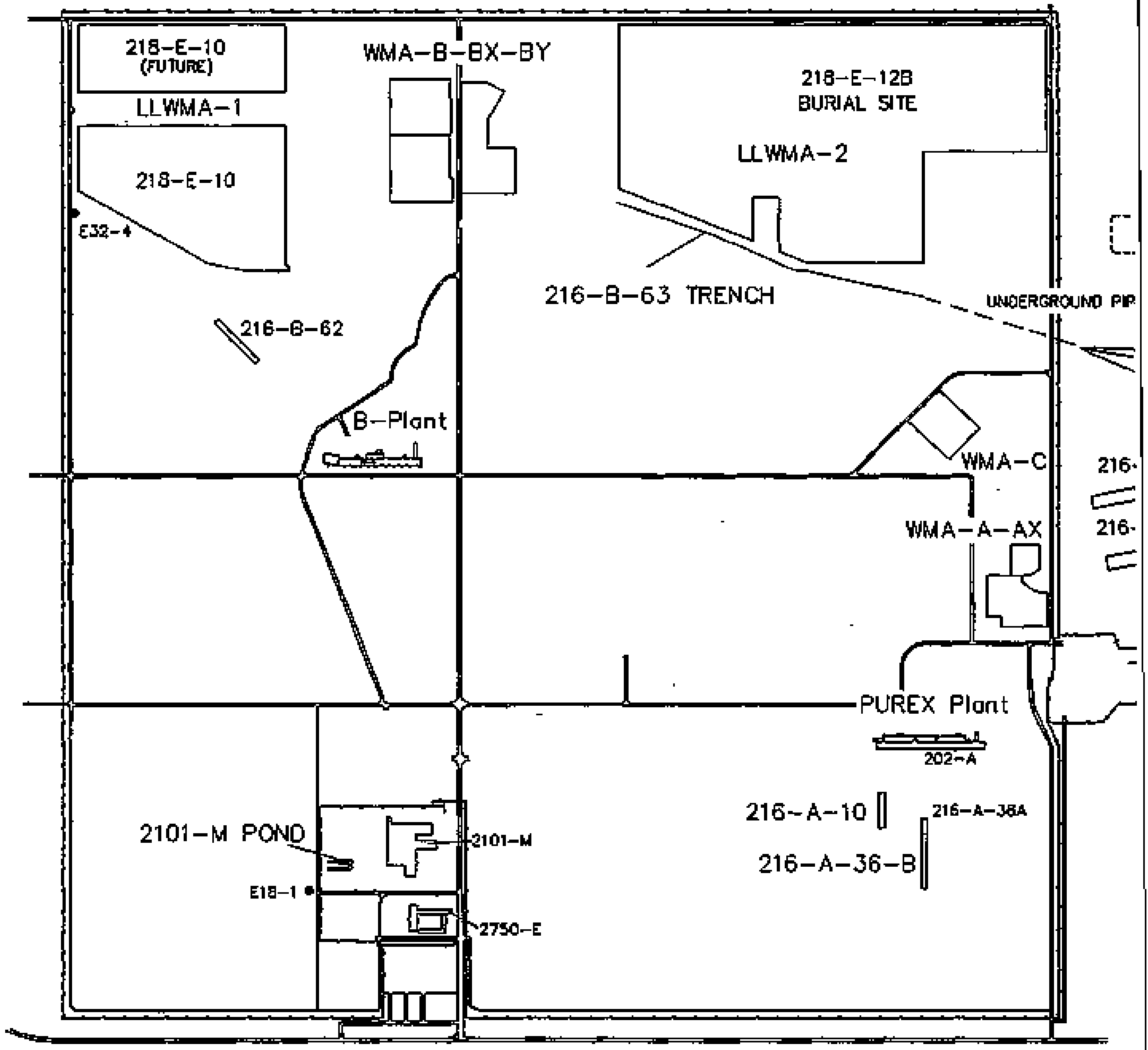

Figure 4.3-1. Monitoring Well Locations for the 216-B-3 Pond.

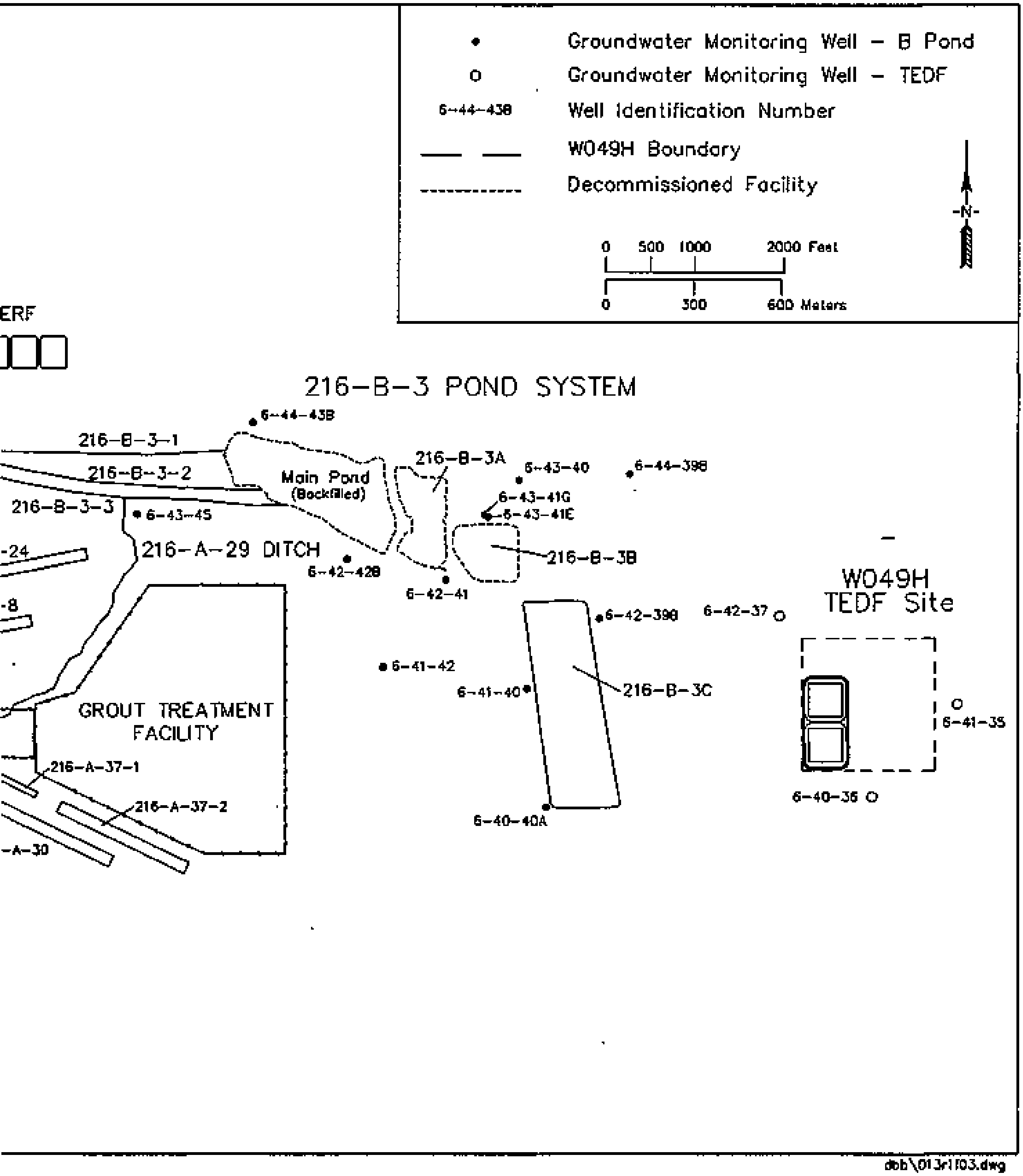

Figure 4.3-2. Potentiometric Surface Map of the 216-B-3 Pond and Vicinity, June 1995.

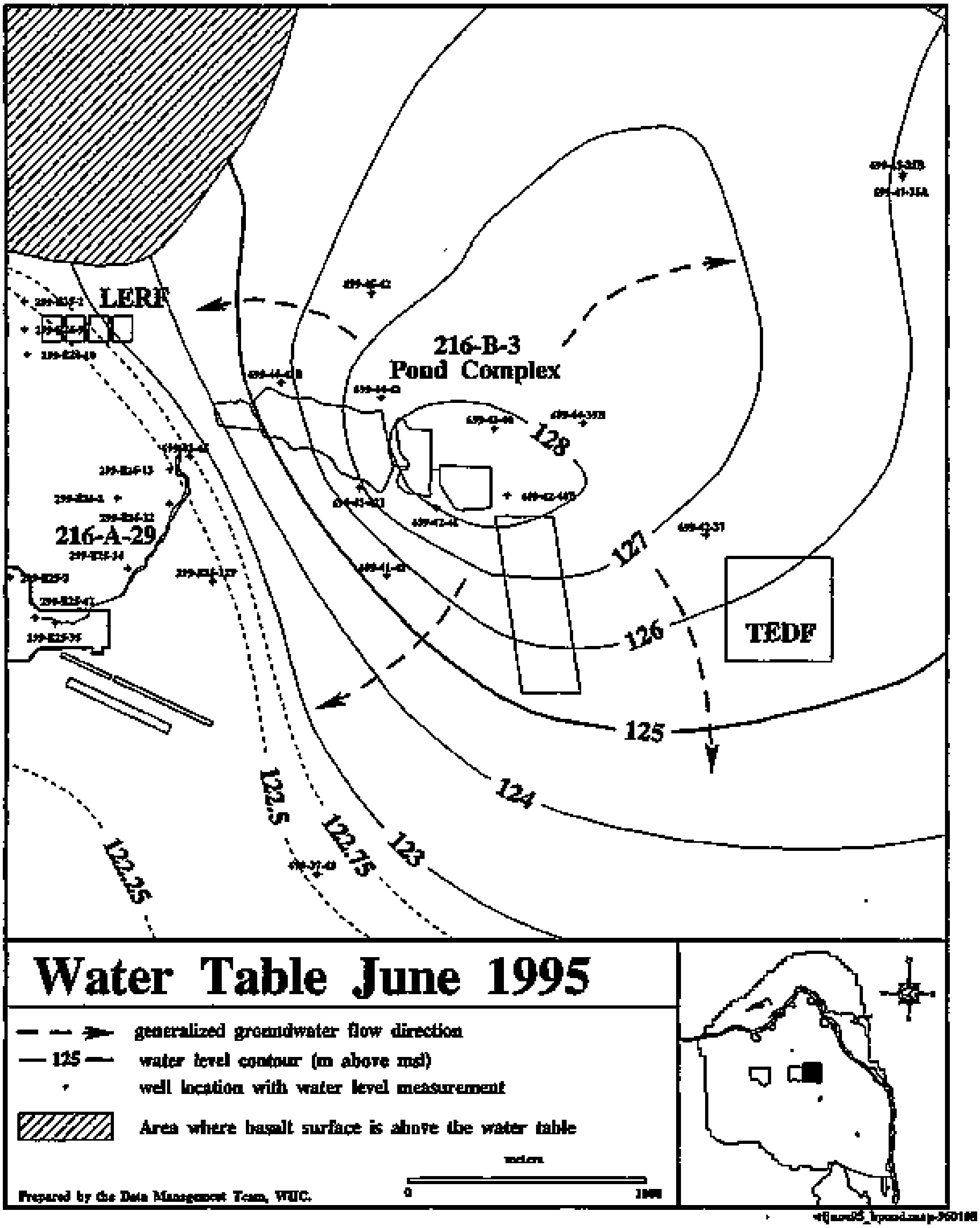

Figure 4.3-3. Composite Hydrograph for Representative Wells, 216-B-3 Pond.

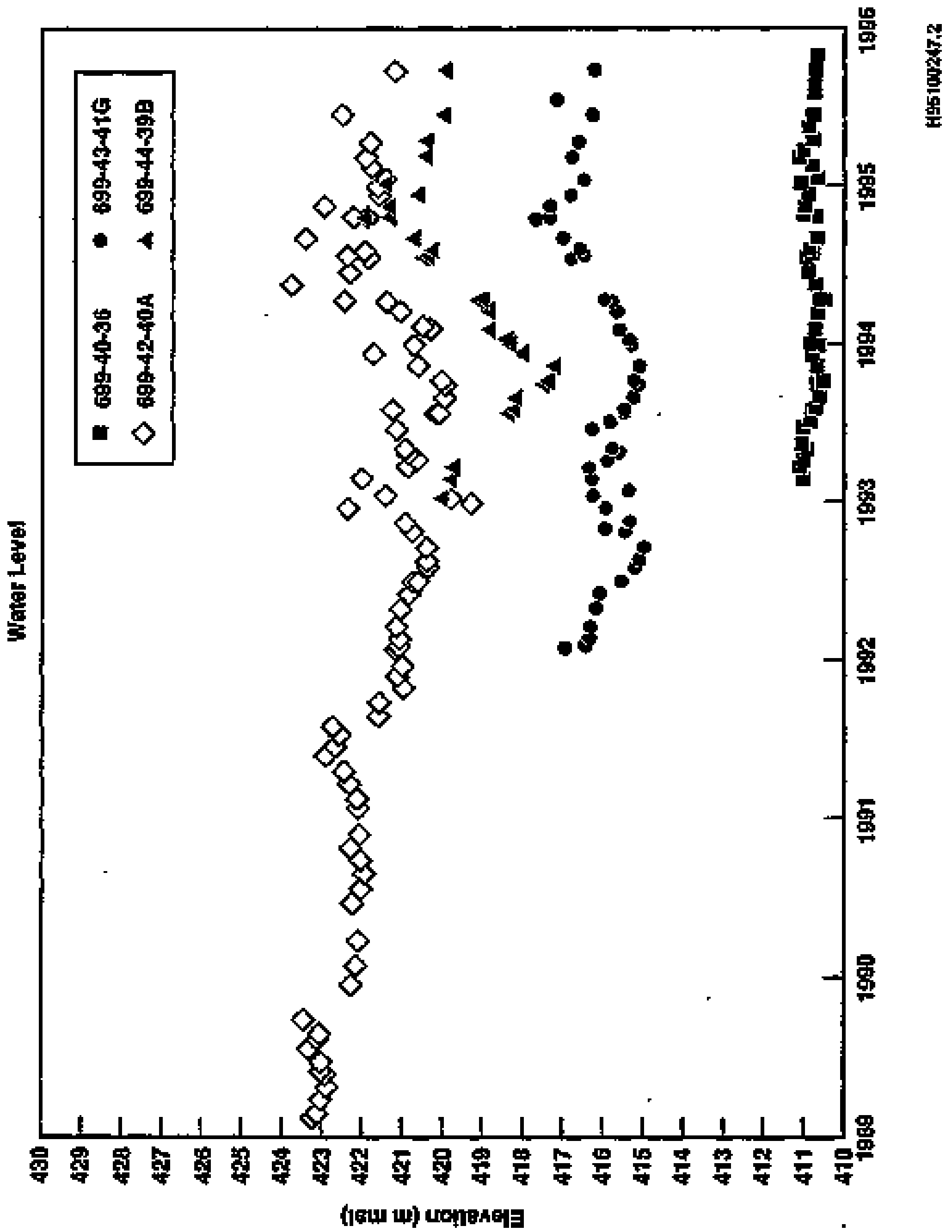

Table 4.3-1. Monitoring Wells Used for the 216-B-3 Pond System.

Well	Aquifer	Sampling frequency	Water levels	Well standards	Other networks
299-E18-1^{88}	Top of unconfined	Q	M	RCRA	2101-M
299-E32-4^{87}	Top of unconfined	Q	M	RCRA	LLWMA-2
699-40-40A^{91}	Lower confined	Q	M	RCRA	--
699-41-40^{89}	Top of confined	Q	M	RCRA	--
699-41-42^{92}	Top of unconfined	Q	M	RCRA	--
699-42-39B^{91}	Lower confined	Q	M	RCRA	--
699-42-41^{91}	Top of unconfined	Q	M	RCRA	--
699-42-42B^{88}	Top of unconfined	Q	M	RCRA	--
699-43-40^{91}	Top of unconfined	Q	M	RCRA	--
699-43-41E^{89}	Top of confined	Q	M	RCRA	--
699-43-41G^{91}	Top of confined	Q	M	RCRA	--
699-43-45^{89}	Top of unconfined	Q	M	RCRA	A-29
699-44-39B^{92}	Top of confined	Q	M	RCRA	--
699-44-43B^{89}	Top of unconfined	Q	M	RCRA	--

Notes: Shading denotes upgradient wells. Superscript following well number denotes the year of installation.

M = frequency on a monthly basis.
PRE = well was constructed before RCRA-specified standards.
Q = frequency on a quarterly basis.
RCRA = well is constructed to RCRA-specified standards.

Table 4.3-2. 216-B-3 Pond, 1995 Chemical Constituent List.

Contamination indicator parameters	
pH	Total organic carbon
Specific conductance	Total organic halogens
Site Specific Parameters	
Semivolatile organic compounds	Alkalinity
ICP metals (filtered)	Anions
Gross alpha	Turbidity
Gross beta	

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4.4 216-A-29 DITCH

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4.4.1 Facility Overview

The 216-A-29 Ditch (A-29 Ditch) was first used in 1955 when the Plutonium-Uranium Extraction (PUREX) Plant began operation. The A-29 Ditch is located east of the 200 East Area in the central portion of the Hanford Site. It was an excavated unlined percolation trench that was approximately 2 m (6 ft) wide at the bottom and 2,000 m (3,600 ft) long. It received effluent from the PUREX Plant chemical sewer line (CSL) and conducted it to the 216-B-3 Pond system (B Pond).

Effluents disposed of in the A-29 Ditch infiltrated into approximately 76 m (250 ft) of unsaturated Hanford formation sediments above the water table. The water table beneath the A-29 Ditch occurs within the indistinct contact between the Hanford formation lower gravel sequence and the underlying Ringold gravel unit A. The uppermost portion of the saturated zone beneath the ditch consists of Ringold Formation sediments (Figure 4.4-1) (WHC 1992).

The A-29 Ditch received sequential discharges of sodium hydroxide and sulfuric acid from the water treatment demineralizer almost daily during the early years of operation. The A-29 Ditch also received inadvertent spills of potentially hazardous chemicals and discharges of characteristically corrosive waste and waste containing the hazardous constituent hydrazine. In 1984, administrative and physical controls were implemented to avoid inadvertent discharges of hazardous chemicals.

A RCRA-compliant groundwater monitoring network was completed and the groundwater beneath the A-29 Ditch has been monitored since November 1988 (Kasza and Goodwin 1992). In January 1990, statistical evaluation indicated that specific conductance in downgradient well 299-E25-35 had exceeded the critical mean. Immediate resampling of the well verified that the specific conductance in well 299-E25-35 was statistically greater than the critical mean. As required by the RCRA, a groundwater quality assessment plan was prepared and issued (Chou et al. 1990). As a result, monthly water level measurements and quarterly groundwater samples were collected from the assessment network as part of the assessment investigation. Groundwater sampling and analysis were not conducted between June 1990 and July 1991 because the groundwater analytical contract was suspended.

On July 15, 1991, effluent from the PUREX CSL was rerouted to the PUREX cooling water line and discharges to the A-29 Ditch were eliminated. The A-29 Ditch was backfilled and the location was graded and revegetated as an interim stabilization measure during autumn of 1991 (Smith 1992). This activity marked the completion of *Hanford Federal Facility Agreement and Consent Order* Milestone M-17-10 (Ecology et al. 1994).

A report describing the results of the groundwater quality assessment program at the 216-A-29 Ditch RCRA facility was prepared and released in October 1995 (Votava 1995). The results of the investigation indicated that the 216-A-29 Ditch is the source that caused elevated specific conductance in well 299-E25-35, and that the source (sulfate, sodium, etc.) is nonhazardous. The report describes the current monitoring status of the 216-A-29 Ditch, groundwater chemical data interpretation, and recommends the reinstatement of an indicator-evaluation monitoring program in accordance with 40 CFR 265.93(d)(6). This program began at the start of FY 1996.

The A-29 Ditch is located in the 200-PO-5 *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) operable unit. The RCRA closure plan is due to the Washington State Department of Ecology and the U.S. Environmental Protection Agency in March 2000.

4.4.2 Summary of 1995 Activities

During 1995, the monitoring activities required by the assessment plan and the groundwater monitoring plan were conducted. The depth to the water table was measured monthly in the wells that constitute the A-29 groundwater monitoring network and quarterly in the wells used to gather supplementary data for the groundwater quality assessment program. Groundwater samples were collected for chemical analysis from the designated monitoring wells during each quarter. Site water levels and groundwater chemistry data were reported in the series of quarterly RCRA groundwater monitoring data reports (Freeman 1995; Votava 1995a, 1995b, and 1996).

4.4.3 Sampling and Analysis Program

The A-29 groundwater monitoring network currently consists of 2 upgradient and 11 downgradient wells, all of which were constructed to RCRA standards. Thirteen additional wells were used to gather supplementary groundwater data for the groundwater quality assessment investigation. Details about the groundwater monitoring network and assessment wells are listed in Table 4.4-1. Figure 4.4-2 shows the locations of the wells. Five wells were cosampled to satisfy the monitoring requirements of other RCRA facilities.

As part of the groundwater quality assessment investigation, the groundwater of the unconfined aquifer beneath the A-29 Ditch was sampled during each calendar quarter at the monitoring network wells and at selected assessment investigation wells (see Table 4.4-1 and Figure 4.4-2) (Chou et al. 1990). These groundwater samples were then analyzed for the constituents listed in Table 4.4-2. Analytical results were reported in the previously listed quarterly reports (see Section 4.4.1.2).

The groundwater quality assessment investigation was designed to determine whether the A-29 Ditch or one of the adjacent disposal sites was the actual source of the groundwater contamination. The determination of the groundwater flow direction and the analyses for the various chemical constituents listed in Table 4.4-2 were intended to identify both the contaminant and the source of the contamination found at well 299-E25-35.

4.4.4 Groundwater Chemistry

The facility was evaluated for changes in the water quality in the 2 upgradient and 11 downgradient RCRA-compliant wells (Section 4.4.5.1). The 13 wells in the assessment program were evaluated to provide a comparison to downgradient well 299-E25-35 (Section 4.4.5.2).

4.4.4.1 Concentration Histories of Waste Indicators. The groundwater quality assessment monitoring program was initiated at A-29 in 1990 because field-measured specific conductance at well 299-E25-35 was 784 μmhos (January 29, 1990). This was above the original critical mean of 455.31 μmhos. The mean was established using well 299-E25-32P, which was then upgradient.

Specific conductance reflects the quantity of ions in the groundwater. The assessment investigation method included evaluating concentrations of major anions and cations that have been monitored and comparing them to average concentrations of waste constituents disposed of to the A-29 Ditch and surrounding cribs. Time concentration patterns of specific conductance in well 299-E25-35 correspond to similar trends of sulfate, sodium, and calcium. Figure 4.4-3 depicts the similar historical concentration plots of these constituents and specific conductance over time. Calcium and sodium, however, are not ideal indicators of contamination because they occur naturally in the uppermost aquifer and they are reported at considerably lower values than sulfate. Therefore, the primary contaminant was determined to be sulfate (Figure 4.4-4).

The specific conductance in well 299-E25-35 fell dramatically in 1993 to approximately one-half of the historic range of values for this constituent. As shown in Figure 4.4-4, the specific conductance values measured at this well during 1995 have remained consistent with 1994 values. The specific conductance values measured at well 299-E25-35 during 1995 remain approximately 1.5 times higher than upgradient wells to the northeast (699-43-43 and 299-E25-43) and slightly higher than upgradient wells to the west (299-E25-42) and southeast (299-E25-18). The specific conductance measured for well 299-E25-35 during all 1995 sample collections was below the critical mean value (455.3 μmho/cm) established when the A-29 Ditch went into groundwater quality assessment monitoring in 1990.

4.4.4.2 Distribution of Waste Constituents. Sulfate is elevated in the groundwater at well 299-E25-35 (Figure 4.4-5). Sulfuric acid from the CSL effluent disassociates into sulfate in water matrices by the resin columns (regeneration cycle) and/or by the soil carbonate in the ditch.
Well 299-E25-35 is located at the head of the ditch; therefore, if any infiltration occurred, it would be noticed first at this well. Specific conductance and sulfate also are elevated slightly, but are not above the critical mean, in well 299-E25-42, which is downgradient of well 299-E25-35. Figure 4.4-6 presents 1995 average specific conductance concentrations in the groundwater. Sulfate concentrations in the groundwater never exceeded the secondary drinking water standard (250,000 ppb) and it is not a hazardous waste constituent. A report on the findings of the groundwater quality assessment investigation was released in October 1995 (Votava 1995). This document recommended to reinstate detection monitoring and schedule it to begin during fiscal year 1996.

4.4.5 Groundwater Flow

4.4.5.1 Groundwater Flow Direction. The A-29 Ditch is located approximately 600 to 1,200 m (2,000 to 4,000 ft) west of the B Pond system. The regional groundwater flow pattern in the unconfined aquifer is radially outward from the B Pond groundwater mound. Figure 4.4-7 presents the June 1995 water level data from surrounding groundwater monitoring wells. The figure defines the local water table and groundwater flow direction in the unconfined aquifer beneath the A-29 Ditch. As shown, the local groundwater flow direction near the A-29 Ditch ranges from a westward flow at the north end of the ditch to a southwestward flow at the south end of the ditch.

Hydrographs from local wells with nested piezometers (299-E25-29P and 299-E25-29Q, and 299-E25-32P and 299-E25-32Q) and a pair of adjacent A-29 network wells with shallow and deep completions (299-E25-34 and 299-E25-28) were examined for calculation of vertical gradients. Review of the available data indicates that the vertical head difference is very small and is difficult to distinguish from measurement errors.

The hydrograph of the A-29 Ditch groundwater monitoring network, Figure 4.4-8, depicts the change in the water table beneath the A-29 Ditch since the start of RCRA monitoring. The hydrograph indicates that water levels across the network have gradually declined. The water table and hydrograph figures indicate that monitoring wells 699-43-43 and 699-43-45 continue to be upgradient of the facility and are appropriate upgradient monitoring wells for the ditch.

Figure 4.4-2 shows the location of the A-29 Ditch in relation to other RCRA or operational facilities. In the past, the disposal of liquid effluent at some of these facilities may have produced local changes to the groundwater flow pattern and may have caused local contaminant flow counter to the regional flow direction. Considering the proximity of the 216-A-30 and 216-A-37-1 Cribs to well 299-E25-35 and the ongoing decrease in the regional water table, the potential for contaminant migration from any of these cribs toward well 299-E25-35 is possible. Water levels and groundwater movement in the area surrounding the A-29 Ditch are also discussed in Section 4.3, 216-B-3 Pond System; Section 4.5, 216-A-36B Crib; and Section 4.6, 216-A-10 Crib of this report.

4.4.5.2 Rate of Flow. Groundwater movement beneath the A-29 Ditch is influenced by the water table mound beneath the B Pond. In June 1995, there was a 5 m (17 ft) difference in the water table between the highest part of the B Pond mound and the monitoring wells immediately adjacent to the A-29 Ditch. The hydraulic gradient and groundwater flow velocity beneath different segments of the A-29 Ditch depend on the proximity of the segment to the B Pond mound. Using the June 1995 water table, the hydraulic gradient at the north end of the ditch is approximately 8.0×10^{-3} and the hydraulic gradient at the south end is 1.6×10^{-3}.

An estimate of the groundwater velocities in these two areas can be calculated from the measured gradients and aquifer test data from the A-29 monitoring network well 299-E25-42 using Darcy's law:

$$V = \frac{Ki}{n_e} \qquad (1)$$

where:

V = Average linear velocity (m/d)
K = Hydraulic conductivity (m/d), 18.29 m/d (Kasza 1992)
i = Hydraulic gradient (m/m), 8.0×10^{-5} to 1.6×10^{-3}
n_e = Effective porosity, 0.25 (WHC 1990).

Groundwater flow velocities beneath the A-29 Ditch during June 1995 ranged from 1.7×10^{-3} m/d (5.9×10^{-3} ft/d) in the southern portion to 3.6×10^{-2} m/d (0.12 ft/d) in the northern portion.

4.4.5.3 Evaluation of Monitoring Well Network. Water levels in each well of the A-29 groundwater monitoring network were compared to the depth of the screen interval and the pump intake elevation to ensure that sufficient volumes of water exist for sampling purposes. There is no short-term need to replace any of the existing groundwater monitoring wells. Wells with high turbidity are slated for cleaning and redevelopment. Once each well is redeveloped, the purge rate determined at development will be the highest rate used for subsequent sampling events. This will reduce the potential for producing turbidity during sampling.

An evaluation of monitoring well locations confirmed that any effect the A-29 Ditch had on groundwater quality could be determined by the monitoring wells located upgradient and downgradient of the facility.

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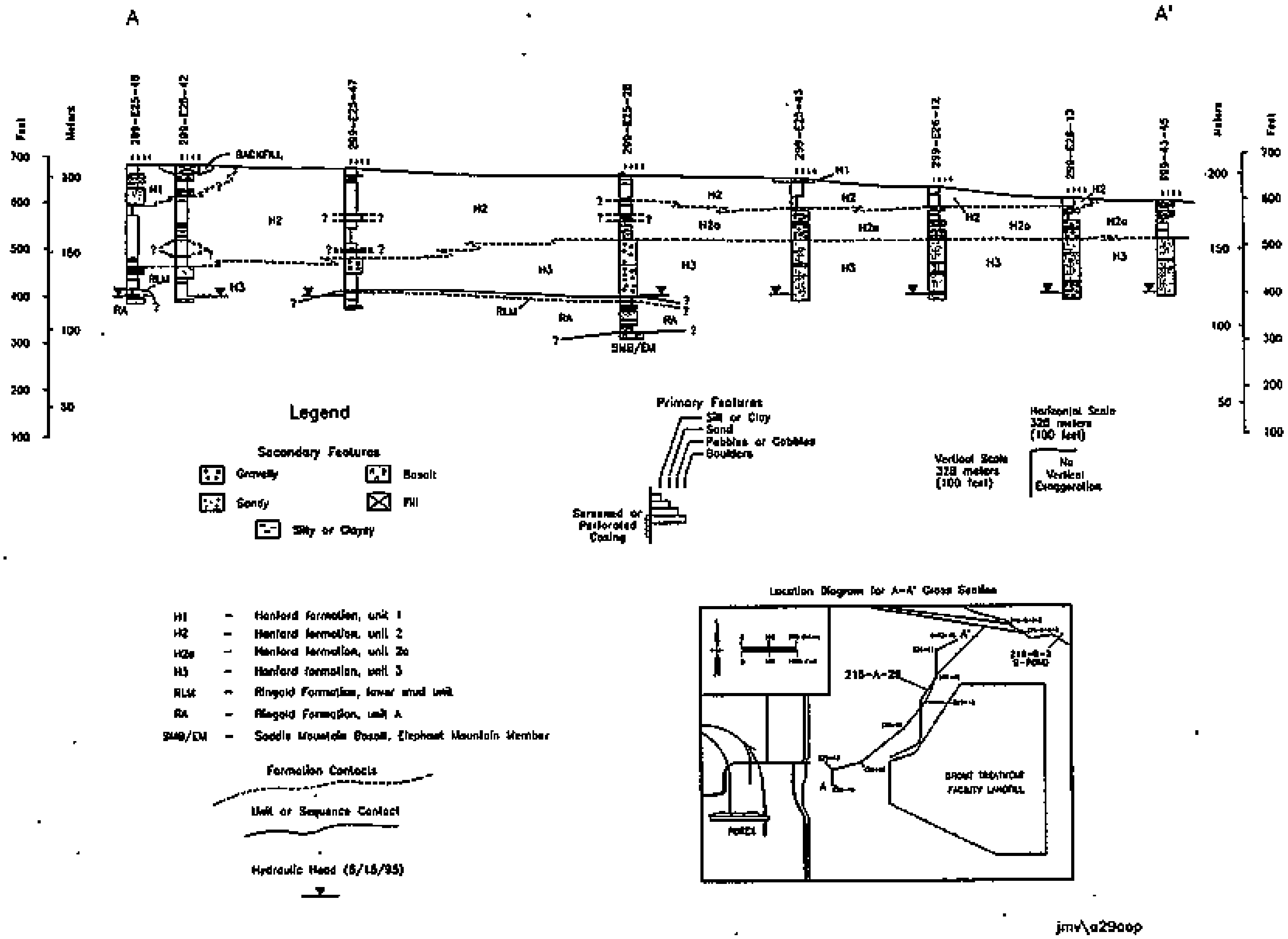

Figure 4.4-1. Cross Section Parallel to the 216-A-29 Ditch.

Figure 4.4-2. Monitoring Well Locations at the 216-A-29 Ditch.

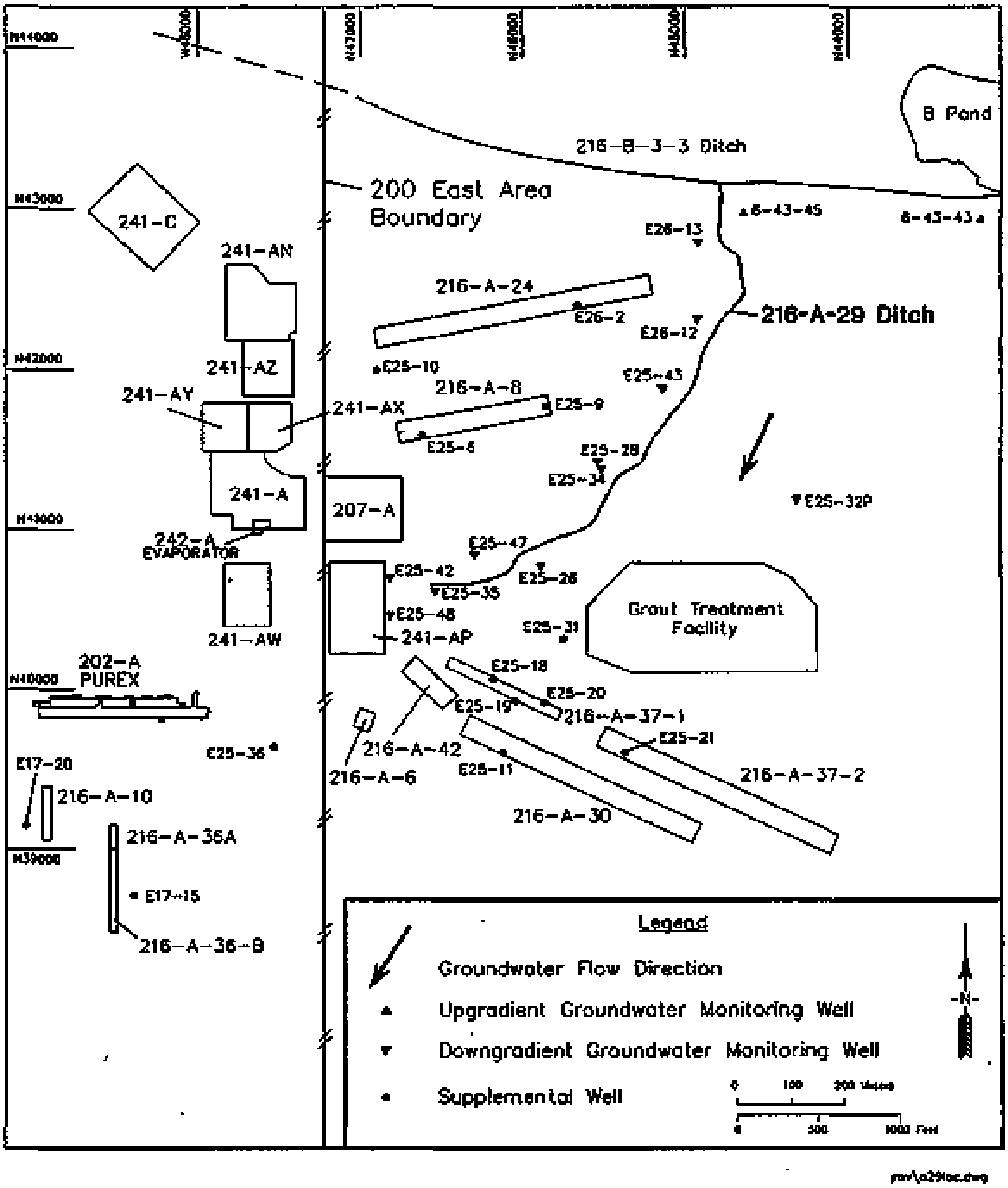

Figure 4.4-3. Specific Conductance and Sulfate, Sodium, and Calcium Concentrations Over Time at Well 299-E25-35.

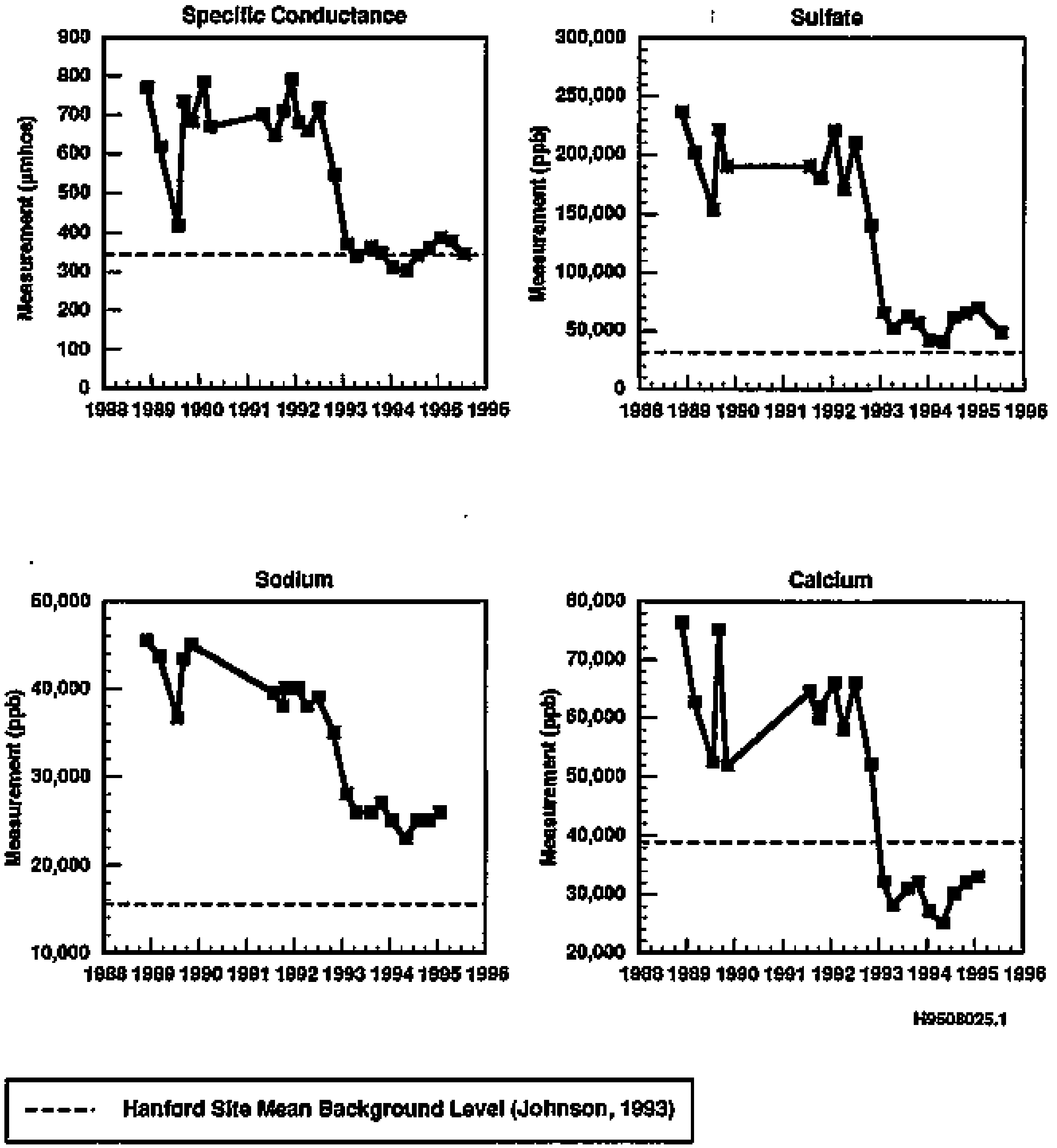

Figure 4.4-4. Specific Conductance Concentrations Over Time at Well 299-E25-35 and Select Wells.

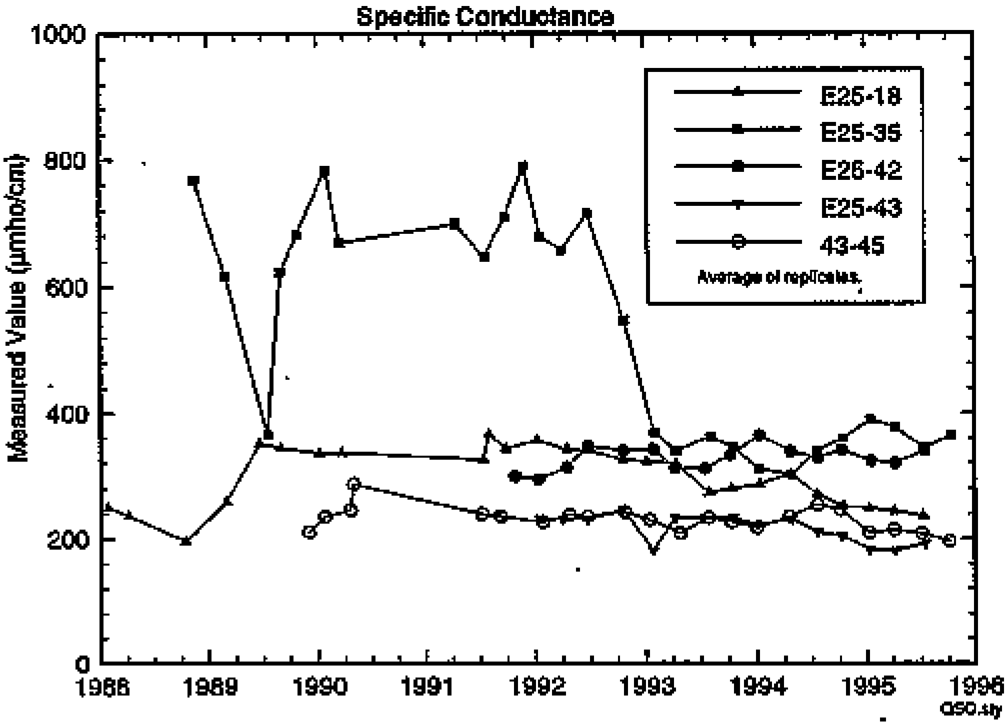

Figure 4.4-5. Sulfate Concentrations Over Time at Well 299-E25-35 and Select Wells.

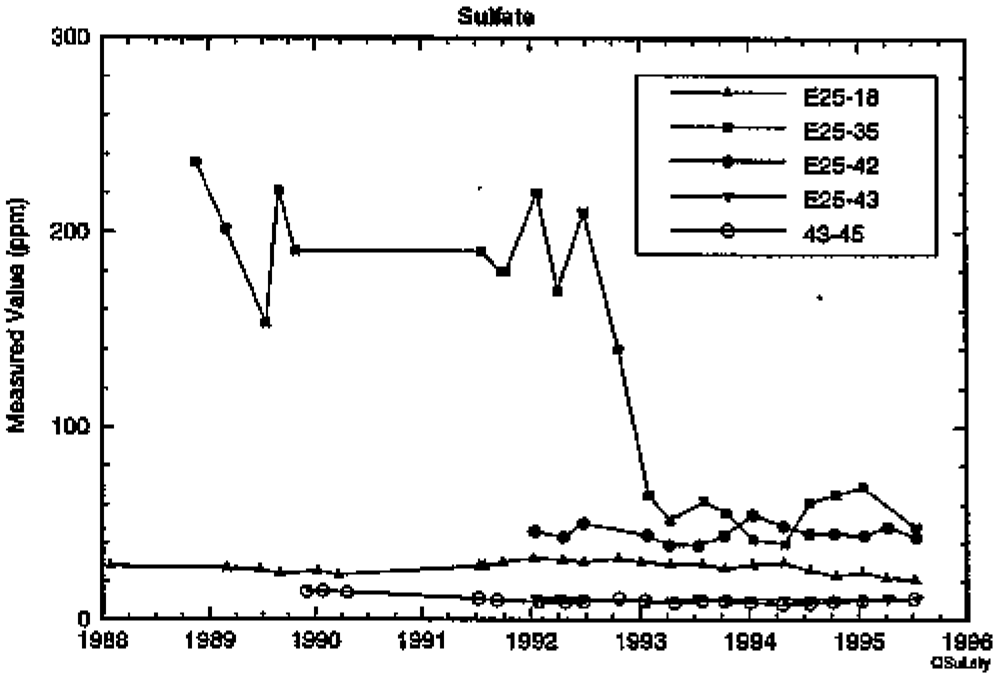

Figure 4.4-6. Specific Conductance of Groundwater (Average 1/95 - 8/95).

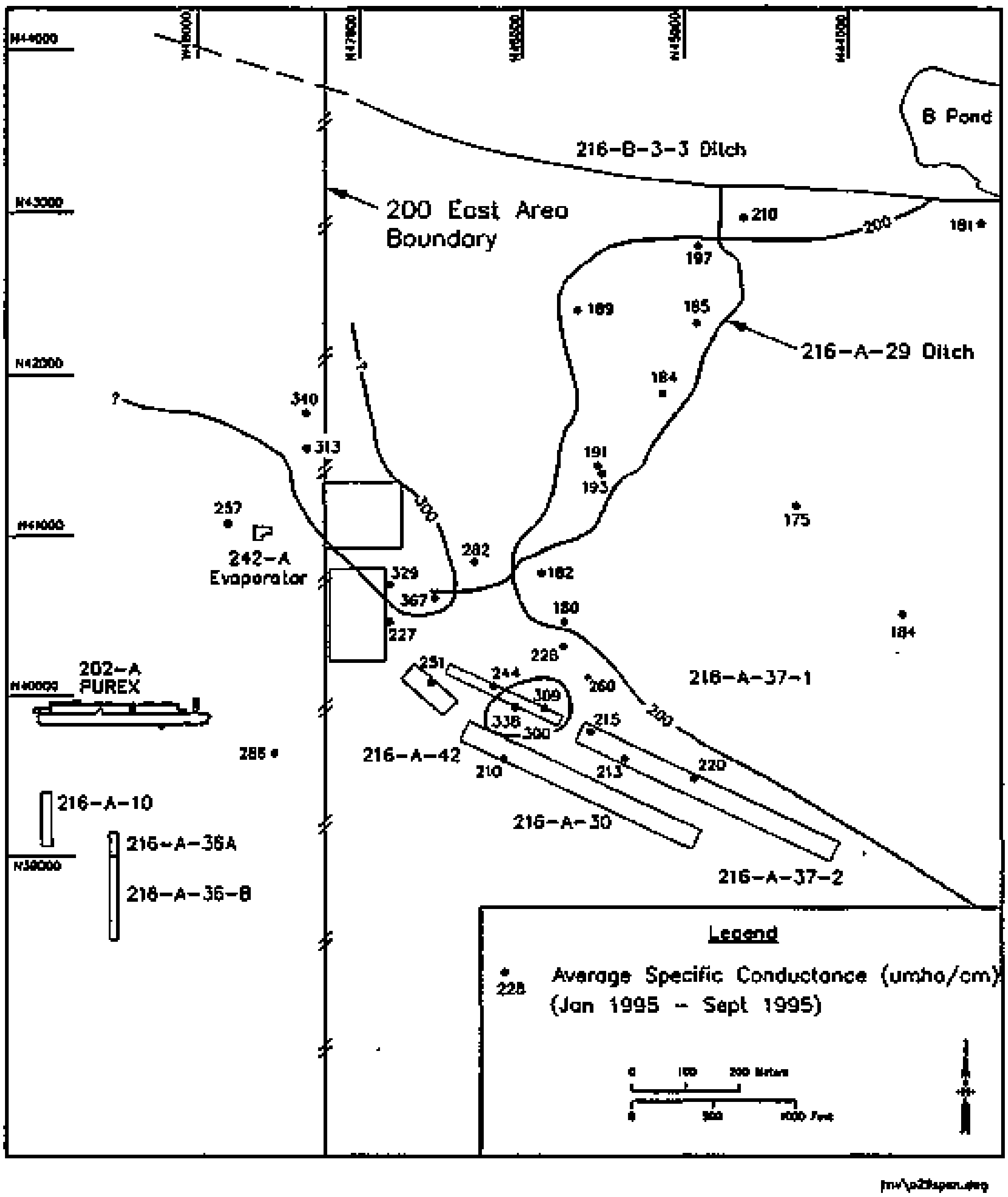

Figure 4.4-7. June 1995 Water Table.

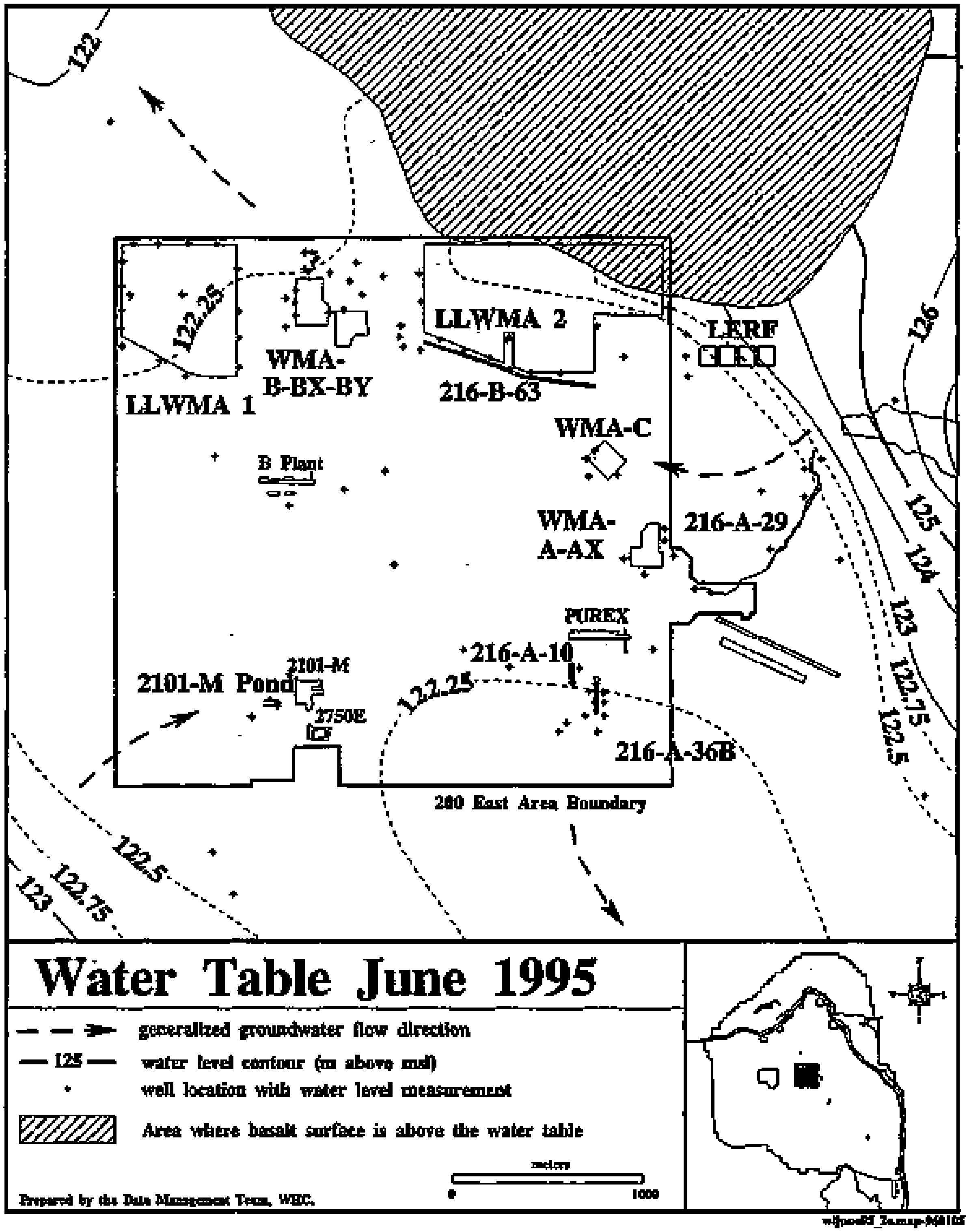

Figure 4.4-8. Hydrograph of 216-A-29 Ditch Monitoring Network Wells.

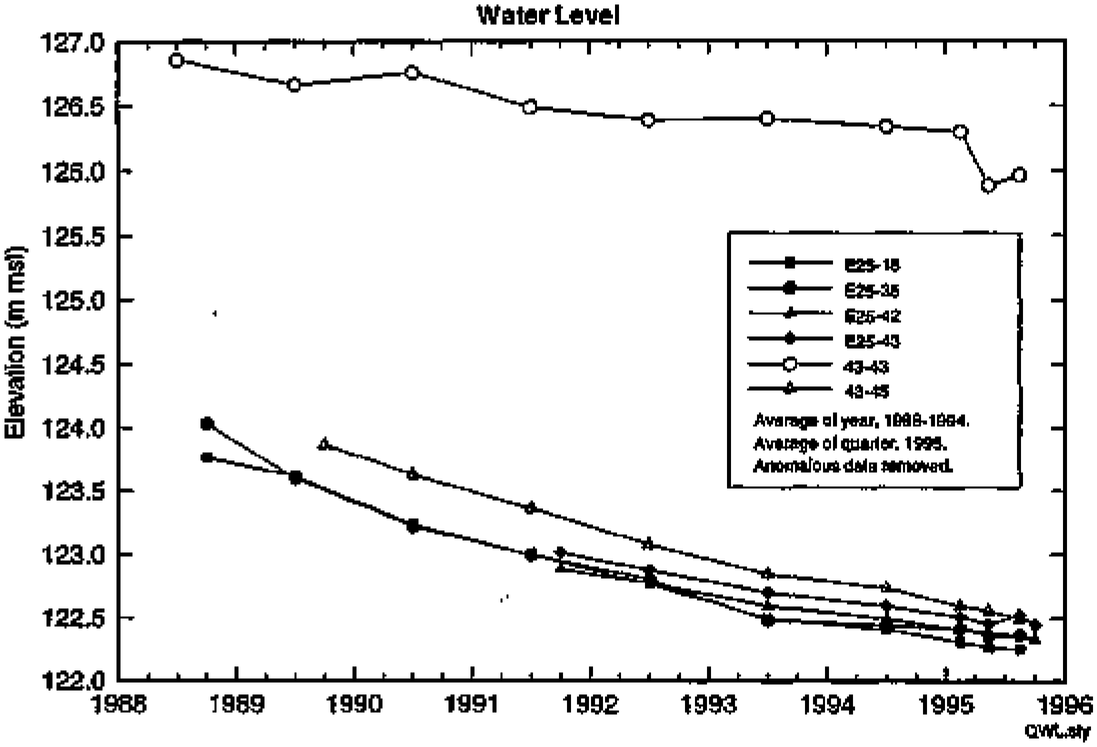

Table 4.4-1. Monitoring Wells Used for the 216-A-29 Ditch.

Well	Aquifer	Sampling frequency	Water levels	Well standard	Other networks
299-E25-26^{85}	Upper unconfined	Q	M	RCRA	--
299-E25-28^{86}	Deep unconfined	Q	M	RCRA	--
299-E25-34^{88}	Top of unconfined	Q	M	RCRA	--
299-E25-35^{88}	Top of unconfined	Q	M	RCRA	--
299-E25-42^{91}	Top of unconfined	Q	M	RCRA	--
299-E25-43^{91}	Top of unconfined	Q	M	RCRA	--
299-E25-47^{92}	Top of unconfined	Q	M	RCRA	--
299-E25-48^{92}	Top of unconfined	Q	M	RCRA	--
299-E26-12^{91}	Top of unconfined	Q	M	RCRA	--
299-E26-13^{91}	Top of unconfined	Q	M	RCRA	--
299-E25-32P^{88}	Top of unconfined	Q	M	RCRA	--
699-43-43^{88}	Top of unconfined	Q	M	RCRA	B Pond
699-43-45^{89}	Top of unconfined	Q	M	RCRA	B Pond
299-E17-15^{88} A	Top of unconfined	Q	Q	RCRA	A-36B
299-E17-20^{88} A	Top of unconfined	Q	Q	RCRA	A-10
299-E25-06^{56} A	Top of unconfined	--	Q	PRE	--
299-E25-09^{56} A	Top of unconfined	--	Q	PRE	--
299-E25-10^{58} A	Deep unconfined	--	Q	PRE	--
299-E25-11^{60} A	Deep unconfined	Q	Q	PRE	--
299-E25-18^{76} A	Top of unconfined	Q	Q	PRE	--
299-E25-19^{76} A	Top of unconfined	Q	Q	PRE	--
299-E25-20^{76} A	Top of unconfined	Q	Q	PRE	--
299-E25-21^{83} A	Top of Unconfined	Q	Q	PRE	--
299-E25-31^{87} A	Top of unconfined	Q	Q	RCRA	--
299-E25-36^{88} A	Top of unconfined	Q	Q	RCRA	A-10
299-E26-02^{58} A	Top of unconfined	--	Q	PRE	--

Notes: Shading denotes upgradient wells. Superscript following well number denotes the year of installation.

A = assessment program well that is sampled for supplementary data.
M = frequency on a monthly basis.
PRE = well was constructed before RCRA-specified standards.
Q = frequency on a quarterly basis.
RCRA = well is constructed to RCRA-specified standards.

Table 4.4-2. Constituents Analyzed in the Groundwater Beneath the 216-A-29 Ditch.

Semiannually	Annually
TOX	alkalinity
TOC	anions
pH	ICP metals
specific conductance	tritium
turbidity	phenols

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4.5 216-A-36B CRIB

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4.5.1 Facility Overview

The 216-A-36B Crib (A-36B Crib), now retired from use, was a liquid waste disposal facility for the Plutonium-Uranium Extraction (PUREX) Plant. The A-36B Crib is located in the 200 East Area approximately 360 m (1,200 ft) south of the PUREX Plant. It is approximately 110 m (360 ft) east of the 216-A-10 Crib. The A-36B Crib is the south end [150 m (500 ft)] of the crib, originally known as the 216-A-36 Crib (Figures 1-1 and 4.5-1).

The original crib dimensions were 180 m (600 ft) long, 4 m (12 ft) wide, and 4 m (12 ft) deep. A 0.15-m- (0.5-ft-) diameter perforated distributor pipe was placed at the bottom of the crib on a 0.3-m (1-ft) bed of gravel, covered with another 0.3 m (1 ft) 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 of and was assumed to have infiltrated sediments near the inlet to the crib. To prevent radionuclides from reaching the water table, Operations personnel decided to treat the head end of the crib as a specific retention facility. This limits the amount of water discharged to the crib (Smith and Kasper 1983). To continue effluent discharge to the crib, the crib was divided into two sections: 216-A-36A and 216-A-36B. Grout was injected into the gravel layer to form a curtain separating the two sections. The liquid effluent discharge point was moved to the 216-A-36B Crib section and the 216-A-36A Crib section was no longer used. Discharge to the 216-A-36B Crib resumed in March 1966 and continued until 1972, when the crib was temporarily removed from service. The 216-A-36B Crib was placed back in service in November 1982 and operated until it was taken out of service again in October 1987.

Ammonia scrubber distillate discharged to 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 tritium, ^{90}Sr, ^{137}Cs, ^{106}Ru, ^{60}Co, and uranium (Buelt et al. 1988).

Waste disposed of in the A-36B Crib encountered approximately 97 m (318 ft) of unsaturated Hanford formation sediments above the water table. The water table beneath the A-36B Crib occurs very near the hard-to-distinguish contact between the unsaturated Hanford formation upper gravel and sandy sequences of the underlying Ringold gravel unit E (see Chapter 2.0). Approximately 40 m (130 ft) of Ringold Formation sediments make up the saturated zone of the uppermost aquifer system beneath the A-36B Crib (WHC 1992).

An interim-status *Resource Conservation and Recovery Act of 1976* (RCRA) groundwater monitoring program has been in operation at the A-36B Crib since May 1988. The groundwater monitoring program at the A-36B Crib is currently in indicator-parameter evaluation status. The RCRA closure/post-closure plan for the A-36B Crib is scheduled to be submitted to the Washington State Department of Ecology and the U.S. Environmental Protection Agency in June 1998. This action will satisfy the *Hanford Federal Facility Agreement and Consent Order* Milestone M-20-34 (Ecology et al. 1994). The A-36B Crib is part of the CERCLA 200-PO-2 operable unit.

4.5.2 Summary of 1995 RCRA Activities

Groundwater samples were collected and analyzed semiannually for TOX, TOC, pH, specific conductance, turbidity, gross alpha, gross beta, and tritium and annually for alkalinity, anions, ICP metals, ^{129}I, and phenols during 1995 for the wells in the A-36B Crib groundwater monitoring network. Samples were collected during October 1994 and April 1995. The depth to the groundwater beneath the A-36B Crib was measured in the monitoring network wells during sample collection and for each quarterly reporting period. The groundwater chemistry data and water level measurements were reported quarterly (Edrington 1995, 1995a; Votava 1995, 1996).

4.5.3 Sampling and Analysis Program

The A-36B Crib groundwater monitoring network (Figure 4.5-1) consists of three upgradient and six downgradient wells. All wells are shallow groundwater monitoring wells. Monitoring well information is presented in Table 4.5-1. All wells in the network, except 299-E17-5 (used for water level measurements only) and 299-E17-9, meet RCRA construction standards. These two wells are older remediated wells with perforated carbon steel casing. Samples from these wells are not used in statistical evaluation of the groundwater monitoring network.

Groundwater samples from the A-36B monitoring network are collected and analyzed semiannually and annually, depending on the constituent, to detect any groundwater contamination originating from the facility. Groundwater samples are analyzed for a series of constituents including: groundwater quality parameters, groundwater contamination indicator parameters, and site-specific constituents. The site-specific constituents were selected based on knowledge of the waste streams formerly discharged to the A-36B Crib. Table 4.6-2 lists these constituents. This sample and analysis program meets RCRA requirements (40 CFR 265).

Well 299-E25-36 is shared with the groundwater monitoring network for the 216-A-29 Ditch (see Section 4.4). This well is sampled quarterly to provide supplementary local groundwater quality data for the 216-A-29 Facility groundwater quality assessment program. Well 299-E24-18 is shared with the 216-A-10 groundwater monitoring network. It is sampled semiannually.

4.5.4 Groundwater Chemistry

The A-36B Crib is located directly over several plumes that define areas where specific constituents exceed the drinking water standards (DWS). The primary constituents of concern are nitrate and tritium (Figures 4.5-2 and 4.5-3). Similarities in the effluent constituents discharged to the A-10 and 216-A-45 Cribs and their proximity to the A-36B Crib make it difficult to determine how much the A-36B Crib affects the groundwater quality.

4.5.4.1 Elevated Constituents. The critical means were not exceeded for the four contamination indicator parameters (specific conductance, pH, TOC, and TOX) in the A-36B Crib monitoring network during 1995. DWS for the following constituents were exceeded in the A-36B network during 1995: nitrate, tritium, ^{129}I, unfiltered chromium, and unfiltered iron (Edrington 1995; Edrington and Votava 1995; Votava 1995, 1996). Requests for analytical data evaluation were submitted for all unusual occurrences of constituents.

Nitrate concentrations (Figure 4.5-4) exceeded the DWS (45,000 ppb) at least once in wells 299-E17-9, 299-E17-14, 299-E17-15, and 299-E17-16 during 1995. The trend of the nitrate concentration in the groundwater beneath the A-36B facility has generally been steady to slightly declining since 1987.

The tritium DWS (20,000 pCi/L) was exceeded in all wells, except 299-E25-36, in the A-36B groundwater monitoring network during 1995 (Figure 4.5-5). The measured concentrations of tritium are unchanged to slightly lower than 1994 results. The ^{129}I DWS (1 pCi/L) also was exceeded in all of the network wells.

During 1995, the chromium DWS (100 ppb) was exceeded in unfiltered samples from wells 299-E24-18 and 299-E25-36. Iron in unfiltered samples also exceeded the DWS (300 ppb) for wells 299-E17-15, 299-E17-16, 299-E17-17, and 299-E25-36. Unfiltered metals are believed to represent effects caused by well construction and not groundwater.

4.5.4.2 Statistical Evaluation. During 1995, groundwater quality beneath the A-36B Crib was subject to the RCRA-required continuing evaluation for sites under indicator parameter evaluation status. Appendix C explains the statistical method used to evaluate the groundwater analytical results. The statistical evaluations of the indicator parameter data consisted of reestablishing background conditions and comparing sample results from upgradient and downgradient wells for any indication of contamination in the groundwater underlying the facility. Statistical analyses required by 40 CFR 265.93(b), and *Washington Administrative Code* (WAC) 173-303-400 were performed on the samples collected from September 1988 to June 1989 for upgradient (at that time) well 299-E17-17 (DOE-RL 1991). Results are presented in Table 4.5-3. This table lists the background average, background standard deviation, and critical mean (or critical range, in the case of pH) and upgradient/downgradient comparison values for the four contamination indicator parameters. The comparison value is the value to which current and future averages of quadruplicate measurements are compared. The comparison value is generally the critical mean or critical range. All values of specific conductance, pH, TOC, and TOX in the downgradient wells in the past year were below the upgradient/downgradient comparison value.

4.5.5 Groundwater Flow

4.5.5.1 Water Level. Water levels in the A-36B network were measured quarterly and during semiannual sampling events in 1995 (Edrington 1995, Edrington and Votava 1995; Votava 1995, 1996). Water level data through September 1995 are presented for all wells in Figure 4.5-6. The average water level decline in these wells was approximately 0.15 m (0.5 ft) between June 1994 and June 1995. This trend continues the long-term decline in water levels that began during 1988 after the PUREX Plant operations shut down and discharges to the A-36B Crib and other nearby liquid effluent disposal facilities ceased.

4.5.5.2 Groundwater Flow Direction. Groundwater flow directions in the vicinity of the A-36B Crib are poorly defined because the local hydraulic gradient is extremely low (Figures 4.5-7). Regional-scale, water table elevation changes indicate that local groundwater flow is toward the south-southeast (see Figure 2-4).

4.5.5.3 Rate of Flow. Water table gradient is estimated to be in the range of 0.0001 to 0.0002 (WHC 1992). Based on these estimates and estimates of hydraulic conductivity (150 to 300 m/d [500 to 1,000 ft/d]) and porosity (0.25) for the unconfined aquifer near the A-36B Crib (WHC 1992), groundwater flow velocities may range from 0.06 to 0.24 m/d (0.2 to 0.8 ft/d) (see Section 4.4). Determining the vertical groundwater gradient is not possible because paired (deep) well completions are lacking in the surrounding area.

4.5.5.4 Evaluation of Monitoring Well Network. Water levels are measured regularly and the adequacy of the existing monitoring network is evaluated accordingly. Because of the steadily decreasing water levels since the newest wells in the network were drilled in 1988, the water level in each well was compared to the depth of the screened interval and pump intake elevation to ensure that sufficient volumes of water exist for sampling. As stated in Section 4.5.2, there is no near-term need to replace any of the existing groundwater monitoring wells. Because the A-36B Crib is surrounded on all sides by seven groundwater monitoring wells, the downgradient monitoring well network is currently adequate to monitor the quality of the groundwater beneath the A-36B Crib.

Because of the low local hydraulic gradient and the continuing decline of the regional water table, the evaluation of the upgradient wells is difficult. Very small relative changes in water levels between wells may constitute a reversal in gradient. Figure 4.5-6 shows that although well 299-E17-17 is an upgradient monitoring point for the A-36B Crib, two other wells in the network have had water levels as high or higher during certain periods. On several occasions during the current report period, downgradient wells 299-E17-14 and 299-E17-18 have had higher water levels than upgradient well 299-E17-17. The use of well 299-E17-17 as the upgradient groundwater monitoring well may not be appropriate in view of the current water table configuration. This issue was addressed in the revision of the *Interim-Status Groundwater Monitoring Plan for the 216-A-10 and 216-A-36B Cribs* (WHC 1994). In the last sampling year, the two upgradient wells from the A-10 monitoring network (299-E25-36 and 299-E24-18) were added as upgradient wells to the A-36B monitoring network for a total of three upgradient wells. See Figure 4.6-6 for the location of these wells; see Section 4.6 for more information about these wells.

4.5.6 References

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

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Figure 4.5-1. Monitoring Well Locations for the 216-A-36B Crib.

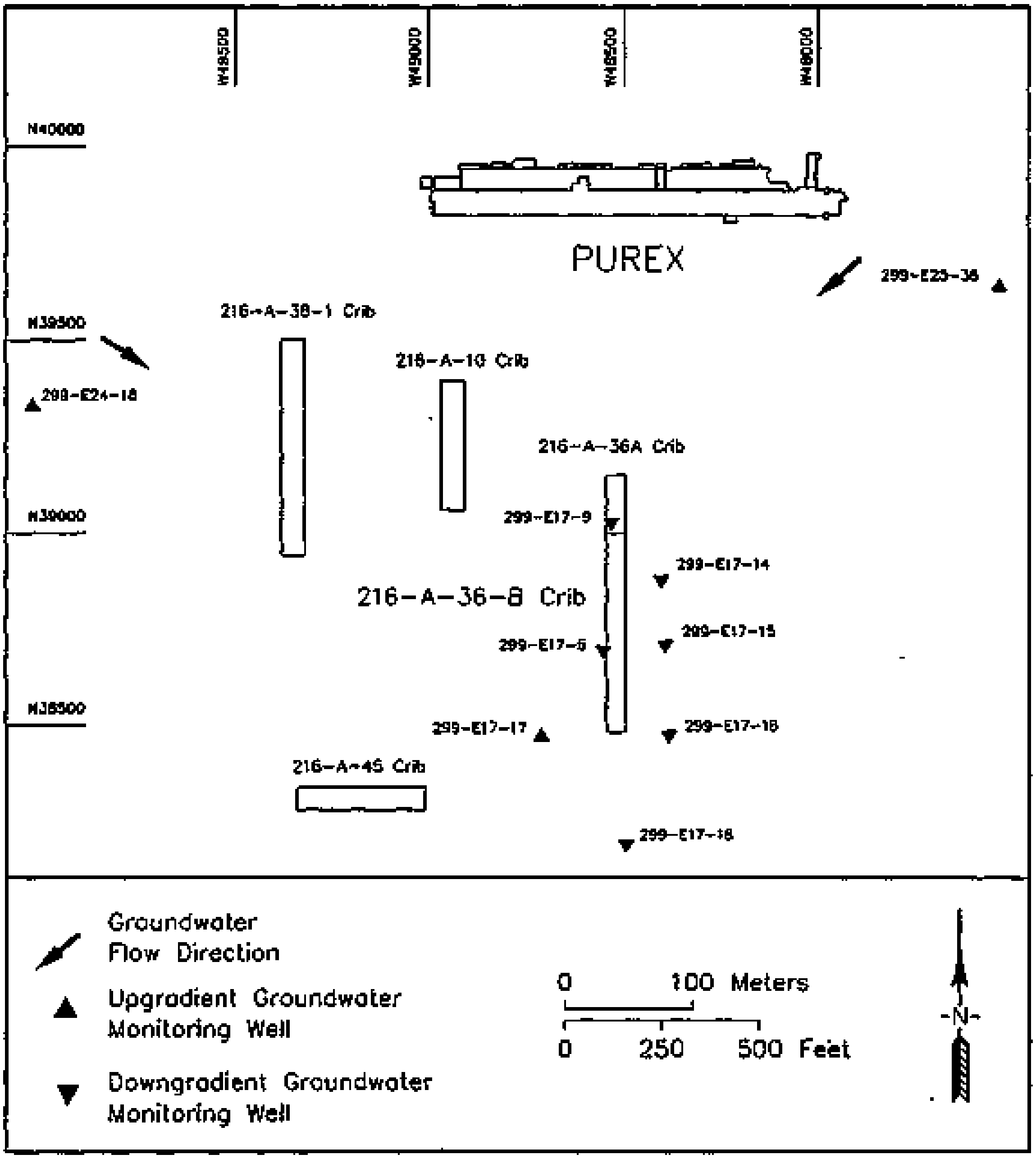

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Figure 4.5-2. Nitrate Distribution in the Uppermost Aquifer Beneath the 200 East Area.

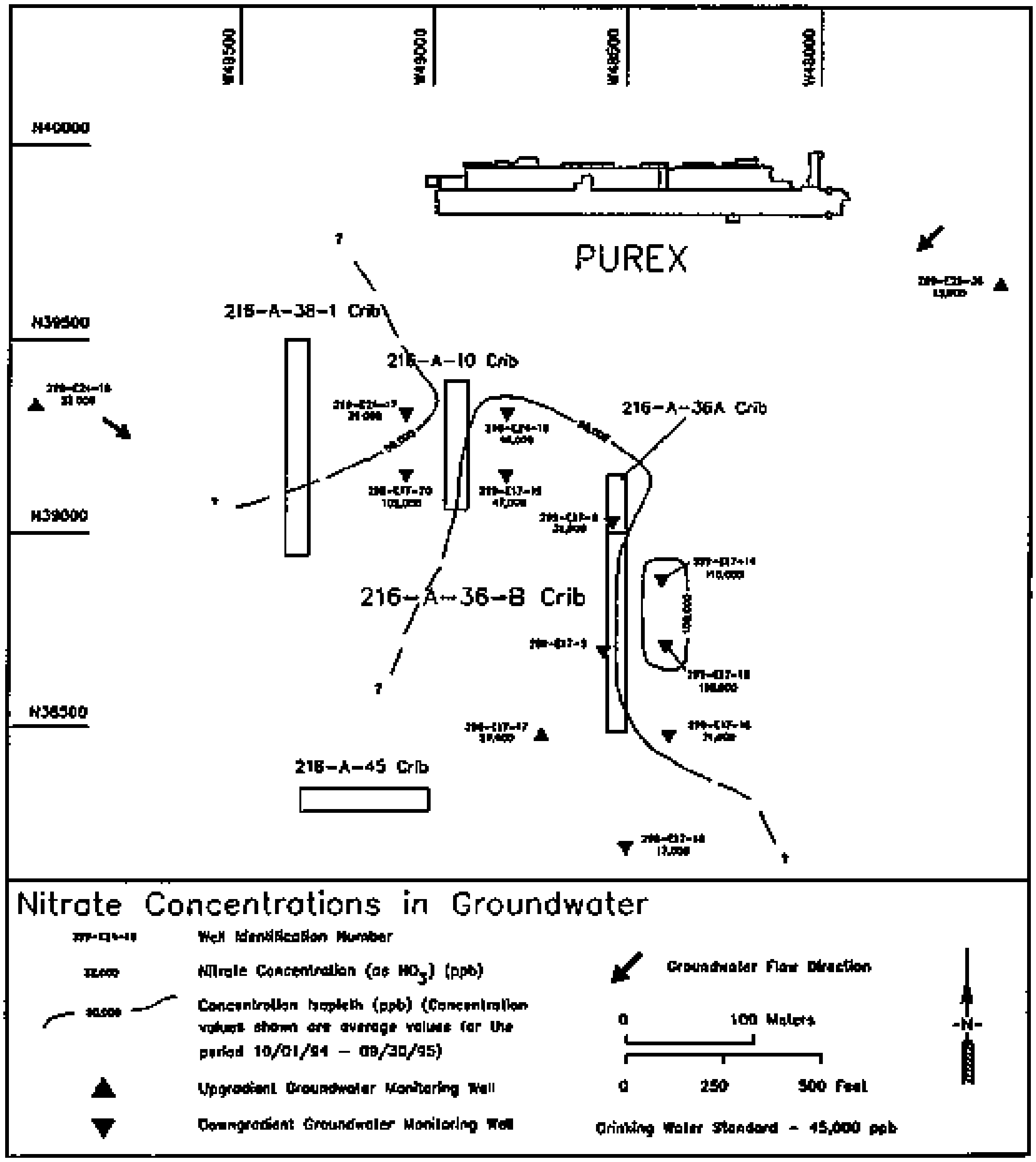

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Figure 4.5-3. Tritium Distribution in the Uppermost Aquifer Beneath the 200 East Area.

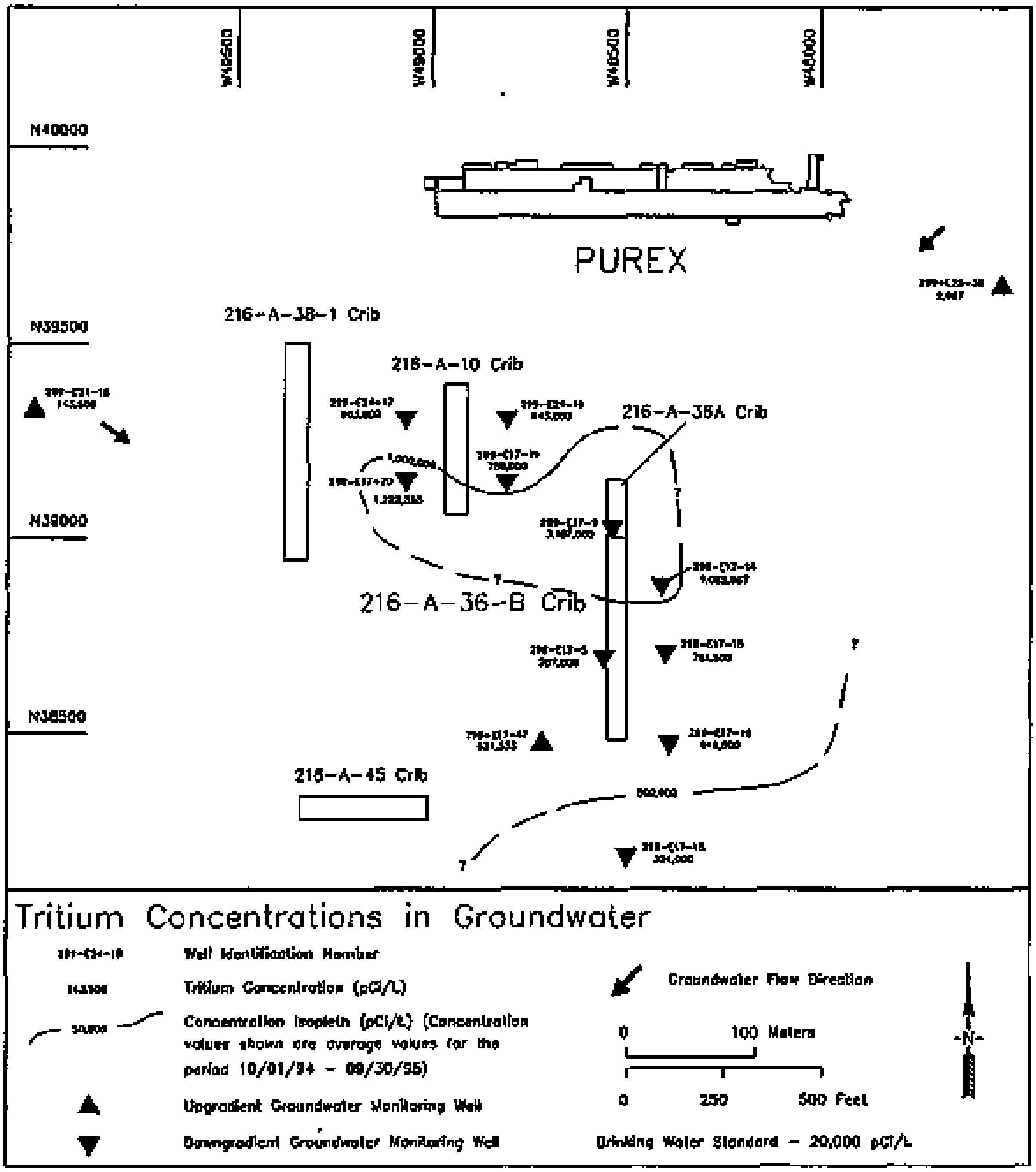

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Figure 4.5-4. Nitrate Concentrations in the 216-A-36B Network Wells.

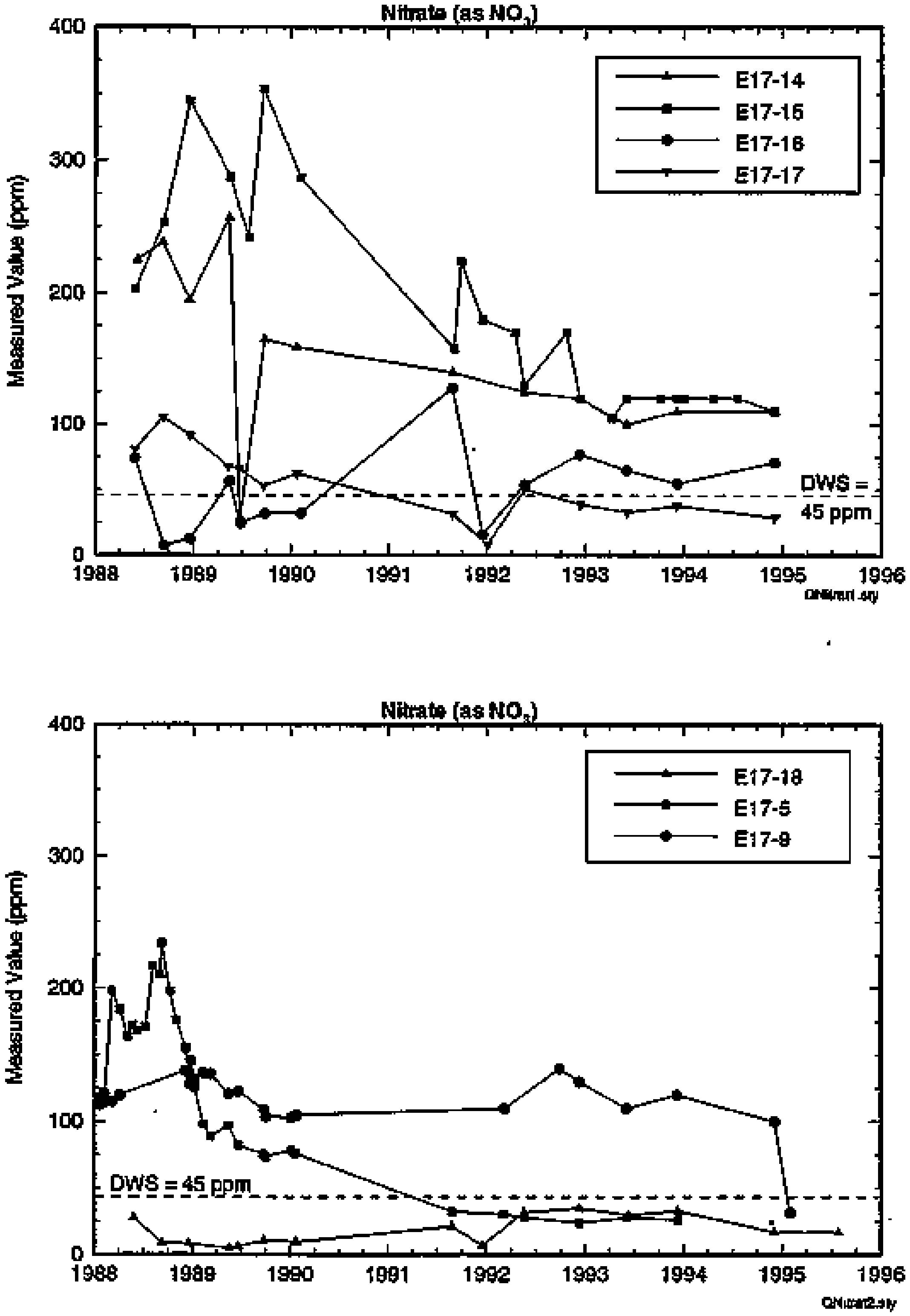
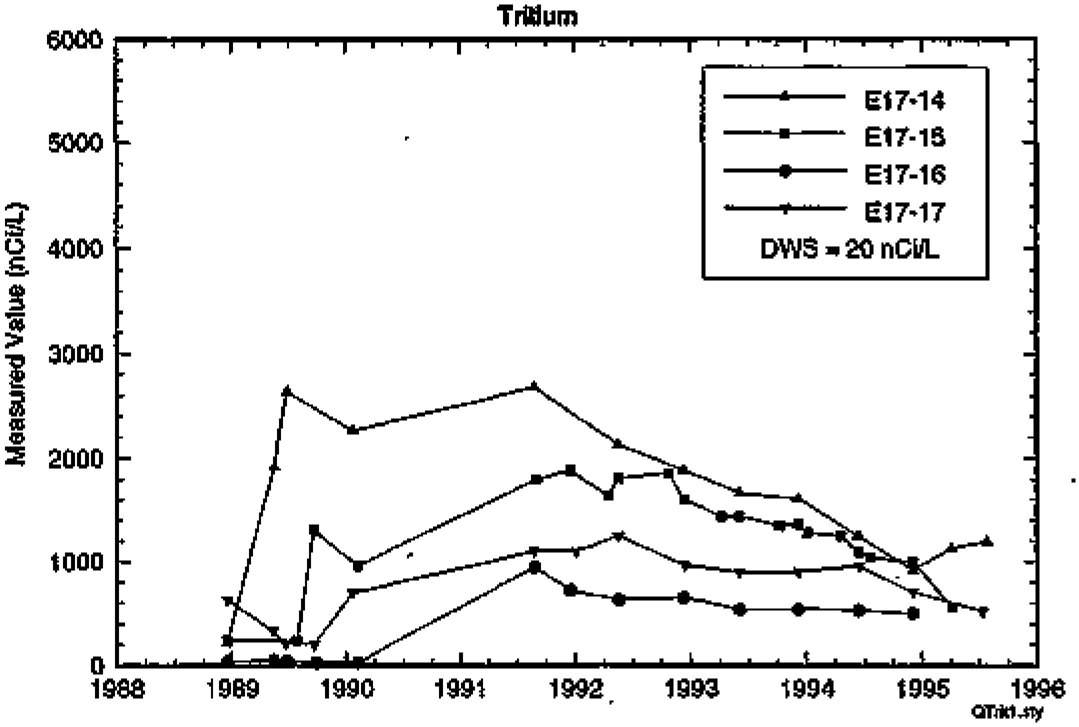


Figure 4.5-5. Tritium Concentrations in the 216-A-36B Network Wells.



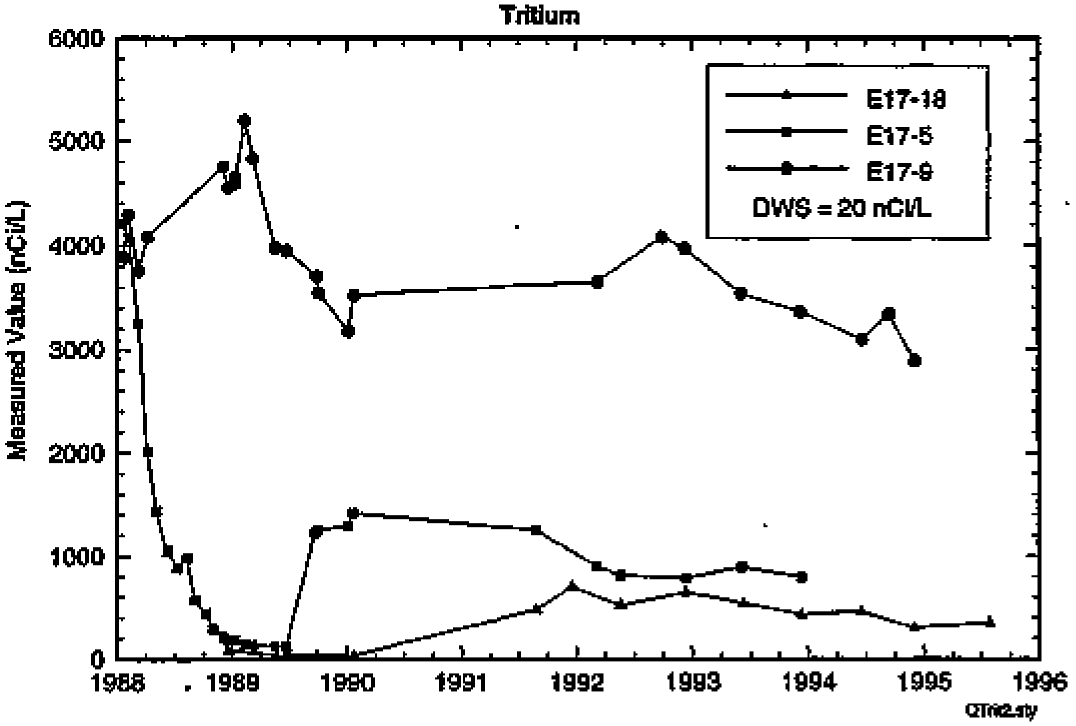
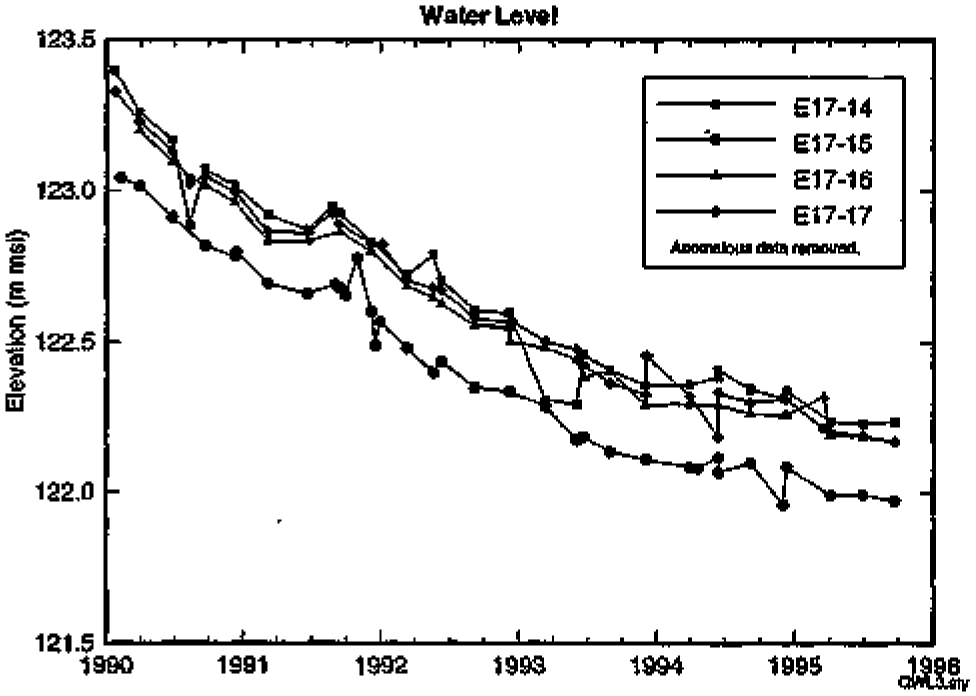


Figure 4.5-6. Composite Hydrograph for the 216-A-36B Network Wells.



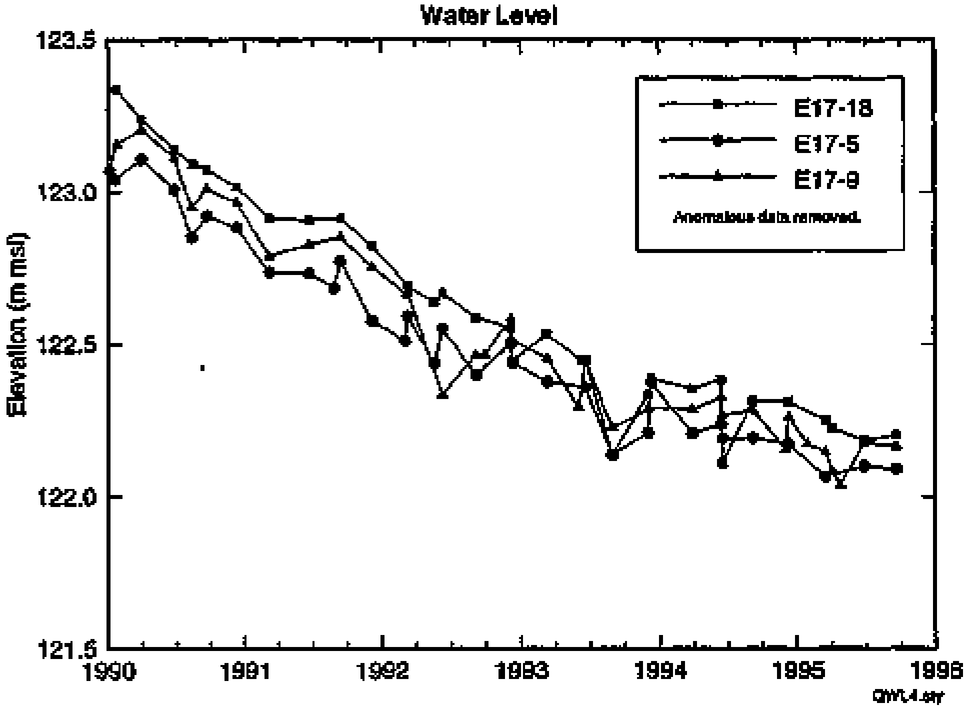


Figure 4.5-7. 200 East Area and 216-A-36B Crib Vicinity Water Table Map, June 1995.

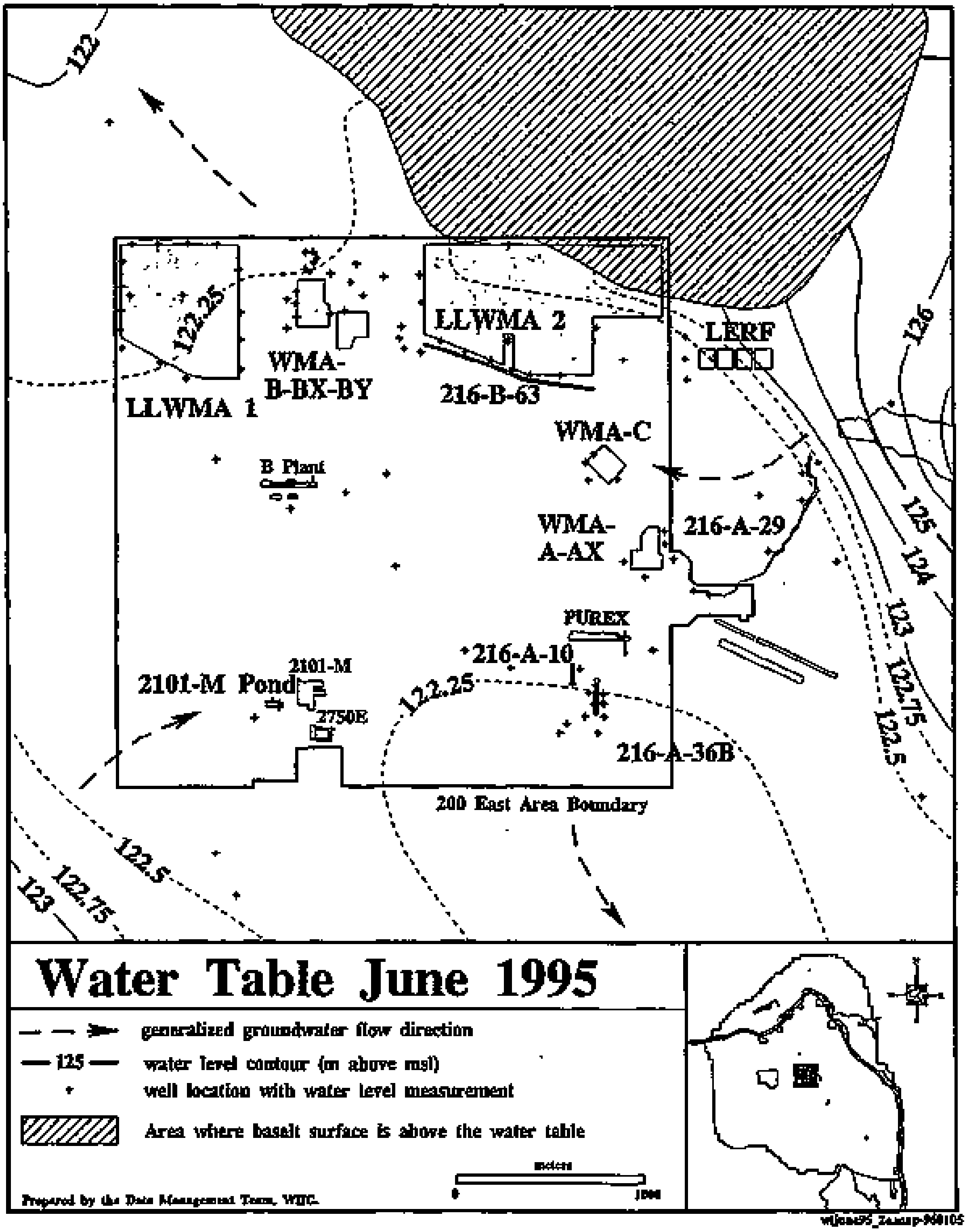


Table 4.5-1. Monitoring Wells in the 216-A-36B Crib Network.

Well	Aquifer	Sampling frequency	Water levels	Well standard	Other networks
299-E17-14	Top of unconfined	S	Q	RCRA	
299-E17-15	Top of unconfined	S	Q	RCRA	
299-E17-16	Top of unconfined	S	Q	RCRA	--
299-E17-17	Top of unconfined	S	Q	RCRA	--
299-E17-18	Top of unconfined	S	Q	RCRA	--
299-E24-18	Top of unconfined	S	Q	RCRA	216-A-10
299-E25-36	Top of unconfined	S	Q	RCRA	216-A-29
299-E17-9	Top of unconfined	S	Q	PRE	--
299-E17-5	Top of unconfined	---	Q	PRE	--

Note: Shading denotes upgradient wells.
PRE = well was constructed before RCRA-specified standards and is not used for statistical evaluation.
Q = frequency on a quarterly basis.
RCRA = well is constructed to RCRA-specified standards.
S = frequency on a semiannual basis.

Table 4.5-2. Constituent's Analyzed in the 216-A-36b Crib Groundwater Monitoring Network.

Semiannually	Annually
TOX	alkalinity
TOC	anions
pH	ICP metals
specific conductance	iodine-129
turbidity	phenols
gross alpha/gross beta	
tritium	

Table 4.5-3. Critical Means Table for 28 Comparisons--Background Contamination Indicator Parameter Data for the 216-A-36B Crib[a,b]

Constituent (Unit)	n	df	tc	Average background	Standard deviation	Critical mean	Upgradient/ downgradient comparison value
Specific Conductance (μmho/cm)	12	11	4.6425	281.646	68.595	613.1	613.1
Field pH	12	11	5.0765	7.953	0.290	[6.42, 9.48]	[6.42, 9.48]
TOC[cd] (ppb)	12	11	4.6425	598.708	125.606	1,205.6	1,205.6
TOX[cd] (ppb)	12	11	4.6425	4.075	2.176	14.6	14.6

[a] Data collected from September 1988 to June 1989 for upgradient wells 299-E17-17, 299-E24-18, and 299-E25-36. Values calculated based on 28 comparisons.

[b] The following notations are used in this table:

df= degrees of freedom (n-1).
n= number of background replicate averages.
t_c = Bonferroni critical t-value for appropriate df and 28 comparisons.

[c] Critical means were calculated from values reported below the CRDL (DOE-RL 1991).

[d] Critical means were calculated using data analyzed by U.S. Testing, Inc. of Richland.

N. C. = not calculated.

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4.6 216-A-10 CRIB

J. M. Votava
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4.6.1 Facility Overview

The 216-A-10 Crib (A-10 Crib), now retired from use, was a liquid waste disposal facility for the Plutonium-Uranium Extraction (PUREX) Plant. The A-10 Crib is located in the 200 East Area approximately 122 m (400 ft) south of the PUREX Plant. It is approximately 110 m (360 ft) west of the 216-A-36B Crib (Figures 1-1 and 4.6-1).

The A-10 Crib is 84 m (275 ft) long, has a V-shaped cross section, and is 14 m (45 ft) 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. From 1982 to 1987, effluent discharges resumed on a continuous basis. Discharge between 1981 and 1986 averaged 1×10^8 L (2.6×10^7 gal) per year. In 1987, the A-10 Crib was taken out of service and replaced by the 216-A-45 Crib.

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 plutonium, uranium, ^{90}Sr, ^{60}Co, ^{134}Cs, ^{137}Cs, ^{103}Ru, ^{106}Ru, and tritium (Aldrich 1987).

Waste disposed of in the A-10 Crib encountered approximately 97 m (318 ft) of unsaturated Hanford formation sediments above the water table. The water table beneath the A-10 Crib occurs very near the contact between the unsaturated Hanford formation upper gravel and sandy sequences and the underlying Ringold gravel unit E (see Chapter 2.0). Approximately 40 m (130 ft) of Ringold Formation sediments make up the saturated zone beneath the A-10 Crib (WHC 1992).

An interim-status *Resource Conservation and Recovery Act of 1976* (RCRA) groundwater monitoring network has been in place for the A-10 Crib since November 1988. The groundwater monitoring program is currently in indicator-parameter evaluation status. The RCRA closure/post-closure plan for the A-10 Crib is scheduled to be submitted to the Washington State Department of Ecology and the U.S. Environmental Protection Agency in June 1998. This document will satisfy the *Hanford Federal Facility Agreement and Consent Order* Milestone M-20-33 (Ecology et al. 1994). The A-10 Crib is part of the CERCLA 200-PO-2 operable unit.

4.6.2 Summary of 1995 RCRA Activities

Groundwater samples were collected and analyzed semiannually for TOX, TOC, pH, specific conductance, turbidity, gross alpha, gross beta, and tritium and annually for alkalinity, anions, ICP metals, ^{129}I, and phenols during 1995 for the wells in the A-10 Crib groundwater monitoring network. Samples were collected in October 1994 and April 1995. The depth to the groundwater beneath the A-10 Crib was measured in the monitoring network wells during sample collection and for each quarterly report period. The groundwater chemistry data and water level measurements were reported quarterly (Edrington 1995, Edrington and Votava 1995, Votava 1995).

4.6.3 Sampling and Analysis Program

The A-10 Crib monitoring network (Figure 4.6-1 and Table 4.6-1) includes two upgradient and six downgradient wells. All wells are shallow groundwater monitoring wells. All RCRA monitoring network wells, except 299-E17-1 and 299-E24-2, meet RCRA construction standards. These two wells are older, remediated wells with perforated carbon steel casing. Samples from these wells are not used in statistical evaluation of the groundwater monitoring network.

Groundwater samples from the A-10 monitoring network are collected and analyzed semiannually or annually, depending on the constituent, to detect any groundwater contamination originating from the facility. Groundwater samples are analyzed for a series of constituents including: groundwater quality parameters, groundwater contamination indicator parameters, and site-specific constituents. The site-specific constituents were selected based on knowledge of the waste streams formerly discharged to the A-10 Crib. Table 4.6-2 lists these constituents. This sample and analysis program meets RCRA requirements (40 CFR 265).

Wells 299-E17-20 and 299-E25-36 are also used for the 216-A-29 groundwater monitoring network. These wells were sampled quarterly to satisfy the groundwater quality assessment monitoring requirements for the 216-A-29 Facility (see Section 4.4).

4.6.4 Groundwater Chemistry

The A-10 Crib is located in a region where several groundwater plumes contain constituents that exceed the drinking water standards (DWS). Examples of some of these constituents include nitrate and tritium (Figures 4.6-2 and 4.6-3). The similarities in effluent constituents disposed of at cribs 216-A-36B and 216-A-45 (monitored under the Operational Program) make determining the effect of the A-10 Crib on groundwater quality difficult.

4.6.4.1 Elevated Constituents. The critical means were not exceeded for the four contamination indicator parameters in the A-10 Crib monitoring network during 1995. DWS for the following constituents were regularly exceeded in the A-10 network during 1995: nitrate, tritium, ^{129}I, unfiltered chromium, unfiltered iron, unfiltered manganese, and gross alpha (Edrington 1995, Edrington and Votava 1995; Votava 1995, 1996). A ^{106}Ru concentration of

70.5 pCi/L was reported for well 299-E24-16 during the October 1994 sampling. However, because its short half-life (~1 year), detectable amounts of this radionuclide are unlikely and the subject result is thus regarded as a false positive. This conclusion is also consistent with a previous LOD determination of 130-150 pCi/L for ^{106}Ru (DOE-RL 1994). RADEs were submitted for all unusual concentrations of constituents.

Nitrate concentrations (Figure 4.6-4) exceeded the DWS (45,000 ppb) at least once in all wells *except* 299-E24-17, 299-E24-18 and 299-E25-36 during 1995. The trend of nitrate concentration in the groundwater beneath the A-10 Facility has generally been steady to slightly declining since 1987.

Tritium concentrations (Figure 4.6-5) exceeded the DWS (20,000 Pci/L) at least once in all wells in the network *except* upgradient well 299-E25-36. All wells show a decreasing trend in tritium concentrations since 1987 when discharges to the A-10 Crib ended. The ^{129}I DWS (1 pCi/L) was exceeded in all of the network wells also.

During 1995, the DWS for chromium (100 ppb) and iron (300 ppb) were exceeded in unfiltered samples from wells 299-E17-19, 299-E17-20, 299-E24-16, 299-E24-17, 299-E24-18, and 299-E25-36. Unfiltered metals are believed to represent effects caused by well construction and not groundwater.

4.6.4.2 Statistical Evaluation. During 1995, the quality of the groundwater beneath the A-10 Crib was subjected to the required evaluation process for sites in indicator parameter evaluation status. Appendix C explains the statistical method used to evaluate the facility's impact, if any, on the quality of groundwater results. The statistical evaluations of data compared sample results between upgradient and downgradient wells for indications of contamination in the uppermost aquifer. Statistical analyses required by 40 CFR 265.93(b) and *Washington Administrative Code* (WAC) 173-303-400 were performed on the samples collected from November 1988 to August 1989 for upgradient wells 299-E24-18 and 299-E25-36 (DOE-RL 1991). Results are presented in Table 4.6-3. This table lists the background average, background standard deviation, critical mean (or critical range, in the case of pH), and upgradient/downgradient comparison values for the four contamination indicator parameters. The comparison value is the value to which current and future averages of quadruplicate measurements are compared. The comparison value is generally the critical mean or critical range. None of the downgradient wells exceeded the contamination indicator parameter critical means.

4.6.5 Groundwater Flow

4.6.5.1 Water Levels. Water levels in the A-10 network were measured quarterly and during semiannual sampling events in 1995 (Edrington 1995; Edrington and Votava 1995; Votava 1995, 1996). A composite hydrograph for data through September 1995 for all wells in the A-10 network is presented in Figure 4.6-6. Water levels declined in all wells during the report period. The average water level decline in the A-10 monitoring well network was approximately 0.13 m (0.44 ft) between October 1994 and October 1995. This trend in declining water levels sustains a longer term decline that became evident during 1988 and 1989, after PUREX Plant operations ended and discharges to the A-10 Crib and other nearby liquid effluent disposal facilities ceased.

4.6.5.2 Groundwater Flow Direction. Groundwater flow in the vicinity of the A-10 Crib is poorly defined because the local hydraulic gradient is extremely low (Figures 4.6-7) and the quality of measurement data is occasionally suspect. Regional-scale, water table elevation measurements suggest that local groundwater flow is generally toward the south-southeast (see Figure 2-4).

4.6.5.3 Rate of Flow. Regional hydraulic head gradient is estimated to be in the range of 0.0001 to 0.0002 (WHC 1992). Based on these estimates and estimates of hydraulic conductivity (150 to 300 m/d [500 to 1,000 ft/d]) and porosity (0.25) for the unconfined aquifer near the A-10 Crib (WHC 1992), groundwater flow velocities may range from 0.06 to 0.2 m/d (0.2 to 0.8 ft/d) (see Section 4.4). Determining vertical groundwater gradients is not possible because paired (shallow and deep) well completions are not located in the immediate vicinity.

4.6.5.4 Evaluation of Monitoring Well Network. Water levels are measured regularly and the adequacy of the existing monitoring network is evaluated accordingly. The water level in each well is compared to the depth of the screened interval and pump intake to ensure that sufficient volumes of water exist for sampling. There is no near-term need to replace any of the existing groundwater monitoring wells. Because the A-10 Crib is surrounded by six groundwater monitoring wells, the downgradient monitoring network is currently adequate to monitor the groundwater quality beneath the crib.

Because of the low hydraulic gradient and continuing decline of the regional water table, the evaluation of the suitability of the upgradient wells is difficult. Wells 299-E24-18 and 299-E25-36 were selected when the monitoring well network was established (1988) to determine the groundwater quality in the most probable upgradient directions from the facility. As Figure 4.6-6 illustrates, assigning relative positions (upgradient or downgradient) for some wells currently is difficult because very small changes in water levels may constitute a reversal in gradient. The adequacy of upgradient wells will be assessed periodically in the future and new upgradient wells will be drilled if necessary.

4.6.6 References

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Figure 4.6-1. Monitoring Well Locations for the 216-A-10 Crib.

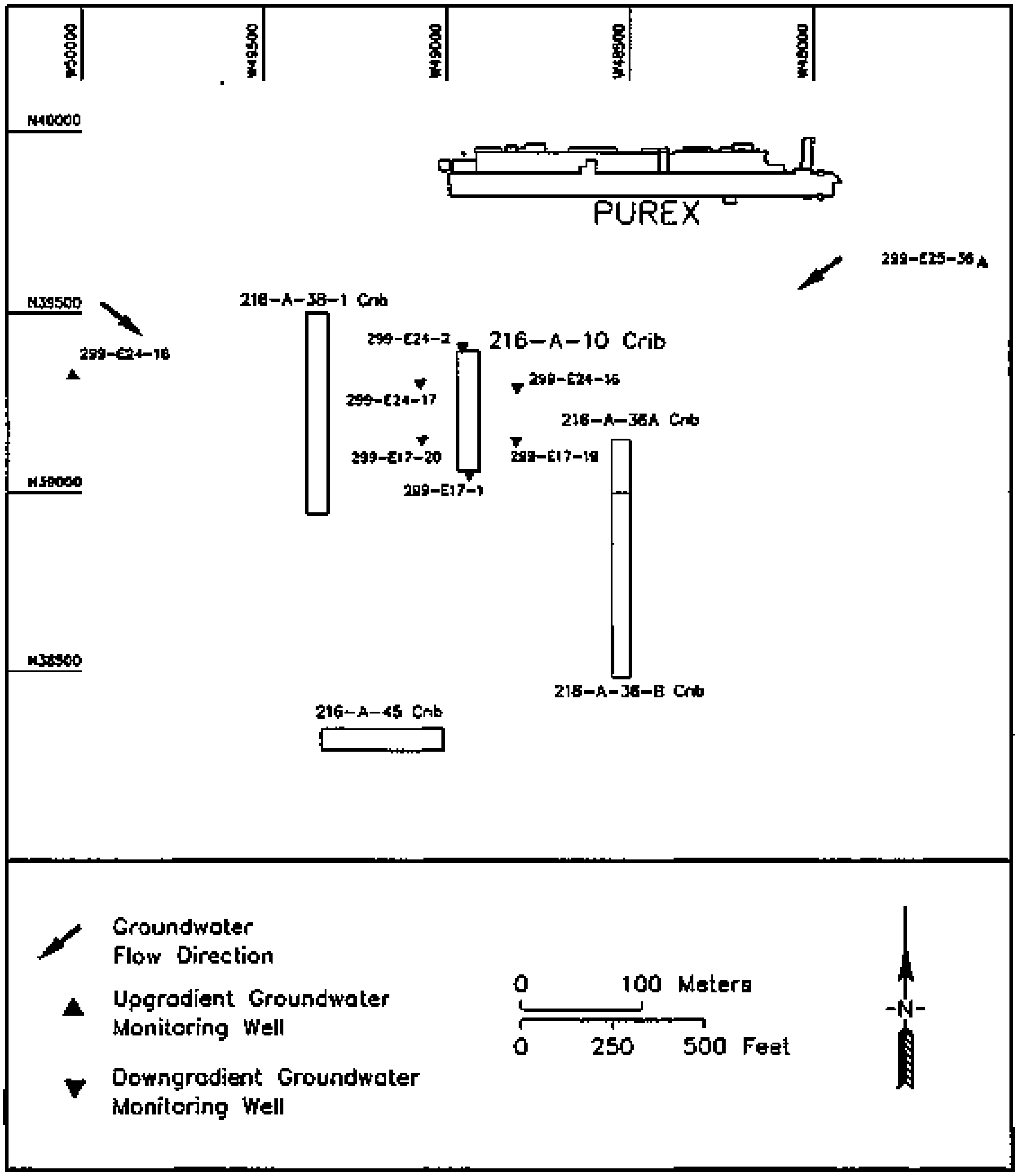

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Figure 4.6-2. Nitrate Distribution in the Uppermost Aquifer Beneath the 200 East Area.

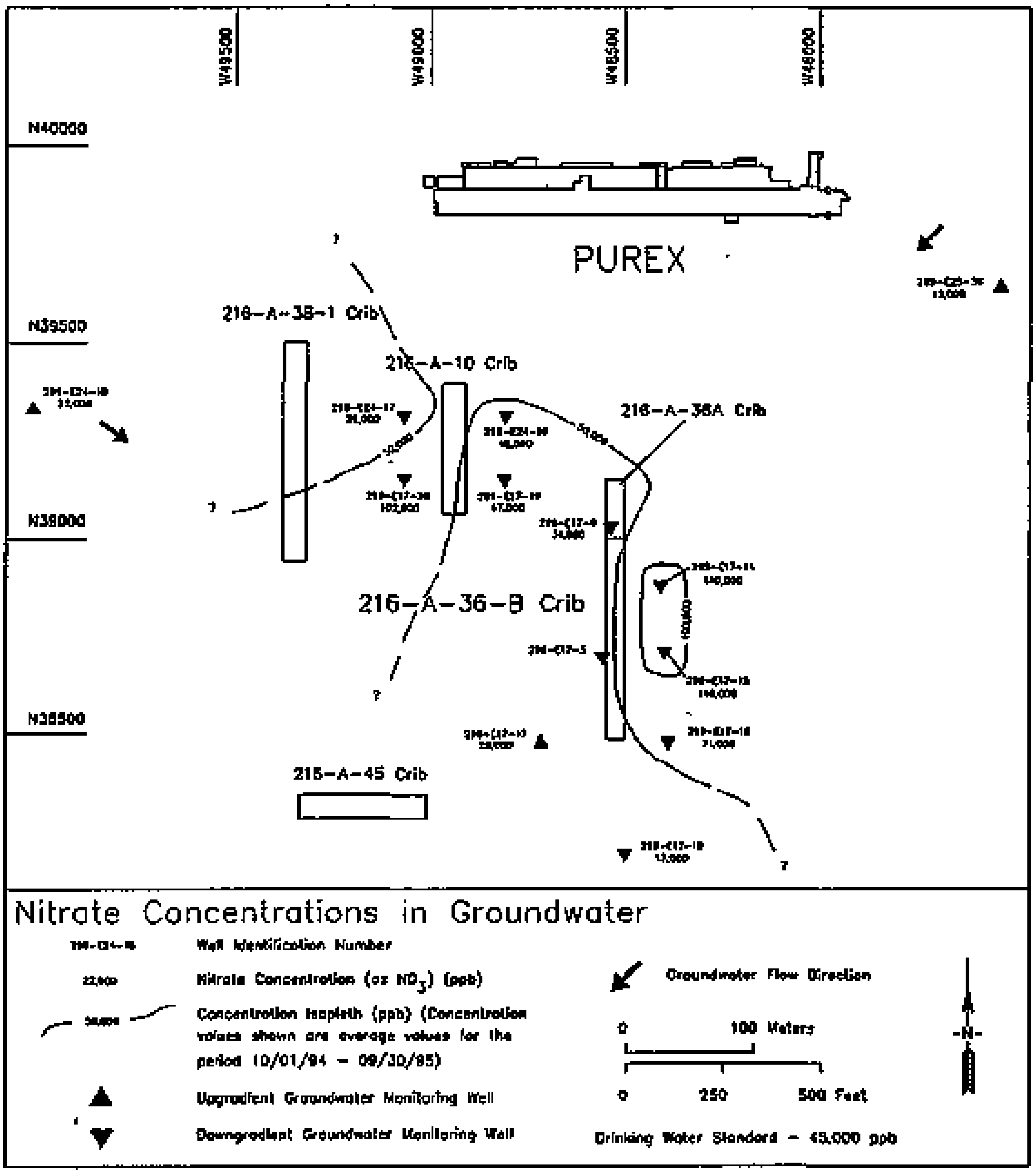

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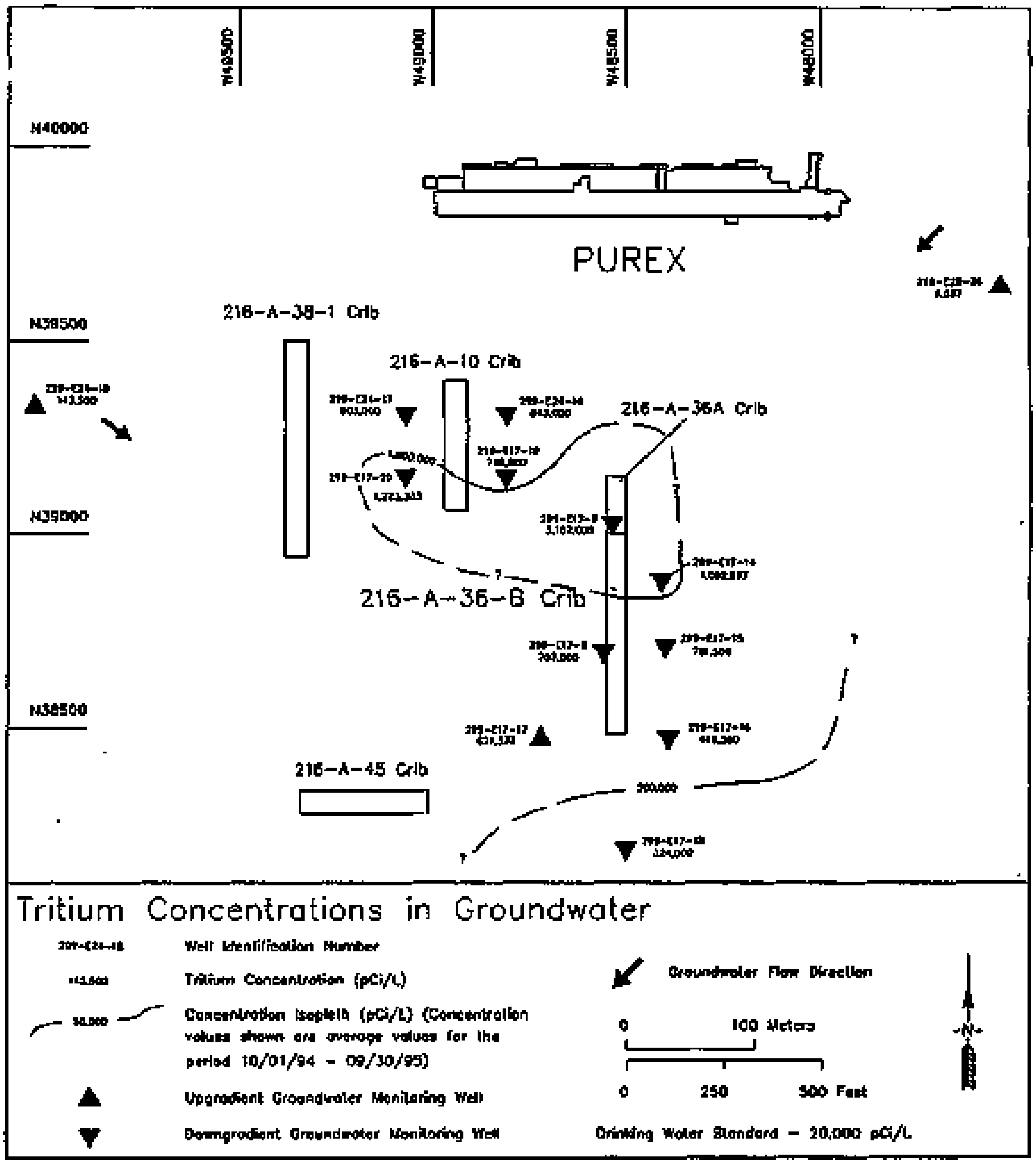
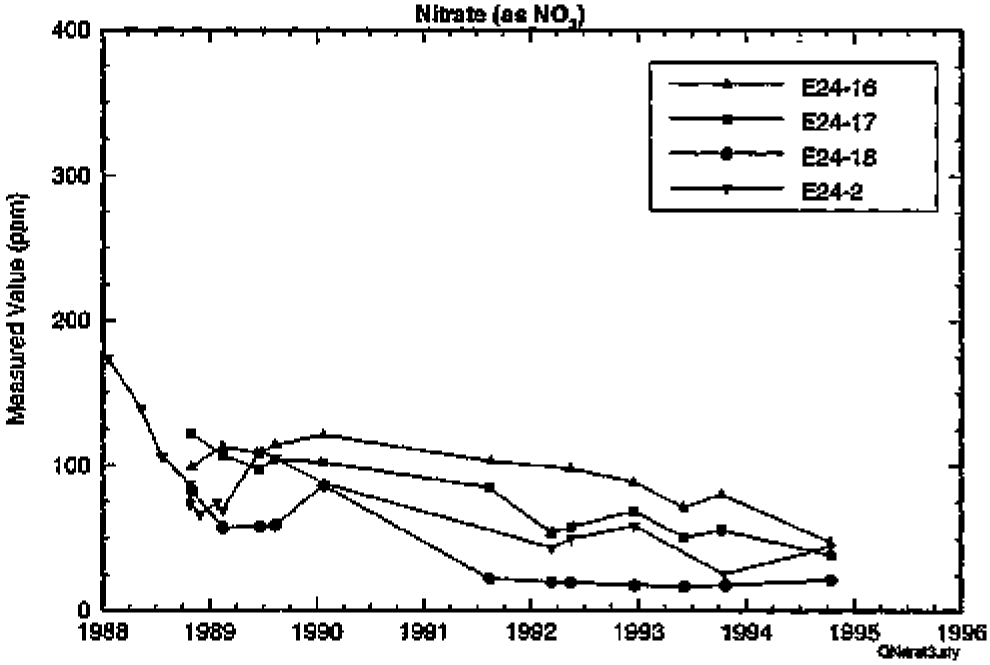
Figure 4.6-3. Tritium Distribution in the Uppermost Aquifer Beneath the 200 East Area.



jmv\a36btrit.dwg

Figure 4.6-4. Nitrate Concentrations in the 216-A-10 Network Wells.



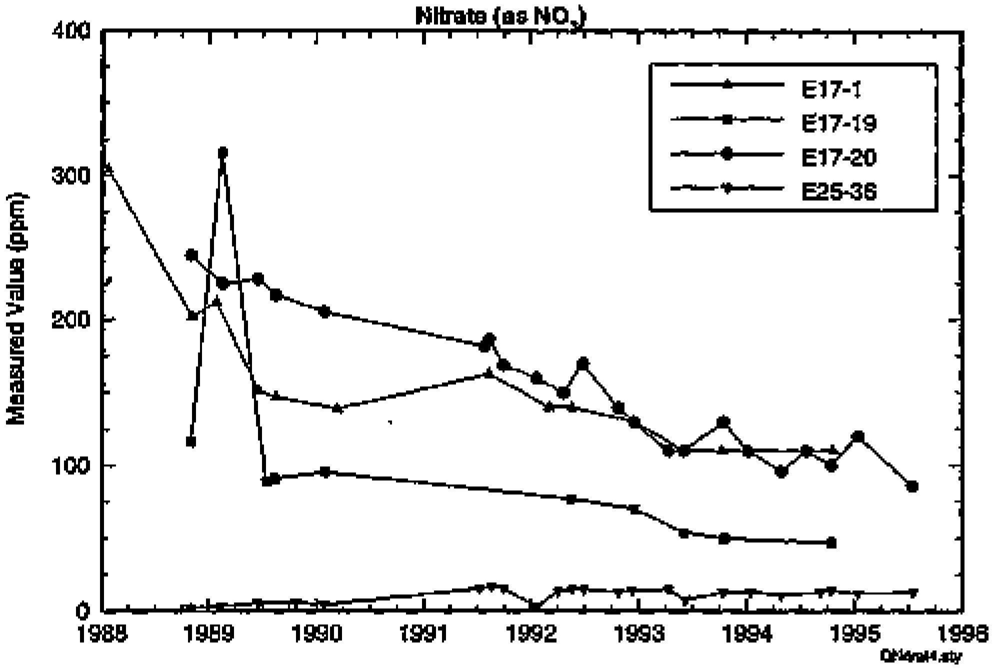


Figure 4.6-5. Tritium Concentrations in the 216-A-10 Network Wells.

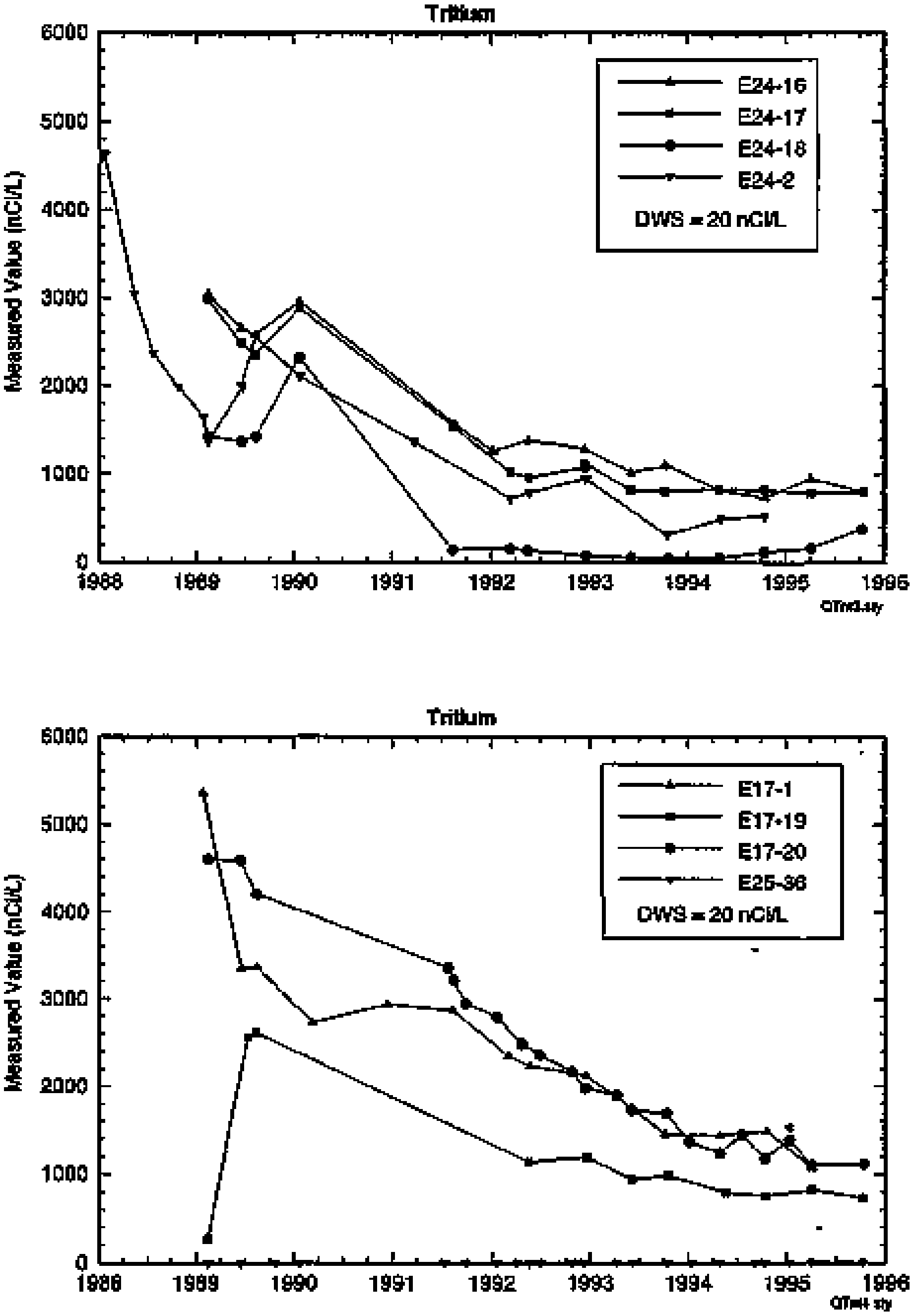
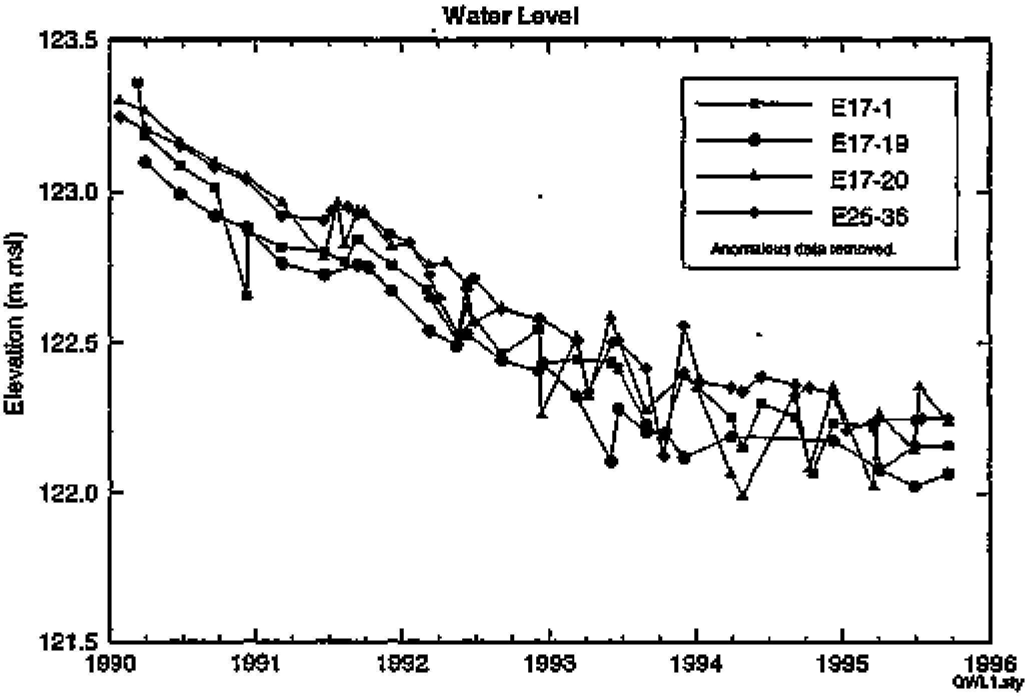


Figure 4.6-6. Composite Hydrograph for the 216-A-10 Network Wells.



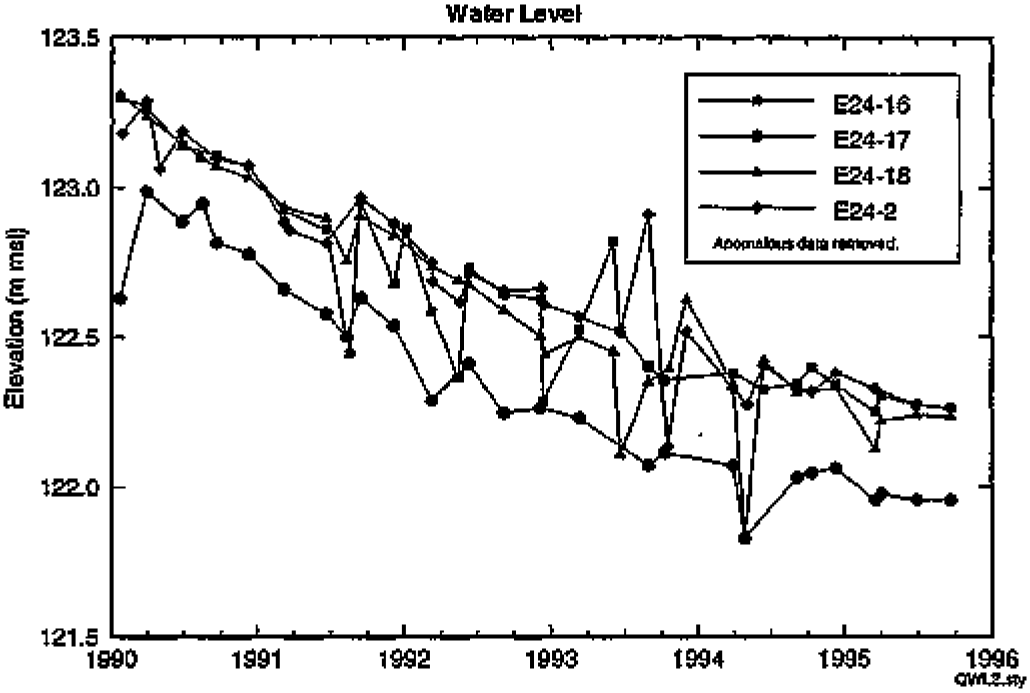


Figure 4.6-7. 200 East Area and 216-A-10 Crib Vicinity Water Table Map, June 1995.

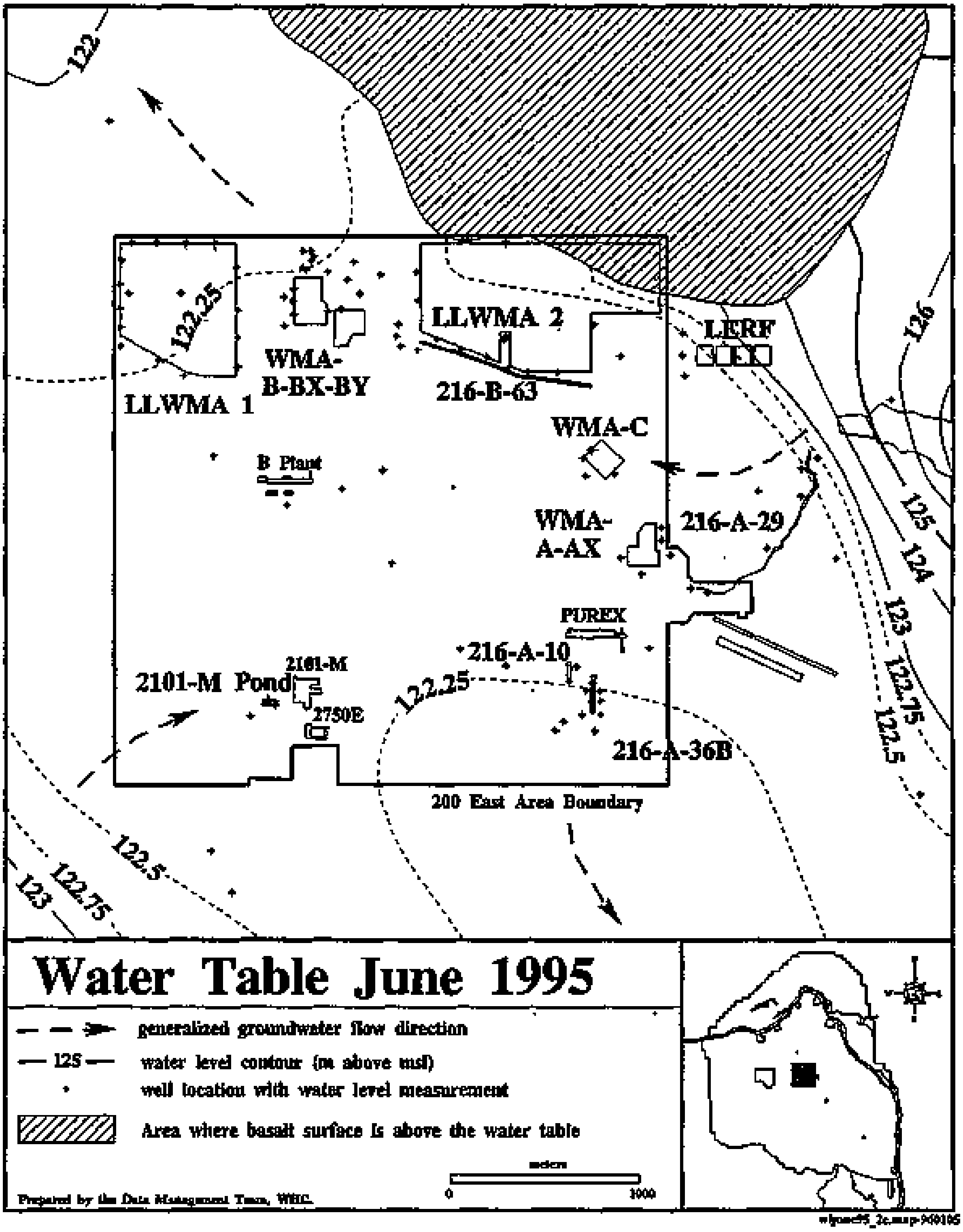


Table 4.6-1. Monitoring Wells in the 216-A-10 Crib Network.

Well	Aquifer	Sampling frequency	Water levels	Well standards	Other networks
299-E24-18^88^	Top of unconfined	S	Q	RCRA	--
299-E25-36^88^	Top of unconfined	Q	Q	RCRA	216-A-29
299-E17-19^88^	Top of unconfined	S	Q	RCRA	--
299-E17-20^88^	Top of unconfined	Q	Q	RCRA	216-A-29
299-E24-16^88^	Top of unconfined	S	Q	RCRA	--
299-E24-17^88^	Top of unconfined	S	Q	RCRA	--
299-E17-1^55^	Top of unconfined	S	Q	PRE	--
299-E24-2^56^	Top of unconfined	S	Q	PRE	--

Notes: Shading denotes upgradient wells. Superscript following well number denotes the year of installation.

PRE = well was constructed before RCRA-specified standards.
Q = frequency on a quarterly basis.
RCRA = well is constructed to RCRA-specified standards.
S = frequency on a semiannual basis.

Table 4.6-2. Constituents Analyzed in the 216-A-10 Crib Groundwater Monitoring Network.

Semiannually	Annually
TOX	alkalinity
TOC	anions
pH	ICP metals
specific conductance	iodine-129
turbidity	phenols
gross alpha/gross beta	
tritium	

Table 4.6-3. Critical Means Table for 24 Comparisons--Background Contamination Indicator Parameter Data for the 216-A-10 Crib.[a,b]

Constituent (Unit)	n	df	tc	Average background	Standard deviation	Critical mean	Upgradient/ downgradient comparison value
Specific Conductance (μmho/cm)	8	7	5.5799	273.31	77.643	732.8	732.8
Field pH	8	7	6.2684	8.0241	0.319	[5.90, 10.14]	[5.90, 10.14]
TOC[c,d] (ppb)	8	7	5.5799	618.75	117.83	1,316.1	1,316.1
TOX[c,d] (ppb)	8	7	5.5799	4.47	1.544	13.6	13.6

[a] Data collected from November 1988 to August 1989 for upgradient wells 299-E24-18 and 299-E25-36. Values calculated based on 24 comparisons.

[b] The following notations are used in this table:
df = degrees of freedom (n-1).
n = number of background replicate averages.
t_c = Bonferroni critical t-value for appropriate df and 24 comparisons.

[c] Critical mean were calculated from values reported below the CRDL (DOE-RL 1991).

[d] Critical mean were calculated using data analyzed by U.S. Testing, Inc. of Richland.

N. C. = not calculated.

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4.7 216-B-63 TRENCH

M. D. Sweeney
Westinghouse Hanford Company

4.7.1 Facility Overview

The 216-B-63 Trench (B-63 Trench), in service from March 1970 to February 1992, received liquid effluent [3.8×10^5 to 1.5×10^6 L/d (1.0×10^5 to 4×10^5 gal/d)] from the B Plant chemical sewer. The liquid effluent was a 70/30 mixture of steam condensate and raw water, which was disposed to the west end of the open, unlined earthen trench. Past releases to the trench included radioactive and dangerous waste. Documented hazardous discharges occurred from 1970 to October 1985, and consisted of aqueous sulfuric acid and sodium hydroxide solutions that had pH values of <2.0 and >12.5, respectively. Radioactive soils were dredged from the trench in August 1970, but no records exist of radioactive waste disposal to the trench. Starting in 1985, physical controls, radiation monitors, and operating procedures were modified to avoid inadvertent discharge of chemicals or radioactive substances to the wastewater stream. Liquid effluent discharge to the B-63 Trench ceased permanently in February 1992.

A *Resource Conservation and Recovery Act of 1976* (RCRA) indicator evaluation groundwater monitoring network has been established under guidelines established in the RCRA interim-status groundwater monitoring plan for the B-63 Trench (PNL 1989) and in accordance with the *Hanford Federal Facility Agreement and Consent Order*, Milestone M-20-38 (Ecology et al. 1994). This network operates under RCRA interim-status regulations (40 *Code of Federal Regulations* [CFR] 265). During its operation, the B-63 Trench received wastewater from the B Plant located in the 200 East Area (see Figure 1-1). This wastewater contained dangerous waste and materials. A RCRA closure/postclosure plan for the B-63 Trench, which is part of the 200-UP-11 operable unit, is due to be submitted in May 1996.

The B-63 Trench lies at an elevation of about 195 m (640 ft) along the northern flank of Cold Creek bar. Cold Creek bar was formed along the margin of a Pleistocene cataclysmic flood channel located in the northeastern portion of the 200 East Area.

Only a single stratigraphic unit, the Hanford formation, overlies basalt beneath the site. The sediments directly beneath the B-63 Trench appear to be mostly mixtures of sand and gravel associated with high-energy deposition by cataclysmic floods. Lateral facies changes occur in the flood deposits to the south and west. Along the southern margin of the flood channel, deposits become finer grained and include fine sand, silt, and occasionally clay, which could act locally as aquitards leading to perched water conditions.

The sediments overlying the basalt become progressively thinner to the northeast. The sediments are 75 to 82 m (245 to 269 ft) thick beneath the trench. The thickness of the saturated zone varies from 1.3 to 7.0 m (4 to 23 ft). The water table varies from 70 to 77 m (228 to 252 ft) below ground surface.

4.7.2 Summary of 1995 RCRA Activities

The 12 wells in the monitoring network were sampled in December 1994 and June 1995 for contamination indicator, groundwater quality, and site-specific parameters. Other analyses, such as for uranium, gamma scan, and volatile organic compounds, were performed during the fourth quarter of 1994 but were subsequently removed from the list of constituents. Results of these analyses are discussed in Section 4.7.4. Data were included in each of the four quarterly reports (Sweeney 1995a, 1995b, 1995c, and 1996).

Periodic water level measurements of the 12-well monitoring network were made from October 1994 through September 1995. Routine water level measurements were made at the time of sampling.

4.7.3 Sampling and Analysis Program

The current groundwater monitoring network consists of 12 wells (Table 4.7-1). The well locations are shown in Figure 4.7-1. The monitoring network conforms to the groundwater monitoring plan for the B-63 Trench (WHC 1995).

Groundwater chemistry data are available for most of the B-63 groundwater monitoring wells for 1995. The wells have been sampled for contamination indicator parameters, groundwater quality parameters, and site-specific parameters as identified in Table 4.7-2. Site-specific parameters were selected based on a history of waste disposed at this site and in surrounding waste management areas. Uranium, gamma scan, and volatile organic compounds were removed from the sampling schedule in the second quarter. These constituents were consistently reported below regulatory thresholds, or were not detected, and were not considered to have affected groundwater beneath the facility. Data were published in quarterly reports (Sweeney 1995a, 1995b, 1995c, and 1996).

4.7.4 Groundwater Chemistry

Groundwater chemistry samples were collected from wells within the B-63 groundwater monitoring network during 1995 on a semiannual schedule.

4.7.4.1 Constituents of Concern. Groundwater monitoring at the 216-B-63 Trench provides no evidence that dangerous, nonradioactive constituents from the site have entered the groundwater. The indicator parameters are specific conductance, pH, total organic carbon (TOC), and total organic halogen (TOX) (40 *Code of Federal Regulations* [CFR] 265.92[b][3]). These analyses are considered screening techniques since the concentrations reported are not for specific contaminants. Other analytes are monitored in groundwater to look for the dangerous waste constituents that were discharged to B-63 Trench during their use (see Table 4.7-2). Included in the B-63 analysis list are gamma scan, alkalinity, gross beta and tubidity. There were no significant detections for these analyses that could be attributed to the B-63 Trench.

4.7.4.2 Statistical Evaluation. Statistical analyses required by 40 CFR 265.93(b) and *Washington Administrative Code* (WAC) 173-303-400 were performed on the samples collected from upgradient wells 299-E27-8, 299-E27-9, 299-E27-11, 299-E27-17, and 299-E34-10. Results are presented in Table 4.7-3. This table lists the background average, standard deviation, critical mean (or critical range, in the case of pH), and upgradient/downgradient comparison values for the contamination indicator parameters. The upgradient/downgradient comparison value is the value to which current and future averages of indicator parameters are compared. The comparison value is generally the critical mean or critical range. The limit of quantitation is used as the comparison value for total organic carbon and total organic halogen instead of the critical mean because most of the upgradient concentrations were below the contractually required quantitation limit (see Appendix C).

There were no exceedances in specific conductance, TOC or TOX. One incident of pH exceedance occurred at a downgradient well 299-E33-36 during the November 11, 1994 sampling event. The replicate average of 6.46 was below the lower critical limit of 7.08. Subsequent verification sampling results confirmed that the initial exceedance was caused by an error in the field measurement.

4.7.5 Groundwater Flow

4.7.5.1 Groundwater Flow Direction. In general, groundwater levels continued to decline in 1995 (Figure 4.7-2). Water levels are recorded semiannually during sample collection. These data are reported in quarterly reports of RCRA groundwater monitoring data (Sweeney 1995a, 1995b, 1995c, and 1996). A water table map of the 200 East Area for June 1995 is presented in Figure 4.7-3. Water table elevations reveal a westward flow direction that roughly parallels the trend of the B-63 Trench (Sweeney 1995d). A significantly steeper gradient than that observed for the region is still apparent based on anomalously low water level readings measured at the west end of the trench in well 299-E33-36 (Sweeney 1995d). The well was surveyed during 1993 but the results do not indicate a survey elevation problem. Other possible explanations for the discrepancy are being explored.

4.7.5.2 Rate of Flow. The horizontal groundwater gradient in the unconfined aquifer under the B-63 Trench is approximately 2.6×10^{-4} between wells 299-E27-17 and 299-E33-37 in 1995. The rate of groundwater flow can be estimated by using a form of the Darcy equation with a range of input parameters

$$v = \frac{Ki}{n_e} \qquad (1)$$

where:

v = Average linear velocity in m/d (ft/d)
K = Hydraulic conductivity in m/d (ft/d)
i = Hydraulic gradient (dimensionless)

n_e = Effective porosity (dimensionless).

The calculations of groundwater velocity assume horizontal flow and a homogeneous aquifer. The following inputs from slug test data were used to determine the velocity near well 299-E33-36:

K = 174 m/d (570 ft/d)
$i = 2.6 \times 10^{-4}$
n_e = 0.20 (Graham et al. 1981).

The given value of K is representative of the Hanford formation, based on pump tests in the 200 Areas (Graham et al. 1981). The calculated velocity is 0.23 m/d (0.7 ft/d).

4.7.5.3 Evaluation of the Monitoring Well Network. Based on the Monitoring Efficiency Model (Jackson et al. 1991), the existing network should provide a monitoring efficiency of 66 to 85% for the B-63 Trench. The 66% monitoring efficiency results from a flow azimuth of 270° (toward the west from 299-E27-17), while an 85% monitoring efficiency is associated with a 225° azimuth flow direction (toward the southwest from 299-E34-10).

The current network is composed of six wells drilled specifically to monitor the B-63 Trench. The network also includes five wells drilled to monitor the Low-Level Burial Grounds located just north of the B-63 Trench (upgradient), and one well drilled to monitor the single-shell tanks (upgradient). Currently the network is considered adequate but will be continuously evaluated as water levels and groundwater gradients change over time.

4.7.6 References

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

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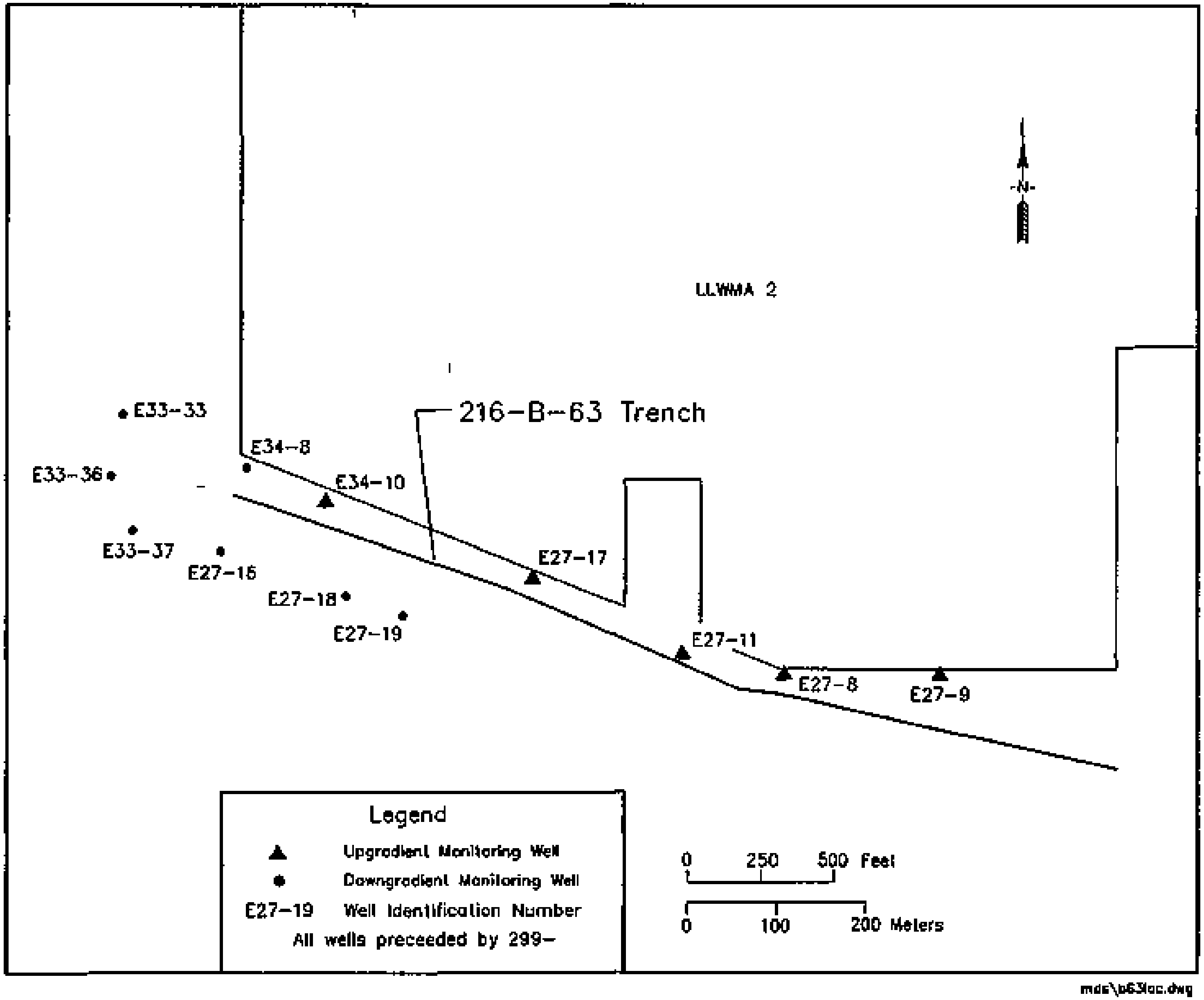

Figure 4.7-1. Monitoring Well Locations for the 216-B-63 Trench.

Figure 4.7-2. Hydrographs of Water Level Measurements for 216-B-63 Wells.

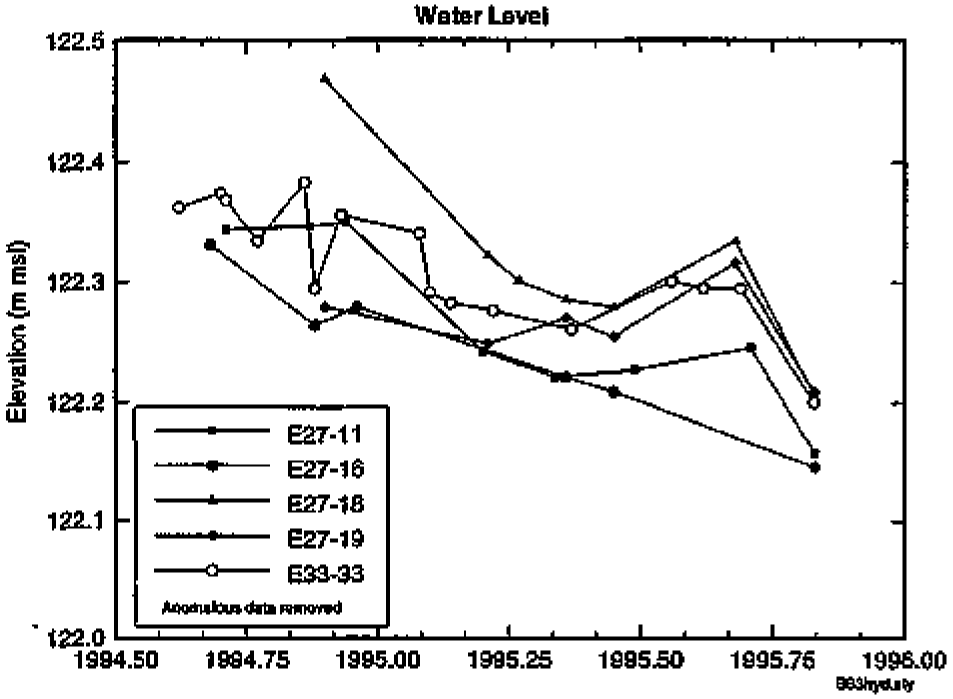

Figure 4.7-3. 200 East Water Table Map.

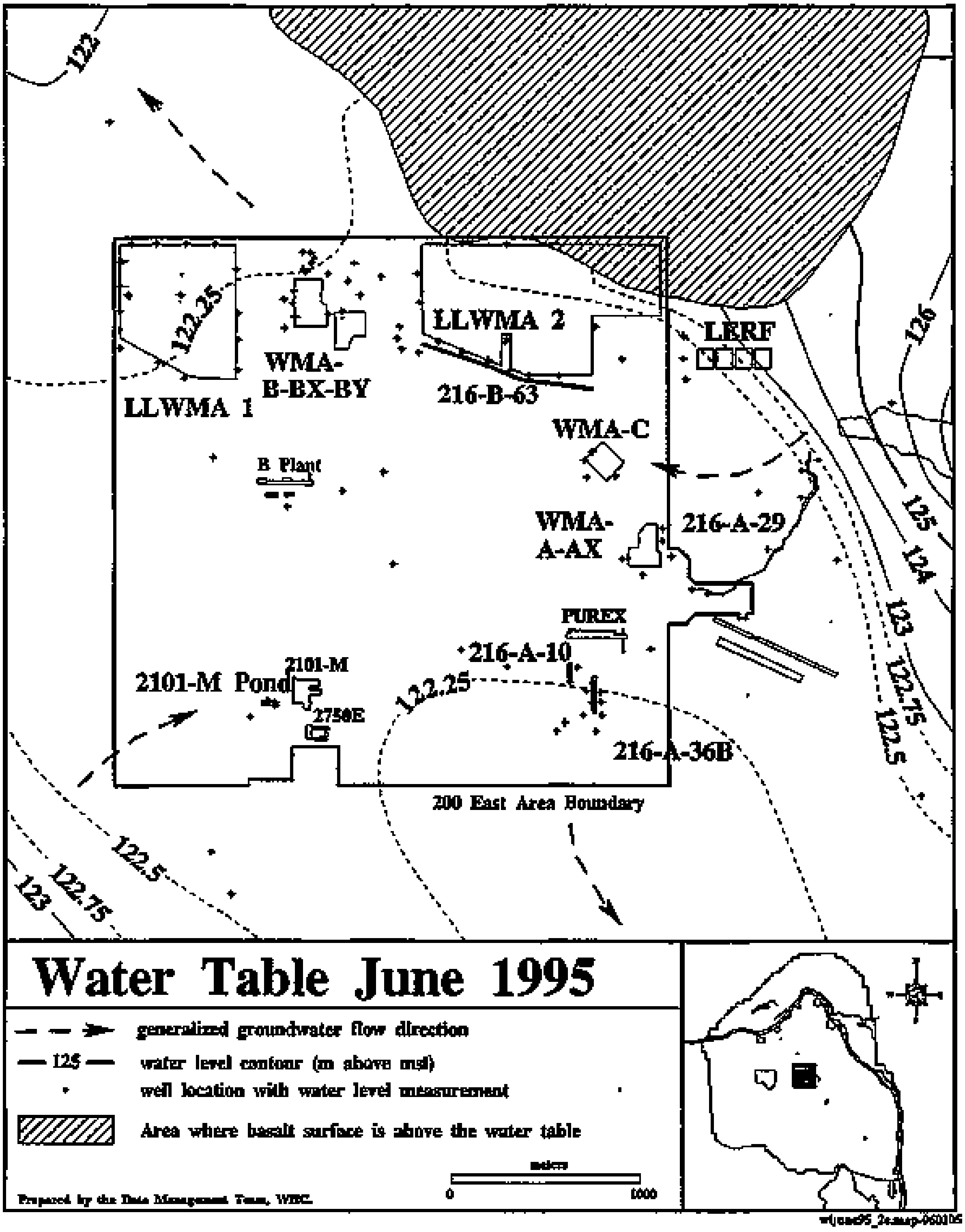

Table 4.7-1. 216-B-63 Groundwater Monitoring Network.

Well	Aquifer	Sampling frequency	Water levels	Well standard	Other networks
299-E27-11^{89}	Top of unconfined	S	Q	RCRA	LLWMA-2
299-E27-16^{90}	Top of unconfined	S	Q	RCRA	--
299-E27-8^{87}	Top of unconfined	S	Q	RCRA	LLWMA-2
299-E27-9^{87}	Top of unconfined	S	Q	RCRA	LLWMA-2
299-E33-33^{90}	Top of unconfined	S	Q	RCRA	SST B-BX-BY
299-E33-36^{90}	Top of unconfined	S	Q	RCRA	--
299-E33-37^{90}	Top of unconfined	S	Q	RCRA	--
299-E34-8^{90}	Top of unconfined	S	Q	RCRA	LLWMA-2
299-E34-10^{91}	Top of unconfined	S	Q	RCRA	LLWMA-2
299-E27-17^{91}	Top of unconfined	S	Q	RCRA	LLWMA-2
299-E27-18^{92}	Top of unconfined	S	Q	RCRA	--
299-E27-19^{92}	Top of unconfined	S	Q	RCRA	--

Notes: Shading denotes upgradient wells. Superscript following well number denotes the year of installation.

LLWMA = Low-Level Waste Management Area.
Q = frequency on a quarterly basis.
RCRA = well is constructed to RCRA-specified standards.
S = frequency on a semiannual basis.
SST = single-shell tank.

Table 4.7-2. Constituent List for the 216-B-63 Trench Monitoring Network.

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

Table 4.7-3. Critical Means Table for 48 Comparisons--Background Contamination Indicator Parameter Data for the 216-B-63 Trench[a,b]

Constituent (Unit)	n	df	tc	Average background	Standard deviation	Critical mean	Upgradient/ downgradient comparison value
Specific Conductance (μmho/cm)	21	20	4.224	369.393	60.192	629.6	629.6
Field pH	20	19	4.572	7.975	0.190	[7.08, 8.87]	[7.08, 8.87]
TOC[c] (ppb)	20	19	4.267	500	N.C.	N.C.	976
TOX[d] (ppb)	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	13.6

[a] Data collected from July 1992 to April 1993 for upgradient wells 2-E27-8, 2-E27-9, 2-E34-10, and 2-E27-17. Data collected from July 1992 to July 1993 for upgradient well 2-E27-11. Values calculated based on 48 comparisons.

[b] The following notations are used in this table:

df = degrees of freedom (n-1).

n = number of background replicate averages.

t_c = Bonferroni critical t-value for appropriate df and 48 comparisons.

[c] Critical mean cannot be calculated due to lack of an estimate of background standard deviation. The upgradient/downgradient comparison value is the limit of quantitation (see Appendix A).

[d] Critical mean cannot be calculated due to problems associated with data quality for samples analyzed by DCL. The upgradient/downgradient comparison value for TOX is the limit of quantitation (see Appendix A).

N. C. = not calculated.

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4.8 200 EAST AREA LIQUID EFFLUENT RETENTION FACILITY

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4.8.1 Overview of the Facility

The Liquid Effluent Retention Facility (LERF) consists of three 24.6 x 10^6-L (6.5-Mgal) surface impoundments (basins), located on a 15.8-ha (39-acre) site northeast of the 200 East Area on the Hanford Site (Figure 4.8-1). The three basins were constructed of two composite liners, a leachate collection system between the liners, and a floating cover. The fourth basin has been excavated but has not been completed and will not be used for 242-A Evaporator effluent.

The LERF serves as a temporary storage facility for evaporator process condensate until the Effluent Treatment Facility for the 242-A Evaporator is operational. The 242-A Evaporator is used to substantially reduce the quantity of waste stored in double-shell tanks. Effluent from the 242-A Evaporator was discharged to cribs in the 200 East Area. The evaporator was shut down when listed waste was found in the effluent stream. The 242-A Evaporator was restarted on April 14, 1994.

Primary constituents detected in the effluent stream from the 242-A Evaporator have been ammonium, acetone, aluminum, 1-butanol, 2-butanone, tritium, ^{90}Sr, ^{106}Ru, and ^{137}Cs. Further information of the effect on groundwater from release of this waste stream is documented in the *Liquid Effluent Study Final Report* (WHC 1990).

A groundwater monitoring network has been established for the LERF (WHC 1991). The 242-A Evaporator process condensate effluent is regulated as a dangerous waste under *Washington Administrative Code* (WAC) 173-303 because of the toxicity of the ammonium and the presence of listed waste constituents. An interim-status groundwater monitoring system is in place to determine the impact of this facility on the groundwater quality until a final permit has been approved (40 *Code of Federal Regulations* [CFR] 265). It is monitored under an interim-status detection-level program.

Four wells have been constructed and are used to monitor groundwater levels and water quality. Data from these wells were used to establish initial background groundwater quality.

A dangerous waste permit application (DOE-RL 1991) was submitted to the Washington State Department of Ecology (Ecology) for review in June 1991. Ecology's response to the application was received in February 1994.

Only a single stratigraphic unit, the Hanford formation, overlies basalt beneath the site. The sediments directly beneath the LERF appear to be mostly mixtures of sand and gravel associated with high-energy deposition by cataclysmic floods. Lateral facies changes occur in the flood deposits to the south and west. Along the southern margin of the flood channel, deposits become finer grained and include fine sand, silt, and occasionally clay, which could act locally as aquitards leading to perched water conditions.

The sediments overlying the basalt become progressively thinner to the northeast of the LERF. The sediments are 62 to 63 m (202 to 206 ft) thick beneath the facility. The thickness of the saturated zone ranges from 0.5 to 3.8 m (2 to 12 ft). The water table varies from 60.7 to 61 m (199 to 200 ft) below ground surface.

4.8.2 Summary of 1995 RCRA Activities

Wells in the monitoring network were sampled in December 1994 and June 1995 for contamination indicator, groundwater quality, and site specific parameters. The water level in the LERF monitoring network continues to decline, thereby requiring the use of specially adapted equipment to obtain representative samples. Results of these sampling event analyses are discussed in Section 4.8.4. Data were included in each of the four quarterly reports (Sweeney 1995a, 1995b, 1995c, and 1996).

Periodic water level measurements of the four-well monitoring network were made from October 1994 through September 1995, in addition to routine water level measurements made at the time of sampling.

4.8.3 Sampling and Analysis Program

The current groundwater monitoring network consists of four wells (Table 4.8-1). The well locations are shown in Figure 4.8-1.

Groundwater chemistry data are available for most of the LERF groundwater monitoring wells for fiscal year 1995. The wells have been sampled for contamination indicator parameters, groundwater quality parameters, and site-specific parameters as identified in Table 4.8-2. Constituents such as uranium, tritium, gamma scan, and volatile organic compounds were deleted from the list of constituents. These constituents were consistently below regulatory limit and termination of these analyses was considered to have no impact on groundwater monitoring beneath the facility. Site-specific parameters were selected based on a history of waste discharged in surrounding waste management areas and on proposed waste characteristics for the effluents targeted for LERF. Data were published in quarterly reports (Sweeney 1995a, 1995b, 1995c, and 1996).

4.8.4 Groundwater Chemistry

During 1995, groundwater samples were collected for most wells within the LERF groundwater monitoring network. Well 299-E26-9 had been removed from the sampling schedule in 1993 because of the low water level in the well casing (0.15 m [0.5 ft]). The well has subsequently been placed back on the schedule now that sampling equipment capable of obtaining samples in low-static water level wells is available.

4.8.4.1 Constituents of Concern. Groundwater monitoring at the LERF provides no evidence that dangerous, nonradioactive constituents from the site have entered the groundwater. The indicator parameters are specific conductance, pH, total organic carbon (TOC), and total organic halogen (TOX) (40 *Code of*

Federal Regulations [CFR] 265.92[b][3]). These analyses are considered screening techniques since the concentrations reported are not for specific contaminants. Other analytes are monitored in groundwater to look for the dangerous waste constituents that have been stored in the LERF since it began receiveing waste (see Table 4.7-2). Included in the LERF analysis list are gross alpha, alkalinity, gross beta and tubidity. There were no significant detections for these analyses that could be attributed to the LERF.

4.8.4.2 Statistical Evaluation. Statistical analyses required by 40 CFR 265.93(b) and WAC 173-303-400 were performed on the samples collected from upgradient well 299-E26-11. Results are presented in Table 4.8-3. This table lists the background average, standard deviation, critical mean (or critical range, in the case of pH), and upgradient/downgradient comparison values for the contamination indicator parameters. An alternative range for upgradient/downgradient comparisons was calculated using data collected from June 1991 to October 1993 because the critical range calculated using four quarters of data is too large to be meaningful (see Appendix C). The upgradient/downgradient comparison value is the value to which current and future averages of indicator parameters are compared. The comparison value is generally the critical mean or critical range. The limit of quantitation is used as the comparison value for total organic halogen instead of the critical mean because most of the upgradient concentrations were below the contractually required quantitation limit (see Appendix C).

There were no exceedances in specific conductance, TOC or TOX. One incident of pH exceedance occurred at a downgradient well 299-E35-2 during the January 31, 1995 sampling event. The replicate average of 5.54 was below the lower critical limit of 6.25. Subsequent verification sampling results confirmed that the initial exceedance was caused by an error in the field measurement.

4.8.5 Groundwater Flow

4.8.5.1 Groundwater Flow Direction. In general, the LERF hydrograph flattened in 1995, which indicates that the water table continues to decline (Figure 4.8-2). These data are reported in previous quarterly reports of RCRA groundwater monitoring data (Sweeney 1995a, 1995b, 1995c, and 1996). A water table map for June 1995 is presented in Figure 4.8-3. The general trend of groundwater flow is from east to west.

4.8.5.2 Rate of Flow. The horizontal groundwater gradient in the unconfined aquifer under the LERF is approximately 6.3×10^{-3} between wells 299-E26-11 and 299-E26-9. An estimation of the average linear groundwater velocity can be calculated from the following equation based on Darcy's law:

$$v = \frac{Ki}{n_e} \tag{1}$$

where:

v = Velocity in m/d (ft/d)
K = Hydraulic conductivity in m/d (ft/d)
i = Hydraulic gradient (dimensionless)
n_e = Effective porosity (dimensionless).

The calculations of groundwater velocity assume horizontal flow and a homogeneous aquifer. The following inputs from slug test data were used to determine the velocity near well 299-E26-9:

K = 122 m/d (400 ft/d)
i = 6.3×10^{-3}
n_e = 0.20 (Graham et al. 1981).

The given value of K is representative of the Hanford formation based on pump tests in the 200 Areas (Graham et al. 1981). The calculated velocity is 3.8 m/d (12 ft/d).

4.8.5.3 Evaluation of the Monitoring Network. The current network comprises four wells, one of which is upgradient. The network is currently considered adequate but will be continually evaluated as water levels and groundwater gradients change over time. The initial MEMO efficiency model was calculated at 95.5%. No additional wells are under consideration at this time.

4.8.6 References

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

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Sweeney, M. D., 1995b, "Liquid Effluent Retention Facility," *Quarterly Report of RCRA Groundwater Monitoring Data for Period January 1, 1995 through March 31, 1995*, DOE/RL-94-69-1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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WHC, 1990, *Liquid Effluent Study Final Report*, WHC-EP-0367, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991, *Interim Status Groundwater Monitoring Plan for the 200 East Area Liquid Effluent Retention Facility*, WHC-SD-EN-AP-024, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

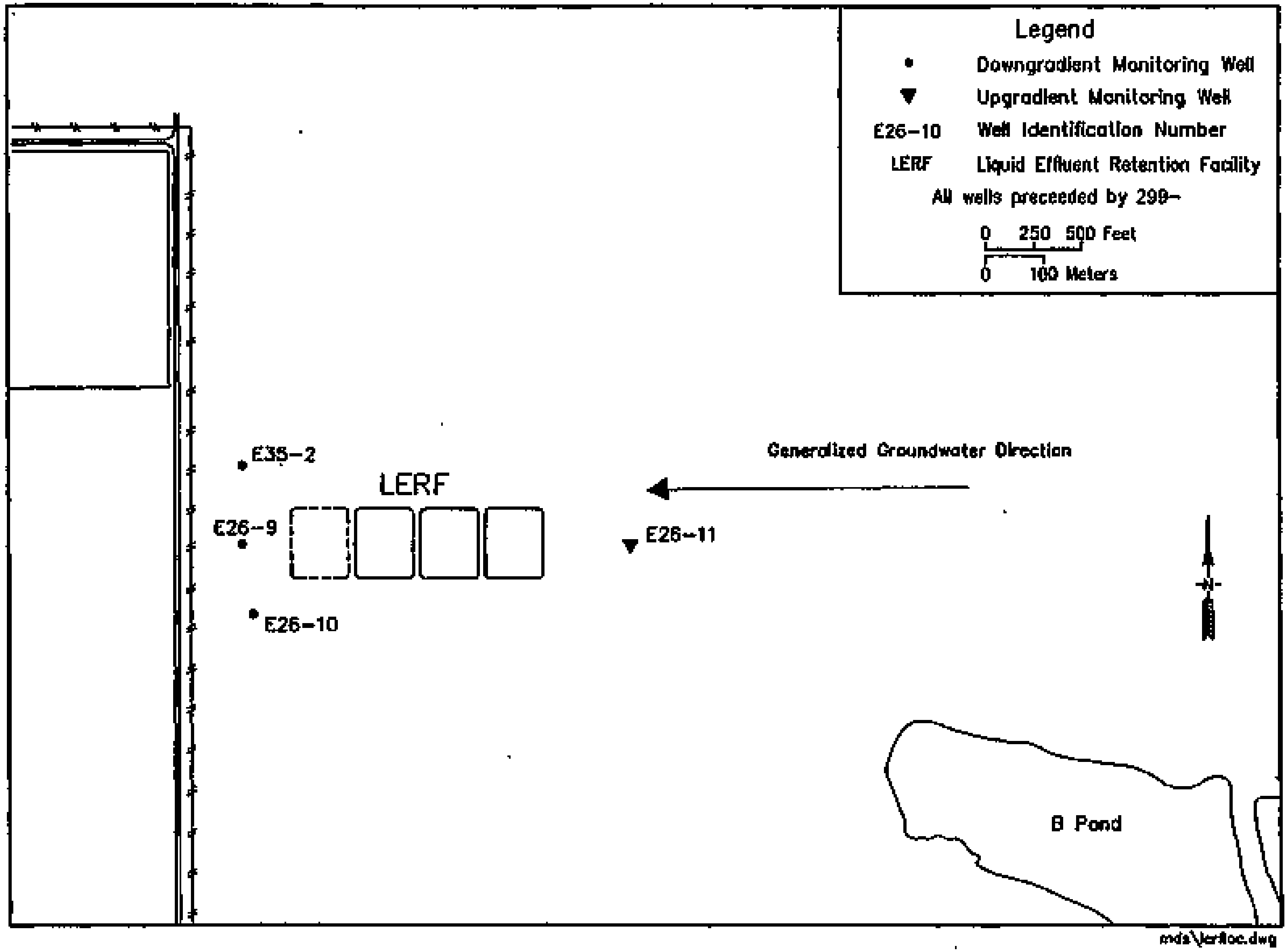

Figure 4.8-1. Monitoring Well Locations for the Liquid Effluent Retention Facility.

Figure 4.8-2. Hydrograph of Water Level Measurements (Feet Above Sea Level) for Liquid Effluent Retention Facility Wells.

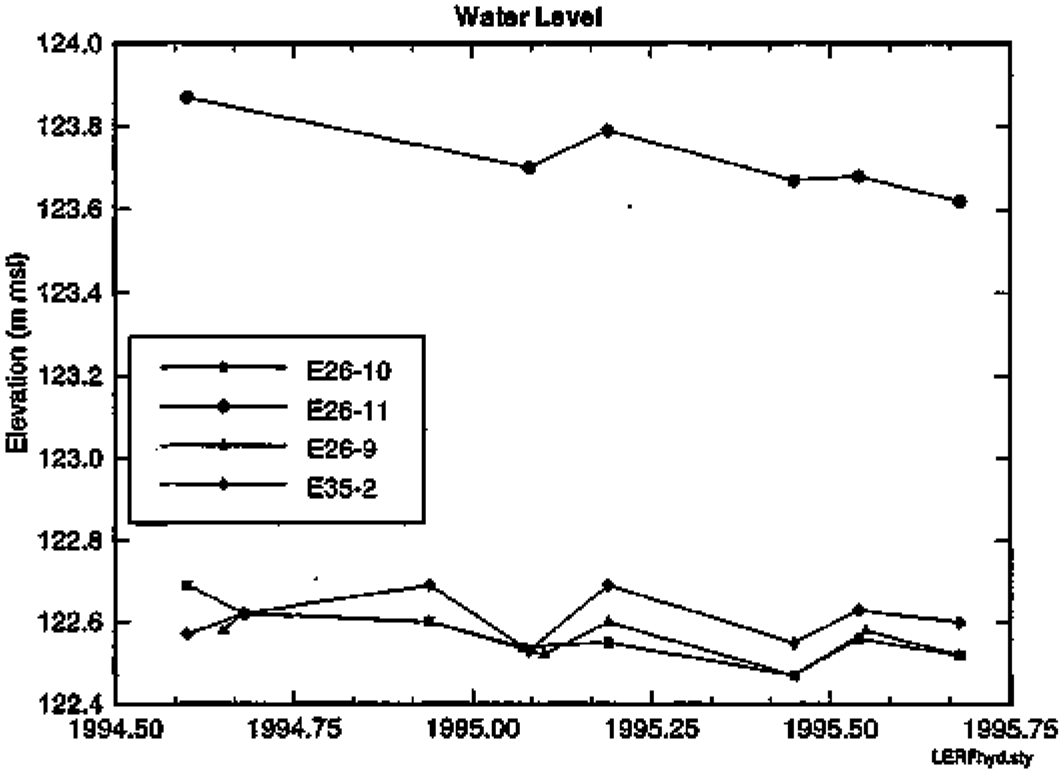

Figure 4.8-3. 200 East Area Water Table Map.

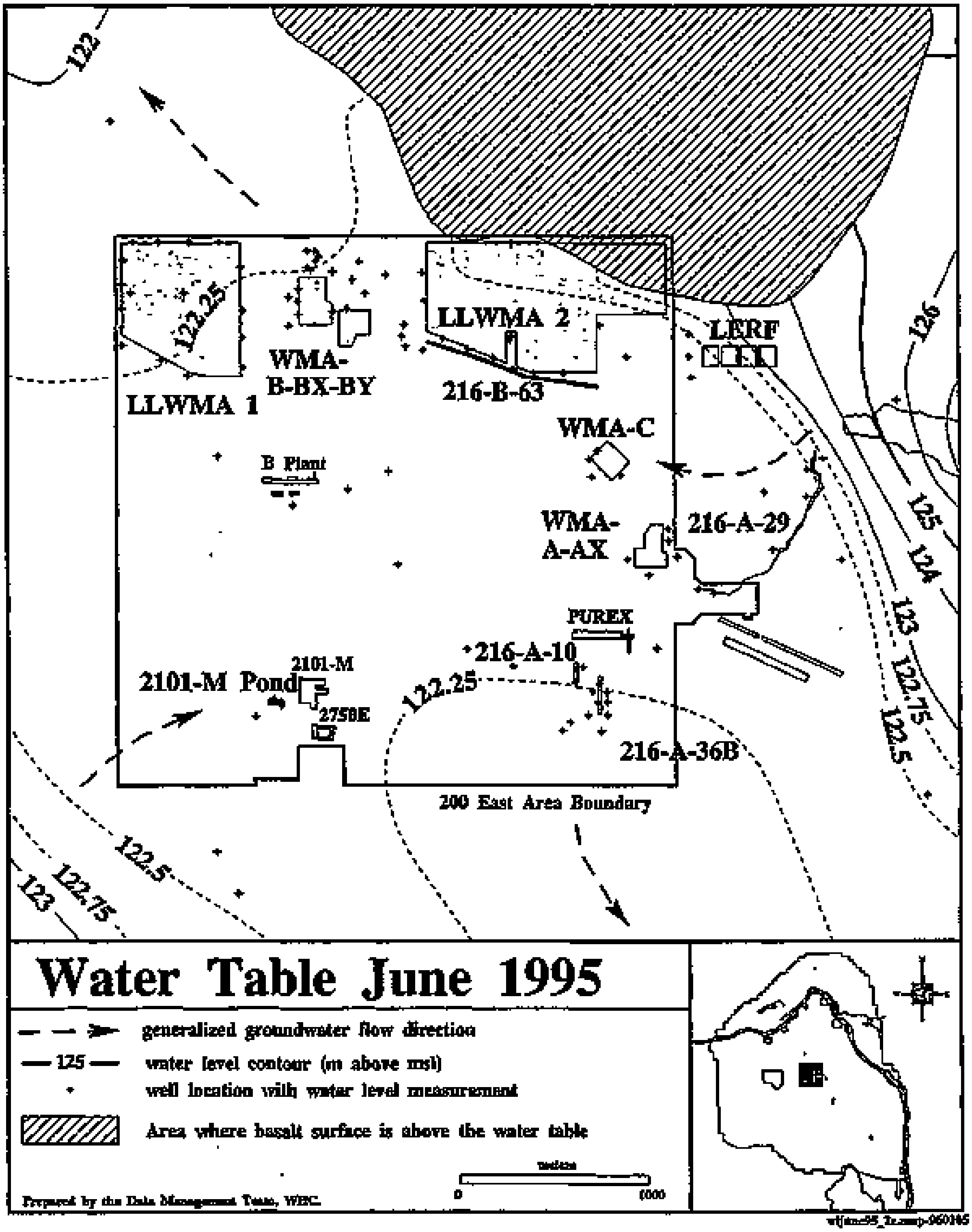

Table 4.8-1. Liquid Effluent Retention Facility Groundwater Monitoring Network.

Well	Aquifer	Sampling frequency	Water levels	Well standard	Other networks
299-E26-11^{89}	Top of unconfined	S	Q	RCRA	--
299-E26-10^{90}	Top of unconfined	S	Q	RCRA	--
299-E26-9^{87}	Top of unconfined	S	Q	RCRA	--
299-E35-2^{87}	Top of unconfined	S	Q	RCRA	--

Notes: Shading denotes upgradient wells. Superscript following well number denotes the year of installation.

Q = frequency on a quarterly basis.

RCRA = well is constructed to RCRA-specified standards.

S = frequency on a semiannual basis.

Table 4.8-2. Constituent List for the Liquid Effluent Retention Facility Monitoring Network.

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

Table 4.8-3. Critical Means Table for 16 Comparisons--Background Contamination Indicator Parameter Data for the Liquid Effluent Retention Facility[a,b]

Constituent (Unit)	n	df	tc	Average background	Standard deviation	Critical mean	Upgradient/ downgradient comparison value
Specific Conductance (μmho/cm)	4	3	11.984	332.125	11.736	489.4	489.4
Field pH	4	3	15.145	7.742	0.311	[2.48, 13.01]	[6.25, 9.42][e]
TOC[c] (ppb)	4	3	11.984	718.75	295.364	4,676	4,676
TOX[d] (ppb)	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	13.6

[a] Data collected from June 1991 to April 1992 for upgradient well 2-E26-11. Values calculated based on 12 comparisons.

[b] The following notations are used in this table:

df = degrees of freedom (n-1).

n = number of background replicate averages.

t_c = Bonferroni critical t-value for appropriate df and 16 comparisons.

[c] Critical mean was calculated from values reported below the CRQL.

[d] Critical mean cannot be calculated due to problems associated with data quality for samples analyzed by DCL. The upgradient/downgradient comparison value for TOX is the limit of quantitation (see Appendix A).

[e] Upgradient/downgradient comparison values for pH were calculated using data from June 1991 to October 1993 (well 2-E26-11) because the critical range calculated using 4 quarters of data is too large to be meaningful.

N. C. = not calculated.

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4.9 2101-M POND

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4.9.1 Facility Overview

A revision of the closure plan has been issued for 2101-M Pond (DOE-RL 1993). Acceptance of a clean closure certification of the 2101-M Pond was indicated by the Washington State Department of Ecology on October 26, 1995. The last groundwater sampling event for this facility occurred in June 1995. Well 299-E18-1 will continue to be sampled, however, in support of the 216-B-3 Pond System.

The 2101-M Pond is a U-shaped, unlined trench located west-southwest of the 2101-M Building in the southwest portion of the 200 East Area (Figure 4.9-1). It has received nondangerous wastewater from the 2101-M Building heating and air conditioning system since 1953. In 1981, Basalt Waste Isolation Project laboratories were plumbed into the discharge line from the 2101-M Building to the 2101-M Pond. From 1981 until mid-1985, these laboratories may have discharged dangerous waste into the 2101-M Pond. The most important chemicals used in the 2101-M Laboratory were barium chloride and hydrochloric and nitric acids. They are assumed to have been disposed of in laboratory drains connected to the 2101-M Pond. Selenium and chromium were also potential contaminants associated with laboratory operations. Administrative controls were established in July 1985 to prohibit disposal of dangerous waste via the laboratory drains.

Since November 1989, the 2101-M Pond has been monitored under *Resource Conservation and Recovery Act of 1976* (RCRA) interim-status regulations (40 *Code of Federal Regulations* [CFR] 265) in an indicator-parameter evaluation program using a four-well network (Chamness et al. 1989). The monitoring wells are installed in the uppermost portion of the unconfined aquifer and completed across the interpreted contact between the base of the Hanford formation and the top of the Ringold Formation (Ford and Trent 1994, Lindsey et al. 1994). The stratigraphy consists of a muddy, sandy gravel to a slightly muddy gravelly sand over the screened interval, which ranges from approximately 92 to 101 m (302 to 331 ft) below the top of the casing (Figure 4.9-2). The 2101-M Pond is located within the 200-SS-1 operable unit.

4.9.2 Summary of 1995 RCRA Activities

All four wells in the monitoring network were sampled in December 1994 and June 1995 for contamination indicator, groundwater quality, and drinking water quality parameters. In addition, well 299-E18-1 was sampled in March and September of 1995 because this well is also an upgradient monitoring well for the 216-B-3 Pond System and is currently being sampled quarterly as part of the assessment monitoring program for that unit. Results of groundwater analyses for 2101-M Pond are discussed in Section 4.9.4.

Monthly water level measurements of the four-well monitoring network were made from October 1994 through December 1994. Since then water level measurements have been performed quarterly (March and June 1995). In addition, water level measurements have been performed at the time of sampling. A discussion of the water level measurements is included in Section 4.9.5.

4.9.3 Sampling and Analysis Program

The indicator-parameter evaluation groundwater monitoring program for the 2101-M Pond is described in Chamness et al. (1989). The monitoring network consists of one upgradient (299-E18-1) and three downgradient (299-E18-2, 299-E18-3, and 299-E18-4) groundwater monitoring wells installed in the uppermost portion of the unconfined aquifer. A well location map is shown in Figure 4.9-1. Sampling began in August 1988 and was conducted quarterly until August 1989 to establish background values. Semiannual indicator parameter evaluation monitoring was initiated in November 1989. Additional information regarding the monitoring network is provided in Table 4.9-1.

Samples were collected from all four wells in December 1994 and June 1995. All four wells were analyzed for the constituents listed in Table 4.9-2 and the resulting data presented in quarterly reports (Thornton 1995a, 1995b, and 1995c). Verification sampling for total organic halogen (TOX) was also performed in October of 1994 for well 299-E18-4 because of a TOX exceedance associated with sampling conducted in December 1993.

4.9.4 Groundwater Chemistry

4.9.4.1 Constituents of Concern. All of the analytical values obtained in the past year for 2101-M Pond were below the drinking water standards (DWS). The four contamination indicator parameters, pH (field), conductance (field), total organic carbon (TOC), and TOX, were monitored for the continuing evaluation of the 2101-M Pond Facility's impact on groundwater. An exceedance of the critical mean for TOX was observed for the December 1993 sampling of well 299-E18-4. The well was resampled for verification and sample splits were sent to two laboratories for analysis. However, results obtained from the two laboratories were considered inconclusive owing to high variability. Another round of verification sampling was undertaken on October 19, 1994. Laboratory results for TOX associated with this sampling were below the critical mean, indicating the earlier exceedance does not reflect an impact of 2101-M Pond on groundwater quality. Specific conductance, pH, and TOC values have not exceeded the statistical background values (see Section 4.9.4.2). Data discussed here have been presented in the quarterly reports (Thornton 1995a, 1995b, and 1995c).

Regulatory standards for turbidity do not apply to groundwater, which is measured at this site only as an indicator of solids content. Only filtered metals are used in measuring the impact of the site on the groundwater; however, unfiltered metals have also been analyzed at 2101-M Pond for comparison with the filtered metals and to evaluate well construction or other effects on groundwater sample data. Elevated unfiltered chromium, iron, manganese, zinc, and nickel concentrations are thought to have been introduced during or after well construction (e.g., metal corrosion products or clays). Unfiltered chromium concentrations for well 299-E18-4 and unfiltered iron for wells 299-E18-1 and 299-E18-4 were elevated relative to the corresponding unfiltered metal concentrations for groundwater samples collected on December 1, 1994. Turbidity values slightly higher than 3 NTUs were also reported for these samples. These data support the proposal that higher metal concentrations associated with unfiltered samples are often related to the presence of solid debris.

Comparing the water chemistry of upgradient well 299-E18-1 with downgradient wells 299-E18-2, 299-E18-3, and 299-E18-4 indicates that a significant volume of water has entered the unconfined aquifer from the 2101-M Pond. Thus, a decrease of specific conductance (Figure 4.9-3) in downgradient wells versus the upgradient well is interpreted to be a dilutional effect of water draining from the pond into the aquifer. Conversely, barium concentrations of about 55 ppb occur in downgradient wells versus 25 to 30 ppb in the upgradient well (Figure 4.9-4). The differences in barium concentrations, however, appear to be inversely related to differences in sulfate concentrations between the upgradient and downgradient wells. Therefore, barium concentrations likely reflect dissolution and precipitation equilibria in the natural system associated with dilutional effects and not from a barium source introduced via the pond (Chamness et al. 1990).

4.9.4.2 Statistical Evaluation. Statistical evaluations at 2101-M Pond during the past year consisted of comparisons between upgradient and downgradient wells for indication of contamination in the groundwater beneath the site. All values of specific conductance, pH, TOC, and TOX in the downgradient wells in the past year were below the upgradient/downgradient comparison values. Statistical methods are described in Appendix C.

Statistical analyses required by 40 CFR 265.93(b) and *Washington Administrative Code* (WAC) 173-303-400 were performed on the samples collected from upgradient well 299-E18-1. Results are presented in Table 4.9-3. This table lists the background average, standard deviation, critical mean (or critical range, in the case of pH), and upgradient/downgradient comparison values for the contamination indicator parameters. The upgradient/downgradient comparison value is the value to which current and future averages of indicator parameters are compared. The comparison value is generally the critical mean or critical range. An alternative pH range for upgradient/downgradient comparisons was calculated using upgradient data collected from August 1988 to June 1989 (see Appendix C) because the critical range calculated using four quarters of data is outside the possible range for pH (0, 14).

4.9.5 Groundwater Flow

4.9.5.1 Groundwater Flow Direction. Water level measurements have been performed quarterly and before collecting groundwater samples during the past year. These data are used to evaluate the groundwater gradient and flow direction (Figure 4.9-5). The groundwater gradient across the 2101-M Pond monitoring network is difficult to determine precisely because it is very small (approximately 5×10^{-4}). The hydrograph for the four-well monitoring network (Figure 4.9-6) reflects not only the difficulty of acquiring accurate measurements but also the very slight difference in water level elevations between the four wells. The hydrograph also indicates a gradual drop in the water table, reflecting declining water levels throughout the 200 East Area because of decreased wastewater discharges to the ground in the 200 Areas. The local water table map (see Figure 4.9-5) indicates, however, that the general groundwater flow direction is still east to northeast. No data are available at present regarding vertical gradients and flow.

In summary, analysis of water level measurements indicates the following:

- The continued decline in water levels of approximately 0.1 m (0.3 ft) in the past year
- A low hydraulic gradient in the vicinity of the 2101-M Pond
- A general groundwater flow direction to the northeast or east.

4.9.5.2 Rate of Flow. An estimate of horizontal flow rates can be obtained by using Darcy's law (Freeze and Cherry 1979)

$$\bar{v} = -\frac{K}{n_e}\frac{\partial h}{\partial l} \qquad (1)$$

where:

$\bar{v}$ = Flow rate or average linear velocity
K = Hydraulic conductivity
n_e = Effective porosity
$\frac{\partial h}{\partial l}$ = Hydraulic gradient.

The monitoring wells at 2101-M Pond are completed in the lower part of the Hanford formation and upper part of the Ringold Formation in a silty gravel-dominated sequence. An estimated value for hydraulic conductivity of 45 m/d (150 ft/d) is appropriate for the screened zone as indicated by pumping test data (Chamness et al. 1990, Connelly et al. 1992). If the hydraulic gradient is assumed to be 5×10^{-4} and effective porosity is assumed to be 0.15, a rate of flow of 0.15 m/d (0.5 ft/d) is obtained. This should be regarded as an approximation only because the hydraulic gradient is difficult to estimate at this location. At present the hydraulic gradient is very low because the water table is nearly flat.

4.9.5.3 Evaluation of Monitoring Well Network. Monitoring well locations satisfied regulatory requirements during the past year based on the regional and local trend of groundwater flow near the 2101-M Pond. This network will no longer be used for 2101-M Pond RCRA monitoring activities because the unit has been clean-closed. Network wells will be evaluated for use in support of other programs, however.

4.9.6 References

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

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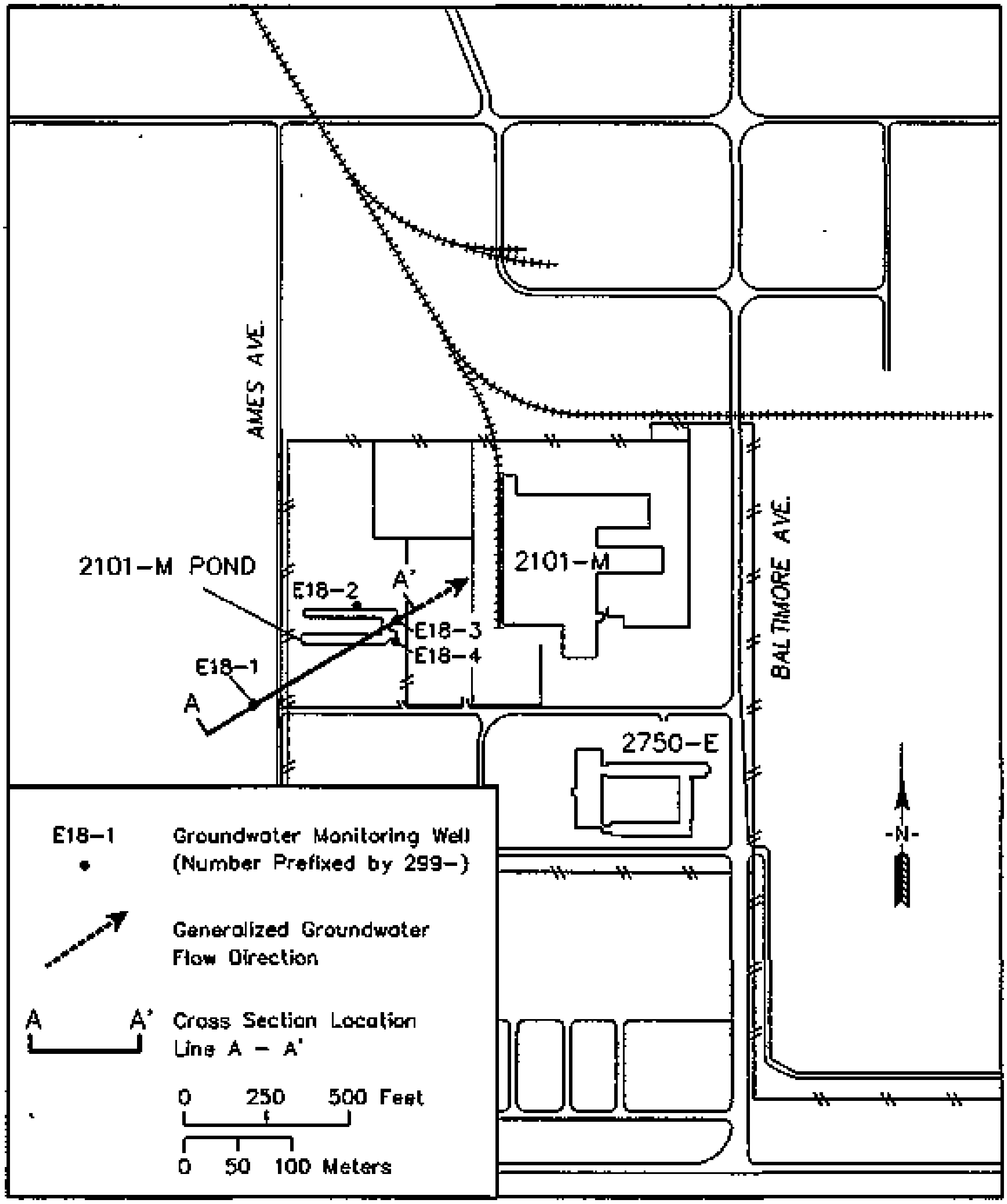
Figure 4.9-1. Monitoring Well Locations for the 2101-M Pond and Location of Cross Section A-A'.



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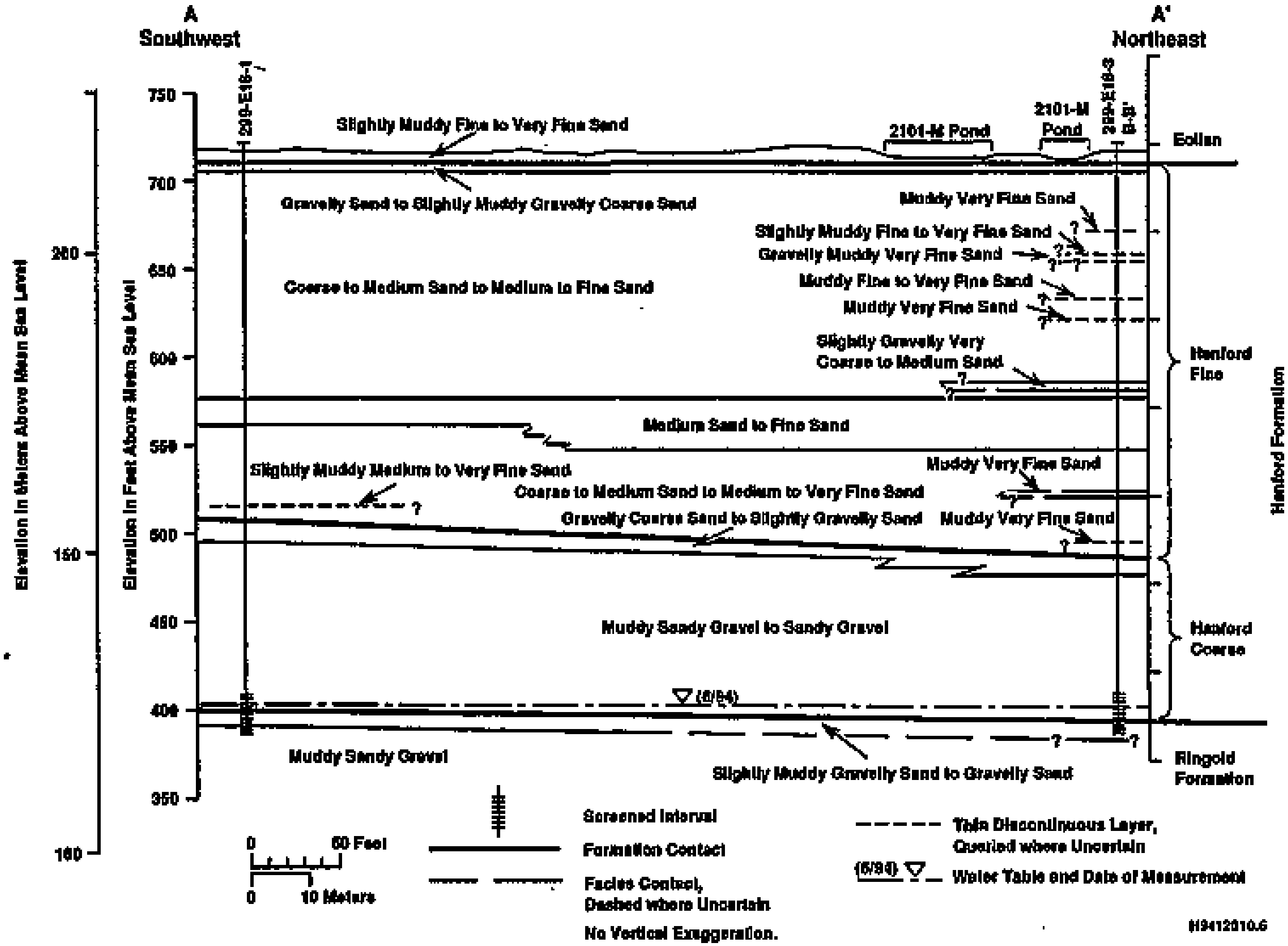

Figure 4.9-2. Geologic Cross Section A-A' (Modified after Chamness et al. 1990, Ford and Trent 1994, and Lindsey et al. 1994).

Figure 4.9-3. Specific Conductance Versus Time in Upgradient Well 299-E18-1 and Downgradient Wells 299-E18-2, 299-E18-3, and 299-E18-4.

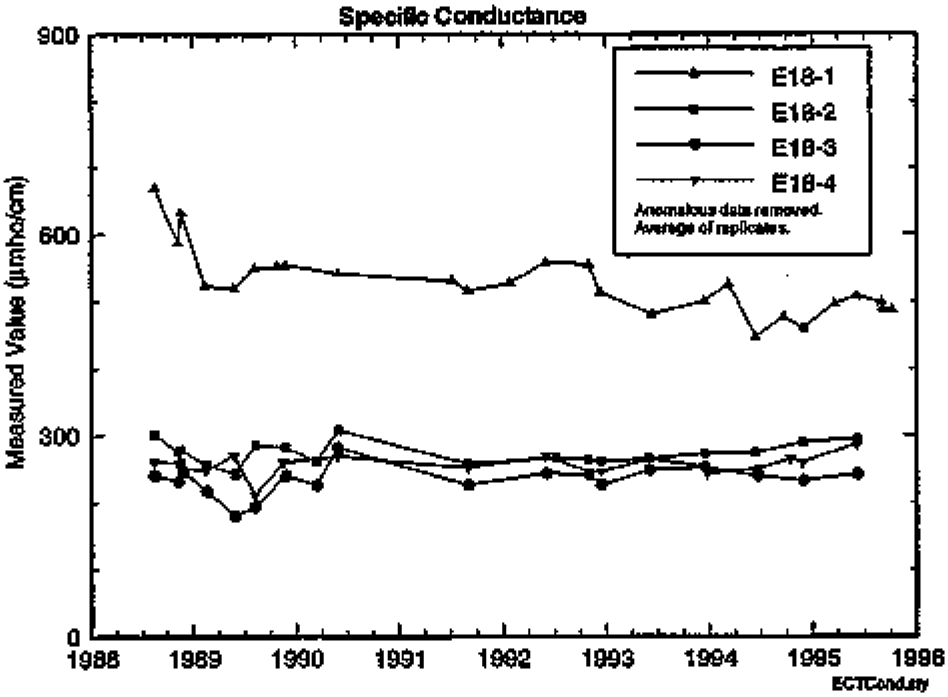

Figure 4.9-4. Filtered Barium Versus Time in Upgradient Well 299-E18-1 and Downgradient Wells 299-E18-2, 299-E18-3, and 299-E18-4.

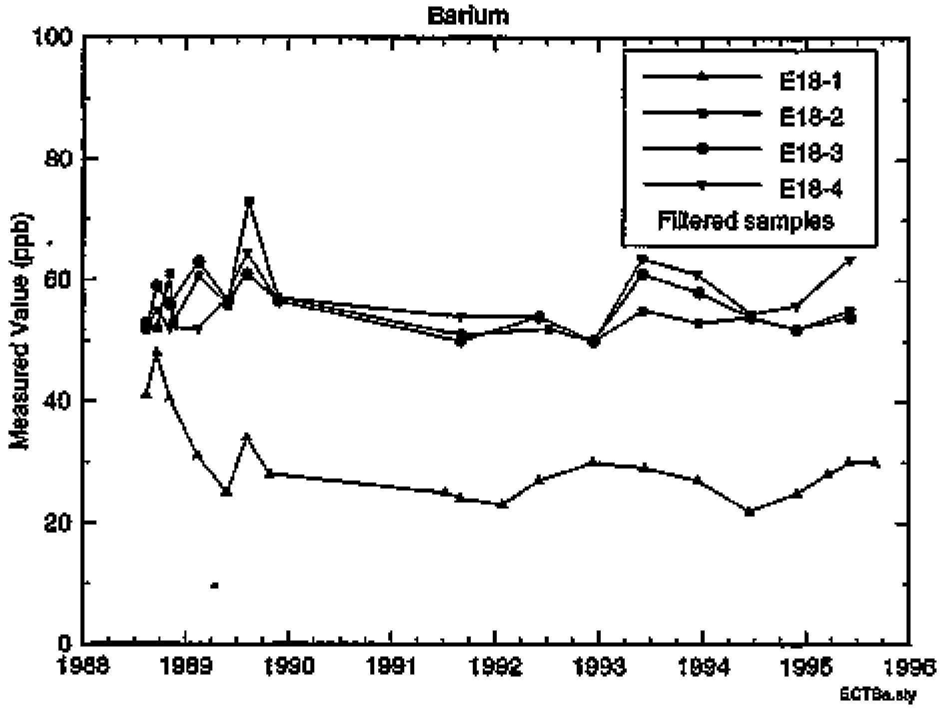

Figure 4.9-5. 200 East Area and 2101-M Pond Water Table Map, June 1995.

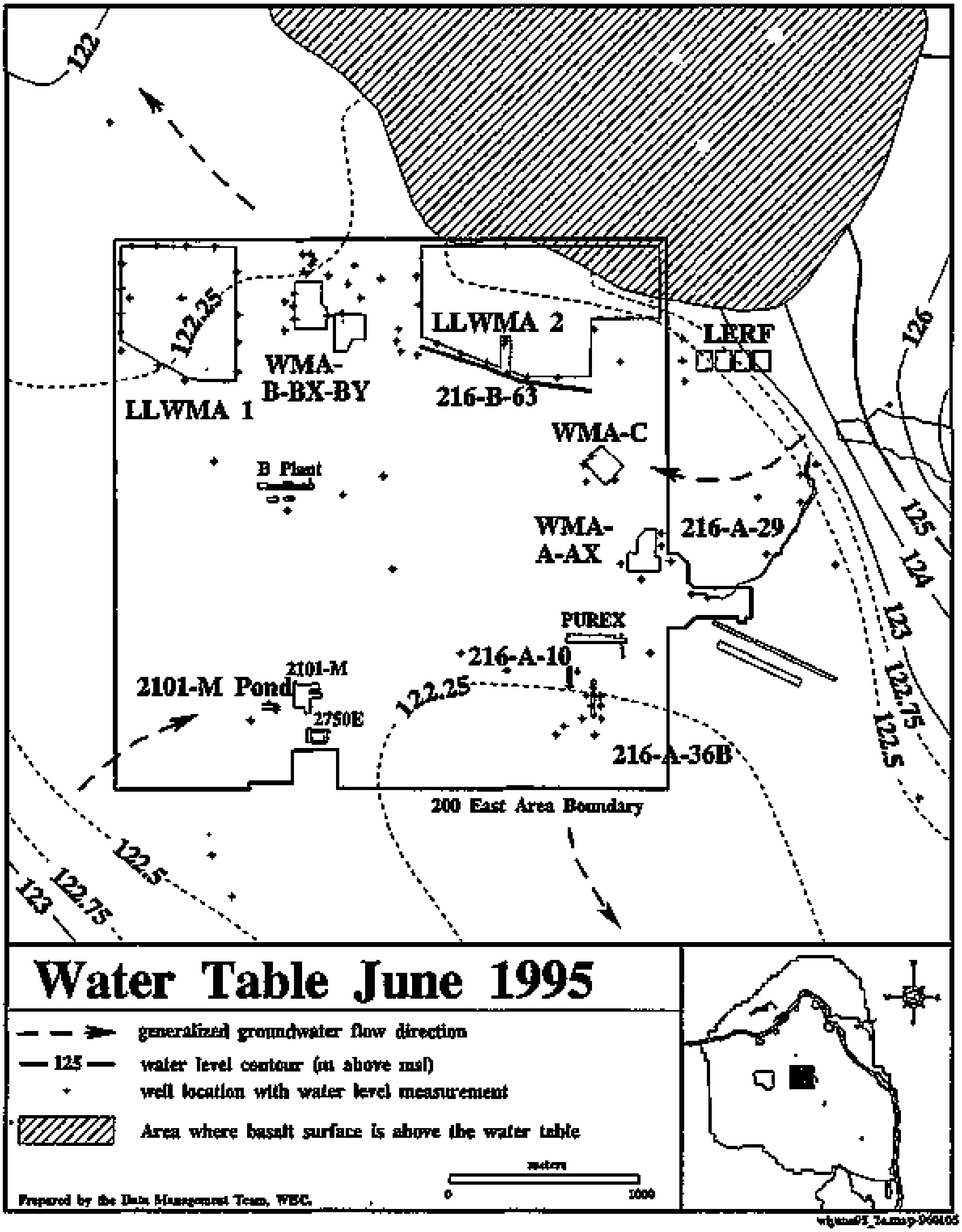

Figure 4.9-6. Hydrograph of Monthly Water Level Measurements (Meters Above Mean Sea Level) at the 2101-M Pond.

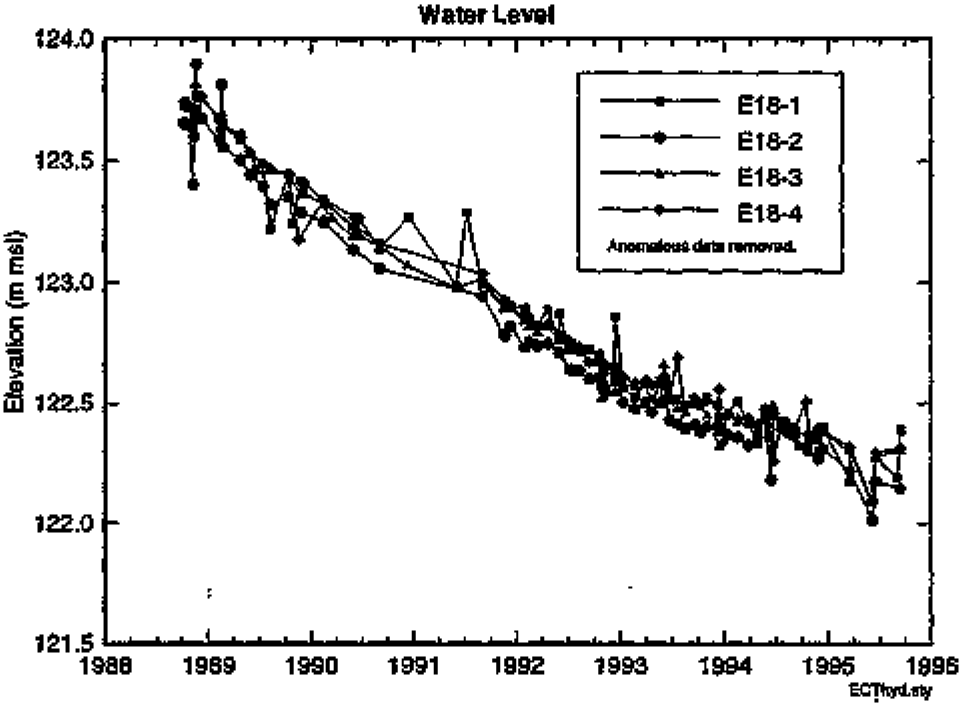

Table 4.9-1. Monitoring Well Network for the 2101-M Pond.

Well	Aquifer	Sampling frequency	Water levels	Well standards	Other networks
299-E18-1[88]	Top of unconfined	Q	Q	RCRA	B Pond
299-E18-2[88]	Top of unconfined	S	Q	RCRA	--
299-E18-3[88]	Top of unconfined	S	Q	RCRA	--
299-E18-4[88]	Top of unconfined	S	Q	RCRA	--

Notes: Shading denotes upgradient well. Superscript following well number denotes the year of installation.

M = monthly sampling frequency.

RCRA = well is constructed to RCRA-specified standards.

S = semiannual sampling frequency.

Q = quarterly sampling frequency. Well 299-E18-1 is sampled on a quarterly basis because it is also designated as an upgradient well for the 216-B-3 Pond system.

Table 4.9-2. Constituents Analyzed at the 2101-M Pond.

Contamination indicator parameters		
pH Specific conductance[c]	Total organic carbon Total organic halogen	
Groundwater quality parameters		
Chloride Iron	Manganese Phenols[a]	Sodium Sulfate
Drinking water parameters		
Arsenic[b] Barium Cadmium Chromium	Fluoride Gross alpha Gross beta	Nitrate Selenium[b] Silver
Site-specific parameters		
Turbidity	Alkalinity	

[a] Analyzed once a year.

[b] Arsenic and selenium were dropped from the 2101-M Pond constituent list in mid-FY 1995 and coliform and uranium were not analyzed for after FY 1994 because they were not present at significant concentration levels in samples previously analyzed.

[c] Measured in field.

Note: No additional groundwater sampling is planned at 2101-M Pond since clean closure certification has been approved.

Table 4.9-3. Critical Means Table for 16 Comparisons--Background Contamination Indicator Parameter Data for the 2101-M Pond.[a,b]

Constituent (unit)	n	df	t_c	Average background	Standard deviation	Critical mean	Upgradient/ downgradient comparison value
Specific conductance (μmho/cm)	4	3	11.984	621.94	128.621	2,345.2	2,345.2
Field pH	4	3	15.145	7.804	0.656	[-3.3, 18.9]	[6.18, 9.79][e]
Total organic carbon[c] (ppb)	4	3	11.984	387.56	156.214	2,480.5	2,480.5
Total organic halogen[d] (ppb)	4	3	11.984	3.587	0.99	16.8	16.8

[a] Data collected from August 1988 to June 1989 for upgradient well 299-E18-1. Values calculated based on 16 comparisons.

[b] The following notations are used in this table:

df = degrees of freedom (n-1).
n = number of background replicate averages.
t_c = Bonferroni critical t-value for appropriate df and 16 comparisons.

[c] Critical mean was calculated from values reported below the contractually required detection limits.

[d] Critical mean was calculated using data analyzed by U.S. Testing Inc. of Richland.

[e] Upgradient/downgradient comparison values for pH were calculated using data from August 1988 to June 1992 (well 299-E18-1) because the critical range calculated using four quarters of data is outside the possible range for pH, [0, 14].

NC = not calculated.

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4.10 200 AREAS LOW-LEVEL BURIAL GROUNDS

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The 200 Areas Low-Level Burial Grounds (LLBG) consist of five Low-Level Waste Management Areas (LLWMA) (see Figure 1-1, Chapter 1.0). The *Resource Conservation and Recovery Act of 1976* (RCRA) groundwater monitoring program for the LLBG began in 1988 (WHC 1989b) and is continuing under interim status. A RCRA Part B permit application has been submitted to the Washington State Department of Ecology for these facilities (DOE-RL 1989).

A diverse range of both radioactive mixed and dangerous waste has been placed in the LLBG from Hanford Site and offsite sources. The waste includes, but is not limited to, miscellaneous dry waste, failed equipment, vehicles, contaminated soil, submarine reactor cores and reactor compartments, and cleanup waste. An inventory of the waste can be found in the *Low-Level Burial Grounds Database* (WHC 1989a). Waste has been placed in the LLBG since 1960 and is contained in unlined trenches and pits, which range from 3.7 to 18.3 m (12 to 60 ft) deep. The LLWMAs also contain some concrete caissons and retrievable storage units (RSU) that receive drummed waste. The RSUs consist of plywood- or asphalt-bottomed trenches or asphalt pads. Both trenches and pads are covered with plywood and, in some cases, an additional layer of heavy plastic and 1.2 m (4 ft) of soil. Each LLWMA will be discussed separately in this section.

The available chemical and water level data collected at the LLBG in this reporting period are published in the 1995 quarterly reports (Mercer 1995a, 1995b, 1995c, and 1996).

The most recent interpretation of the geology and hydrology of the LLBGs is discussed in Lindsey et al. (1994). The 200 Areas are situated on the generally southward-dipping north limb of the Cold Creek syncline. The Elephant Mountain Member of the Saddle Mountains Basalt is the uppermost basalt beneath the LLBGs. The suprabasalt sediments in the 200 East Area (LLWMA-1 and LLWMA-2) are made up of the sands and gravels of the Hanford formation. The 200 West Area burial grounds are underlain by the Ringold Formation and Hanford formation. The uppermost aquifer beneath the 200 West Area is entirely within the Ringold Formation. There are indications that the aquifer is locally semiconfined beneath the northern portions of LLWMA-3 and LLWMA-5.

4.10.1 Low-Level Waste Management Area 1

4.10.1.1 LLWMA-1 Facility Overview. This LLWMA is located in the northwest corner of the 200 East Area (see Figure 1-1, Chapter 1.0). As recommended in the assessment report (Mercer 1994a), critical means for contamination indicator parameters (CIPs) were reestablished in 1994. This waste management area is currently following interim-status detection-level monitoring regulations. It includes all of the 218-E-10 Burial Ground (Figure 4.10-1). This LLWMA is divided by an east-west access road. The southern portion of the burial ground is currently active, while the portion north of the road is reserved for future expansion. The active area measures 22.9 ha (56.7 acres) and the expansion area measures 15.3 ha (37.7 acres), for a total area of 38.2 ha (94.4 acres).

Disposal activities at this LLWMA began in 1960 and continue to the present. Materials placed in this facility are primarily dragoff waste, failed equipment, and mixed industrial waste from the Plutonium-Uranium Extraction Plant, B Plant, and N Reactor. LLWMA-1 is located within the 200-BP-10 source operable unit and the 200-BP-5 groundwater operable unit.

4.10.1.2 LLWMA-1 Summary of 1995 RCRA Activities. This LLWMA continued in CIP detection monitoring in 1995. Groundwater sampling was on a semiannual schedule and water levels were measured quarterly in 1995.

4.10.1.3 LLWMA-1 Sampling and Analysis Program. The existing RCRA groundwater monitoring network consists of 16 wells (see Figure 4.10-1). Table 4.10-1 lists the wells in the LLWMA-1 monitoring network. The sampling and analysis program at LLWMA-1 was initiated in 1988. A list of analytical constituents for LLWMA-1 is presented in Table 4.10-2.

4.10.1.4 LLWMA-1 Groundwater Chemistry.

4.10.1.4.1 Constituents of Concern. Critical means for the CIPs established for LLWMA-1 were not exceeded at any LLWMA-I groundwater monitoring well in this reporting year.

Chemical analyses indicated that unfiltered iron and chromium were above regulatory standards in 1995 in several wells at LLWMA-1. In the majority of cases, elevated levels are found only in the unfiltered samples and are not reflected in the corresponding filtered samples. These constituents are not indicative of waste disposed of at the burial grounds and the elevated levels are assumed to be related to well construction or some other common factor. The elevated values for unfiltered metals have been roughly correlated to high turbidity. As a result of the lack of a related source and continued spatially random and widely fluctuating values, analysis of unfiltered metals was discontinued in calendar year (CY) 1995.

Although no evidence indicates any contribution from LLWMA-1, contaminant plumes are affecting the groundwater quality beneath LLWMA-I (Johnson 1993, WHC 1992a). Nitrate and tritium plumes are evident and appear to be the major contaminants in the area of LLWMA-I (Figures 4.10-2 and 4.10-3). Tritium values indicate the presence of a plume beneath LLWMA-1 with a source to the southeast. The data suggest that the maximum concentrations have already passed beneath LLWMA-1 and the values continue to decline.

Values for gross alpha from well 299-E32-5 exceeded the DWS in the last quarter of 1994. This result (15.6 pCi/L), while above the established standard (15 pCi/L), did not exceed the historical maximum for upgradient well 299-E28-26 (24 pCi/L, December 27, 1988). Values for gross alpha are generally declining in wells south of the east-west road that crosses LLWMA-1 (Figure 4.10-1) and generally increasing in the monitoring wells north of the road. These trends are expected to continue as the plume passes beneath the burial ground. This plume appears to originate at the 216-B-62 Crib (Johnson 1993).

Wells 299-E33-34 and 299-E33-35 continue to have elevated levels of gross beta contamination and the trends appear to be slightly downward. An upgradient source is apparent in the gross beta plume for the 200 East Area in Johnson (1993).

4.10.1.4.2 Statistical Evaluation. Statistical evaluations of data for the past year at the LLWMA-1 consisted of comparing upgradient and downgradient wells for any indication of contamination in the groundwater underlying the facility. Background data and background summary statistics are presented in Mercer (1994a). Statistical analyses required by 40 *Code of Federal Regulations* (CFR) 265.93(b) and *Washington Administrative Code* (WAC) 173-303-400 were performed on the samples collected from upgradient wells. Results are presented in Table 4.10-3. This table lists the background average, background standard deviation, critical mean (or critical range, in the case of pH) and upgradient/downgradient comparison value for the four CIPs. The comparison value (or range) is the value to which current and future averages of quadruplicate measurements are compared. Statistical methods are described in Appendix C.

If the average concentration for a parameter from a downgradient well exceeds the upgradient/downgradient comparison value listed in Table 4.10-3, that parameter is considered statistically different from background. If this is confirmed by subsequent verification sampling and analysis, the regulatory program is triggered into assessment. There were no exceedances in 1995.

4.10.1.5 LLWMA-1 Groundwater Flow.

4.10.1.5.1 Groundwater Flow Direction. The groundwater flow direction in the area of LLWMA-1 is difficult to determine using only water level data from the monitoring wells around the burial ground. The groundwater gradient in this area is extremely low and several uncertainties contribute to the difficulties in producing a water table map. These uncertainties include barometric effects, inaccuracies in the borehole surveys, slight deviations from the vertical in the boreholes, and errors associated with the water level measurements themselves. To demonstrate the groundwater flow directions under LLWMA-1, a general map of the entire 200 East Area is presented in Figure 4.10-4. This map represents the best estimate of the water table elevation beneath LLWMA-1 in June 1995 and was generated using data from wells in the 200 East Area and surroundings.

An interpretation of the groundwater flow direction from the groundwater map is inconclusive. A better estimate of the groundwater flow direction can be inferred from various contaminant plume maps presented in WHC (1992a) and Johnson (1993). The contamination distribution suggests that the general direction of flow is to the northwest beneath LLWMA-1.

4.10.1.5.2 Rate of Flow. Using the Darcy equation (Equation 1) and some conservative values for hydrologic properties, an estimate of the groundwater flow velocity was determined. The hydraulic conductivity of the aquifer beneath LLWMA-1 has been estimated to be between 73 and 762 m/d (240 and 2,500 ft/d) (Last et al. 1989, page 6.8) and the effective porosity is assumed to be on the order of 0.1. Using water levels from June 1995, an approximation of the hydraulic gradient can be estimated to be 0.00008. Calculations using these values result in estimates of groundwater velocity between 0.06 and 0.60 m/d (0.2 and 2.0 ft/d). These values are highly subjective; however, they represent the best estimate of the actual conditions beneath LLWMA-1.

$$v = \frac{Ki}{n_e} \qquad (1)$$

where:

v = Average linear groundwater velocity (m/d)
K = Hydraulic conductivity (m/d)
i = Hydraulic gradient
n_e = Effective porosity.

4.10.1.5.3 Evaluation of Monitoring Network. The groundwater monitoring network continues to meet requirements. There are no plans for additional groundwater monitoring wells at this time.

4.10.2 Low-Level Waste Management Area 2

4.10.2.1 LLWMA-2 Facility Overview. Currently in indicator parameter evaluation status, LLWMA-2 is located in the northeast corner of the 200 East Area and includes all of burial ground 218-E-12B (Figures 1-1 and 4.10-5). This burial ground has a total area of 70.1 ha (173.1 acres) and has been in use since 1968. The majority of the waste deposited in this area is located in the eastern half of the burial ground. This waste consists primarily of miscellaneous dry waste and submarine reactor compartments. Parts of two trenches contain transuranic waste. LLWMA-2 is located in the 200-BP-11 source operable unit and the 200-BP-5 groundwater operable unit.

4.10.2.2 LLWMA-2 Summary of 1995 Activities. The indicator parameter evaluation monitoring program for LLWMA-2 continued in 1995. Groundwater samples were collected semiannually and water levels were measured quarterly.

4.10.2.3 LLWMA-2 Sampling and Analysis Program. The current monitoring network consists of 16 wells. Monitoring wells for LLWMA-2 are listed in Table 4.10-4 and are shown in Figure 4.10-5. The sampling and analysis program for LLWMA-2 was initiated in 1988 (WHC 1989b), with quarterly sampling until the last quarter of 1989. At that time the required background values were calculated. Sampling was placed on a semiannual schedule. The constituent list for LLWMA-2 is the same as Table 4.10-2 with the addition of polychlorinated biphenyls (PCBs). No analyses of CIPs from downgradient wells exceeded the critical means.

4.10.2.4 LLWMA-2 Groundwater Chemistry Evaluation.

4.10.2.4.1 Constituents of Concern. As at LLWMA-1, analyses indicated that unfiltered iron and chromium were above regulatory standards in 1995 in several wells at LLWMA-2. This has been an ongoing concern at several RCRA sites (see Section 4.10.1.4.1) and since these constituents are not indicative of wastes disposed in the LLBG analysis of unfiltered metals was discontinued in CY 1995. Values of Iodine-129 were slightly above the DWS in several of the wells along the southern boundary of LLWMA-2. These are related to the widespread ^{129}I plume beneath the 200 East Area. There is no evidence of contamination from LLWMA-2.

4.10.2.4.2 Statistical Evaluation. Statistical evaluations at the LLWMA-2 compared CIP data from upgradient and downgradient wells for indications of contamination in the uppermost aquifer beneath the site. Values of specific conductance, pH, total organic halogen (TOX), and total organic carbon (TOC) in the downgradient wells in the past year were below the upgradient/downgradient comparison values. Statistical methods are described in Appendix C.

Statistical analyses required by 40 CFR 265.93(b) and WAC 173-303-400 were performed on the samples collected from upgradient wells. Results are presented in Table 4.10-5. This table lists the background average, standard deviation, critical mean (or critical range, in the case of pH), and upgradient/downgradient comparison values for the CIPs. The comparison value is the value to which current and future averages of indicator parameters are compared. The comparison value is generally the critical mean or critical range. Statistical methods are described in Appendix C. Statistical analysis of indicator parameters indicated that the established critical means were not exceeded in any well in 1995.

4.10.2.5 LLWMA-2 Groundwater Flow.

4.10.2.5.1 Groundwater Flow Direction. Water level data from LLWMA-2 monitoring wells do not present a clear picture of groundwater flow. To obtain a better overall idea of the groundwater flow pattern, a water table map of the 200 East Area and surroundings for June 1995 was generated (see Figure 4.10-4). The groundwater flow direction in this area is primarily from east to west. Groundwater flow is affected by the basalt high located north and east of LLWMA-2 and the presence of a groundwater mound associated with B Pond.

4.10.2.5.2 Rate of Flow. The groundwater gradient beneath LLWMA-2 is very slight, i.e., on the order of 0.00001. Using this gradient, an effective porosity of 0.1, and hydraulic conductivity values in the range of 427 to 2,042 m/d (1,400 to 6,700 ft/d) (Last et al. 1989) and applying Equation 1, groundwater velocities were estimated to be between 0.4 and 2.0 m/d (1.4 and 6.7 ft/d).

4.10.2.5.3 Evaluation of Monitoring Well Network. The monitoring network continues to satisfy the requirement for at least one upgradient and three downgradient wells and is adequate to monitor the burial ground. No additional monitoring wells are planned for the LLWMA-2 monitoring network.

The declining water level in this area is forcing a reevaluation of the groundwater monitoring network. Monitoring wells 299-E34-4, 299-E34-6, and 299-E35-1 remain dry.

4.10.3 Low-Level Waste Management Area 3

4.10.3.1 LLWMA-3 Facility Overview. LLWMA-3 continued in detection-level groundwater monitoring in this reporting year. Background values were reestablished for the CIPs following the March 1995 sampling event. This was necessary because of the recent installation of three additional upgradient monitoring wells. Burial grounds 218-W-3A, 218-W-3AE, and 218-W-5 make up LLWMA-3, which is located in the north-central portion of the 200 West Area (Figures 1-1 and 4.10-6). These facilities cover 74.3 ha (183.7 acres). Burial ground 218-W-3A began accepting waste in 1970 and has received primarily ion-exchange resins and failed equipment (e.g., tanks, pumps, ovens, agitators, heaters, hoods, jumpers, vehicles, and accessories). This burial ground also contains remote-handled transuranic waste in RSUs. Burial ground 218-W-3AE was put in operation in 1981 and contains low-level and mixed waste. This includes rags, paper, rubber gloves, broken tools, and industrial waste. Burial ground 218-W-5 first received waste in 1986. This burial ground contains low-level and low-level mixed waste, including lead bricks and shielding. LLWMA-3 is in the 200-ZP-3 source operable unit and the 200-ZP-1 groundwater operable unit.

4.10.3.2 LLWMA-3 Summary of 1995 Activities. Groundwater at LLWMA-3 samples were collected semiannually. Additional samples (CIPs only) were taken quarterly through the first quarter of 1995 at the five shallow upgradient monitoring wells to reestablish background conditions. Water levels were measured quarterly.

4.10.3.3 LLWMA-3 Sampling and Analysis Program. Six upgradient and 14 downgradient groundwater wells monitor LLWMA-3. One upgradient and one downgradient well monitor the bottom of the uppermost aquifer. A complete list of groundwater monitoring wells for LLWMA-3 is presented in Table 4.10-6; the wells are shown in Figure 4.10-6. Groundwater sampling at LLWMA-3 began in 1988. A constituent list is presented in Table 4.10-2. Samples collected in the last quarter of 1989 indicated that TOX values in downgradient well 299-W7-4 exceeded the critical mean (95.5 ppb) calculated for LLWMA-3. An interim-status groundwater quality assessment plan (Chamness et al. 1990b) was prepared in response to the elevated TOX values. A groundwater quality assessment report (Mercer 1994b) determined that the cause of the elevated TOX was the extensively documented CCl_4 plume beneath the 200 West Area. As recommended in the assessment report, quarterly sampling was continued at the shallow upgradient wells through the first quarter of 1995 to reestablish background levels for the CIPs.

4.10.3.4 LLWMA-3 Groundwater Chemistry.

4.10.3.4.1 Constituents of Concern. Carbon tetrachloride and nitrate have been consistently above DWSs at LLWMA-3. These constituents are trending upward in the LLWMA-3 monitoring wells, especially in upgradient wells and the wells near burial ground 216-W-3AE (Figures 4.10-7 and 4.10-8). The elevated values can be attributed to contaminant plumes originating to the south of

LLWMA-3 (see Figure 2-10). Additional plumes have been documented in Johnson (1993) and WHC (1992b). Trichloroethene has exceeded the DWS of 5 ppb in upgradient wells 299-W10-19, 299-W10-20, and 299-W10-21. There does not appear to be any groundwater contamination directly attributable to LLWMA-3.

4.10.3.4.2 Statistical Evaluation. Following the recommendations presented in the groundwater quality assessment report (Mercer 1994b), the upgradient/downgradient comparison values for the CIPs were reestablished for LLWMA-3. On review of the data, it was decided to calculate two sets of critical means for LLWMA-3 (Tables 4.10-7 and 4.10-8). One set was calculated using 299-W9-1 and 299-W10-13 as the upgradient wells (Table 4.10-7). These critical means are used for comparison with the downgradient wells north of burial grounds 218-W-3A and 218-W-5. The second set of critical means were calculated using 299-W10-19, 299-W10-20, and 299-W10-21 as the upgradient wells (Table 4.10-8). These values are used for comparing downgradient wells north and east of burial ground 218-W-3AE. This was done because of the obvious difference in TOX values between wells affected by the CCl_4 plume and those so far unaffected by this plume (see Figure 4.10-7). There were no exceedances of CIPs in this reporting period. Statistical methods are discussed in Appendix C.

4.10.3.5 LLWMA-3 Groundwater Flow.

4.10.3.5.1 Groundwater Flow Direction. A water table map of the entire 200 West Area (Figure 4.10-9) has been constructed in an attempt to present an overall concept of the groundwater flow pattern beneath LLWMA-3. This map used water level data from June 1995. Figure 4.10-9 generally confirms the flow directions presented previously in the groundwater monitoring plan (Last et al. 1989, page 6.20). The flow direction generally is northward with a slight eastward component, which increases to the east. The eastward component is increasing as expected, resulting from the decreased disposal of liquid in this area.

Water level data from the two groundwater wells that monitor the base of the unconfined aquifer indicate that the vertical groundwater gradient in the unconfined aquifer in this area is downward. The water levels in downgradient shallow well 299-W7-2 are consistently greater than those in nearby deep well 299-W7-3 by approximately 0.3 m (1 ft). Water levels in the upgradient shallow well 299-W10-13 are generally 0.12 m (0.4 ft) greater than in deep well 299-W10-14.

4.10.3.5.2 Rate of Groundwater Flow. The rate of groundwater flow beneath LLWMA-3 can be estimated using the Darcy equation (Equation 1). Values of hydraulic conductivity (0.02 to 9.8 m/d [0.06 to 32 ft/d]) from Last et al. (1989, page 6.18), a conservative effective porosity of 0.1, and a hydraulic gradient of 0.00127 result in a groundwater velocity from 0.0002 to 0.12 m/d (0.0008 to 0.41 ft/d). An average hydraulic conductivity value of 1.5 m/d (5 ft/d) gives a groundwater velocity of 0.02 m/d (0.06 ft/d).

4.10.3.5.3 Evaluation of Monitoring Well Network. The monitoring well network for LLWMA-3 is complete and adequately monitors the burial ground. No additional wells are planned at this time.

4.10.4 Low-Level Waste Management Area 4

4.10.4.1 LLWMA-4 Facility Overview. Waste Management Area 4 covers 24.4 ha (60.3 acres) in the south-central portion of the 200 West Area (see Figure 1-1) and is currently in detection-level indicator parameter evaluation status. Burial grounds 218-W-4B and 218-W-4C make up LLWMA-4 (Figure 4.10-10). Burial ground 218-W-4B first received waste in 1968 and contains mixed and retrievable transuranic waste in trenches and 12 caissons. One caisson is believed to contain mixed waste. Waste was first deposited in burial ground 218-W-4C in 1978. Transuranic, mixed, and low-level waste has been placed in burial ground 218-W-4C. The waste includes contaminated soil, decommissioned equipment, and remote-handled transuranic waste. Several trenches in LLWMA-4 have been designed as RSUs. LLWMA-4 is within the 200-ZP-3 source operable unit and the 200-ZP-1 and 200-UP-1 groundwater operable units.

The monitoring network at LLWMA-4 has 17 wells: 6 upgradient and 11 downgradient. Table 4.10-7 lists all RCRA monitoring wells for LLWMA-4 and Figure 4.10-10 shows the well locations.

4.10.4.2 LLWMA-4 Summary of 1995 Activities. Indicator parameter evaluation monitoring continued at LLWMA-4 in 1995. Groundwater chemistry samples were collected semiannually and water levels were measured quarterly.

A CCl_4 pump-and-treat demonstration project uses several wells near LLWMA-4. Groundwater is being extracted from well 299-W18-1 and injected into well 299-W18-4 after treatment. Groundwater levels are being monitored with transducers in the extraction and injection wells and in wells 299-W18-2, 299-W18-5, and 299-W18-24. Well 299-W18-24 is an upgradient monitoring well for LLWMA-4. This project is part of the overall Hanford Site environmental remediation program. A full-scale pump-and-treat program to contain the 1000-ppb CCl_4 isopleth is being installed with extraction wells located to the east and injection wells to the west of LLWMA-4. Considerable changes in the local hydrologic flow and hydrochemical regimes are expected when this program begins operation in March of 1996.

4.10.4.3 LLWMA-4 Sampling and Analysis Program. Groundwater sampling at LLWMA-4 began in 1988 (WHC 1989b) and continued quarterly until the last quarter of 1989. The required statistical comparisons were performed and downgradient wells did not exceed the critical means established for the indicator parameters in 1995. Indicator evaluation sampling is conducted semiannually for constituents listed in Table 4.10-2.

4.10.4.4 LLWMA-4 Groundwater Chemistry.

4.10.4.4.1 Constituents of Concern. LLWMA-4 does not appear to have contributed to groundwater contamination. The samples from the downgradient wells have not exceeded the critical means established for the contamination indicator parameters. Concentrations of CCl_4 above DWSs were found in most wells in 1995; the elevated values are related to the plumes discussed in Johnson (1993) and WHC (1992b). The most likely source for the CCl_4 is the 216-Z-18 Crib and other facilities associated with Z Plant located east of LLWMA-4 (see Figure 2-10).

The TOX levels in the groundwater historically have been high beneath LLWMA-4. The high levels are related to the CCl_4 plume. The upgradient wells are generally higher than the downgradient wells. The pH values were below the DWS.

Nitrate also exceeded the DWSs in wells 299-W15-15, 299-W15-16, 299-W15-18, 299-W15-19, 299-W15-24, 299-W18-21, and 299-W18-24 this year. This is most likely related to the nitrate plume described in Johnson (1993) and WHC (1992b) (see Figure 2-9). Well 299-W18-21 has shown a continuing increase in nitrate and the values are considerably above the adjacent wells. This discrepancy is also evident in the CCl_4 results (see Figure 4.10-11). This leads to the supposition that there may be a highly localized preferential pathway to the southwest in this vicinity.

4.10.4.4.2 Statistical Evaluation. Statistical evaluations at the LLWMA-4 compared upgradient and downgradient wells for indication of contamination in the uppermost aquifer beneath the site. All values of specific conductance, pH, TOX, and TOC in the downgradient wells were below the upgradient/downgradient comparison values. Statistical methods are described in Appendix C.

Statistical analyses required by 40 CFR 265.93(b) and WAC 173-303-400 were performed on the samples collected from upgradient wells. Results are presented in Table 4.10-8. This table lists the background average, standard deviation, critical mean (or critical range, in the case of pH), and upgradient/downgradient comparison values for the CIPs. In general, the upgradient/downgradient comparison value is the value to which current and future averages of indicator parameters are compared. The comparison value is generally the critical mean or critical range. There were no exceedances in downgradient wells in 1995. Upgradient well 299-W15-16 was below the critical range for pH during the November 18, 1994, sampling event. Laboratory pH confirmed that the exceedance was caused by an error in the field measurements.

4.10.4.5 LLWMA-4 Groundwater Flow.

4.10.4.5.1 Groundwater Flow Direction. The water table map for the 200 West Area, presented in Figure 4.10-9, indicates that the original interpretation of groundwater flow direction beneath LLWMA-4 (Last et al. 1989, page 6.20) is still valid. The flow direction is primarily to the west, trending to northwest in the northern portions of LLWMA-4, and possibly slightly to the southwest in the extreme southern portions of LLWMA-4 (see Figure 4.10-9). Flow directions are expected to change radically when the CCl_4 pump-and-treat program becomes operational.

The vertical groundwater gradient in the unconfined aquifer in this area is downward based on water levels from the wells that monitor the base of the unconfined aquifer (wells 299-W15-17 and 299-W18-22). The water levels in these wells are consistently lower than the nearby wells monitoring the top of the unconfined aquifer. The differences are approximately 0.07 m (0.24 ft) between wells 299-W15-16 and 299-W15-17 and 0.13 m (0.43 ft) between wells 299-W18-21 and 299-W18-22.

4.10.4.5.2 Rate of Flow. The groundwater flow velocity calculated for LLWMA-4 is in the range of 0.002 to 0.21 m/d (0.006 to 0.69 ft/d). These values were determined using an approximate hydraulic gradient of 0.00034, effective porosity of 0.1, and values of hydraulic conductivity from 0.52 to 61 m/d (1.7 to 200 ft/d) (Last et al. 1989, pages 6.18 and 6.19). The lower velocity value uses a hydraulic conductivity from well 299-W18-22, which monitors the bottom of the uppermost aquifer. Using the average hydraulic conductivity for shallow wells (23.8 m/d [78 ft/d]) gives a groundwater velocity of 0.08 m/d (0.27 ft/d).

4.10.4.5.3 Evaluation of Monitoring Well Network. The groundwater monitoring network at LLWMA-4 continues to satisfy the requirement for at least one upgradient and three downgradient wells. No additional monitoring wells are planned for this network. Considerable changes in the groundwater flow direction caused by the pump-and-treat activities will necessitate the review of the upgradient/downgradient status of many wells in this monitoring network.

4.10.5 Low-Level Waste Management Area 5

4.10.5.1 LLWMA-5 Facility Overview. This waste management area contains future burial ground 218-W-6 and is located in the north-central portion of the 200 West Area (Figures 1-1 and 4.10-12). LLWMA-5 has not yet received any waste. This facility will consist of 35 trenches and cover approximately 18.0 ha (44.5 acres). At this time the trenches are planned to be used for mixed waste. LLWMA-5 is within the 200-ZP-3 source operable unit and the 200-ZP-1 groundwater operable unit.

4.10.5.2 LLWMA-5 Summary of 1995 Activities. The indicator parameter evaluation monitoring program for LLWMA-5 continued in 1995. Groundwater samples were collected semiannually and water level measurements were made quarterly.

4.10.5.3 LLWMA-5 Sampling and Analysis Program. Groundwater sampling for LLWMA-5 began in 1992. Table 4.10-9 lists wells in the RCRA monitoring network for LLWMA-5. Indicator parameter evaluation samples are collected semiannually for constituents listed in Table 4.10-2.

4.10.5.4 LLWMA-5 Groundwater Chemistry.

4.10.5.4.1 Constituents of Concern. No wastes have been disposed of at LLWMA-5 and there is no indication that the groundwater has been affected by this facility. The required background levels were calculated and the critical means for the indicator parameters were not exceeded by any monitoring well in the LLWMA-5 network. Carbon tetrachloride (Figure 4.10-13) and nitrate (Figure 4.10-14) exceeded the DWSs in several wells. Both constituents are associated with documented plumes in the 200 West Area (Johnson 1993 and WHC 1992b). Trichloroethylene has been reported above the 5 ppb DWS in wells 299-W6-5, 299-W6-10, and 299-W11-31.

Tritium is also present in concentrations above the DWS at monitoring wells on the eastern side of LLWMA-5 (Figure 4.10-15).

Filtered samples for chromium (299-W6-5) and manganese (299-W6-6) were above the 100 ppb and 50 ppb DWS respectively. There is no obvious source of either of these contaminants.

4.10.5.4.2 Statistical Evaluation. Statistical evaluations at the LLWMA-5 compared upgradient and downgradient wells for indications of contamination in the uppermost aquifer beneath the site. All values of specific conductance, pH, and TOC in the downgradient wells in the past year were below the upgradient/downgradient comparison values. Statistical methods are described in Appendix C.

Statistical analyses required by 40 CFR 265.93(b) and WAC 173-303-400 were performed on the samples collected from upgradient wells (see Table 4.10-9). Results are presented in Table 4.10-10. This table lists the background average, standard deviation, critical mean (or critical range, in the case of pH), and upgradient/downgradient comparison values for the contamination indicator parameters. The upgradient/downgradient comparison value is the value to which current and future averages of indicator parameters are compared. The comparison value is generally the critical mean or critical range. The limit of quantitation, rather than the critical mean, is used as the comparison value for TOC because most of the upgradient concentrations were below the contractually required quantitation limit (see Appendix C). TOX values from upgradient wells are detected above the detection limit. Therefore, four quarters of monitoring data will be needed to establish the upgradient/downgradient comparison value (see Appendix C). There were no confirmed exceedances in downgradient wells in 1995.

4.10.5.5 LLWMA-5 Groundwater Flow.

4.10.5.5.1 Groundwater Flow Direction. The water table map for the 200 West Area presented in Figure 4.10-9 gives the best representation of the conditions beneath LLWMA-5. The groundwater flow direction beneath LLWMA-5 is to the northeast.

The vertical groundwater gradient in the unconfined aquifer in this area is downward. Water levels in well 299-W6-3, which monitors the base of the unconfined aquifer, are generally 0.2 m (0.64 ft) less than water levels in well 299-W6-4. The difference in water level measurements from shallow/deep paired wells 299-W6-6 and 299-W6-7 is smaller: 0.01 m (0.04 ft).

4.10.5.5.2 Rate of Flow. The average hydraulic conductivity for shallow wells completed in 1991 and 1992 was 11.9 m/d (39 ft/d) (Mercer 1993a, 1993b). Using this estimate, the Darcy equation (Equation 1), an effective porosity of 0.1, and a hydraulic gradient of 0.0024, a groundwater flow velocity of 0.29 m/d (0.95 ft/d) was calculated.

4.10.5.5.3 Evaluation of Monitoring Well Network. The groundwater monitoring network for LLWMA-5 complies with regulatory requirements for upgradient and downgradient wells. No additional groundwater monitoring wells are planned.

4.10.6 References

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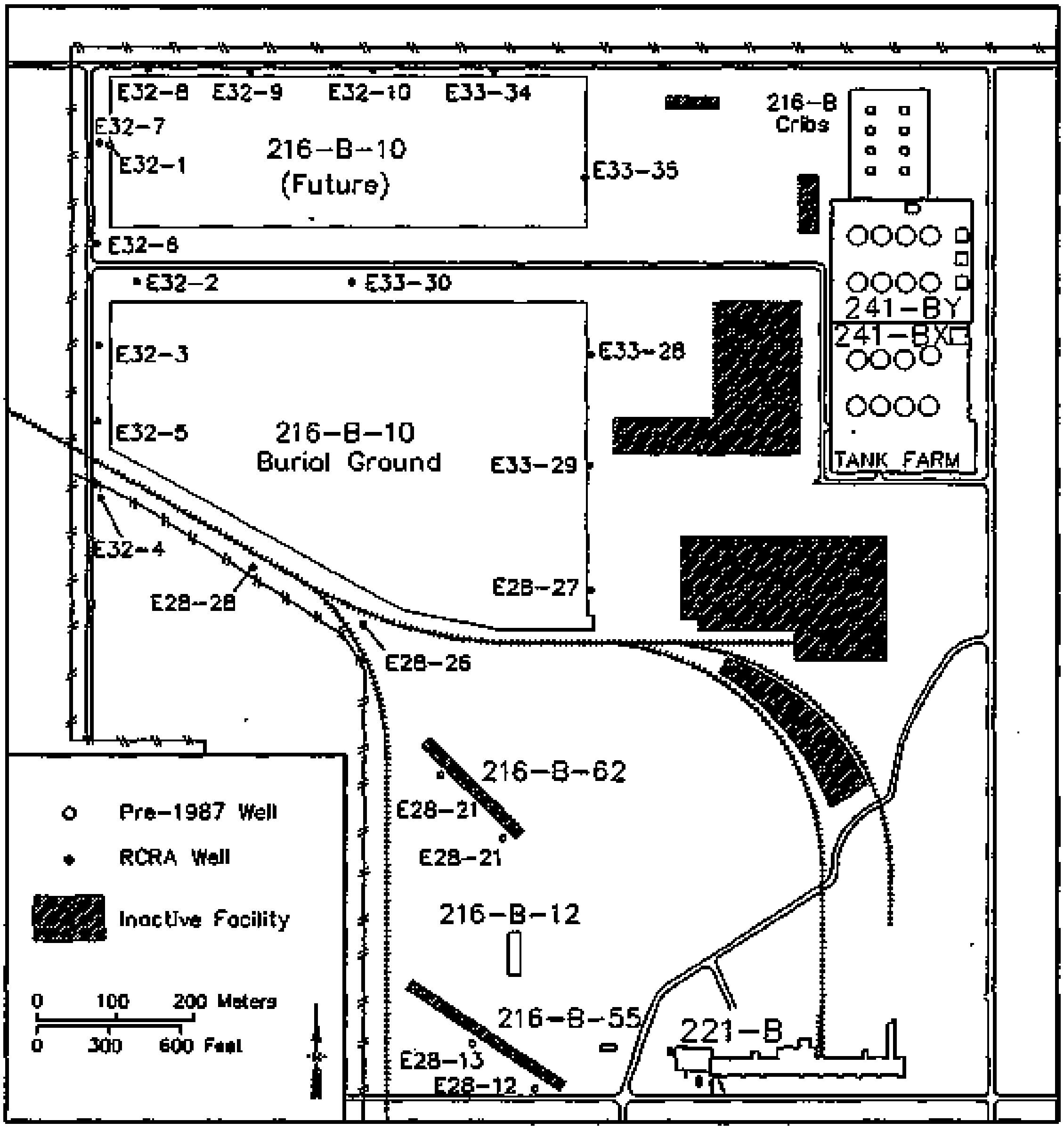
WHC, 1992a, *Hydrogeologic Model for the 200 East Groundwater Aggregate Area*, WHC-SD-EN-TI-019, Rev. 0, prepared by M. P. Connelly, B. H. Ford, J. W. Lindberg, S. J. Trent, and C. D. Delaney, Westinghouse Hanford Company, Richland, Washington, and J. V. Borghese, Pacific Northwest Laboratory for Westinghouse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

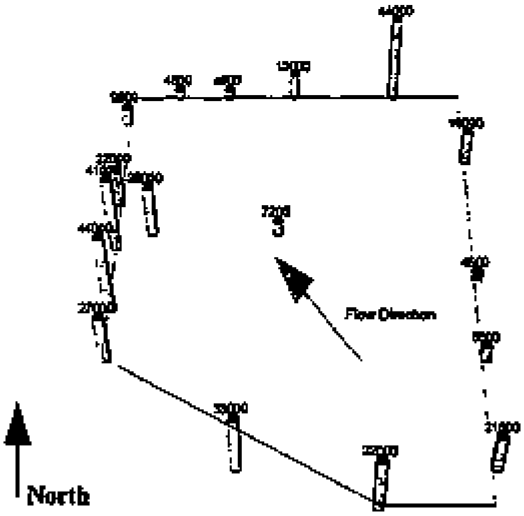
WHC, 1992b, *Hydrogeologic Model for the 200 West Groundwater Aggregate Area*, WHC-SD-EN-TI-014, Rev. 0, prepared by M. P. Connelly and B. H. Ford, Westinghouse Hanford Company, Richland, Washington, and J. V. Borghese, Pacific Northwest Laboratory for Westinghouse Hanford Company, Richland, Washington.

Figure 4.10-1. Low-Level Waste Management Area 1.

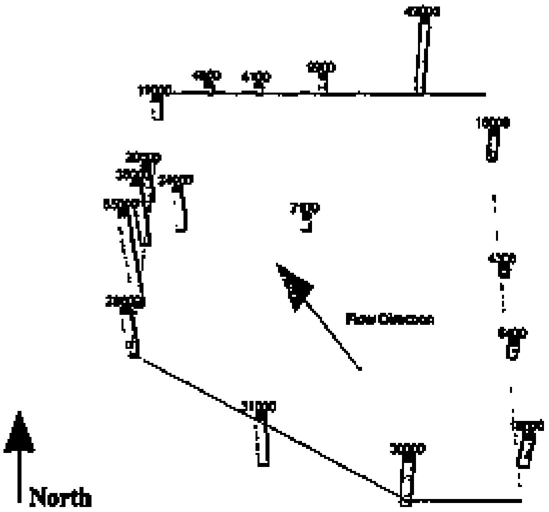


rbm\llwma1.dwg

Figure 4.10-2. Nitrate at Low-Level Waste Management Area 1.

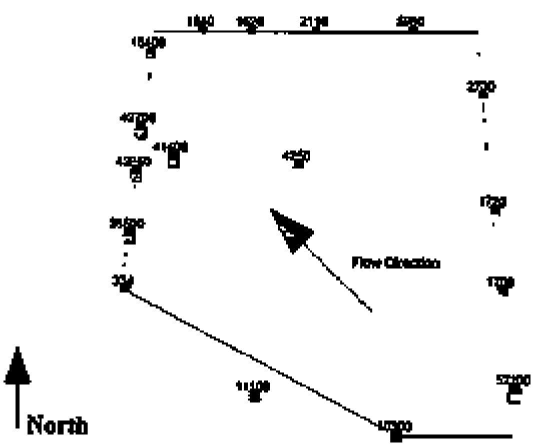


LLWMA-1
Nitrate (ppb)
2nd Quarter 1994

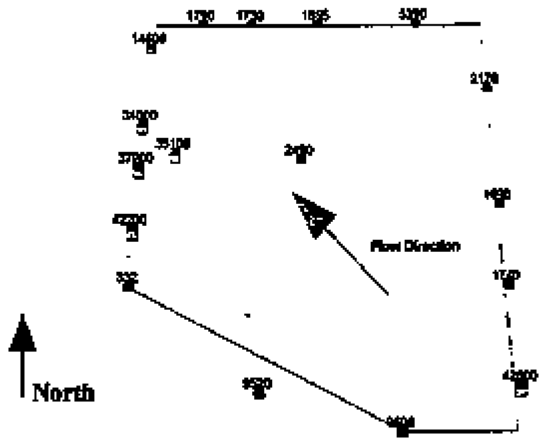


LLWMA-1
Nitrate (ppb)
2nd Quarter 1995

Figure 4.10-3. Tritium at Low-Level Waste Management Area 1.

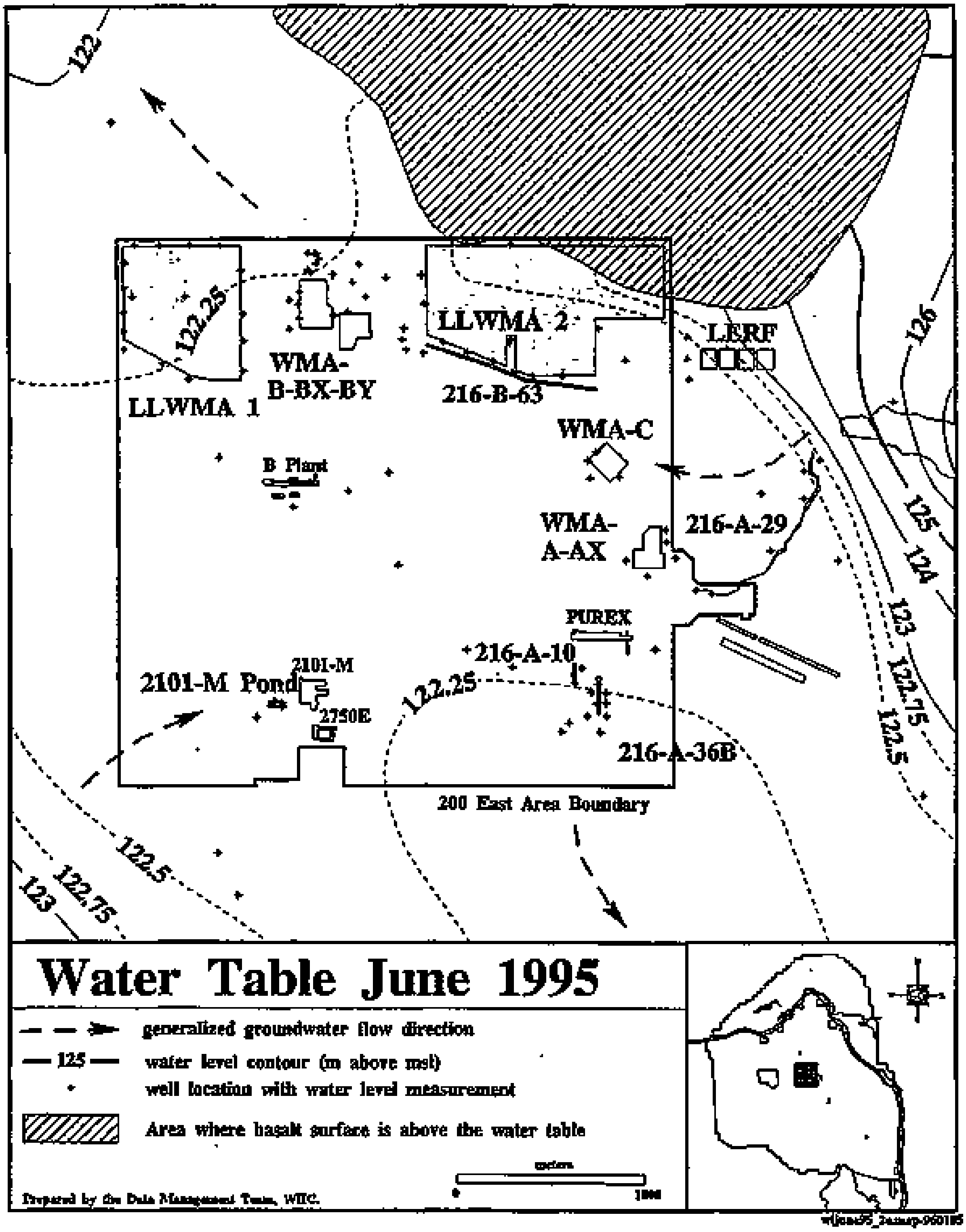


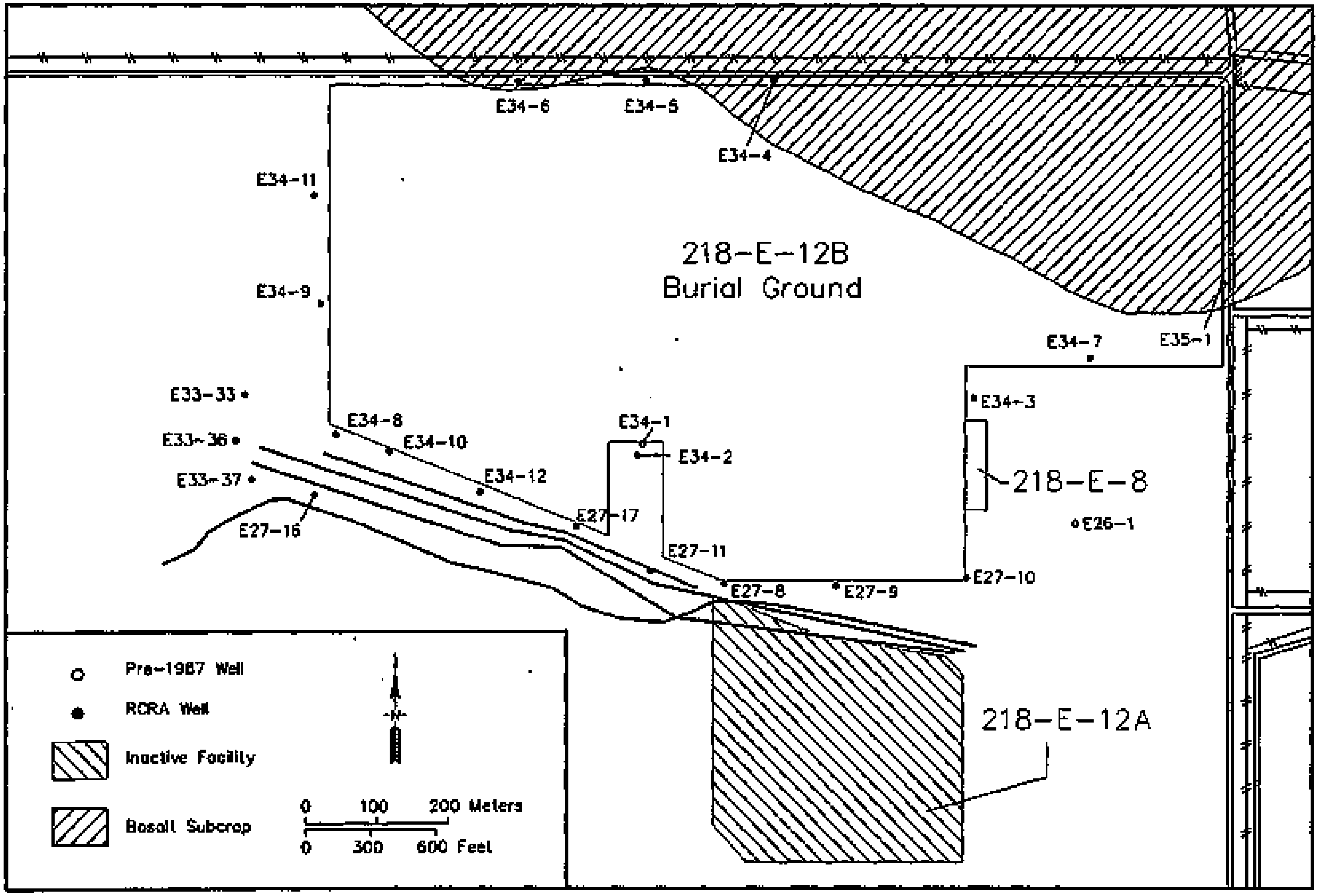
LLWMA-1
Tritium (pCi/l)
2nd Quarter 1994



LLWMA-1
Tritium (pCi/l)
2nd Quarter
1995

Figure 4.10-4. Water Table Contour Map for the 200 East Area, June 1995.





rbm\llwma2.dwg

Figure 4.10-5. Low-Level Waste Management Area 2.

Figure 4.10-6. Low-Level Waste Management Area 3.

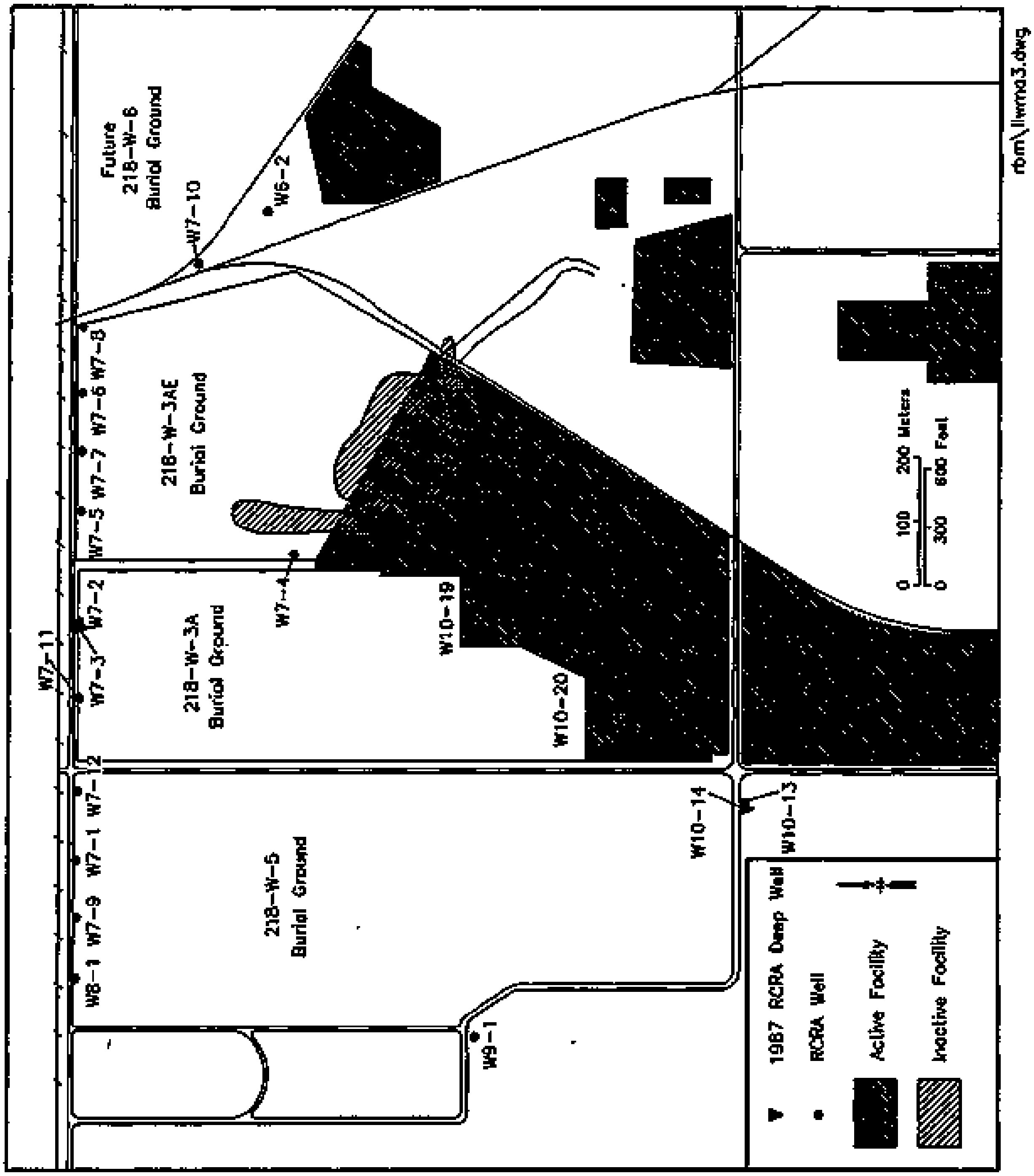
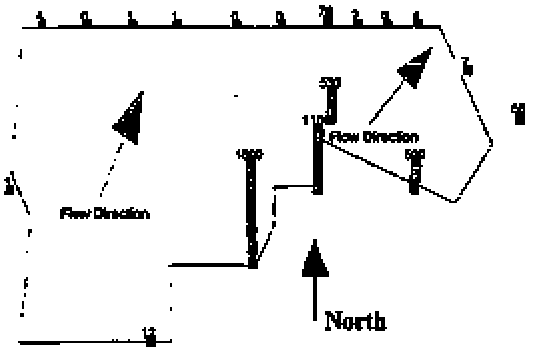
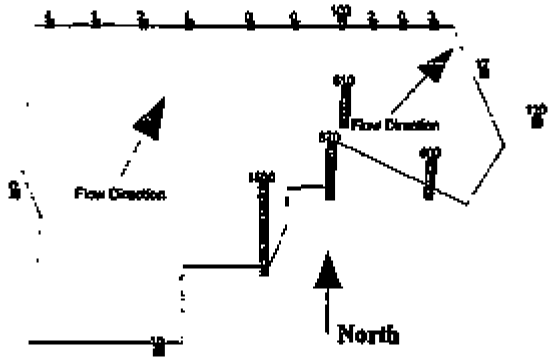


Figure 4.10-7. Carbon Tetrachloride at Low-Level Waste Management Area 3.



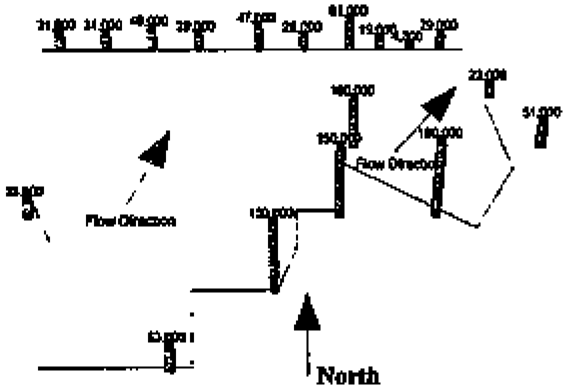
LLWMA-3
Carbon Tetrachloride (ppb)
3rd Quarter 1994



LLWMA-3
Carbon Tetrachloride (ppb)
3rd Quarter 1995

Figure 4.10-8. Nitrate at Low-Level Waste Management Area 3.

LLWMA-3
Nitrate (ppb)
3rd Quarter 1994



LLWMA-3
Nitrate (ppb)
3rd Quarter 1995

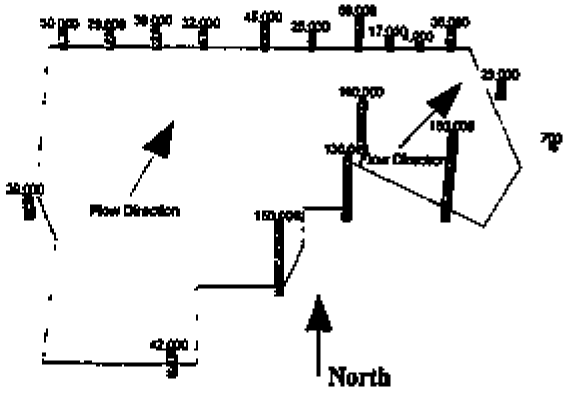


Figure 4.10-9. Water Table Contour Map for the 200 West Area, June 1995.

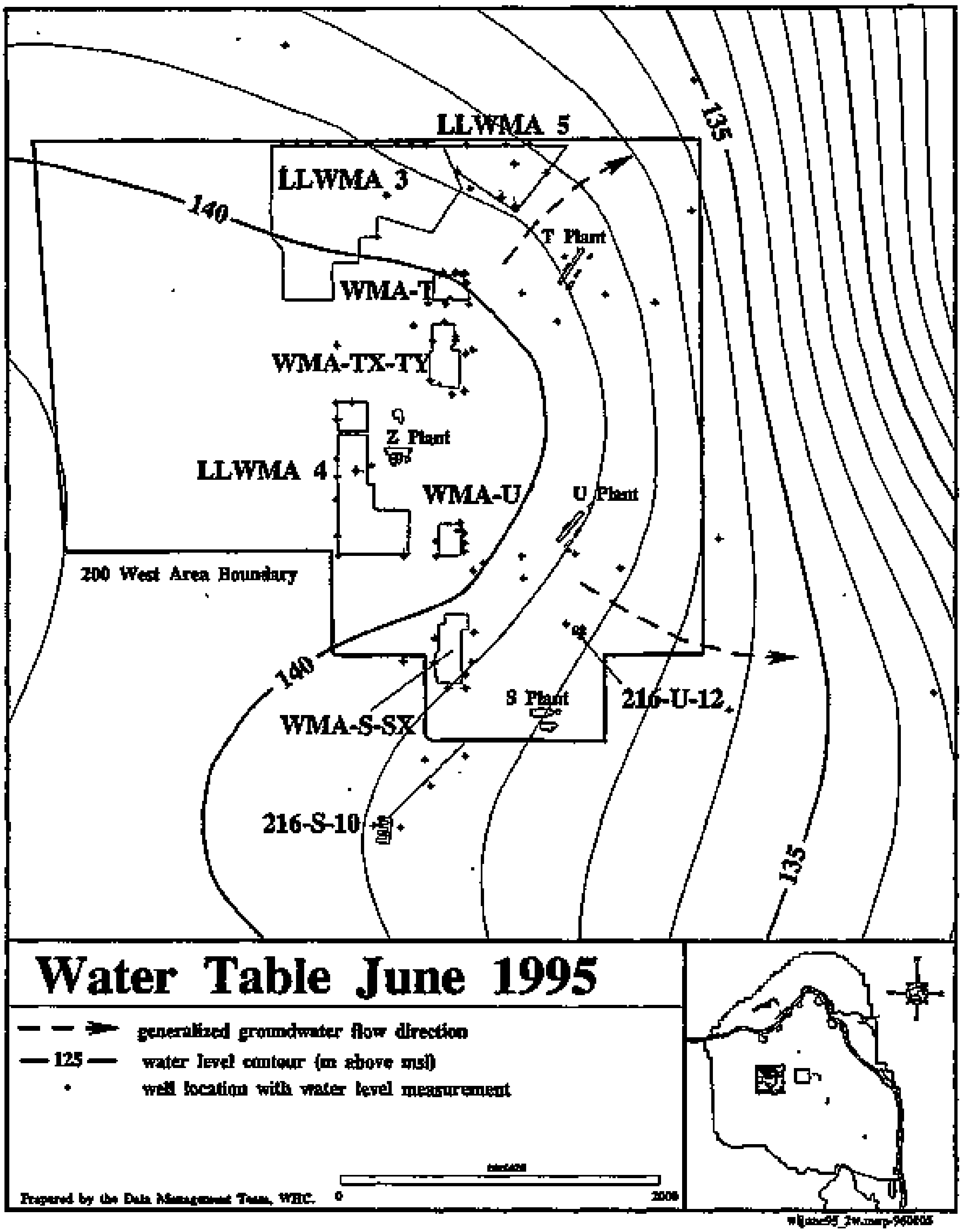
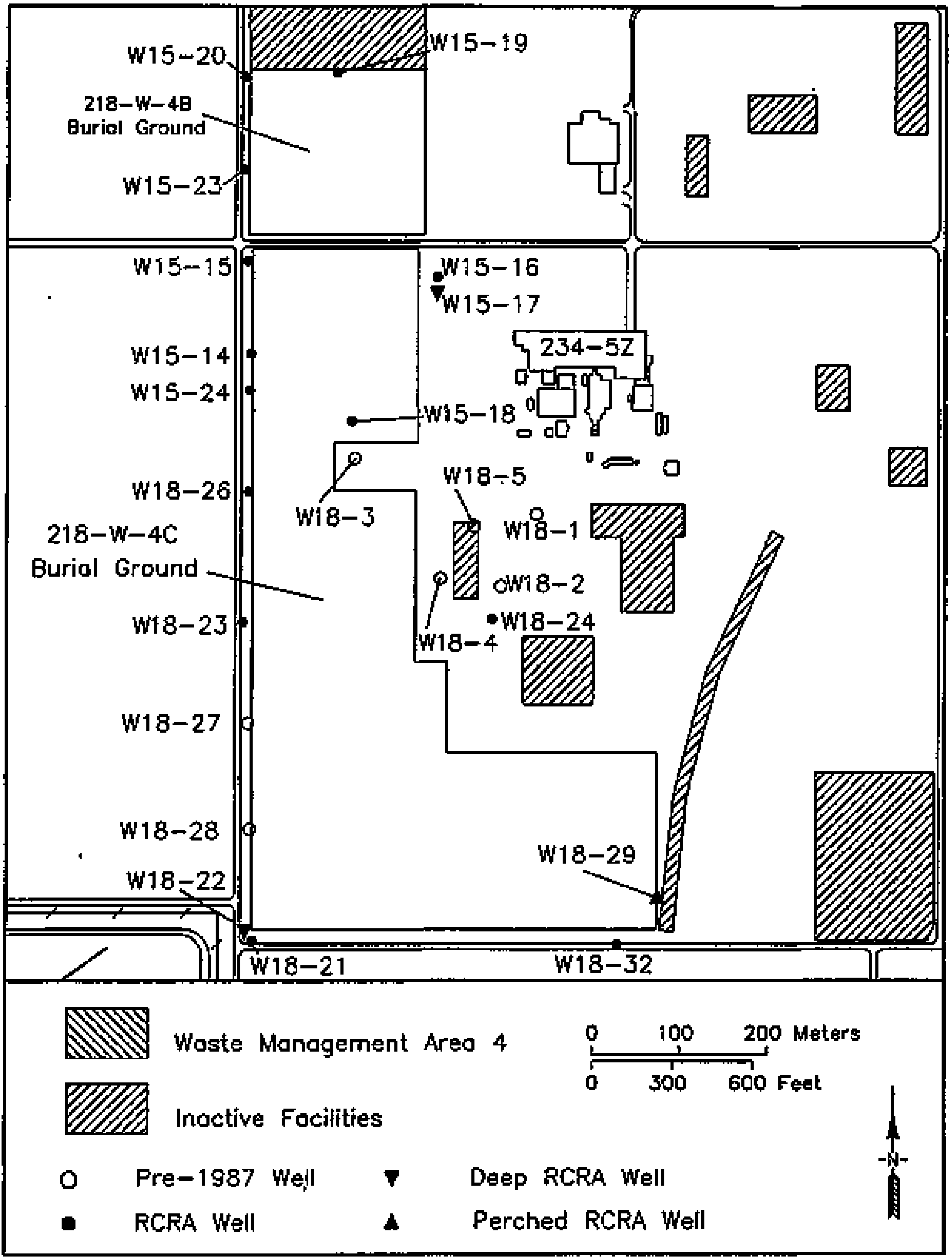


Figure 4.10-10. Low-Level Waste Management Area 4.



rbm\llwma4.dwg

Figure 4.10-11. Nitrate and Carbon Tetrachloride at 299-W18-21.

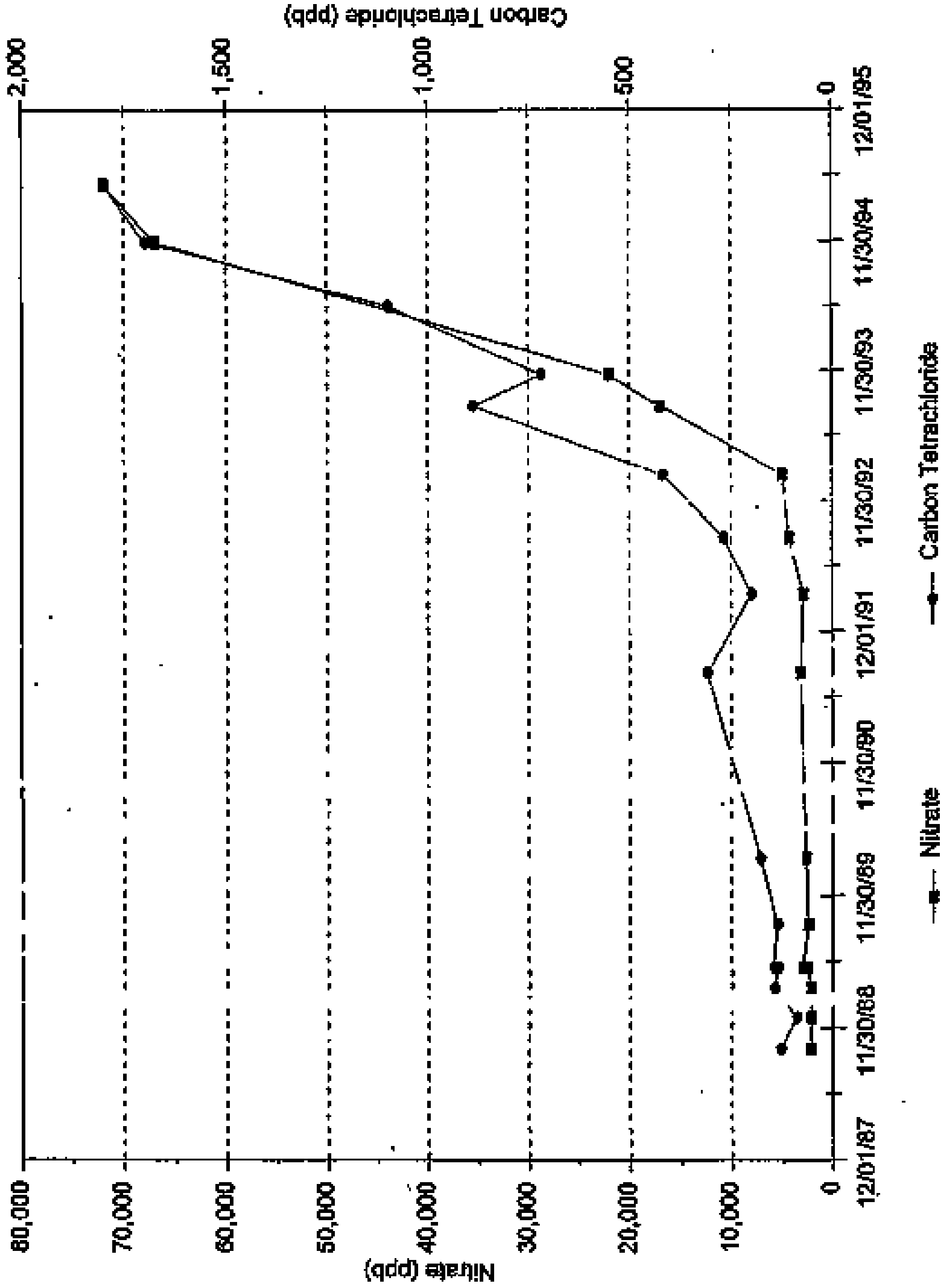
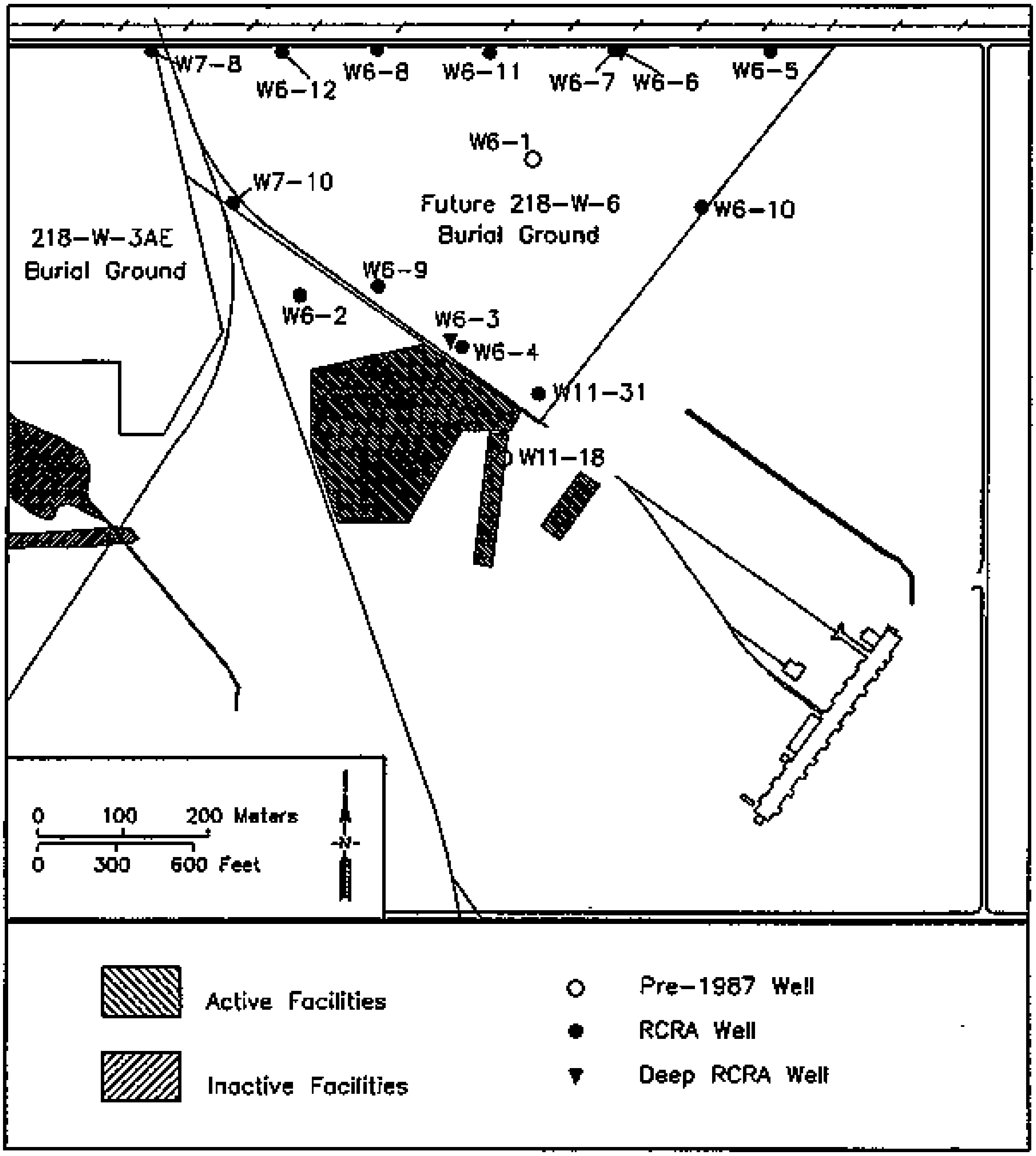


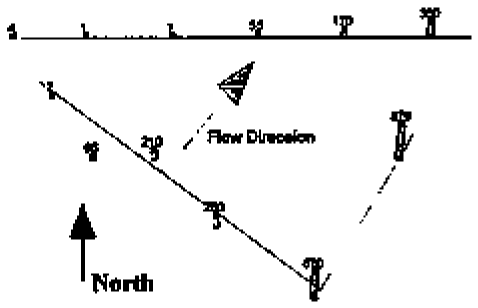
Figure 4.10-12. Low-Level Waste Management Area 5.



rbm\llwma5.dwg

Figure 4.10-13. Carbon Tetrachloride at Low-Level Waste Management Area 5.

LLWMA-5
Carbon Tetrachloride (ppb)
3rd Quarter 1994



LLWMA-5
Carbon Tetrachloride (ppb)
3rd Quarter 1995

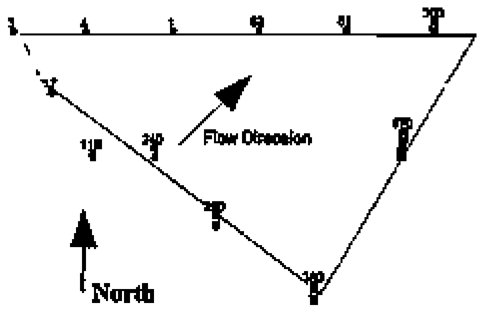
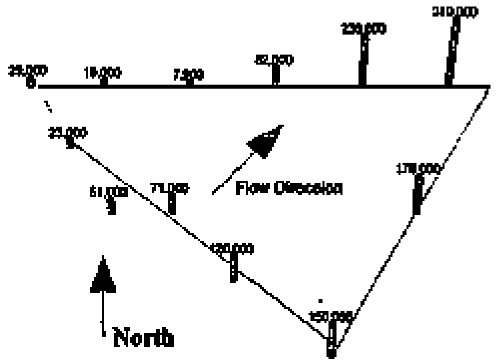


Figure 4.10-14. Nitrate at Low-Level Waste Management Area 5.

LLWMA-5
Nitrate (ppb)
3rd Quarter 1994



LLWMA-5
Nitrate (ppb)
3rd Quarter 1995

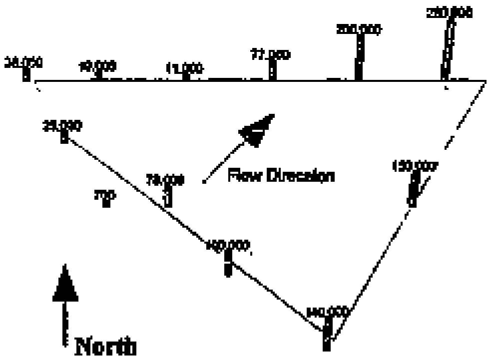
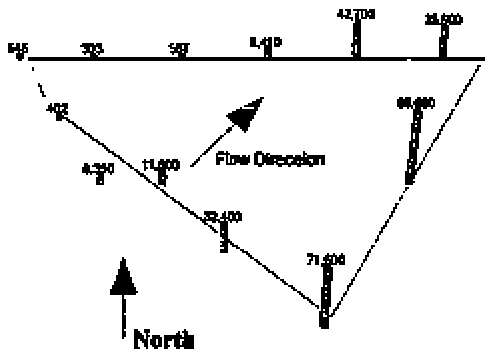


Figure 4.10-15. Tritium at Low-Level Waste Management Area 5.

LLWMA-5
Tritium (pCi/l)
3rd Quarter 1994



LLWMA-5
Tritium (pCi/l)
3rd Quarter 1995

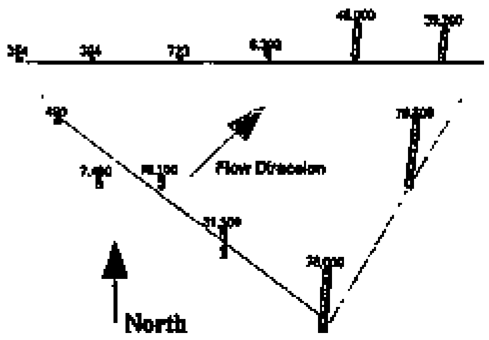


Table 4.10-1. Low-Level Waste Management Area 1 Monitoring Network.

Well	Aquifer	Sampling frequency	Water levels	Well standards	Other networks
299-E28-26^{87}	Top of unconfined	SA	Q	RCRA	--
299-E28-27^{87}	Top of unconfined	SA	Q	RCRA	--
299-E28-28^{90}	Top of unconfined	SA	Q	RCRA	--
299-E32-2^{87}	Top of unconfined	SA	Q	RCRA	200-BP-1
299-E32-3^{87}	Top of unconfined	SA	Q	RCRA	--
299-E32-4^{87}	Top of unconfined	SA	Q	RCRA	B Pond
299-E32-5^{89}	Top of unconfined	SA	Q	RCRA	--
299-E32-6^{91}	Top of unconfined	SA	Q	RCRA	--
299-E32-7^{91}	Top of unconfined	SA	Q	RCRA	--
299-E32-8^{91}	Top of unconfined	SA	Q	RCRA	--
299-E32-9^{91}	Top of unconfined	SA	Q	RCRA	--
299-E32-10^{92}	Top of unconfined	SA	Q	RCRA	--
299-E33-28^{87}	Top of unconfined	SA	Q	RCRA	200-BP-1
299-E33-29^{87}	Top of unconfined	SA	Q	RCRA	200-BP-1
299-E33-30^{87}	Top of unconfined	SA	Q	RCRA	200-BP-1
299-E33-34^{90}	Top of unconfined	SA	Q	RCRA	200-BP-1
299-E33-35^{90}	Top of unconfined	SA	Q	RCRA	200-BP-1

Notes: Shading denotes upgradient wells. Superscript following well number denotes the year of installation.

Q = frequency on a quarterly basis.
SA = frequency on a semiannual basis.
RCRA = well is in compliance with RCRA standards.

Table 4.10-2. Constituents Analyzed at the Low-Level Burial Ground.

Contamination indicator parameters		
pH	Total organic carbon	
Specific conductance	Total organic halogen	
Groundwater quality parameters		
Chloride	Manganese	Sodium
Iron	Phenols	Sulfate
Drinking water parameters		
2,4-D	Endrin	Methoxychlor
2,4,5-TP Silvex	Fluoride	Nitrate
Arsenic	Gross alpha	Radium
Barium	Gross beta	Selenium
Cadmium	Lead	Silver
Chromium	Lindane	Toxaphene
Coliform bacteria	Mercury	
Site-specific parameters for the Low-Level Burial Grounds		
1,1,2,2-tetrachloroethane	Carbon tetrachloride	Tetrachloroethylene
1,2 dichloroethane	Chlorobenzene	Toluene
1,2 dichloropropane	cis-1,1 dichloroethylene	trans-1,1 dichloroethylene
Acetonitrile	Copper	Trichloroethylene
Benzene	Cyanide	Uranium
Beryllium	Ethylbenzene	Vinyl chloride
Bromoform	Naphthalene	Xylene

Table 4.10-3. Critical Means Table for 68 Comparison--Background Contamination Indicator Parameter Data for Low-Level Waste Management Area 1.[a,b]

Constituent (Unit)	n	df	tc	Average background	Standard deviation	Critical mean	Upgradient/ downgradient comparison value
Specific Conductance (µmho/cm)	26[*]	25	4.2027	373.721	74.637	693.4	693.4
Field pH	27	26	4.4409	7.896	0.330	[6.40, 9.39]	[6.40, 9.39]
TOC[c] (ppb)	26	25	4.2027	500	N.C.	N.C.	976
TOX[d] (ppb)	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	13.6

[a] Data collected from July 1992 to April 1993 for upgradient wells 299-E28-26, 299-E28-27, 299-E28-28, 299-E33-28, 299-E33-29, and from July 1992 to January 1993 for 299-E33-35, and from September 1991 to July 1992 for 299-E32-4. Critical means calculated based on 68 comparisons.

[b] The following notations are used in this table:
df= degrees of freedom (n-1).
n = number of background replicate averages.
t_c = Bonferroni critical t-value for appropriate df and 68 comparisons.

[c] Critical mean cannot be calculated because an estimate of background standard deviation is lacking. The upgradient/downgradient comparison value for TOC is the limit of quantitation (see Appendix A).

[d] Critical mean cannot be calculated because of problems associated with data quality for samples analyzed by DCL. The upgradient/downgradient comparison value for TOX is the limit of quantitation (see Appendix A).

[*] Excluding outlier (collected on 7/2/92 from well 299-E33-28).

N. C. = not calculated.

Table 4.10-4. Low-Level Waste Management Area 2 Monitoring Network.

Well	Aquifer	Sampling frequency	Water levels	Well standards	Other networks
299-E27-8^{87}	Top of unconfined	SA	Q	RCRA	B-63 Trench
299-E27-9^{87}	Top of unconfined	SA	Q	RCRA	B-63 Trench
299-E27-10^{90}	Top of unconfined	SA	Q	RCRA	--
299-E27-11^{89}	Top of unconfined	SA	Q	RCRA	B-63 Trench
299-E27-17^{91}	Top of unconfined	SA	Q	RCRA	B-63 Trench
299-E34-2^{87}	Top of unconfined	SA	Q	RCRA	200-BP-1
299-E34-3^{87}	Top of unconfined	SA	Q	RCRA	--
299-E34-4^{87}	Top of unconfined	--	Dry	RCRA	--
299-E34-5^{87}	Top of unconfined	SA	Q	RCRA	200-BP-1
299-E34-6^{87}	Top of unconfined	--	Dry	RCRA	--
299-E34-7^{89}	Top of unconfined	SA	Q	RCRA	--
299-E34-9^{91}	Top of unconfined	SA	Q	RCRA	--
299-E34-10^{91}	Top of unconfined	SA	Q	RCRA	B-63 Trench
299-E34-11^{92}	Top of unconfined	SA	Q	RCRA	--
299-E34-12^{92}	Top of unconfined	SA	Q	RCRA	--
299-E35-1^{89}	Top of unconfined	--	Dry	RCRA	--

Notes: Shading denotes upgradient wells. Superscript following well number denotes the year of installation.

Q = frequency on a quarterly basis.
SA = frequency on a semiannual basis.
RCRA = well is in compliance with RCRA standards.

Table 4.10-5. Critical Means Table for 52 Comparisons--Background Contamination Indicator Parameter Data for Low-Level Waste Management Area 2.[a,b]

Constituent (Unit)	n	df	tc	Average background	Standard deviation	Critical mean	Upgradient/ downgradient comparison value
Specific Conductance (μmho/cm)	12	11	5.0293	385.875	116.987	998.3	998.3
Field pH	12	11	5.4790	8.077	0.174	[7.08, 9.07]	[7.08, 9.07]
TOC[c] (ppb)	12	11	5.0293	445.833	94.648	941.3	976
TOX[d] (ppb)	12	11	5.0293	4.833	2.861	19.8	19.8

[a] Data collected from September 1988 to July 1989 for upgradient wells 299-E27-10 and 299-E34-5. Critical means calculated based on 52 comparisons.

[b] The following notations are used in this table:

df = degrees of freedom (n-1).

n = number of background replicate averages.

t_c = Bonferroni critical t-value for appropriate df and 52 comparisons.

[c] Critical mean was calculated from values reported below CRDL. The upgradient/downgradient comparison value for TOC is the limit of quantitation (see Appendix A).

[d] Critical mean was calculated using data analyzed by U.S. Testing, Inc. of Richland.

N. C. = not calculated.

Table 4.10-6. Low-Level Waste Management Area 3 Monitoring Network.

Well	Aquifer	Sampling frequency	Water levels	Well standards	Other networks
299-W6-2^{87}	Top of unconfined	SA	Q	RCRA	LLWMA-5
299-W7-1^{87}	Top of unconfined	SA	Q	RCRA	--
299-W7-2^{87}	Top of unconfined	SA	Q	RCRA	--
299-W7-3^{87}	Deep unconfined	SA	Q	RCRA	--
299-W7-4^{87}	Top of unconfined	SA	Q	RCRA	--
299-W7-5^{87}	Top of unconfined	SA	Q	RCRA	--
299-W7-6^{87}	Top of unconfined	SA	Q	RCRA	--
299-W7-7^{89}	Top of unconfined	SA	Q	RCRA	--
299-W7-8^{89}	Top of unconfined	SA	Q	RCRA	--
299-W7-9^{90}	Top of unconfined	SA	Q	RCRA	--
299-W7-10^{90}	Top of unconfined	SA	Q	RCRA	LLWMA-5
299-W7-11^{91}	Top of unconfined	SA	Q	RCRA	--
299-W7-12^{91}	Top of unconfined	SA	Q	RCRA	--
299-W8-1^{87}	Top of unconfined	SA	Q	RCRA	--
299-W9-1^{87}	Top of unconfined	Q	Q	RCRA	--
299-W10-13^{87}	Top of unconfined	Q	Q	RCRA	--
299-W10-14^{87}	Deep unconfined	SA	Q	RCRA	--
299-W10-19^{92}	Top of unconfined	Q	Q	RCRA	--
299-W10-20^{93}	Top of unconfined	Q	Q	RCRA	--
299-W10-21^{93}	Top of unconfined	Q	Q	RCRA	--

Notes: Shading denotes upgradient wells. Superscript following well number denotes the year of installation.

LLWMA = Low-Level Waste Management Area.
Q = frequency on a quarterly basis through the 1st quarter of 1995 then semiannually.
SA = frequency on a semiannual basis.
RCRA = well is in compliance with RCRA standards.

Table 4.10-7. Critical Means Table for 32 Comparisons--Background Contamination Indicator Parameter Data for Low-Level Waste Management Area 3.[a,b]

Constituent (Unit)	n	df	tc	Average background	Standard deviation	Critical mean	Upgradient/ downgradient comparison value
Specific Conductance (μmho/cm)	12	11	4.7248	439.812	26.865	579.1	579.1
Field pH	12	11	5.1621	8.120	0.294	[6.54, 9.70]	[6.54, 9.70]
TOC[c] (ppb)	10	9	5.1241	195.75	42.296	423.1	976
TOX (ppb)	9	8	5.4284	8.731	7.183	49.8	49.8

[a] Data collected from February 1994 to March 1995 for upgradient wells 299-W10-13 and 299-W9-1. Critical means calculated based on 32 comparisons for area of the LLWMA-3 not impacted by upgradient source of contamination.

[b] The following notations are used in this table:

df = degrees of freedom (n-1).

n = number of background replicate averages.

t_c = Bonferroni critical t-value for appropriate df and 32 comparisons.

[c] Critical mean was calculated from values reported below CRDL. The upgradient/downgradient comparison value for TOC is the limit of quantitation (see Appendix A).

N. C. = not calculated.

Table 4.10-8. Critical Means Table for 40 Comparisons--Background Contamination Indicator Parameter Data for Low-Level Waste Management Area 3.[a,b]

Constituent (Unit)	n	df	tc	Average background	Standard deviation	Critical mean	Upgradient/ downgradient comparison value
Specific Conductance (μmho/cm)	17	16	4.3467	580.941	32.230	725.1	725.1
Field pH	17	16	4.6820	7.838	0.3867	[5.97, 9.70]	[5.97, 9.70]
TOC[c] (ppb)	15	14	4.4995	367.833	107.483	867.3	976
TOX (ppb)	14	13	4.5978	797.923	319.605	2,319.0	2.319.0

[a] Data collected from February 1994 to March 1995 for upgradient wells 299-W10-19, 299-W10-20, and 299-W10-21. Critical means calculated based on 40 comparisons for area of the LLWMA-3 impacted by upgradient source of contamination.

[b] The following notations are used in this table:

df = degrees of freedom (n-1).
n = number of background replicate averages.
t_c = Bonferroni critical t-value for appropriate df and 40 comparisons.

[c] Critical mean was calculated from values reported below CRDL. The upgradient/downgradient comparison value for TOC is the limit of quantitation (see Appendix A).

N. C. = not calculated.

Table 4.10-9. Low-Level Waste Management Area 4 Monitoring Network.

Well	Aquifer	Sampling frequency	Water levels	Well standards	Other networks
299-W15-15^{87}	Top of unconfined	SA	Q	RCRA	--
299-W15-16^{87}	Top of unconfined	SA	Q	RCRA	--
299-W15-17^{87}	Deep unconfined	SA	Q	RCRA	--
299-W15-18^{87}	Top of unconfined	SA	Q	RCRA	--
299-W15-19^{89}	Top of unconfined	SA	Q	RCRA	--
299-W15-20^{89}	Top of unconfined	SA	Q	RCRA	--
299-W15-23^{90}	Top of unconfined	SA	Q	RCRA	--
299-W15-24^{89}	Top of unconfined	SA	Q	RCRA	--
299-W18-21^{87}	Top of unconfined	SA	Q	RCRA	--
299-W18-22^{87}	Deep unconfined	SA	Q	RCRA	--
299-W18-23^{87}	Top of unconfined	SA	Q	RCRA	--
299-W18-24^{87}	Top of unconfined	SA	Q	RCRA	--
299-W18-26^{89}	Top of unconfined	SA	Q	RCRA	--
299-W18-27^{91}	Top of unconfined	SA	Q	RCRA	--
299-W18-28^{91}	Top of unconfined	SA	Q	RCRA	--
299-W18-29^{91}	Perched zone	SA	Q	RCRA	--
299-W18-32^{92}	Top of unconfined	SA	Q	RCRA	--

Notes: Shading denotes upgradient wells. Superscript following well number denotes the year of installation.

Q = frequency on a quarterly basis.
SA = frequency on a semiannual basis.
RCRA = well is in compliance with RCRA standards.

Table 4.10-10. Critical Means Table for 56 Comparisons--Background Contamination Indicator Parameter Data for Low-Level Waste Management Area 4.[a,b]

Constituent (Unit)	n	df	tc	Average background	Standard deviation	Critical mean	Upgradient/ downgradient comparison value
Specific Conductance (μmho/cm)	16	15	4.586	328.594	133.345	958.9	958.9
Field pH	16	15	4.938	7.779	0.261	[6.45, 9.11]	[6.45, 9.11]
TOC[c] (ppb)	15	14	4.676	470.0	142.428	1,157.8	1,157.8
TOX[c] (ppb)	11	10	5.2814	2,029.796	2,002.864	13,078	13,078

[a] Data collected from October 1988 to July 1989 for upgradient wells 299-W15-16, 299-W15-18, and 299-W18-24 and from October 1992 to August 1993 for the newly installed upgradient well 299-W18-32. Critical means calculated based on 56 comparisons.

[b] The following notations are used in this table:
df= degrees of freedom (n-1).
n= number of background replicate averages.
t_c = Bonferroni critical t-value for appropriate df and 56 comparisons.

[c] Critical mean was calculated using data analyzed by U.S. Testing, Inc. of Richland.

[d] Upgradient/downgradient comparison value for TOC is the limit of quantitation (see Appendix A).

N. C. = not calculated.

Table 4.10-11. Low-Level Waste Management Area 5 Monitoring Network.

Well	Aquifer	Sampling frequency	Water levels	Well standards	Other networks
299-W6-2^{87}	Top of unconfined	SA	Q	RCRA	LLWMA-3
299-W6-3^{91}	Deep unconfined	SA	Q	RCRA	--
299-W6-4^{91}	Top of unconfined	SA	Q	RCRA	--
299-W6-5^{91}	Top of unconfined	SA	Q	RCRA	--
299-W6-6^{91}	Deep unconfined	SA	Q	RCRA	--
299-W6-7^{91}	Top of unconfined	SA	Q	RCRA	--
299-W6-8^{91}	Top of unconfined	SA	Q	RCRA	--
299-W6-9^{92}	Top of unconfined	SA	Q	RCRA	--
299-W6-10^{92}	Top of unconfined	SA	Q	RCRA	--
299-W6-11^{92}	Top of unconfined	SA	Q	RCRA	--
299-W6-12^{92}	Top of unconfined	SA	Q	RCRA	--
299-W7-10^{90}	Top of unconfined	SA	Q	RCRA	LLWMA-3
299-W11-31^{92}	Top of unconfined	SA	Q	RCRA	--

Notes: Shading denotes upgradient wells. Superscript following well number denotes the year of installation.

LLWMA = Low-Level Waste Management Area.
Q = frequency on a quarterly basis.
RCRA = well is in compliance with RCRA standards.
SA = frequency on a semiannual basis.

Table 4.10-12. Critical Means Table for 44 Comparisons--Background Contamination Indicator Parameter Data for Low-Level Waste Management Area 5.[a,b]

Constituent (Unit)	n	df	tc	Average background	Standard deviation	Critical mean	Upgradient/ downgradient comparison value
Specific Conductance (μmho/cm)	24	23	4.086	519.562	167.372	1,217.6	1,217.6
Field pH	24	23	4.364	7.920	0.225	[6.92, 8.92]	[6.92, 8.92]
TOC (ppb)	18	17	4.330	480.6	49.67	701.6	976[c]
TOX[d] (ppb)	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.

[a] Data collected from December 1992 to September 1993 for upgradient wells 299-W6-9, 299-W6-10, and 299-W11-31 and from May 1992 to May 1993 for well 299-W6-2 and from September 1992 to June 1993 for well 299-W6-4 and from August 1992 to May 1993 for well 299-W7-10. Critical means calculated based on 44 comparisons.

[b] The following notations are used in this table:
df = degrees of freedom (n-1).
n = number of background replicate averages.
t_c = Bonferroni critical t-value for appropriate df and 44 comparisons.

[c] Upgradient/downgradient comparison value for TOC is the limit of quantitation (see Appendix A).

[d] Critical mean cannot be calculated because of problems associated with data quality for samples analyzed by DCL. TOX values from upgradient wells have been detected above the method detection limit (see Appendix C).

N. C. = not calculated.

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4.11 SINGLE-SHELL TANKS

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4.11.1 Introduction

Although decommissioned in 1980, the single-shell tanks (SST) are storing hazardous and radioactive waste and have been designated as *Resource Conservation and Recovery Act of 1976* (RCRA) facilities. The groundwater beneath the SSTs is monitored by an interim-status RCRA groundwater monitoring network that was initiated in 1989 (Jensen et al. 1989). The SST monitoring network contains 35 RCRA-standard groundwater monitoring wells. No wells were constructed this year. Three other wells monitor the top of the unconfined aquifer and comply with construction standards in *Washington Administrative Code* (WAC) 173-160. These wells are located around Waste Management Area (WMA) B-BX-BY and can be used for collecting groundwater samples for analysis of hazardous and radioactive constituents. All SST waste management areas now comply with the RCRA requirement to have at least one upgradient and three downgradient wells. An additional 30 wells are used to measure water levels. Most of these wells are older carbon steel wells, but some are RCRA-standard wells constructed for other projects. Table 4.11-1 lists the wells in the SST monitoring network.

Final disposition of SSTs and their contained waste is discussed in a closure/corrective action work plan submitted to the Washington State Department of Ecology (Ecology) in 1989 (DOE-RL 1989). Revision 1 of this closure plan was submitted to Ecology in June 1995. Chapter 5.0 of the original closure plan on groundwater and groundwater monitoring (DOE-RL 1989) has been revised and is Appendix 2A of Revision A DOE-RL (1995). Appendix 2A also covers vadose zone characteristics and processes. The SSTs are included in the following six source operable units.

Waste Management Area	Source Operable Unit	Groundwater Operable Unit
A-AX	200-PO-3[a]	200-PO-1
C	200-PO-3[a]	200-BP-5
B-BX-BY	200-BP-7	200-BP-5
S-SX	200-RO-4[a]	200-UP-1
T	200-TP-3	200-ZP-1
TX-TY	200-TP-5	200-ZP-1
U	200-UP-3	200-UP-1

[a] Includes one or more adjoining double-shell tank farms.

Although each SST farm (or groups of adjoining farms) is in a CERCLA operable unit, the SSTs will be closed as RCRA TSD units. The radioactive component of the waste is regulated under the *Atomic Energy Act of 1954*. DOE is responsible for administration and compliance. The hazardous component is regulated under the *Washington Hazardous Waste Management Act of 1976*. Ecology regulates the SSTs as RCRA treatment, storage, and disposal (TSD) units under WAC 173-303. RCRA/CERCLA conflicts are addressed as they are discovered. Groundwater beneath the SST farms is part of groundwater operable units (previously listed) that are being remediated under CERCLA. Further discussion of the regulatory process related to final disposition of the SSTs can be found in Chapter 3 of DOE-RL (1995).

4.11.1.1 Facility Overview. The 149 SSTs are located in 7 WMAs containing one or more tank farms. Three WMAs are located in the 200 East Area (A-AX, B-BX-BY, and C). Four are located in the 200 West Area (S-SX, T, TX-TY, and U) (Figures 1-1, 4.11-1, and 4.11-2). Each tank farm contains from 4 (AX Tank Farm) to 18 (TX Tank Farm) underground reinforced concrete tanks. Each tank has a single liner of carbon steel. The larger tanks have diameters of 22.86 m (75 ft), have varying heights, and are buried at least 1.8 m (6 ft) below the ground surface. Depending on their dimensions, these tanks hold between 1,892,500 and 3,785,000 L (530,000 and 1,000,000 gal). They were constructed between 1943 and 1964. Tank farms B, C, T, and U contain four 200-series tanks each. These tanks hold 208,175 L (55,000 gal).

The SSTs actively store metal and first- and second-cycle radioactive and hazardous (i.e., mixed) waste received from chemical processing facilities in the 200 Areas of the Hanford Site. Types of waste added to the SSTs and their general composition are discussed in Anderson (1990). The waste in the SSTs was generated by chemical processing of spent fuel rods from several reactors located in the 100 Areas of the Hanford Site, using the tributyl phosphate, bismuth phosphate, Reduction-Oxidation, or Plutonium-Uranium Extraction (PUREX) process. Isotopes for various weapons systems were recovered in these processes and subsequently refined to weapons-grade materials.

The SSTs received mixtures of organic and inorganic liquids containing radionuclides, solvents, and metals that were originally discharged to the tanks as alkaline slurries. Waste management operations have mixed waste streams from numerous processes and batches that were generated while processing spent fuel rods. This mixing and subsequent chemical reactions and radionuclide degradation and decay make the specific contents of each tank difficult to determine. The radionuclide and chemical inventory of the SSTs was summarized in a Westinghouse Hanford Company (WHC) report (WHC 1993). Historical operations at the tank farms are summarized in Anderson (1990).

The last SST was removed from active service in 1980. Because discharges to the SSTs stopped in 1980, some of the tanks have been interim stabilized by removing the supernate and interstitial liquids to minimize the potential for leaks. As of July 1995, 111 SSTs have been interim stabilized. Some tanks were interim isolated by removing piping to prevent the inadvertent addition of liquids to the tanks. (See Hanlon [1995] for details.)

Presently, the SSTs cumulatively store about 140,045,000 L (37 Mgal) of waste that consists mostly of salt cake and sludge (the residue from pumping free liquids to the double-shell tanks). The waste also contains small quantities of supernate and interstitial liquids that could not be removed by pumping. The waste is largely inorganic and consists primarily of sodium hydroxide and sodium salts of nitrate, nitrite, carbonate, aluminate, and phosphate. Some hydrous oxides of iron and manganese also are present.

Fission-product radionuclides (such as ^{137}Cs, ^{90}Sr, ^{99}Tc) and actinide elements (such as uranium, thorium, plutonium, and neptunium) are the principal radioactive components of the waste. Some of the SSTs are "Watch List Tanks" because they contain ferrocyanide or organic salts, they could possibly release hydrogen, or they generate high heat from the radioactive decay of their contents. (See Hanlon [1995] for details.)

The SST liners are made of carbon steel that was not treated during fabrication to relieve stress. Consequently, heat-induced stress-corrosion cracks have developed along with other stress-caused changes from fluctuating liquid levels and temperatures in the tanks. These changes have caused some of the steel liners to fail and liquids to escape from some of the tanks. Of the 149 SSTs, 67 are assumed to be leaking (Hanlon 1995). The largest known leaks occurred at Tank 241-T-106 in 1973 (estimated at 435,275 L [115,000 gal]) and Tank 241-BX-102 in 1971 (estimated at 264,950 L [70,000 gal]). Most leaks are estimated to be considerably smaller.

Water was added to some tanks (e.g., Tank 241-A-105) to control temperatures, which prevents degradation of the reinforced concrete. Some of this water also may have leaked from the tanks. The earliest leaks at the SSTs were detected in the late 1950's. The most recent change to the list of assumed leakers was made in February 1994 when Tank 241-T-111 was declared an assumed releaker because measurements showed a trend of in-tank liquid levels decreasing. The 241-T-111 Tank was initially declared to be of questionable integrity in 1974. No changes were made to the list of assumed leakers in 1995.

Whether any contaminants in the groundwater in the Separations Areas were derived from the waste leaked from the SSTs or whether they were from nearby unlined waste disposal facilities such as cribs, trenches, or ponds that received liquid wastes containing similar constituents is uncertain. Analyses of gross gamma logs from dry wells adjacent to Tank 241-T-106 indicate that the leaked waste appeared to stabilize in the vadose zone well above the groundwater (Routson et al. 1979). The maximum detected depth of the 1-pCi/L concentration of ^{106}Ru (following the T-106 leak) was 28.8 m (95 ft) above the regional water table, while the depth to groundwater beneath the tanks exceeds 30.3 m (100 ft). Modeling studies using ^{106}Ru (Smoot et al. 1989) suggest that some of the leaked waste from Tank 241-T-106 may have reached groundwater. In 1993, a borehole (299-W10-196) was drilled through the waste plume leaked from this tank and, at least in this borehole, the waste is still contained in the vadose zone at least 21 m (70 ft) above the present water table (Freeman-Pollard et al. 1994, Caggiano and Anderson 1994).

Liquid observations wells (LOW) and liquid-monitoring devices are used in the tanks to detect changing liquid levels. A series of vertical wells in the unsaturated zone (dry wells) around the periphery of each tank augment this monitoring system. Two of the tank farms (A and SX) each have a series of three lateral lines beneath each tank extending from a 3.6-m- (12-ft-) diameter caison. The lines have been periodically monitored by gross gamma probes to detect radioactive decay counts elevated above baseline and to observe any changes in the detected peaks.

Spectral gamma logging in the dry wells and laterals around SSTs using high-purity germanium iodide sources is now being performed by RUST Geotech under contract to the U.S. Department of Energy, Richland Operations Office (RL). Spectral gamma logging replaced gross gamma surveillance logging in 1995. The plan is to log each dry well around each tank in each tank farm. Logging has been completed in the 241-SX Tank Farm and is under way in the 241-U Tank Farm. These first logging runs will form a baseline against which future logs will be compared to detect changes from decay and/or transport. Characterizing the waste in the vadose zone and determining its mobility are significant because this uncontained waste could infiltrate to groundwater. A partial list of documents released to date about spectral gamma logging of SST farms is included in the reference list.

In late 1993, new methods for detecting leaks at the SSTs were implemented in accordance with a new leak-detection strategy that was issued in July 1994 (WHC 1994). Gross gamma logging in external dry wells is no longer used to detect leaks at SSTs, although logging will continue temporarily until LOWs have been installed in all 149 SSTs. Currently 61 tanks have LOWs; additional wells are being installed each year in tanks containing pumpable liquids. Logging in the LOWs and measuring liquid levels in the tanks using Food Instrument Corporation equipment or manual tapes will be the primary methods of leak detection. It should be noted that technology is not available to detect the minimum leak from an SST under RCRA regulations (currently 2 kg or 7.5 L [2 gals]) and that WHC is implementing best available technology in an effort to comply with the RCRA requirement.

Stratigraphy beneath tank farms in the 200 Areas is generally summarized in Chapter 2.0. More detail about the stratigraphy beneath the 200 Areas are included in Section 4.1 of the 1993 annual report (Ford and Trent in DOE-RL 1994), which also contains figures showing numerous cross sections through the 200 Areas. Details of stratigraphy beneath each WMA are included in the groundwater monitoring plan for the SSTs (Jensen et al. 1989, Caggiano and Goodwin 1991). In general, network groundwater monitoring wells in the 200 East Area are screened in the Hanford formation (WMA B-BX-BY) or the Ringold Formation (WMAs A-AX and C). Wells in all WMAs in the 200 West Area are screened in the Ringold Formation (mostly in the Ringold unit E gravels, most of which previously were designated as the Middle Ringold).

4.11.1.2 Summary of 1995 Activities. All of the existing RCRA wells were sampled quarterly or semiannually in 1995. Wells in WMAs T and TX-TY were sampled quarterly because they are in assessment monitoring status. All other WMAs were sampled in March and September. The data from all well sampling are reported in quarterly reports (Caggiano 1995b, 1995c, 1995d, 1996). Water levels were measured monthly in all the RCRA-standard wells and in 19 older non-RCRA wells. Water level measurements are also included in the quarterly reports.

Wells near WMAs T and TX-TY were evaluated for incorporation into an expanded network for groundwater quality assessment monitoring. Several RCRA-standard groundwater monitoring wells for low-level burial ground (LLBG) WMAs 3 and 5 were incorporated into the expanded network. Site-specific radionuclides were added to the constituent list for these wells in an effort to determine the potential source of elevated field specific conductance, which triggered these two WMAs into assessment monitoring. WHC is currently preparing an assessment report on WMAs T and TX-TY.

Measurements of water level in an expanded network of wells at WMA U confirmed that the direction of groundwater flow beneath this facility has changed (see WMA U hydrograph on Figure 4.11-3). The original groundwater monitoring network was planned and installed beginning in 1989 when groundwater flow was to the northeast. The northeast direction of groundwater flow was in response to the 200 West Area water table mound that originated beneath the 216-U-10 Pond in the southwestern part of the 200 West Area. Since decommissioning of that facility in 1984, the apex of the water table mound has declined and moved eastward in response to the addition of liquid effluent to other facilities (e.g., the 216-U-14 Ditch). Even though the highest point in the 200 West Area water table is north of WMA U (Figure 4.11-4), the apex of a local water table mound is now located southeast of WMA U resulting in groundwater flow shifting to a northwestern direction. The configuration of the water table is expected to change because liquid discharges to the soil column ceased in June 1995.

A north-northwest direction of groundwater flow beneath WMA U was confirmed in May 1995 when the borehole velocity flowmeter was run in wells 299-W19-31 and 299-W19-32. The flowmeter was set at three different levels within the screen of each well and measurements of flow direction and groundwater flow velocity were made. Each of these wells is screened in unit E of the Ringold Formation. Data obtained during the flowmeter testing are presented in Table 4.11-2. Note that a different direction of groundwater flow was measured in well 299-W18-25. The efficiency of the groundwater monitoring network at WMA U (determined by MEMO [Jackson et al. 1991]) is now 24.8% for a north-northwestern direction of flow. The borehole velocity flowmeter will be run in WMA U wells periodically for the next year. This monitoring will ascertain whether this groundwater flow direction is permanent and help determine whether and where to construct a new well.

4.11.1.3 Other Activities in 1995. A RCRA-standard well (299-W10-22) was constructed north of WMA T in 1994 as part of a groundwater impact assessment for the 216-T-4-2 ditch. A groundwater impact assessment report (Alexander et al. 1995) on this facility was released in February 1995 and includes data on groundwater quality from this well located a few hundred feet north of WMA T.

Spectral gamma logging of vadose zone borings (dry wells) around the SSTs is now being performed by RUST Geotech under direct contract with DOE. Logging is proceeding by tank farm (RUST 1995). A report for the 241-SX tank farm is in preparation. Individual tank data reports have been prepared.

During 1995, the Environmental Restoration Contractor (ERC) conducted pump-and-treat operations in a number of wells for operable units 200-BP-5 (northern 200 East area), 200-UP-1 (southern 200 West area) and 200-ZP-1 (northern 200 West area). Groundwater was extracted from some wells, passed through an above-ground treatment system, and then returned to the aquifer via injection wells. The feasibility of pump-and-treat systems was tested for both the 216-B-5 reverse well and the 216-BY cribs in operable unit 200-BP-5 (DOE 1995e). These facilities are located south and north of WMA B-BX-BY. To date no effects of these withdrawal and reinjection systems were observed on water levels or hydrochemistry in wells in WMA B-BX-BY.

4.11.2 Sampling and Analysis Program

Groundwater beneath the SSTs is being monitored by a RCRA interim-status groundwater monitoring well network as specified in the original groundwater monitoring plan (Jensen et al. 1989) and its revision (Caggiano and Goodwin 1991). Background values for indicator parameters have been established at each WMA. However, because groundwater flow has changed direction beneath WMA U, background values were recalculated for this site. Wells 299-W19-31 and 299-W19-32, which were installed as downgradient wells, are now upgradient of this facility. Indicator parameter evaluation monitoring is occurring at all WMAs except WMAs T and TX-TY, which are in assessment monitoring.

4.11.2.1 Monitoring Well Network. Thirty-eight RCRA-standard wells monitor the SSTs; 3 of these wells are part of other monitoring networks surrounding WMA B-BX-BY (see Table 4.11-1). An additional 19 older carbon steel wells have been used to measure water levels. Older carbon steel wells within the perimeter fences of the tank farms have been removed from the water level monitoring network. Groundwater monitoring wells are shown in Figures 4.11-5 and 4.11-6 and are listed in Table 4.11-1. All RCRA-standard wells are located outside the perimeter fences of the tank farms and at least 30.3 m (100 ft) from the nearest tank (in accordance with an agreement with Ecology). This agreement was reached to avoid drilling through contaminants in the unsaturated zone and driving them to groundwater during well construction. As a further precaution, cable tool drilling is initiated with 30.5-cm- (12-in.-) or larger-diameter casing so that any string of casing can be terminated in a zone of contamination (or perched water) and the well drilling can be continued with smaller diameter casing inside (if drilling is continued after an evaluation of field data). The first 12 RCRA groundwater monitoring wells were installed in 1989 at WMAs A-AX, B-BX-BY, C, and T. Eleven more were installed in 1990 at WMAs A-AX, B-BX-BY, S-SX, TX-TY, and U. Ten additional wells were constructed at the SSTs in 1991 at WMAs B-BX-BY, S-SX, T, TX-TY, and U. Two were constructed in 1992 at WMAs A-AX and S-SX.

Fifty-one wells constructed of carbon steel casing before 1986 penetrate the uppermost unconfined aquifer within 300 m (1,000 ft) of the SSTs. The casing in these wells is perforated at various lengths and intervals to communicate with the unconfined aquifer. When constructed, these wells generally lacked annular or surface seals and do not have nonreactive screens and filter packs surrounding the screens as required by WAC 173-160 for newly constructed monitoring (resource protection) wells. Partial annular seals were installed in some of these wells in the 1970's. Some of these wells have been used to measure water levels around the SSTs (see Table 4.11-1).

4.11.2.2 Sampling and Analysis. Groundwater sampling began in February 1990 in wells that were completed in 1989 and in some existing wells, but this activity was terminated in May 1990 because a contract was not in place for a supporting analytical laboratory. Quarterly sampling of wells in WMAs A-AX, B-BX-BY, C, and T was resumed in July 1991. Wells in WMAs S-SX, TX-TY, and U were first sampled in October 1991. Analytical data have been reported in quarterly reports listed in Section 1.1. Four quarters of background data have been obtained at all WMAs; however, background for TOX for WMA U is being recalculated because of the change in groundwater flow direction. Groundwater is now sampled semiannually at WMAs A-AX, B-BX-BY, C, S-SX, and U and analyzed for indicator parameters. Annual sampling for analysis of groundwater quality and site-specific parameters has occurred at these five WMAs also. Quarterly sampling is conducted at WMAs T and TX-TY because these sites are in groundwater quality assessment monitoring under interim status.

Groundwater samples from SST monitoring wells were analyzed for drinking water standards (DWS), indicator parameters, and water quality parameters (Table 4.11-3) during the period of background monitoring. Samples also were analyzed for ^{137}Cs, ^{90}Sr, ^{99}Tc, ^{60}Co, and tritium because these were among the key radionuclides discharged to the SSTs. Samples are analyzed for ^{129}I semiannually as a part of another program and the data are included for the SSTs. Total uranium and plutonium also were monitored. Gamma scans were run on samples from SST wells. All SST WMAs except T and TX-TY are now in indicator-parameter evaluation status and are sampled semiannually for indicator parameters and annually for selected groundwater-quality parameters and site-specific parameters (as shown on Table 4.11-3). Only filtered samples are now analyzed for metals. Site-specific constituents are analyzed only in samples from WMAs T and TX-TY.

4.11.3 Groundwater Chemistry Evaluation

4.11.3.1 Possible Sources. In addition to indicator parameters, certain other constituents identified in Table 4.11-3 were monitored during indicator-parameter evaluation in 1995. Because these constituents were also discharged to nearby cribs, unlined specific-retention trenches, unlined ditches, French drains, and ponds (some of which are upgradient of SST tank farms), distinguishing the source of these contaminants in groundwater is not possible. No unique indicator analytes are known that would allow tracing of contaminants directly to the SSTs as a source. If a leak from any SST had reached groundwater (investigations of tank leaks indicate leaks are confined to the vadose zone well above groundwater), the analytes discharged to nearby cribs would overwhelmingly mask any contribution from the leaking tank. During operations, supernatant from the last tank in a cascade line was discharged to nearby cribs at times to make space for additional discharges to the SSTs. Some of this discharged supernatant may have infiltrated to groundwater.

4.11.3.2 Elevated Constituents. A number of constituents have exceeded regulatory limits in RCRA groundwater monitoring wells at SST WMAs. These exceedances are summarized in Table 4.11-4. Beginning in 1995, only filtered samples were analyzed for ICP metals and only exceedances of filtered metals appear in Table 4.11-4.

Turbidity in samples often exceeds the WAC standard of 1 nephelometric turbidity unit (NTU) for surface water, but is not included in this table. However, in previous analyses, turbidity appears to affect results for metals at about 30 NTU. Therefore, sample collection targets a turbidity of 5 NTU and no sample is collected if turbidity of the groundwater exceeds 20 NTU. All SST WMAs in the 200 East Area are located above a plume of ^{129}I that has been mapped in groundwater (Connelly et al. 1992a, DOE 1995). Most values for ^{129}I in groundwater from 200 East Area SST wells are between 1 and 10 pCi/L (see Table 4.11-4 and Figure 2.8).

Chromium in filtered analyses of groundwater in well 299-E24-19 at WM A-AX has been erratic (Figure 4.11-7). This constituent exhibited a steady rise to 1,800 ppb in November 1992, declined to 280 ppb in March 1993, and then rose again to 960 ppb in June 1993. Results for filtered chromium in 1994 declined to less than the 100-ppb DWS before rising again to 410 ppb in 1995. Results for filtered analyses of nickel and manganese have shown similar trends, but the concentrations have been lower. No other constituents appear to exhibit this trend and there has been no significant change in pH or specific conductance to accompany this change. This is the only downgradient well at WMA A-AX exhibiting this trend. No new leaks or spills of dangerous waste have been reported in either the 241-A or 241-AX tank farm that might account for this phenomenon.

Groundwater contaminant plumes beneath the 200 Areas have been mapped (Ford 1993, Johnson 1993). Contaminants in groundwater include constituents discharged to SSTs. These constituents were also discharged to unlined cribs, ditches, French drains, and ponds at lower activity levels. No unique indicator contaminants are known that trace solely to the SSTs as a source. Therefore, it is not possible to state unequivocally that the SSTs have not contaminated groundwater. A similar point was made by Caggiano (1991b) regarding the fate of cooling water added to Tank 241-A-105 between 1971 and 1978. Routson et al. (1979) demonstrated that the contaminants that leaked from Tank 241-T-106, the largest known tank leak at the Hanford Site, did not reach the water table and had stabilized in the vadose zone. A single borehole drilled in 1993 through the plume of waste leaked from Tank 241-T-106 indicated that the waste that leaked in 1973 still appears to be confined to the vadose zone (Freeman-Pollard et al. 1994). Whether contaminants leaked from any of the SSTs have penetrated the entire vadose zone to reach groundwater is unknown, supernatant was pumped from the last tank in a cascade line of SSTs to cribs during earlier operations at the Hanford Site. Whether the SSTs have contributed to contamination of groundwater at the Hanford Site remains equivocal.

As stated in Section 4.11.1, field specific conductance in downgradient well 299-W10-15 at WMA T and wells 299-W10-17 and 299-W14-12 at WMA TX-TY exceeded the critical mean for this parameter and triggered these sites into groundwater quality assessment monitoring under 40 CFR 265. Field specific conductance in these wells has historically been high during RCRA sampling and continues to be elevated. Quarterly sampling during assessment monitoring was used along with historical groundwater monitoring and waste management data to identify nitrate and chloride as the causative constituents. Large volumes of these constituents were discharged to nearby cribs, trenches, and ponds, with significantly elevated nitrate in several older wells surrounding these facilities in the mid-1950's. With crib-derived nitrate (and probably also chloride) in groundwater before any SSTs were reported leaking, determining whether leaking SSTs may have contributed to degradation of groundwater quality is not possible. Elevated specific conductance is areally widespread in groundwater in the northern part of the 200 West Area. (See Johnson 1993, Figure 5-37.)

4.11.3.3 Analyte Trends. For most constituents in most wells, analyte concentration and activity during RCRA sampling/analyses have shown no apparent trend. Some exceptions are discussed in the following:

- **WMA A-AX**. Tritium activity has been declining since 1991 in well 299-E25-40 at WMA A-AX. This upgradient well is downgradient of the 216-A-8 and 216-A-24 cribs, which received substantial quantities of PUREX liquid effluent. A similar decline in tritium over a longer time is seen in upgradient well 299-E25-2 (Figure 4.11-8).

- **WMA B-BX-BY**. Nitrate and chloride have been steadily increasing in downgradient well 299-E33-32 at WMA B-BX-BY and may have been causing a corresponding increase in specific conductance, which is approaching (but not exceeding) the critical mean. These anions have more than doubled in concentration since the onset of monitoring in this well in 1992. However, the concentration of chloride also has been increasing in upgradient well 299-E33-33. This appears to have caused a rise of specific conductance by about 60 μmhos/cm since 1992. Well 299-E33-33 was used to calculate the background critical mean for indicator parameters for this site. The quality of groundwater in both the upgradient and one downgradient well is changing with time, reflecting dilution by a westward-extending lobe of "fresh" water from B Pond.

- **WMA C**. Gross beta and ^{99}Tc activities have declined steadily since 1991 in upgradient well 299-E27-14 at WMA C. Conversely, these two constituents have risen steadily since 1991 in downgradient well 299-E27-13. While the changes have been enough to make these trends apparent, the DWS has not been exceeded or even approached.

- **WMA S-SX**. Gross beta, ^{99}Tc, and nitrate have declined significantly since 1993 in downgradient well 299-W23-15 at WMA S-SX. Technitium-99 and gross beta have been slowly increasing since 1992 in well 2-W22-39. Tritium in wells 299-W23-14 and 299-W23-15 has been declining steadily since 1992, but is still above the DWS of 20,000 pCi/L. Tritium has been increasing in well 299-W22-46 since 1993, but is still below the DWS. Tritium began a slow increase in late 1994, which has continued into 1995, moving from less than 1,000 pCi/L to about 1,600 pCi/L.

- **WMA TX-TY**. Field specific conductance has been slowly declining in downgradient well 299-W10-17 (WMA TX-TY) since 1991 and is approaching the critical mean calculated in 1992. Along with elevated specific conductance in well 299-W14-12, specific conductance in this well triggered WMA TX-TY into groundwater quality assessment monitoring in 1993. Field specific conductance in upgradient well 299-W15-22 has been slowly increasing since 1992 and now averages about 600 μmhos/cm. Filtered sodium began increasing in downgradient well 299-W14-12 in late 1994 and continues into 1995. Sodium values have increased from about 25,000 ppb in 1994 to 31,000 in 1995. Technitium-99 and gross beta increased in downgradient well 299-W10-18 in 1994 and 1995. Tritium is increasing in upgradient well 299-W15-22, but decreasing in downgradient well 299-W10-18.

- **WMA U**. The change in groundwater flow direction beneath WMA U has caused some changes in the concentration/activity of some analytes.

Gross alpha and uranium have increased noticeably in well 299-W19-32. Chloride, which rose steadily from 12,000 ppb in 1991 to 30,000 ppb in 1994, appears to have stabilized at about 28,000 ppb in 1995. Nitrate in well 299-W19-32 declined steadily in 1994 from about 18,000 ppb to about 2,000 ppb and appears to have stabilized at lower concentrations. Nitrate has steadily increased in wells 299-W18-25 and 299-W18-31 since 1993 and began increasing in well 299-W18-30 in 1994 (Figure 4.11-6). In 1995, gross beta and ^{99}Tc have also declined in well 299-W19-32 from peaks in 1993 (60 pCi/L and 300 pCi/L ^{99}Tc, respectively) to values of less than 50 pCi/L in 1994 and stabilized at these levels in 1995. These trends appear to be continuing. These changes are an expected consequence of groundwater contamination emanating from cribs upgradient of WMA U where wastes generated from uranium recovery operations in the 221-U Plant (Uranium Oxide Plant) were discharged to ground.

Pre-RCRA Historical Data. A general decrease in the concentration and activity of analytes can be seen in data when comparing results from analyses performed in the 1950's, 1960's, and 1970's with those performed during RCRA sampling/analyses. However, the analysis methods and detection limits have changed as have the wells that were sampled. The construction of the older carbon steel wells and the section of the unconfined aquifer sampled differ significantly from RCRA wells. Older wells have perforated carbon steel casing ranging in length from 6 to 30+ m (20 to 100+ ft), have no annular seal or filter pack, have experienced varying degrees of development, and may have been sampled by varying types of pumps or bailers during their history. The data are not directly comparable.

Contaminants listed as elevated in Table 4.11-4 generally have been elevated to varying degrees in nearby older carbon steel wells at varying times during the well's sampling history. Few wells have been consistently sampled throughout their lifetimes; many were sampled while the facility that the well was monitoring operated, but long intervals with no sample data available are common. One that was regularly sampled is well 299-W15-4, which is located adjacent to the 216-T-19 crib and tile field and received 455,000,000 L (120,211,000 gal) of process condensate, second-cycle SST supernatant and steam condensate from processing plants and an evaporator. The 216-T-19 crib and tile field is located adjacent to the south perimeter fence of the 241-TX Tank Farm in 200 West area (operable unit 200-TP-2) and was intermittently active from 1951 to 1980. Figure 4.11-8 illustrates variations in nitrate and tritium (two commonly and nearly continuously monitored constituents) in this well over time. WIDS indicates that this crib received 150,000 kg nitrate, 18,000 kg ammonium nitrate, and many curies of tritium, which had decayed to 4.25 Ci by 1989. Tritium, with a half life of 12.3 years, has declined significantly in this well from its peak of 5,600,000 pCi/L in 1973, but is still well above the 20,000-pCi/L DWS for this constituent. The decrease in activity is likely caused by dilution, decay, and transport. Nitrate concentration is declining at a much slower rate because it is chemically stable. Nitrate is still above the 45,000 ppb DWS. The high nitrate concentration (in this well and this area) accounts for a significant part of the elevated specific conductance that has triggered WMA TX-TY into groundwater quality assessment monitoring under interim-status regulations.

Another regularly sampled well is 299-E25-2, a carbon steel well located adjacent to the 216-A-1 crib and downgradient of the 216-A-8 crib. The 216-A-1 crib operated briefly in late 1955, but the 216-A-8 crib operated intermittently from 1955 to 1995 receiving waste from PUREX operations. The total volume of liquid effluent discharged to the 216-A-8 crib was 1,150,000,000 L (303,831,000 gal). As of December 1989, 0.35 Ci of tritium remained from the large quantity discharged over time. A single value for tritium in 1967 showed nearly 900,000 pCi/L of tritium in this well. Figure 4.11-8 illustrates the decline in tritium activity with time in this well from 1977 through 1989 reflecting decay, dilution, and transport.

To evaluate contamination in groundwater beneath the SSTs relative to total contamination of groundwater in the 200 Areas, the reader is referred to contaminant plume maps elsewhere in this report or those contained in Johnson (1993), Ford (1993), or the 1993 RCRA annual report (DOE-RL 1994).

4.11.3.4 Statistical Evaluation. Background sampling and analyses have been completed at all WMAs. Tables 4.11-5 through 4.11-9 present the critical means for all WMAs. Previous RCRA groundwater monitoring at the SSTs is summarized in other annual reports (Caggiano 1991a, 1992a, 1993, 1994).

For all WMAs, the critical mean for TOC cannot be calculated because all of the background values taken from the upgradient well (or wells) for TOC are below the contractually required quantitation limit, and an estimate for the background standard deviation is not available. For these sites, a limit of quantitation (LOQ) is calculated from the 1995 field blanks data. Following U.S. Environmental Protection Agency (EPA) guidance (EPA 1986), the LOQ will be used as the TOC upgradient/downgradient comparison value. This approach uses quality-control data to target the limit of quantifiable data and provide a realistic approach for upgradient/downgradient comparisons. The LOQ for TOC (analyzed by DataChem Laboratories) is 976 ppb (see Appendix A for calculations).

For all WMAs, the critical mean for total organic halogen (TOX) is not calculated because audit findings of unsatisfactory were assigned to the laboratory's quality control of analytical procedures for performing these analyses (see Section 1.5.4). However, TOX data from downgradient wells were evaluated using methods described in Appendix C (see Section C.1.1).

4.11.3.4.1 Waste Management Area A-AX. The critical mean was not exceeded for field specific conductance, field pH, TOC, or TOX at WMA A-AX. Constituents that exceeded regulatory limits are listed in Table 4.11-4.

4.11.3.4.2 Waste Management Area B-BX-BY. The critical mean was not exceeded for field specific conductance, field pH, TOC, or TOX at WMA B-BX-BY. Constituents that exceeded regulatory limits are listed in Table 4.11-4.

4.11.3.4.3 Waste Management Area C. The critical mean was not exceeded for field specific conductance, field pH, TOC, or TOX at WMA C. Constituents that exceeded regulatory limits are listed in Table 4.11-4.

4.11.3.4.4 Waste Management Area S-SX. The critical mean was not exceeded for field specific conductance, field pH, TOC, or TOX at WMA S-SX. Constituents that exceeded regulatory limits are listed in Table 4.11-4.

4.11.3.4.5 Waste Management Area T. The critical mean (or critical range) was not exceeded for indicator parameters other than specific conductance at WMA T. Exceedance of the critical mean for field specific conductance triggered WMA T into groundwater quality assessment monitoring status under 40 CFR 265. Details are in Section 4.11.1.2 and Caggiano and Chou (1993).

Field specific conductance values in well 299-W10-15 have been both above and below the critical mean of 1,174 mmhos/cm during 1994, but no consistent trend toward values below the critical mean has been observed. However, the variability of values for field specific conductance increased significantly this year. High conductivity of groundwater appears to be related to chloride, fluoride, and nitrate in well 299-W10-15, the well that triggered this site into assessment monitoring under interim-status regulations. It is somewhat enigmatic that the high values for anions that were likely part of liquid effluents discharged in this area are not accompanied by similarly high values for the radionuclides that were discharged in these solutions to nearby cribs, ponds, and trenches. Only tritium is significantly elevated, and it is elevated above the 20,000 pCi/L limit in upgradient well 299-W10-16 as well as in downgradient well 299-W10-15. Gross beta and ^{99}Tc were elevated in well 299-W10-15 in July, but these values depart significantly from historical trends and are likely in error.

4.11.3.4.6 Waste Management Area TX-TY. The critical mean (or critical range) has not been exceeded for indicator parameters other than specific conductance at WMA TX-TY. Exceedance of the critical mean for field specific conductance triggered WMA TX-TY into groundwater quality assessment monitoring status under 40 CFR 265. Details can be found in Section 4.11.1.2 and Caggiano and Chou (1993). Constituents that exceeded regulatory limits are listed in Table 4.11-4.

4.11.3.4.7 Waste Management Area U. Statistical analyses required by 40 CFR 265.93(b) and WAC 173-303-400 were performed on the samples collected from July 1991 to May 1992 for upgradient wells 299-W19-31 and 299-W19-32. Results are presented in Table 4.11-10, which lists the background average, background standard deviation, critical mean (or critical range, in the case of pH), and the upgradient/downgradient comparison value for the contamination indicator parameters. The comparison value is the value to which future averages of quadruplicate measurements will be compared. In general, the upgradient/downgradient comparison value is the critical mean. As indicated in Section 4.11.3.2, critical mean for TOX was not calculated because the upgradient TOX values are above the MDL. Therefore, the quantitation limit cannot be used as a surrogate for the critical mean. Statistical methods are described in Appendix C. Beginning in 1996, four quarters of TOX data will be obtained from upgradient wells.

The critical mean was not exceeded for field specific conductance, field pH, or TOC at WMA U. Constituents that exceeded regulatory limits are listed in Table 4.11-4.

4.11.4 Evaluation of Water Levels

4.11.4.1 Water Level Data. Water levels have been measured monthly in all RCRA groundwater monitoring wells constructed in all WMAs, as well as in some older pre-RCRA wells. Water level measurements for 1995 can be found in quarterly reports of RCRA groundwater monitoring (Caggiano 1995b, 1995c, 1995d, 1996). Data from these and other wells for June 1995 are plotted in Figures 4.11-4 and 4.11-9 to depict the general direction of groundwater flow. Across areas as small as most WMAs, the difference in water level elevation is less than 0.3 m (1 ft), and in many cases less than 0.15 m (0.5 ft) (Table 4.11-11, hydrographs on Figure 4.11-10). To show direction of flow, data from SST wells and wells from other RCRA facilities have been combined into smaller scale maps of larger areas to illustrate the groundwater flow direction and gradient.

Water level declines between June 1994 and June 1995 around SST WMAs are tabulated in Table 4.11-11. Water levels are measured monthly in 62 wells. Water level data are presented in quarterly reports (Caggiano 1995b, 1995c, 1995d, 1996). Water level trends can be seen on the hydrographs of 200 Area wells shown in Figures 4.11-3, 4.11-10, and 4.11-11.

From 1994 through 1995, the elevation of the water table has continued to decline beneath the 200 East and 200 West Areas because discharges to cribs, unlined trenches, and B Pond have decreased. All liquid effluent discharges to the ground ceased in June 1995 except for facilities that were granted operating permits by Ecology. As seen in Table 4.11-11, the decline is not the same in all wells in a WMA. Differences in hydraulic conductivity may account for the different rates of decline between the 200 West and 200 East Areas shown on Figures 4.11-3, 4.11-10, and 4.11-11. Between June 1994 and June 1995 water levels beneath WMAs in the 200 East Area resumed a steady decline compared with 1994 when the rate of decline slowed noticeably (Table 4.11-11, figure 4.11-10). From July to September the rate of water table decline again appeared to be slowing. The maximum decline in water level in SST wells in the 200 East Area from June 1994 to June 1995 was 40 cm (1.32 ft) in well 299-W33-36.

Water levels in the southern part of the 200 West Area (WMAs S-SX and U) have declined between 50 and 120 cm (1.63 and 3.93 ft), with the declines in most wells being 49 cm (1.6 ft) or more (Figures 4.11-4, 4.11-11). The decline of the water table in 1995 accelerated rapidly beneath WMA U compared to the decline in 1994, with an average decline of 94 cm among 9 wells. The water level decline in the northern part of the 200 West Area resumed its rate of decline from several years ago when the water table dropped at least 45 cm/yr (1.5 ft/yr). The average water table drop for 11 wells beneath WMA T was 56 cm (1.85 ft.); the average drop for 6 wells beneath WMA TX-TY was 57 cm (1.88 ft.).

4.11.4.1.1 200 East Area Groundwater Flow Direction. For WMAs A-AX, B-BX-BY, and C, the controlling influence of groundwater flow is the water table mound beneath B Pond. Discharges to B Pond have created this mound that has reversed the direction of flow from a west-to-east flow, which existed before Hanford Site operations, to an east-to-west flow across the northern part of the 200 East Area. Along with the high transmissivity of the Hanford formation, the B Pond mound creates a water table in the 200 East Area that slopes very gently.

Figure 4.11-9 illustrates that a low saddle in the water table exists beneath the 200 East Area. The saddle was created by both the regional eastward groundwater flow and the westward flow from the B Pond mound. Although difficult to demonstrate from water table elevations, past long-term groundwater flow paths can be demonstrated by the migration of contaminant plumes from the area of the PUREX Plant as well as from the 216-BY Cribs in the northern part of the 200 East Area. Groundwater flow in the unconfined aquifer from the northern part of the 200 East Area is to the north toward Gable Mountain, while groundwater flow in the unconfined aquifer from the southeastern part of the 200 East Area is to the southeast. The top of the basalt (i.e., the bottom of the unconfined aquifer in the 200 East Area) slopes to the south along the north flank of the Cold Creek syncline, the axis of which plunges southeast. The borehole velocity flowmeter was run in several wells in operable unit 200-BP-1 this summer, including a few SST water level monitoring wells (Kasza 1995, Lindberg 1995). The results indicate that the groundwater divide in the 200 East Area is moving slowly to the north. The water table in the northern 200 East Area and the area immediately north is nearly flat. The variations in flow directions measured within and between wells with the borehole velocity flow meter are consistent with this interpretation.

Groundwater flow across WMA A-AX is generally from the east to the west-southwest. The hydraulic gradient calculated from June 1995 data is about 0.0005. Groundwater flow across WMA C is generally toward the west. The hydraulic gradient calculated from June 1995 water level data is about 0.0003. Groundwater flow across WMA B-BX-BY is generally toward the west. The true direction of groundwater flow in this area of very low gradient in the northern part of the 200 East Area is difficult to determine accurately. The hydraulic gradient calculated from July 1995 water level data (April, May, and June 1995 data depart from the historical trend by 0.5 ft because of an unknown error) is about 0.00008.

4.11.4.1.2 200 West Area Groundwater Flow Direction. For WMAs in the 200 West Area, the controlling influence on the direction of groundwater flow is the regional west-to-east gradient, as well as a water table mound that developed beneath the former 216-U-10 Pond (the U Pond mound) (see Figure 4.11-4). The U Pond received liquid effluents from 1944 to 1984. Since 1984, the U Pond mound has been declining and the crest of the groundwater mound has been shifting eastward because the mound is decaying and loci of wastewater discharge are shifting (Serkowski and Jordan 1989, Kasza 1990, Newcomer 1990, Kasza et al. 1992). Because the transmissivity of unit E in the Ringold Formation (the principal stratigraphic unit of the unconfined aquifer in the 200 West Area)is lower, the U Pond mound was higher and resulted in a steeper radially outward gradient than the B Pond mound in the 200 East Area. (From June 1984 to June 1995, the water level in well 299-W18-15 near U Pond had declined 7.6 m [25 ft].) Smaller groundwater mounds may have developed beneath some cribs that received high volumes of liquid effluent in the early days of Hanford Site operations, but the data are not adequate to decipher any such small features. The water level around WMA U (in older carbon steel-constructed well 299-W19-1) is known to have fluctuated by about 2.4 m (8 ft) from the late 1950's to 1984 when U Pond was decommissioned. The water level in this well has declined more than 7.6 m (25 ft) since 1984.

In the southern part of the 200 West Area, the direction of groundwater flow beneath WMA S-SX is to the south-southeast. With the decline and eastward shift of the U Pond mound, groundwater flow will assume a more southerly direction before eventually returning to the pre-Hanford Site west-to-east flow. The hydraulic gradient calculated from June 1995 water level data is about 0.002.

The direction of groundwater flow beneath WMA T in the northern part of the 200 West Area is to the north-northeast. The gradient calculated from June 1995 water level data is 0.0006. With the projected decline in the U Pond mound in the next several years, groundwater flow is anticipated to return to the original pre-Hanford Site west-to-east direction beneath this WMA.

The direction of groundwater flow beneath WMA TX-TY is to the north-northeast, similar to WMA T immediately to the north. The hydraulic gradient calculated from June 1995 water level data is 0.0009. With the anticipated further decline of the U Pond mound, the direction of groundwater flow is expected to gradually shift to the regional west-to-east direction.

The direction of groundwater flow beneath WMA U in the southern part of the 200 West Area has been to the east-northeast. However, the water level in well 299-W19-32 has been higher than in well 299-W18-25 by up to 9 cm (0.3 ft) beginning in late spring 1993. Water level data from an expanded water level monitoring network confirms that the apex of a water table mound is now southeast of WMA U. The high point in the 200 West Area water table is still to the north of WMA U. A local water table mound southeast of WMA U has resulted in a northwestern groundwater flow beneath WMA U, which was measured with the borehole velocity flow meter in wells 299-W19-31 and 299-W19-32 in early May (see Table 4.11-11). Water level data for June through September 1995 indicate a very gentle slope to the water table to the south-southwest (Table 4.11-11). The hydraulic gradient calculated from June 1995 water level data is about 0.0007. Differences in hydraulic head between upgradient and downgradient wells are generally less than 0.1 m (0.3 ft), within the probable range of combined error of geodetic survey measurements, depth to water measurements, and verticality of wells. The decline of water levels in an area of variable hydraulic conductivity through which a water table mound is migrating makes accurate determination of hydraulic head and gradient very difficult.

As seen from Table 4.11-11, groundwater levels beneath the 200 Areas are on a slow steady decline. The amount of decline of water level varies from well to well within a network and with the location of the well. With the closure of chemical processing facilities at the Hanford Site, the volume of liquid effluents will continue to decrease; thus, artificial recharge also will decrease. Also, the discharges will be to locations where waste has not been previously discharged to the soil. Reduction of liquid discharges is expected to result in a continued decline of water levels in SST groundwater monitoring wells. The discharge of liquids to the ground ceased in June 1995 except for discharges to facilities for which Ecology has granted a permit.

4.11.4.1.3 Rate of Groundwater Flow. The groundwater gradient beneath the 200 West Area is steeper and better defined than that beneath the 200 East Area where there is little more than a 30-cm (1-ft) difference in water table elevation between the eastern and western parts of the area (compare Figure 4.11-9 with Figure 4.11-4). Water table gradients are given in Table 4.11-12. The water table beneath the 200 East Area represents a broad hydraulic low area between westward-flowing water from the B Pond mound and the regional eastward gradient (i.e., eastward flow from the 200 West Area, see Figure 2-4).

Groundwater flow velocities were calculated using equation (1) and are given in Table 4.11-13. Hydraulic conductivities were calculated from analysis of single-well slug test data which Connelly et al. (1992b) found to be generally an order of magnitude lower than hydraulic conductivities calculated from constant discharge tests. Data from aquifer tests using constant discharge methods are not available for any SST wells; therefore, slug test data were used. Calculations used effective porosities of 10 and 20%. Compare Tables 4.11-2 and 4.11-13 to compare calculated velocities to measured velocities in wells 299-W18-25, 299-W19-31, and 299-W19-32.

$$v = \frac{Ki}{n_e} \qquad (1)$$

where:

v = Groundwater velocity
K = Hydraulic conductivity
i = Hydraulic gradient
n_e = Effective porosity.

4.11.4.2 Evaluation of Monitoring Well Network. Based on water levels measured in 1994 and 1995 and on interpreted direction of groundwater flow, the monitoring well networks for WMA A-AX, B-BX-BY, C, S-SX, T, and TX-TY appear to comply with the requirement for placement of groundwater monitoring wells. The wells constructed as upgradient appear to be upgradient; wells constructed as downgradient appear to be downgradient. Groundwater flow direction beneath WMA U has changed from the northeast direction used to plan the original monitoring network. The present monitoring well network is inadequate and an additional RCRA-standard well may be constructed near the northwest corner of WMA U to bring the network's efficiency to approximately 90% (as determined by MEMO [Jackson et al. 1991]). The direction of groundwater flow will be measured periodically in wells in WMA U using the borehole velocity flowmeter to confirm that the north-northwest flow direction measured in May 1995 persists.

Older carbon steel wells are present in all WMAs and serve as screening wells for measuring water levels. Thus, monitoring of the groundwater flow direction is more accurate than would be afforded by the minimal four-RCRA-standard-well network.

The Monitoring Efficiency Model (MEMO) was run for all WMAs to maximize efficiency of the monitoring network and to expedite new well locations. The goal in locating wells is to achieve 90% efficiency of the network using MEMO (Wilson et al. 1992). Efficiencies were calculated for all WMAs; they are close to or exceed the target efficiency. Detailed results of the MEMO calculations can be found in the revised groundwater monitoring plan for the SSTs (Caggiano and Goodwin 1991).

4.11.4.3 Monitoring Network Modifications. Hydraulic gradients are very low in the 200 East Area. Continued observation will be required as discharges to B Pond diminish and the B Pond mound dissipates to ensure that wells are properly placed so as to be upgradient or downgradient from WMAs. With a change in flow direction anticipated as long term, additional wells will be needed in the 200 East Area. As water levels continue to decline, groundwater monitoring wells may have to be replaced or remediated when the wells no longer penetrate the saturated zone of the uppermost unconfined aquifer. Pump intakes were lowered in several wells in 1995 to accommodate declining water levels. This activity is likely to be needed in other SST monitoring wells. No changes to any network because the groundwater flow direction is changing are anticipated in the 200 East Area at this time.

With dissipation of the U Pond mound, groundwater flow in the 200 West Area will shift eastward. As this long-term change occurs, additional wells may be required to ensure that wells for the various WMAs in the 200 West Area are located appropriately upgradient and downgradient and that the wells penetrate the saturated section of the uppermost unconfined aquifer. The only anticipated change to the SST facility-specific monitoring networks in the 200 West Area is at WMA U where a new RCRA-standard well may be installed in 1996 because groundwater flow changed direction. Measurements made in May 1995 indicate that groundwater flows north-northwest in wells 299-W19-31 and 299-W19-32. The borehole velocity flowmeter will be run in these and other wells to confirm the permanence of this direction before resources are committed to construct a new well near the northwest corner of the 241-U Tank Farm.

The inability to determine whether the SSTs or various nearby cribs are the source of contaminants in groundwater at WMAs T and TX-TY may lead to an expansion and integration of cribs, trenches, etc., regulated under CERCLA into these two SST WMAs. The two WMAs would be expanded to one unit that would include the nearby cribs, trenches, and ponds that received essentially the same wastes and that likely contributed the groundwater contaminants. The intent would be to determine the magnitude, extent, and mobility of contaminants causing elevated specific conductance (nitrate and chloride) that triggered these two WMAs into groundwater quality assessment monitoring under interim-status regulations. Facility-specific monitoring would be replaced or supplemental to plume tracking of selected constituents at regular intervals. For these two WMAs, using an expanded network using mostly RCRA-standard wells from other nearby RCRA TSD facilities to monitor anions and selected radionuclides seems appropriate.

Other SST WMAs may become candidates for RCRA/CERCLA integration as the need is changed from facility-specific monitoring to a regional approach. As integration occurs, the current networks will be compared to the data quality objectives for the integrated networks to determine the adequacy of existing wells to accomplish the objectives.

4.11.5 References

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- *Tank Summary Data Report for Tank SX-102*, GJ-HAN-6
- *Tank Summary Data Report for Tank SX-103*, GJ-HAN-4
- *Tank Summary Data Report for Tank SX-104*, GJ-HAN-3
- *Tank Summary Data Report for Tank SX-105*, GJ-HAN-7
- *Tank Summary Data Report for Tank SX-106*, GJ-HAN-8
- *Tank Summary Data Report for Tank T-107*, GJ-HAN-2
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Figure 4.11-1. Single-Shell Tank Waste Management Areas in the 200 East Area.

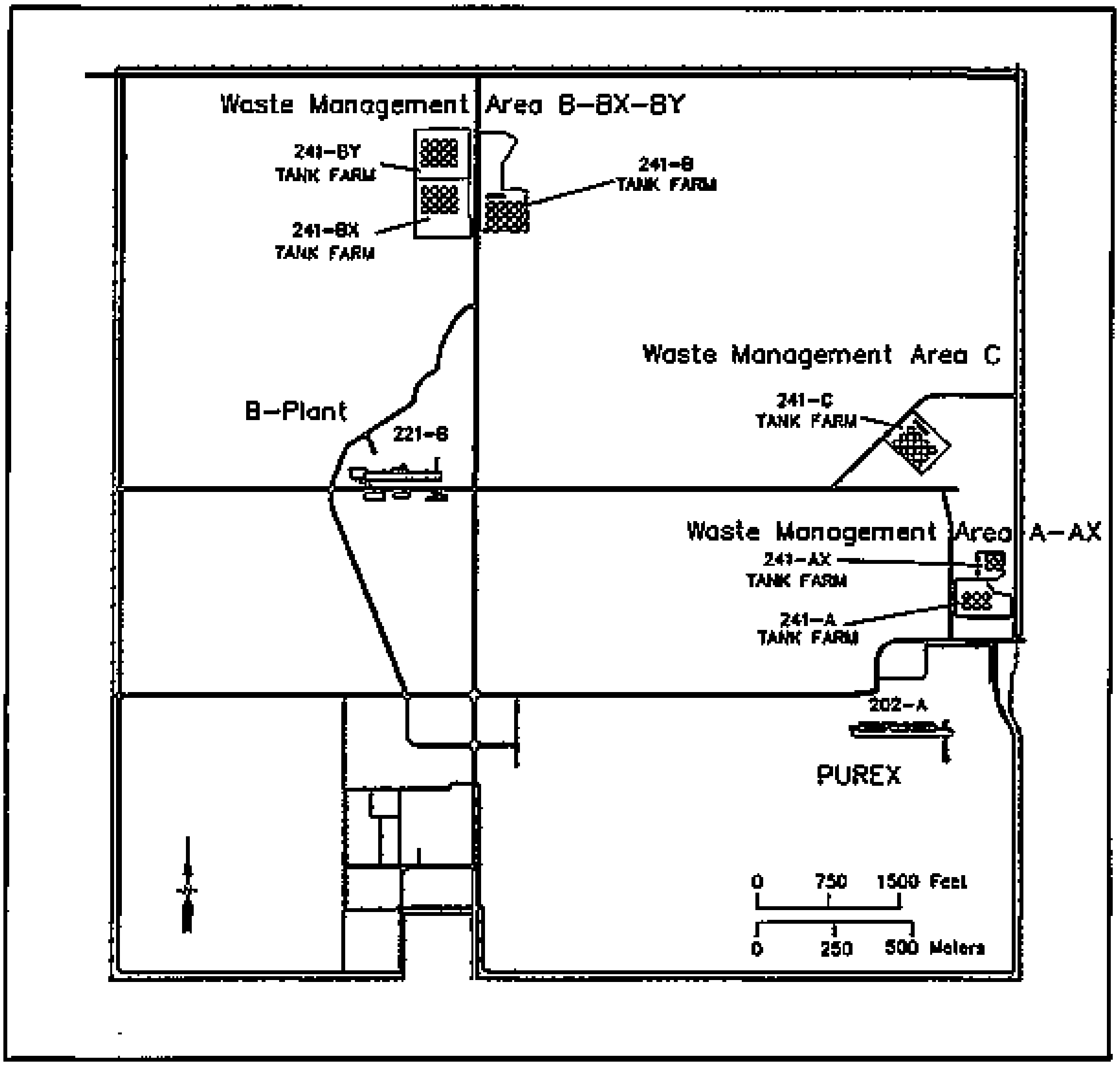

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Figure 4.11-2. Single-Shell Tank Waste Management Areas in the 200 West Area.

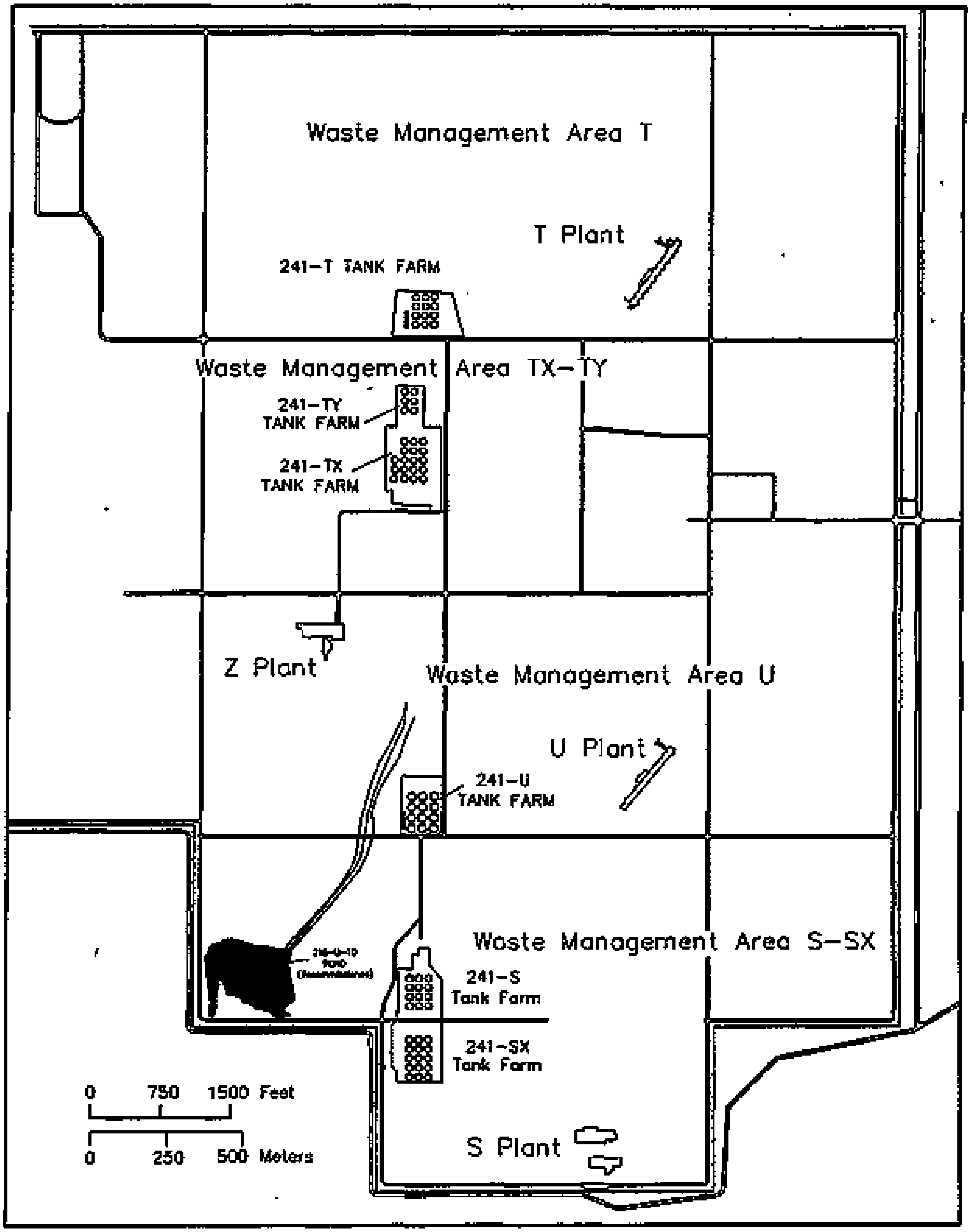

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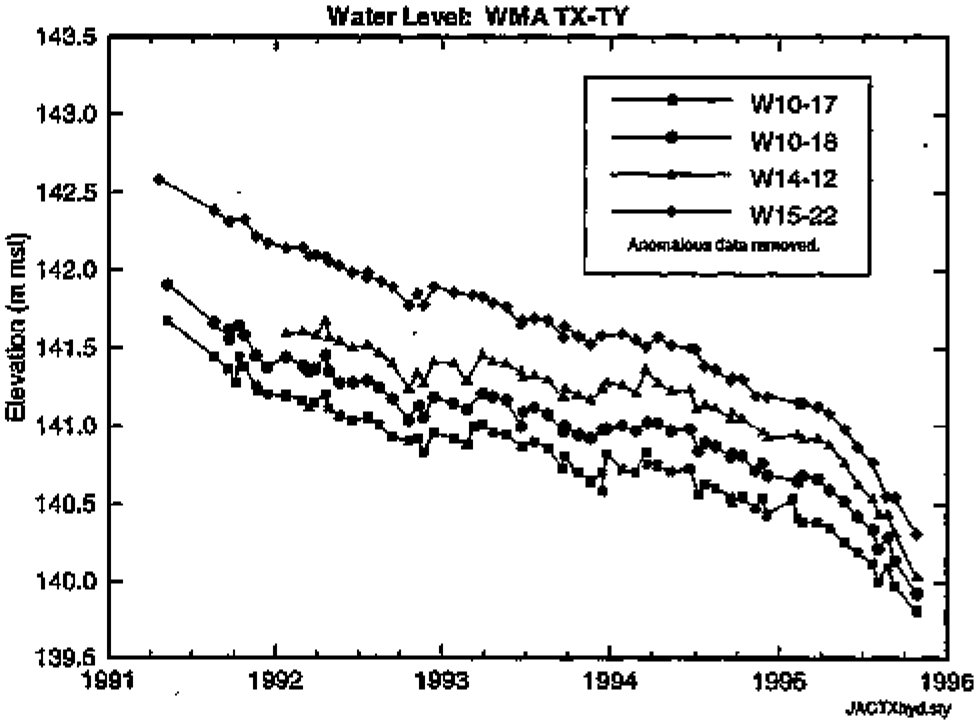
Figure 4.11-3. 200 West Area Hydrographs for Single-Shell Tank Waste Management Areas TX-TY and U.



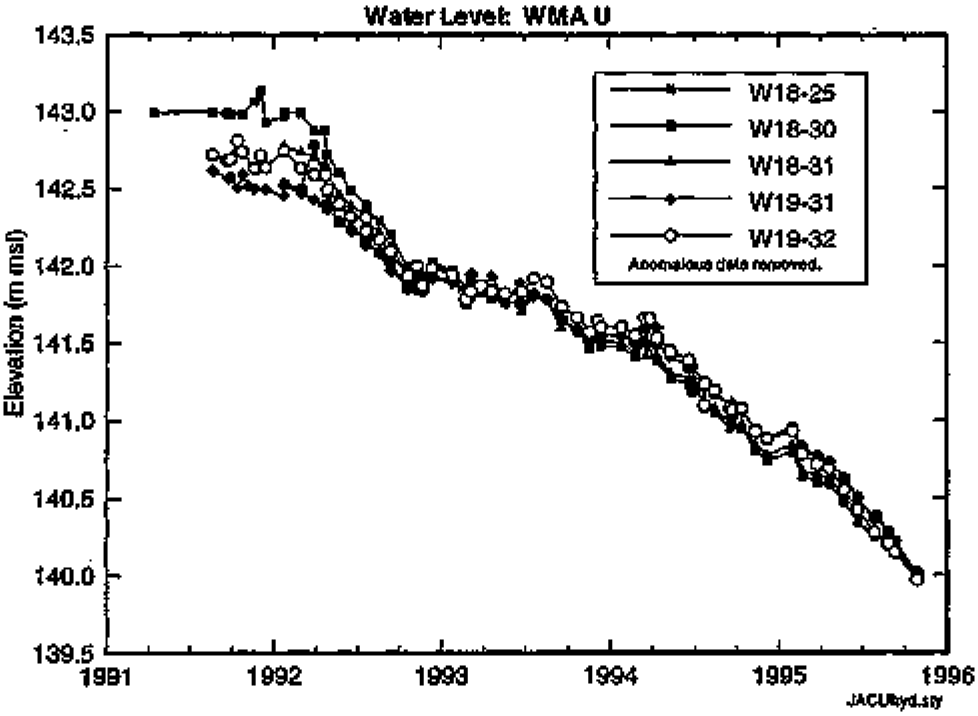
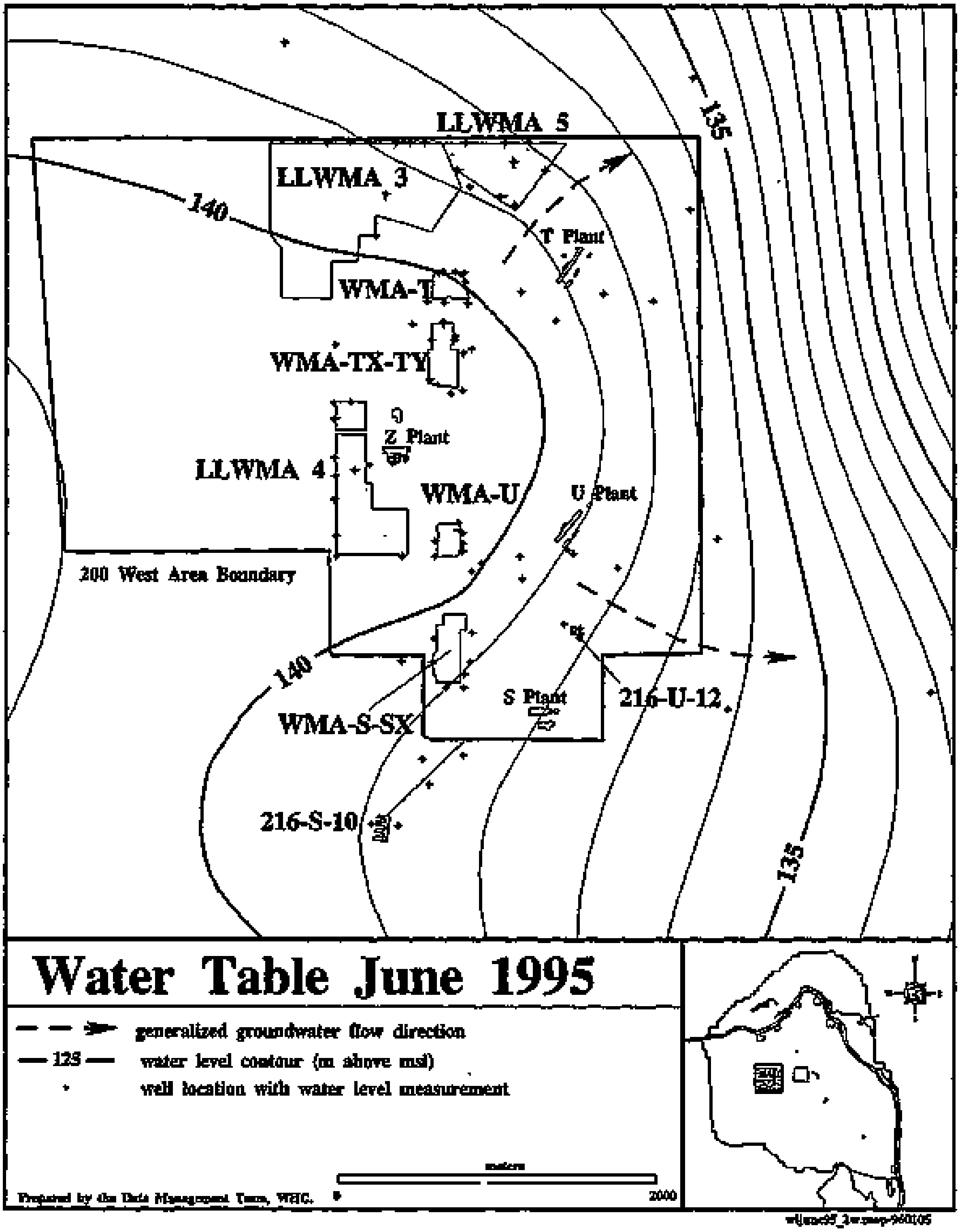


Figure 4.11-4. 200 West Area Water Table Map, June 1995.



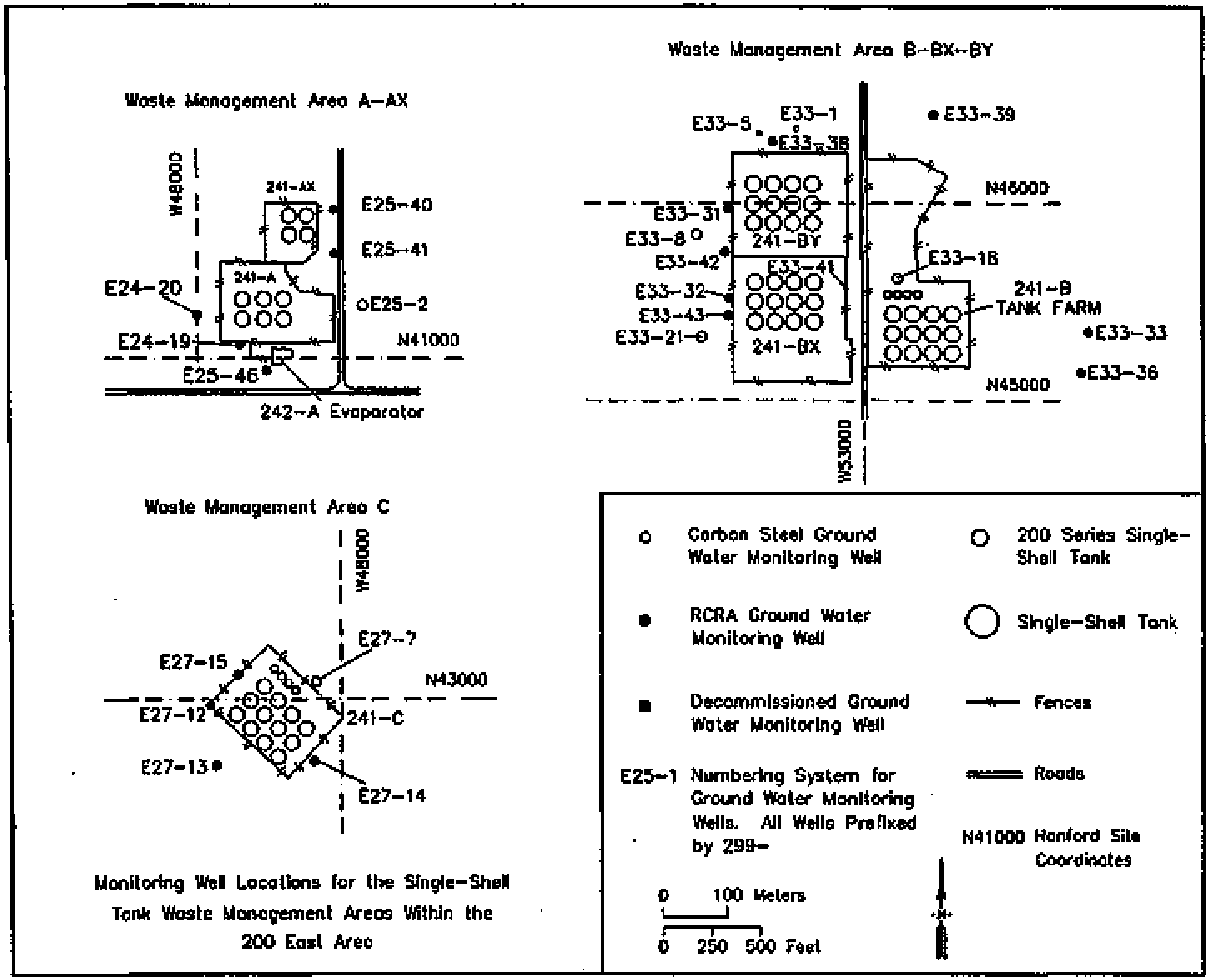


Figure 4.11-5. Monitoring Well Locations for the Single-Shell Tank Waste Management Areas in the 200 East Area.

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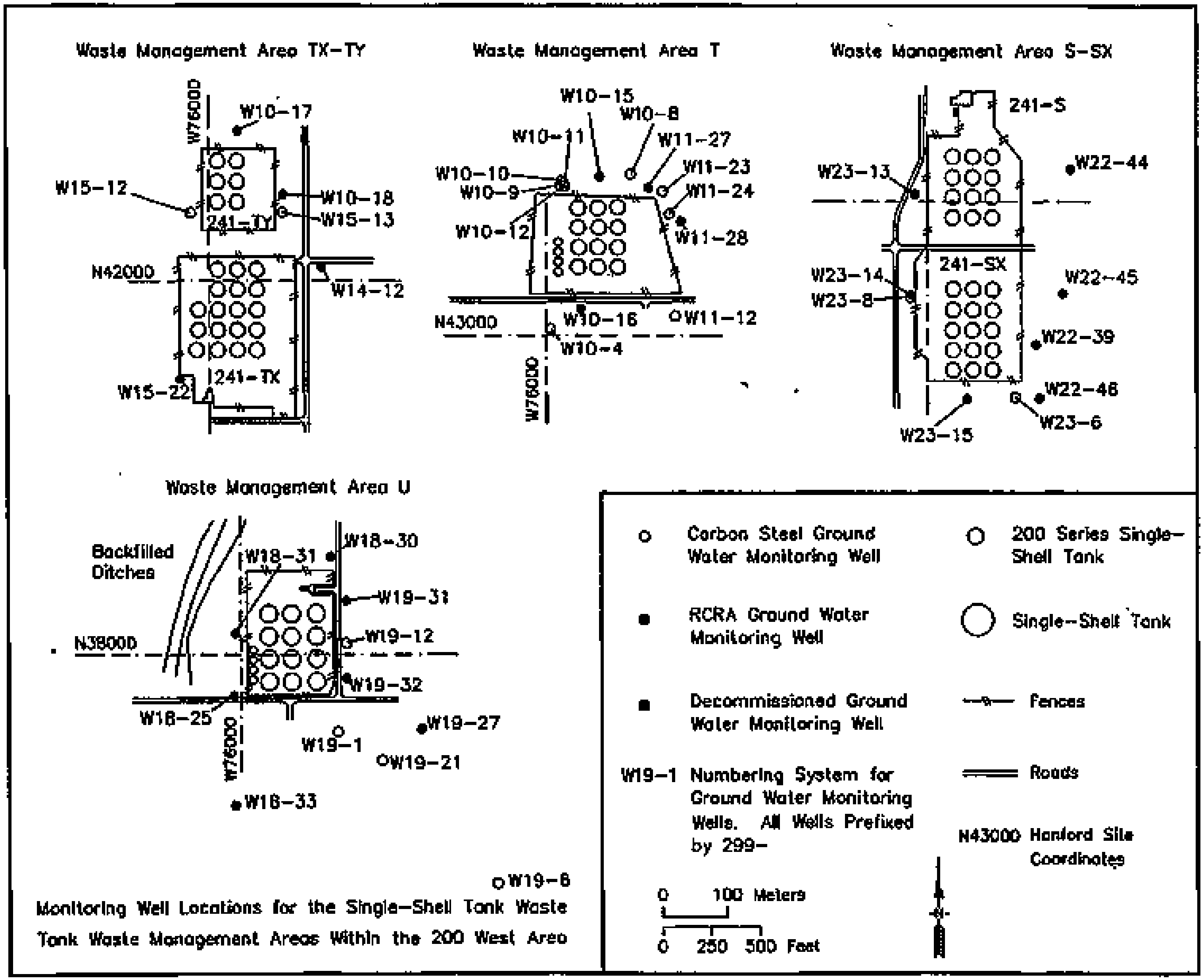

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Figure 4.11-6. Monitoring Well Locations for the Single-Shell Tank Waste Management Areas in the 200 West Area.

Figure 4.11-7. Filtered Chromium and Nickel Versus Time for Well 299-E24-19.

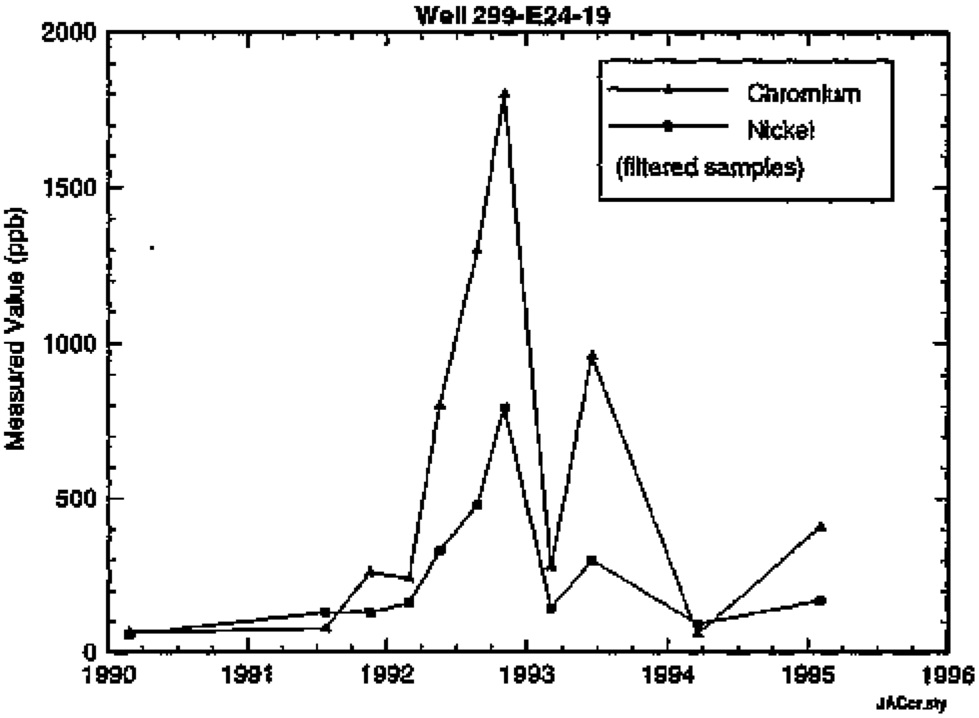


Figure 4.11-8. Trends in Historic Groundwater Monitoring Data in Wells 299-W15-4 and 299-E25-2.

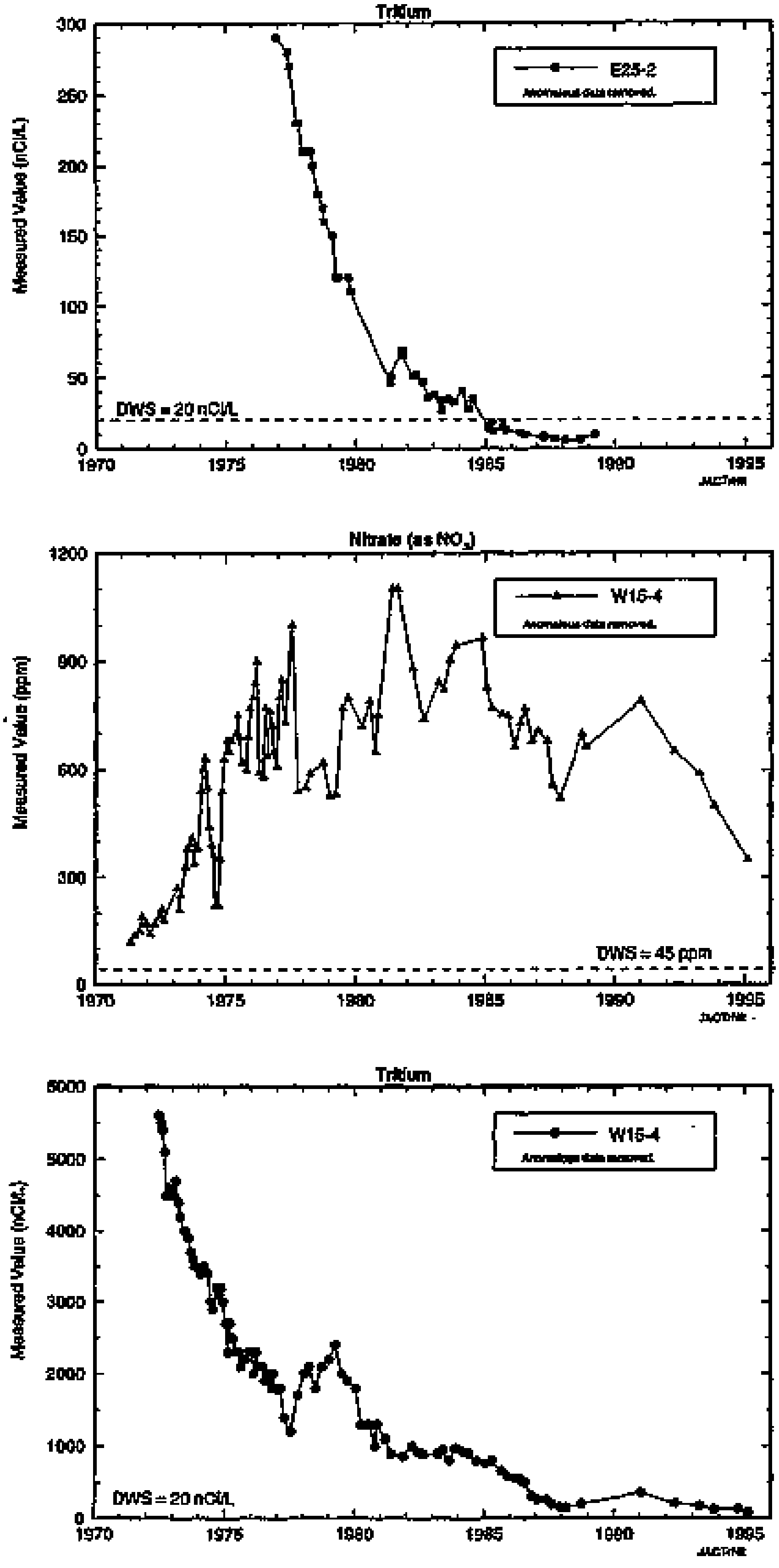


Figure 4.11-9. 200 East Area Water Table Map, June 1995.

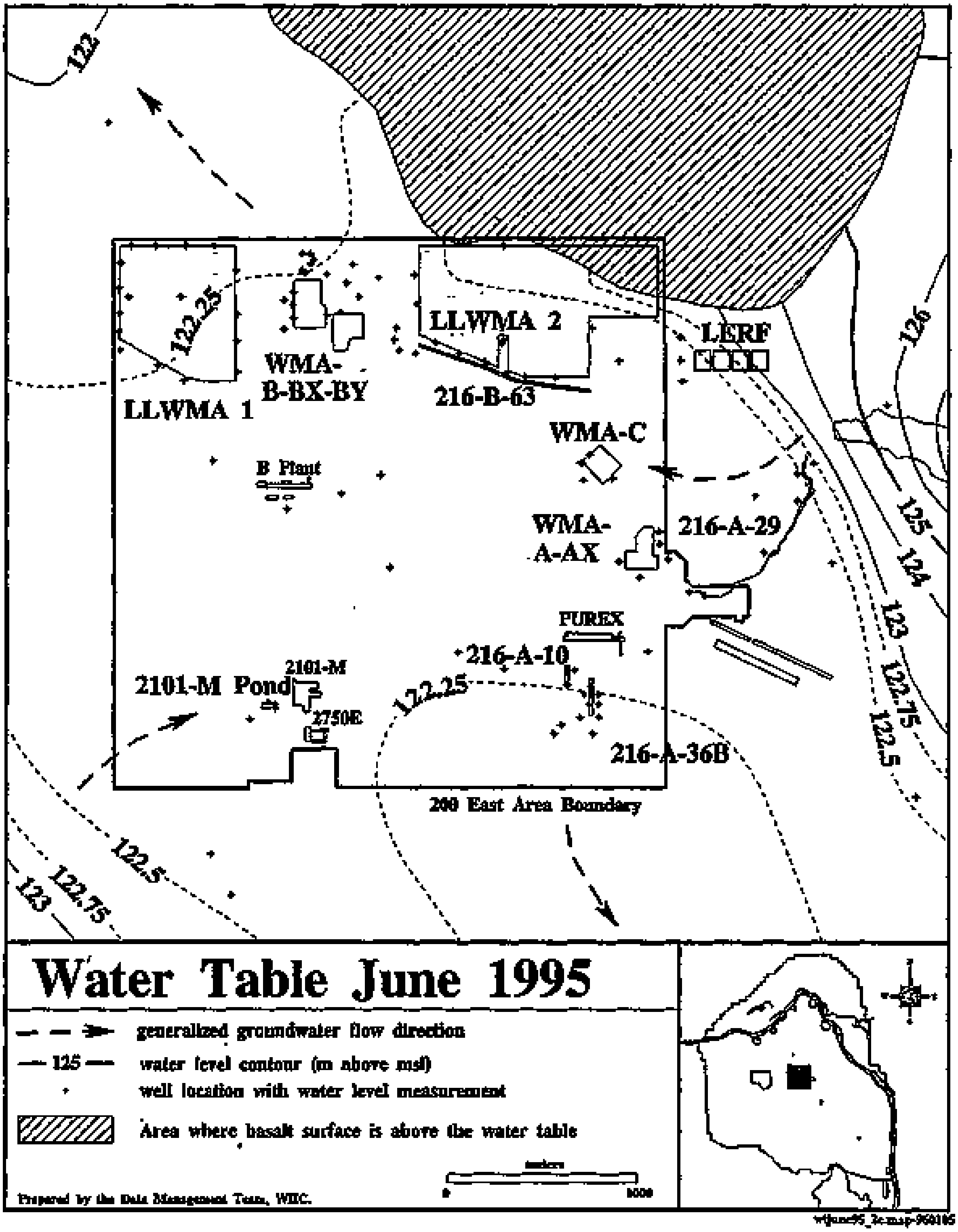


Figure 4.11-10. 200 East Area Hydrographs for Single-Shell Tank Waste Management Areas A-AX, B-BX-BY, and C.

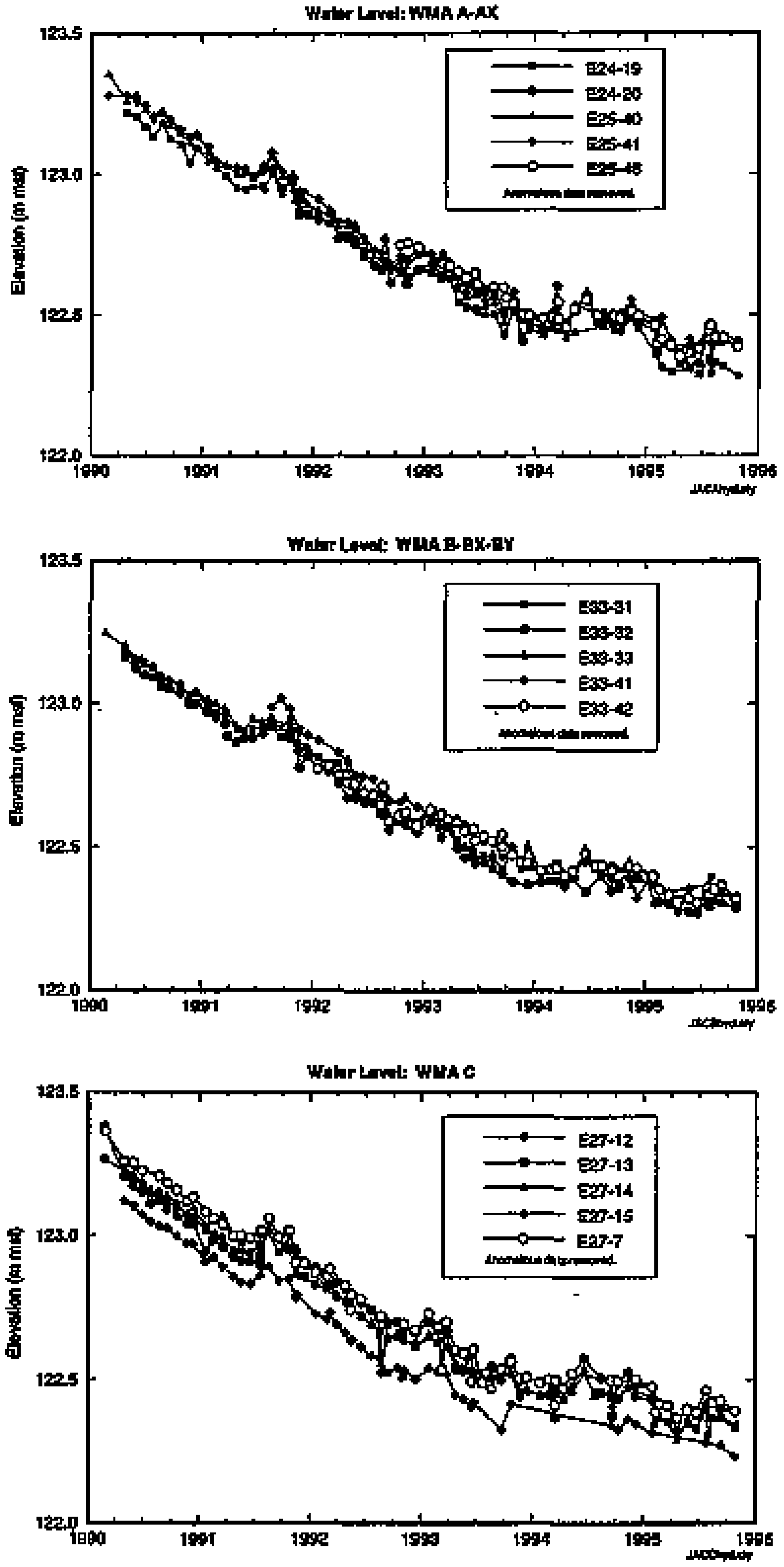
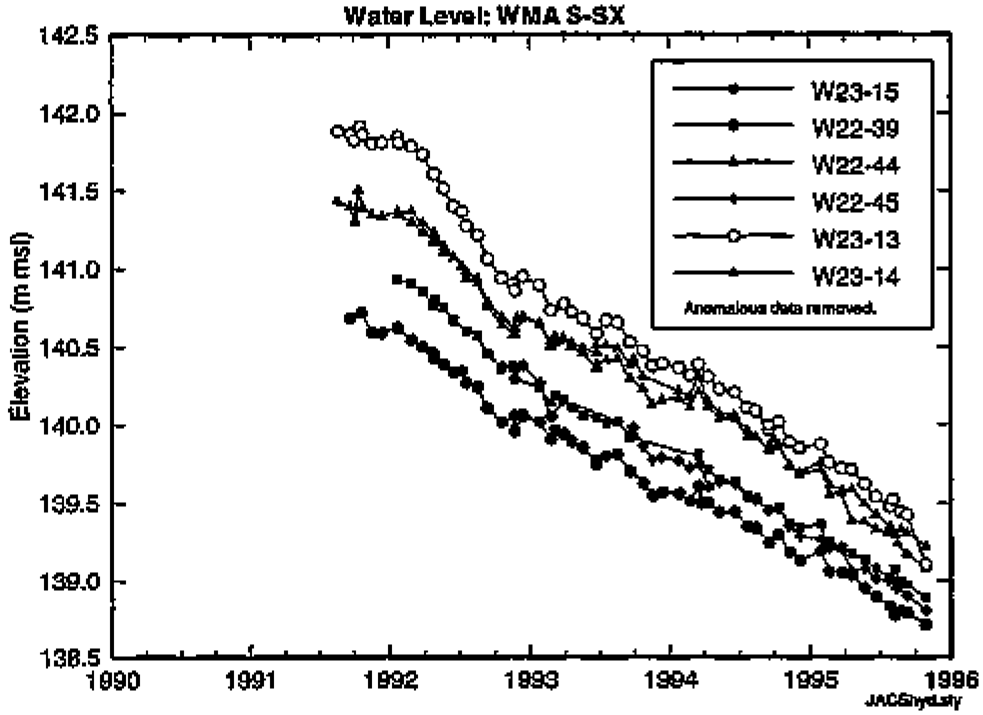


Figure 4.11-11. 200 West Area Hydrographs for Single-Shell Tank Waste Management Areas S-SX and T.



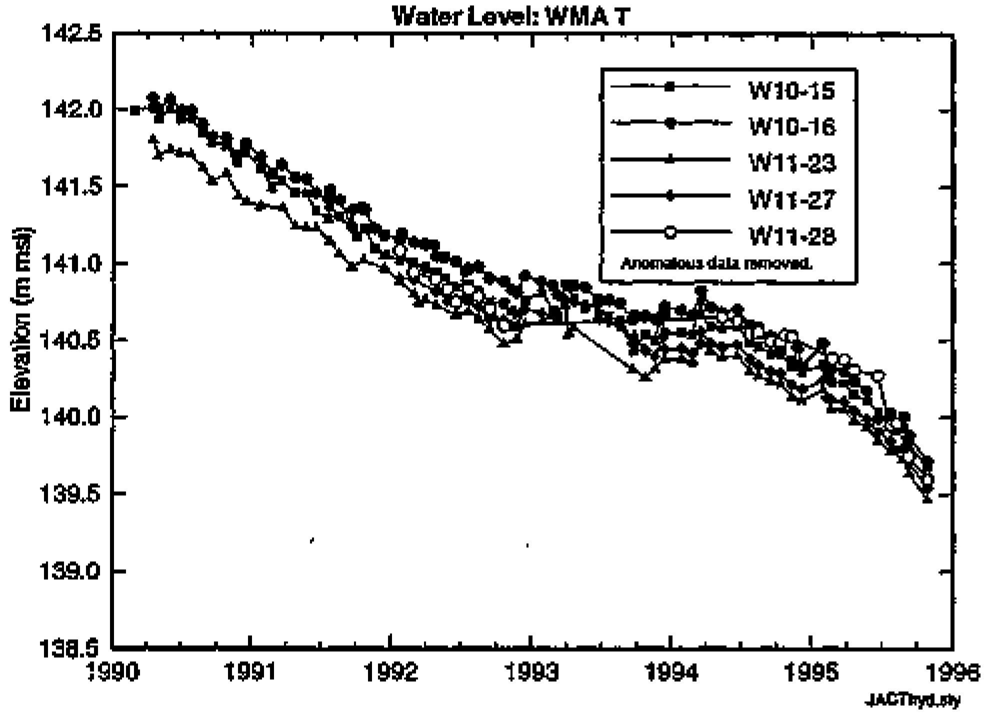


Table 4.11-1. Groundwater Monitoring Wells for the Single-Shell Tanks. (2 sheets)

Well	Aquifer	Sampling frequency	Water levels	Well standards	Other networks
Waste Management Area A-AX					
299-E24-19[illegible]	Top of unconfined	S	M	RCRA	--
299-E24-20[illegible]	Top of unconfined	S	M	RCRA	--
299-E25-40[illegible]	Top of unconfined	S	M	RCRA	--
299-E25-2[illegible]	Top of unconfined	--	M	PRE	--
299-E25-41[illegible]	Top of unconfined	S	M	RCRA	--
299-E25-46[illegible]	Top of unconfined	S	M	RCRA	--
Waste Management Area B-BX-BY					
299-E33-31[illegible]	Top of unconfined	S	M	RCRA	--
299-E33-32[illegible]	Top of unconfined	S	M	RCRA	--
299-E33-33[illegible]	Top of unconfined	S	M	RCRA	--
299-E33-36[illegible]	Top of unconfined	S	M	RCRA	216-B-63
299-E33-41[illegible]	Top of unconfined	S	M	RCRA	--
299-E33-38[illegible]	Top of unconfined	S	M	RCRA	200-BP-1
299-E33-39[illegible]	Top of unconfined	S	M	RCRA	200-BP-1
299-E33-42[illegible]	Top of unconfined	S	M	RCRA	--
299-E33-43[illegible]	Top of unconfined	S	M	RCRA	--
299-E33-1[illegible]	Top of unconfined	--	M	PRE	--
299-E33-5[illegible]	Top of unconfined	--	M	PRE	--
299-E33-8[illegible]	Top of unconfined	--	M	PRE	--
299-E33-18[illegible]	Top of unconfined	--	M	PRE	--
299-E33-21[illegible]	Top of unconfined	--	M	PRE	--
Waste Management Area C					
299-E27-12[illegible]	Top of unconfined	S	M	RCRA	--
299-E27-13[illegible]	Top of unconfined	S	M	RCRA	--
299-E27-14[illegible]	Top of unconfined	S	M	RCRA	--
299-E27-15[illegible]	Top of unconfined	S	M	RCRA	--
299-E27-7[illegible]	Top of unconfined	S[illegible]	M	PRE	--
Waste Management Area S-SX					
299-W22-39[illegible]	Top of unconfined	S	M	RCRA	--
299-W22-44[illegible]	Top of unconfined	S	M	RCRA	--
299-W22-45[illegible]	Top of unconfined	S	M	RCRA	--
299-W22-46[illegible]	Top of unconfined	S	M	RCRA	--
299-W23-13[illegible]	Top of unconfined	S	M	RCRA	--
299-W23-14[illegible]	Top of unconfined	S	M	RCRA	--
299-W23-15[illegible]	Top of unconfined	S	M	RCRA	--
299-W23-6[illegible]	Top of unconfined	--	M	PRE	--
299-W23-7[illegible]	Top of unconfined	--	M	PRE	--
299-W23-8[illegible]	Top of unconfined	--	M	PRE	--

Table 4.11-1. Groundwater Monitoring Wells for the Single-Shell Tanks. (2 sheets)

Well	Aquifer	Sampling frequency	Water levels	Well standards	Other networks
Waste Management Area T[a]					
299-W10-15^{89}	Top of unconfined	Q	M	RCRA	--
299-W10-16^{89}	Top of unconfined	Q	M	RCRA	--
299-W11-27^{91}	Top of unconfined	Q	M	RCRA	--
299-W11-28^{91}	Top of unconfined	Q	M	RCRA	--
299-W10-8^{73}	Top of unconfined	--	M	PRE	--
299-W10-9^{73}	Top of unconfined	--	M	PRE	--
299-W10-11^{74}	Top of unconfined	--	M	PRE	--
299-W10-12^{74}	Top of unconfined	--	M	PRE	--
299-W11-23^{73}	Top of unconfined	--	M	PRE	--
299-W11-24^{73}	Top of unconfined	--	M	PRE	--
Waste Management Area TX-TY					
299-W10-17^{91}	Top of unconfined	Q	M	RCRA	--
299-W10-18^{90}	Top of unconfined	Q	M	RCRA	--
299-W14-12^{91}	Top of unconfined	Q	M	RCRA	--
299-W15-22^{91}	Top of unconfined	Q	M	RCRA	--
299-W15-12^{73}	Top of unconfined	--	M	PRE	--
299-W15-13^{73}	Top of unconfined	--	M	PRE	--
Waste Management Area U*					
299-W18-25^{90}	Top of unconfined	S	M	RCRA	--
299-W18-30^{91}	Top of unconfined	S	M	RCRA	--
299-W18-31^{91}	Top of unconfined	S	M	RCRA	--
299-W19-31^{90}	Top of unconfined	S	M	RCRA	--
299-W19-32^{91}	Top of unconfined	S	M	RCRA	--
299-W19-12^{89}	Top of unconfined	S	M	PRE	--
299-W18-33	Top of unconfined	--	M	RCRA	
299-W19-6	Middle unconfined	--	M	PRE	
299-W19-21	Top of unconfined	--	M	PRE	
299-W19-27	Top of unconfined	--	M	RCRA	

Notes: Shading denotes upgradient wells. Superscript following well number denotes the year of completion.

M = frequency on a monthly basis.
PRE = well was constructed before RCRA specified standards.
Q = frequency on a quarterly basis.
RCRA = well is constructed to RCRA-specified standards.
S = frequency on a semiannual basis.
* = well is sampled for supporting data.

*Wells may be sampled quarterly for TOX only to reestablish background for this facility as a result of the change in groundwater flow direction.

[a]Wells 299-W6-2, 299-W6-4, 299-W6-6, 299-W6-9, 299-W10-19, 299-W10-20, 299-W10-21 and 299-W11-31 have been added to the expanded network for groundwater quality assessment monitoring under interim-status. These wells are RCRA Standard wells for Low-Level Burial Grounds WMAs 3 and 5 and may be located on Figures 4.10-6 and 4.10-12. Selected radionuclides have been added to the sampling list for these wells to assist in the determination of whether SST WMA T or SST WMA TX-TY is contributing to the degradation of groundwater quality beneath these WMAs. These wells are all located to the north or west of WMA T.

Table 4.11-2. In-Situ Flow Meter Results Single-Shell Tanks Waste Management Area U, May 4-12, 1995.

Well No.	Probe Depth (ft)	Direction	Velocity m/d (ft/d)
299-W18-25	208	N.72°E.	0.25 (0.82)
	208	N.78°E.	0.20 (0.65)
	212	N.86°E.	0.71 (2.32)
	216	N.77°E.	0.45 (1.46)
299-W19-31	214.5	?	<0.01 (<0.04)
	217.5	N.4°E.	0.01 (0.04)
	220.5	N.14°W.	0.22 (0.71)
	223.5	N.36°W.	0.23 (0.74)
299-W19-32	214.5	N.30°W.	0.12 (0.40)
	217.5	N.15°W.	0.12 (0.39)
	220.5	N.21°W.	0.07 (0.23)

? = Direction indeterminate when velocity is below 0.01 m/d (0.04 ft/d).

Table 4.11-3. Constituent List for the Single-Shell Tanks.

	Contamination indicator parameters	
pH Specific conductance	Total organic carbon Total organic halogen	
	Groundwater quality parameters	
Chloride Iron	Manganese Phenols	Sodium Sulfate
	Drinking water parameters	
Barium Cadmium Chromium	Fluoride Gross alpha Gross beta	Nitrate Silver Turbidity
	Site-specific parameters	
Ammonium Technicium-99+	Cesium-137+ Cobalt-60+ Gamma scan+	Iodine-129 Tritium

+WMAs T and TX-TY only

Table 4.11-4. Constituents Exceeding Regulatory Limits. (5 sheets)

WMA	Well No.	Up/Down	Constituent[a]	Value	Limit	Date(s)
A-AX	2-E24-19	Down	Filtered Chromium	410 ppb	100 ppb[b]	2/2/95
			^{129}I	7.78 pCi/L	1 pCi/L	2/2/95
				5.36 pCi/L	1 pCi/L	8/3/95
	2-E24-20	Down	^{129}I	4.37 pCi/L	1 pCi/L	2/2/95
				6.73 pCi/L	1 pCi/L	8/2/95
	2-E25-40	Up	^{129}I	7.03 pCi/L	1 pCi/L	2/6/95
				7.65 pCi/L	1 pCi/L	8/1/95
	2-E25-41	Up	^{129}I	4.57 pCi/L	1 pCi/L	2/6/95
				4.97 pCi/L	1 pCi/L	8/2/95
	2-E25-46	Down	^{129}I	5.87 pCi/L	1 pCi/L	2/6/95
				3.26 pCi/L	1 pCi/L	8/1/95
B-BX-BY	2-E33-31	Down	^{129}I	5.99 pCi/L	1 pCi/L	2/8/95
				7.59 pCi/L	1 pCi/L	8/4/95
	2-E33-32	Down	^{129}I	5.65 pCi/L	1 pCi/L	2/7/95
				3.86 pCi/L	1 pCi/L	8/2/95
	2-E33-33	Up	^{129}I	3.62 pCi/L	1 pCi/L	2/7/95
				5.85 pCi/L	1 pCi/L	8/1/95
	2-E33-36	Up	^{129}I	5.3 pCi/L	1 pCi/L	2/7/95
				5.65 pCi/L	1 pCi/L	8/1/95
	2-E33-38[c]	Down	^{129}I	6.1 pCi/L	1 pCi/L	4/5/95
	2-E33-39[c]	Down	^{129}I	1.49 pCi/L	1 pCi/L	4/5/95
	2-E33-41	----	^{129}I	5.07 pCi/L	1 pCi/L	2/13/95
				5.95 pCi/L	1 pCi/L	8/4/95
			^{99}Tc	948 pCi/L	900 pCi/L	2/13/95
				1,630[d] pCi/L	900 pCi/L	8/4/95
	2-E33-42	Down	^{129}I	5.65 pCi/L	1 pCi/L	2/8/95
				8.68 pCi/L	1 pCi/L	8/3/95
	2-E33-43	Down	^{129}I	4.18 pCi/L	1 pCi/L	2/8/95
				3.61 pCi/L	1 pCi/L	8/3/95
C	2-E27-7	Up	^{129}I	3.19 pCi/L	1 pCi/L	2/9/95
				3.8 pCi/L	1 pCi/L	8/2/95
	2-E27-12	Down	^{129}I	2.62 pCi/L	1 pCi/L	2/8/95
				3.92 pCi/L	1 pCi/L	8/2/95
	2-E27-13	Down	^{129}I	4.73 pCi/L	1 pCi/L	2/13/95
				4.37 pCi/L	1 pCi/L	8/3/95
	2-E27-14	Up	^{129}I	4.87 pCi/L	1 pCi/L	2/13/95
				4.07 pCi/L	1 pCi/L	8/2/95
	2-E27-15	Down	^{129}I	3.71 pCi/L	1 pCi/L	2/8/95

Table 4.11-4. Constituents Exceeding Regulatory Limits. (5 sheets)

WMA	Well No.	Up/Down	Constituent[a]	Value	Limit	Date(s)
				7.09 pCi/L	1 pCi/L	8/2/95
S-SX	2-W23-14	Up	Tritium	127,000 pCi/L	20,000 pCi/L	2/14/95
				137,000 pCi/L	20,000 pCi/L	8/9/95
	2-W23-15	Down	Tritium	44,200 pCi/L	20,000 pCi/L	2/14/95
				27,700 pCi/L	20,000 pCi/L	8/9/95
T^	2-W6-2	Down	Nitrate	52,000 ppb	45,000 ppb	12/14/94
				53,000 ppb	45,000 ppb	3/13/95
				59,000 ppb	45,000 ppb	6/14/95
	2-W6-6	Down	Tritium	32,900 pCi/L	20,000 pCi/L	12/14/94
				31,600 pCi/L	20,000 pCi/L	3/3/95
				31,600 pCi/L	20,000 pCi/L	6/12/95
				31,300 pCi/L	20,000 pCi/L	9/14/95
			Nitrate	97,000 ppb	45,000 ppb	12/14/94
				97,000 ppb	45,000 ppb	3/3/95
				100,000 ppb	45,000 ppb	6/12/95
				100,000 ppb	45,000 ppb	9/14/95
	2-W6-9	Down	Nitrate	69,000 ppb	45,000 ppb	12/13/94
				70,000 ppb	45,000 ppb	3/2/95
				72,000 ppb	45,000 ppb	6/13/95
				78,000 ppb	45,000 ppb	9/14/95
	2-W6-10	Down	Tritium	85,100 pCi/L	20,000 pCi/L	12/14/94
				80,400 pCi/L	20,000 pCi/L	3/3/95
				79,600 pCi/L	20,000 pCi/L	6/13/95
				79,800 pCi/L	20,000 pCi/L	9/13/95
			Nitrate	130,000 ppb	45,000 ppb	12/14/94
				130,000 ppb	45,000 ppb	3/3/95
				140,000 ppb	45,000 ppb	6/13/95
				150,000 ppb	45,000 ppb	9/13/95
	2-W10-15	Down	Carbon Tetrachloride	930 ppb	5 ppb	8/3/95
			Filtered Iron	3,100 ppb	300 ppb	8/8/95
			Filtered Chromium	110 ppb	100 ppb	11/30/94
				110 ppb	100 ppb	2/10/95
				110 ppb	100 ppb	5/18/95
				930[d] ppb	100 ppb	8/8/95
			Filtered Nickel	500[d] ppb	100 ppb	8/8/95
			Fluoride	5,100 ppb	4,000 ppb[e]	9/24/94
				4,700 ppb	4,000 ppb[e]	2/10/95

Table 4.11-4. Constituents Exceeding Regulatory Limits. (5 sheets)

WMA	Well No.	Up/Down	Constituent[a]	Value	Limit	Date(s)
				5,000 ppb	4,000 ppb[e]	5/18/95
				4,800 ppb	4,000 ppb[e]	8/8/95
			Nitrate	320,000 ppb	45,000 ppb	9/21/94
				230,000 ppb	45,000 ppb	2/10/95
				260,000 ppb	45,000 ppb	5/18/95
				280,000 ppb	45,000 ppb	8/8/95
			TDS[f]	730 ppm	500 ppm	11/30/94
				760 ppm	500 ppm	2/10/95
				760 ppm	500 ppm	5/18/95
				760 ppm	500 ppm	8/8/95
			Tritium	32,800 pCi/L	20,000 pCi/L	11/30/94
				35,200 pCi/L	20,000 pCi/L	2/10/95
				35,300 pCi/L	20,000 pCi/L	5/18/95
				33,100 pCi/L	20,000 pCi/L	8/8/95
			pH	8.4, 8.74	6.6 - 8.5	11/30/94
	2-W10-16	Up	Carbon Tetrachloride	1,200[e] ppb	5 ppb	11/29/94
			Nitrate	140,000 ppb	45,000 ppb	9/21/94
				120,000 ppb	45,000 ppb	2/9/95
				120,000 ppb	45,000 ppb	5/17/95
				130,000 ppb	45,000 ppb	8/7/95
			TDS[f]	510 ppm	500 ppm	2/9/95
				520 ppm	500 ppm	5/17/95
				510 ppm	500 ppm	8/7/95
			Tritium	45,000 pCi/L	20,000 pCi/L	11/29/94
				43,800 pCi/L	20,000 pCi/L	2/9/95
				45,600 pCi/L	20,000 pCi/L	8/7/95
	2-W11-28	Down	Nitrate	200,000 ppb	45,000 ppb	9/21/94
				130,000 ppb	45,000 ppb	2/23/95
				130,000 ppb	45,000 ppb	5/17/95
				140,000 ppb	45,000 ppb	8/10/95
			TDS[f]	640 ppm	500 ppm	10/26/94
				620, 590 ppm	500 ppm	2/23/95
				610 ppm	500 ppm	5/17/95
				650 ppm	500 ppm	8/10/95
			Tritium	57,500 pCi/L	20,000 pCi/L	10/26/94
				57,600 pCi/L	20,000 pCi/L	2/23/95
				60,300 pCi/L	20,000 pCi/L	5/17/95

Table 4.11-4. Constituents Exceeding Regulatory Limits. (5 sheets)

WMA	Well No.	Up/Down	Constituent[a]	Value	Limit	Date(s)
				57,900 pCi/L	20,000 pCi/L	8/10/95
			Carbon Tetrachloride	1,068 ppb	5 ppb	12/13/94
				1,000 ppb	5 ppb	7/26/95
	2-W11-31	Down	Tritium	74,000 pCi/L	20,000 pCi/L	12/14/94
				76,200 pCi/L	20,000 pCiL	3/8/95
				73,100 pCi/L	20,000 pCi/L	6/12/95
				76,000 pCi/L	20,000 pCi/L	9/13/95
			Nitrate	120,000 ppb	45,000 ppb	12/14/94
				110,000 ppb	45,000 ppb	3/8/95
				130,000 ppb	45,000 ppb	6/12/95
				140,000 ppb	45,000 ppb	9/13/95
TX-TY	2-W10-17	Down	Nitrate	100,000 ppb	45,000 ppb	9/22/94
				99,000 ppb	45,000 ppb	2/10/95
				86,000 ppb	45,000 ppb	5/17/95
				97,000 ppb	45,000 ppb	8/7/95
			Tritium	33,800 pCi/L	20,000 pCi/L	11/30/94
				35,600 pCi/L	20,000 pCi/L	2/10/95
				34,200 pCi/L	20,000 pCi/L	5/17/95
				29,900 pCi/L	20,000 pCi/L	8/7/95
			Carbon Tetrachloride	1,000 ppb	5 ppb	5/11/95
	2-W10-18	Down	Nitrate	78,000 ppb	45,000 ppb	11/30/94
				83,000 ppb	45,000 ppb	2/10/95
				95,000 ppb 94,000 ppb	45,000 ppb	5/17/95
				95,000 ppb	45,000 ppb	8/7/95
	2-W14-12	Down	Nitrate	320,000 ppb	45,000 ppb	11/30/94
				450,000 ppb	45,000 ppb	2/10/95
				360,000 ppb	45,000 ppb	5/17/95
				350,000 ppb	45,000 ppb	8/8/95
			^{99}Tc	6,290 pCi/L	900 pCi/L	11/30/94
				9,950 pCi/L	900 pCi/L	2/10/95
				9,000 pCi/L	900 pCi/L	5/17/95
				6,060 pCi/L	900 pCi/L	8/8/95
			Tritium	233,000 pCi/L	20,000 pCi/L	11/30/94
				585,000 pCi/L	20,000 pCi/L	2/10/95
				319,000 pCi/L	20,000 pCi/L	5/17/95
				184,000 pCi/L	20,000 pCi/L	9/8/95
			^{129}I	29 pCi/L	1 pCi/L	11/30/94

Table 4.11-4. Constituents Exceeding Regulatory Limits. (5 sheets)

WMA	Well No.	Up/Down	Constituent[a]	Value	Limit	Date(s)
				47.8 pCi/L	1 pCi/L	2/10/95
				39.3 pCi/L	1 pCi/L	5/17/95
				30.4 pCi/L	1 pCi/L	8/8/95
			Filtered Chromium	190 ppb	100 ppb	11/30/94
				290 ppb	100 ppb	2/10/95
				360 ppb	100 ppb	5/17/95
				250 ppb	100 ppb	8/8/95
			Filtered Manganese	120 ppb	50 ppb	11/30/94
				100 ppb	50 ppb	2/10/95
			TDS[f]	770 ppm	500 ppm	11/30/94
				970 ppm	500 ppm	2/10/95
				890 ppm	500 ppm	5/17/95
				810 ppm	500 ppm	8/8/95
	2-W15-22	Up	Nitrate	110,000 ppb	45,000 ppb	11/30/94
				96,000 ppb	45,000 ppb	2/10/95
				93,000 ppb	45,000 ppb	5/17/95
				100,000 ppb	45,000 ppb	8/24/95
			Tritium	22,600 pCi/L	20,000 pCi/L	11/30/94
				27,800 pCi/L	20,000 pCi/L	2/10/95
				30,600 pCi/L	20,000 pCi/L	5/17/95
				43,200 pCi/L	20,000 pCi/L	8/24/95
			Carbon Tetrachloride	600 ppb	5 ppb	11/30/94
U	2-W18-25	Down	Carbon Tetrachloride	100 ppb	5 ppb	2/13/95
	2-W19-31	Up	Carbon Tetrachloride	71 ppb	5 ppb	2/11/95
	2-W19-32	Up	Carbon Tetrachloride	30 ppb	5 ppb	2/11/95

NOTES

+Elevated Specific Conductance in this well has triggered the site into groundwater quality assessment monitoring under interim-status regulations (40 CFR 265)
, beta-emitting radionuclides, and not a standard in and of itself.

[b] The DWS for chromium changed to 100 ppb in July 1992, but the interim DWS in 40 CFR 265 is still 50 ppb.
[c] Well sampled for 200-BP-1 investigations.
[d] Suspect value under investigation.
[e] DWS from 40 CFR 264; DWS from 40 CFR 265 is 1,400 - 2,400 ppb.
[f] TDS = Total Dissolved Solids.
[g] Value flagged by laboratory because result was above high standard, but within instrument range.
&& Average of several values in the exceedance tables for LLBG WMA 5.

Table 4.11-5. Critical Means Table for 20 Comparisons--Background Contamination Indicator Parameter Data for the Single-Shell Tanks Waste Management Area A-AX.[a,b]

Constituent (Unit)	n	df	tc	Average background	Standard deviation	Critical mean	Upgradient/ downgradient comparison value
Specific Conductance (µmho/cm)	8	7	5.4079	396.563	59.671	738.8	738.8
Field pH	8	7	6.0818	7.798	0.194	[6.55/9.05]	[6.55/9.05]
TOC[c] (ppb)	6*	5	5.4079	500	N.C.	N.C.	976
TOX[d] (ppb)	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	13.6

[a] Data collected from July 1991 to May 1992 for upgradient wells 299-E25-40 and 299-E25-41. Critical means calculated based on 20 comparisons.

[b] The following notations are used in this table:

df = degrees of freedom (n-1).
n = number of background replicate averages.
t_c = Bonferroni critical t-value for appropriate df and 20 comparisons.
N.C. = not calculated.

[c] Critical mean cannot be calculated because an estimate of background standard deviation is lacking. TOX values from upgradient wells have been detected above the method-detection limit (see Appendix A).

[d] Critical mean cannot not be calculated because of problems associated with data quality for samples analyzed by DCL. The upgradient/downgradient comparison value for TOX is the limit of quantitation (see Appendix A).

*Excluding TOC values collected on 2/28/92 from wells 299-E25-40 and 299-E25-41 because of Nonconformance Report.

Table 4.11-6. Critical Means Table for 28 Comparisons--Background Contamination Indicator Parameter Data for the Single-Shell Tanks Waste Management Area B-BX-BY.[a,b]

Constituent (Unit)	n	df	tc	Average background	Standard deviation	Critical mean	Upgradient/ downgradient comparison value
Specific Conductance (μmho/cm)	8	7	5.7282	262.656	16.958	365.7	365.7
Field pH	8 7*	7 6	6.4295 7.2227	7.902 8.126	0.709 0.344	[3.07/12.74] [5.47/10.78]	[6.91/9.28]*
TOC[c] (ppb)	8	7	5.7282	500	N.C.	N.C.	976
TOX[d] (ppb)	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	13.6

[a] Data collected from July 1991 to June 1992 for upgradient wells 299-E33-33 and 299-E33-36. Critical means calculated based on 28 comparisons.

[b] The following notations are used in this table:
df = degrees of freedom (n-1).
n = number of background replicate averages.
t_c = Bonferroni critical t-value for appropriate df and 20 comparisons.
N.C. = not calculated.

[c] Critical mean cannot be calculated because an estimate of background standard deviation is lacking. The upgradient/downgradient comparison value for TOC is the limit of quantitation (see Appendix A).

[d] Critical mean cannot not be calculated because of problems associated with data quality for samples analyzed by OCL. The upgradient/downgradient comparison value for TOX is the limit of quantitation (see Appendix A).

*Upgradient/downgradient comparison value for pH is the critical mean calculated excluding the inconsistent pH replicate average 6.335 of samples collected on 1/3/92 from well 299-E33-36.

Table 4.11-7. Critical Means Table for 16 Comparisons--Background Contamination Indicator Parameter Data for the Single-Shell Tanks Waste Management Area C.[a,b]

Constituent (Unit)	n	df	tc	Average background	Standard deviation	Critical mean	Upgradient/ Downgradient Comparison Value
Specific Conductance (μmho/cm)	4	3	11.9838	353.063	14.244	543.9	543.9
Field pH	4	3	15.1451	8.038	0.109	[6.19/9.88]	[6.19/9.88]
TOC[c] (ppb)	4	3	11.9838	500	N.C.	N.C.	976
TOX[d] (ppb)	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	13.6

[a] Data collected from July 1991 to August 1992 for upgradient well 299-E27-14. Critical means calculated based on 16 comparisons.

[b] The following notations are used in this table:
df= degrees of freedom (n-1).
n = number of background replicate averages.
t_c = Bonferroni critical t-value for appropriate df and 20 comparisons.
N.C. = not calculated.

[c] Critical mean cannot be calculated because an estimate of background standard deviation is lacking. The upgradient/downgradient comparison value for TOC is the limit of quantitation (see Appendix A).

[d] Critical mean cannot not be calculated because of problems associated with data quality for samples analyzed by DCL. The upgradient/downgradient comparison value for TOX is the limit of quantitation (see Appendix A).

Table 4.11-8. Critical Means Table for 28 Comparisons--Background Contamination Indicator Parameter Data for the Single-Shell Tanks Waste Management Area S-SX.[a,b]

Constituent (Unit)	n	df	tc	Average background	Standard deviation	Critical mean	Upgradient/ downgradient comparison value
Specific Conductance (μmho/cm)	8	7	5.3168	246.3125	42.666	486.9	486.9
Field pH	7	6*	6.4295	7.918	0.307	[5.81, 10.03]	[6.68/9.18][e]
TOC[c] (ppb)	8	7	5.3168	500	N.C.	N.C.	976
TOX[d] (ppb)	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	13.6

[a] Data collected from October 1991 to July 1992 for upgradient wells 299-W23-13 and 299-W23-14. Critical means calculated based on 28 comparisons.

[b] The following notations are used in this table:
df = degrees of freedom (n-1).
n = number of background replicate averages.
t_c = Bonferroni critical t-value for appropriate df and 20 comparisons.
N.C. = not calculated.

[c] Critical mean cannot be calculated because an estimate of background standard deviation is lacking. The upgradient/downgradient comparison value for TOC is the limit of quantitation (see Appendix A).

[d] Critical mean cannot not be calculated due to problems associated with data quality for samples analyzed by DCL. The upgradient/downgradient comparison value for TOX is the limit of quantitation (see Appendix A).

[e] Upgradient/downgradient comparison value for pH were calculated using data collected from October 1991 to June 1993 (wells 299-W23-13 and 299-W23-14) because the critical range calculated using four quarters of data is too large to be meaningful.

* Excluding inconsistent pH replicate average 5.868 of samples collected on 10/9/91 from well 299-W23-14.

Table 4.11-9. Critical Means Table for 20 Comparisons--Background Contamination Indicator Parameter Data for the Single-Shell Tanks Waste Management Area U.[a,b]

Constituent (Unit)	n	df	tc	Average background	Standard deviation	Critical mean	Upgradient/ Downgradient Comparison Value
Specific Conductance (μmho/cm)	8	7	5.4079	335.906	27.700	494.8	494.8
Field pH	8	7	6.0818	8.040	0.202	[6.74, 9.34]	[6.74/9.34]
TOC[c] (ppb)	7[e]	6	5.9588	500	N.C.	N.C.	976
TOX[d] (ppb)	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.

[a] Data collected from April 1992 to March 1993 for upgradient wells 2-W19-31 and 299-W19-32. Critical means calculated based on 20 comparisons.

[b] The following notations are used in this table:
df= degrees of freedom (n-1).
n = number of background replicate averages.
t_c= Bonferroni critical t-value for appropriate df and 20 comparisons.
N.C.= not calculated.

[c] Critical mean cannot be calculated because an estimate of background standard deviation is lacking. TOX values from upgradient wells have been detected above the method detection limit (see Appendix C).

[d] Critical mean cannot not be calculated because of problems associated with data quality for samples analyzed by DCL. The upgradient/downgradient comparison value for TOX is the limit of quantitation (see Appendix A).

[e] Excluding TOC values collected on 4/21/92 from wells 299-W19-31 because of a nonconformance report.

Table 4.11-10. Water Level Declines in RCRA Wells. (2 sheets)

WMA	Well No.	6/91 - 6/92	6/92 - 6/93	6/93 - 6/94	6/94 - 6/95
A-AX	E24-19	0.62	0.64	0.29*	0.43
	E24-20	–	–	0.06	0.80
	E25-2	0.52	0.57	0.0	0.67
	E25-40	0.74	0.60	+0.03	0.68
	E25-41	0.71	0.57	0.06	0.70
	E25-46	–	–	0.22	0.57
	Avg.	0.70	0.60	0.12	0.64
B-BX-BY	E33-8	0.70	0.63	+0.02	0.57
	E33-18	–	–	0.23	0.70
	E33-21	0.73	0.70	+0.09	0.55
	E33-31	0.73	0.77	+0.08	0.61
	E33-32	0.75	0.70	0.32	0.24
	E33-33	0.80	0.77	+0.08	1.02
	E33-36	0.81	0.59	0.25	1.32
	E33-41	–	0.75	0.24	0.46
	E33-42	–	0.54	0.15	0.56
	E33-43	–	0.57	0.16	0.56
	Avg.	0.75	0.67	0.12	0.66
C	E27-7	0.69	0.58	0.23	0.43*
	E27-12	0.71	0.66	+0.03	0.64
	E27-13	0.46	0.81	0.04	0.65
	E27-14	0.69	0.62	+0.03	0.70
	E27-15	0.72	0.64	0.64	0.92
	Avg.	0.69	0.67	0.05	0.67
S-SX	W22-39	1.57	1.93	1.00	1.80
	W22-44	–	2.01	1.31	2.41
	W22-45	–	–	1.20	2.01
	W22-46	–	1.85	1.01	1.63
	W23-6	1.37	2.12	0.67	1.81
	W23-8	1.58	2.47	1.07	1.99
	W23-13	1.93	2.67	1.23	2.20
	W23-14	1.56	2.33	1.08	2.00
	W23-15	–	–	1.09	1.84
	Avg.	1.61	2.20	1.07	1.97
T	W10-8	1.87	0.52	0.32	1.88
	W10-9	–	0.71	0.27	1.92
	W10-10	1.59	0.60	0.23	1.87
	W10-11	1.69	0.59	0.26	1.83
	W10-12	1.58	0.61	0.25	1.85
	W10-15	1.82	0.57	0.26	1.85
	W10-16	1.47	0.81	0.20	2.34
	W11-23	1.86	0.64	–	1.82
	W11-24	1.82	0.69	–	1.84
	W11-27	–	0.69	0.54	1.87
	W11-28	–	–	–	1.29
	Avg.	1.68	0.63	0.29	1.85
TX-TY	W10-17	1.46	0.54	0.47	1.74
	W10-18	1.37	0.62	0.35	1.82
	W14-12	–	0.62	0.25	1.97

Table 4.11-10. Water Level Declines in RCRA Wells. (2 sheets)

	W15-12	1.48	0.98	0.47	1.84
	W15-13	1.40	0.85	0.37	1.80
	W15-22	1.51	1.0	0.58	2.08
	Avg.	1.44	0.77	0.42	1.88
U	W18-26	2.08	2.56	1.56	2.92
	W18-30	–	1.55	0.36	2.73
	W18-31	–	2.26	1.40	2.85
	W18-33	–	–	–	2.85
	W19-12	1.65	1.80	1.32	2.94
	W19-21	0.79	2.48	1.38	3.93
	W19-27	0.86	1.29	1.91	3.72
	W19-31	1.66	1.56	1.73	2.80
	W19-32	1.63	1.59	1.46	3.17
	Avg.	1.45	1.89	1.40	3.10
NOTES					
Water level measurements are made in feet and are reported in original					
* Annual data for period May to following May (rather than June) are rep					

Table 4.11-11. Water Level Measurements 1991-1995. (2 sheets)

WMA	Well No.	6/91 - 6/92	6/92 - 6/93	6/93 - 6/94	6/94 - 6/95
A-AX	E24-19	0.82	0.64	0.29*	0.43
	E24-20	--	--	0.06	0.80
	E25-2	0.52	0.57	0.0	0.67
	E25-40	0.74	0.60	+0.03	0.68
	E25-41	0.71	0.57	0.06	0.70
	E25-46	--	--	0.22	0.57
	Avg	0.70	0.60	0.12	0.64
B-BX-BY	E33-8	0.70	0.63	+0.02	0.57
	E33-18	--	--	0.23	0.70
	E33-21	0.73	0.70	+0.09	0.55
	E33-31	0.73	0.77	+0.08	0.61
	E33-32	0.75	0.70	0.32	0.24
	E33-33	0.80	0.77	+0.08	1.02
	E33-36	0.81	0.59	0.25	1.32
	E33-41	--	0.75	0.24	0.46
	E33-42	--	0.54	0.15	0.56
	E33-43	--	0.57	0.16	0.56
	Avg	0.75	0.67	0.12	0.66
C	E27-7	0.69	0.58	0.23	0.43*
	E27-12	0.71	0.68	+0.03	0.64
	E27-13	0.46	0.81	0.04	0.65
	E27-14	0.89	0.62	+0.03	0.70
	E27-15	0.72	0.64	0.64	0.92
	Avg	0.69	0.67	0.05	0.67
S-SX	W22-39	1.57	1.93	1.00	1.80
	W22-44	--	2.01	1.31	2.41
	W22-45	--	--	1.20	2.01
	W22-46	--	1.85	1.01	1.63
	W23-6	1.37	2.12	0.67	1.81
	W23-8	1.58	2.47	1.07	1.99
	W23-13	1.93	2.67	1.23	2.20
	W23-14	1.58	2.33	1.08	2.00
	W23-15	--	--	1.09	1.84
	Avg	1.61	2.20	1.07	1.97
T	W10-8	1.87	0.52	0.32	1.88

Table 4.11-11. Water Level Measurements 1991-1995. (2 sheets)

WMA	Well No.	6/91 - 6/92	6/92 - 6/93	6/93 - 6/94	6/94 - 6/95
	W10-9	--	0.71	0.27	1.92
	W10-10	1.59	0.60	0.23	1.87
	W10-11	1.59	0.59	0.26	1.83
	W10-12	1.58	0.61	0.25	1.85
	W10-15	1.62	0.57	0.26	1.85
	W10-16	1.47	0.81	0.20	2.34
	W11-23	1.86	0.64	--	1.82
	W11-24	1.82	0.69	--	1.84
	W11-27	--	0.69	0.54	1.87
	W11-28	--	--	--	1.29
	Avg	1.68	0.83	0.29	1.85
TX-TY	W10-17	1.46	0.54	0.47	1.74
	W10-18	1.37	0.62	0.35	1.82
	W14-12	--	0.62	0.25	1.97
	W15-12	1.48	0.98	0.47	1.84
	W15-13	1.40	0.85	0.37	1.80
	W15-22	1.51	1.0	0.58	2.08
	Avg	1.44	0.77	0.42	1.88
U	W18-25	2.08	2.56	1.56	2.92
	W18-30	--	1.55	0.36	2.73
	W18-31	--	2.26	1.40	2.85
	W18-33	--	--	--	2.85
	W19-12	1.65	1.80	1.32	2.94
	W19-21	0.79	2.48	1.38	3.93
	W19-27	0.86	1.29	1.91	3.72
	W19-31	1.66	1.55	1.73	2.80
	W19-32	1.63	1.59	1.46	3.17
	Avg	1.45	1.89	1.40	3.10

NOTES: Water level measurements are made in feet and are reported in original units of measure. To convert these values to metric measure, multiply by 0.3048.

* Annual data for period May to following May (rather than June) are reported.

Table 4.11-12. Hydraulic Gradients at Single-Shell Tank Waste Management Areas.

WMA	Well no.	Date water levels measured	Difference in head (ft)[a]	Gradient
A-AX	E25-2, E24-19	6/23/95	0.38	0.0005
B-BX-BY	E33-33, E33-32	7/25/95[c]	0.15	0.00008
C	E27-7, E27-12	6/23/95	0.19	0.0003
S-SX	W23-14, W22-46	6/21/95	1.85	0.002
T	W10-16, W11-27	6/20/95	0.47	0.0006
TX-TY	W15-22, W10-17	6/20/95	2.21	0.0009
U[b]	W18-25, W18-30	6/21/95	0.52	0.0007

[a] Measurements are made in feet and fractions thereof and are therefore reported in those units. To convert feet to meters, divide by 3.28.

[b] The direction of groundwater flow beneath WMA U has changed. Water level data for the period June through September 1995 indicate that groundwater is flowing approximately south-southwest. Borehole velocity flowmeter measurements in wells 299-W19-31 and 299-W19-32 in May 1995 measured a north-northwest direction of flow. The calculation of gradient here assumes a south-southwest flow, with well 299-W18-30 as the upgradient well. Water level data for September 1995 indicate a head difference of 0.22 ft between these two wells.

[c] Gradient was calculated from July 1995 water level measurements because of an error of unknown origin in June 1995 data.

Table 4.11-13. Groundwater Flow Velocities[a,b,c] Unconfined Aquifer Beneath Single-Shell Tank Waste Management Areas.

WMA	Well no.	Hydraulic conductivity (m/d [ft/d])	Hydraulic gradient	Effective porosity	Flow velocity (m/d [ft/d])
A-AX	E24-19	33.5 (110) 33.5 (110)	0.0005 0.0005	0.20 0.10	0.08 (0.28) 0.17 (0.55)
	E25-40	21.3 (70) 21.3 (70)	0.0005 0.0005	0.20 0.10	0.05 (0.18) 0.11 (0.35)
	E25-41	7.3 (24) 7.3 (24)	0.0005 0.0005	0.20 0.10	0.02 (0.06) 0.04 (0.12)
B-BX-BY	E33-33	97.5 (320) 97.5 (320)	0.00008 0.00008	0.20 0.10	0.04 (0.13) 0.08 (0.26)
C	E27-13	54.8 (180) 54.8 (180)	0.0003 0.0003	0.20 0.10	0.08 (0.27) 0.16 (0.54)
	E27-14	48.7 (160) 48.7 (160)	0.0003 0.0003	0.20 0.10	0.07 (0.24) 0.15 (0.48)
	E27-15	119 (390) 119 (390)	0.0003 0.0003	0.20 0.10	0.18 (0.56) 0.36 (1.17)
S-SX	W23-13	27.4 (90) 27.4 (90)	0.002 0.002	0.20 0.10	0.27 (0.9) 0.55 (1.8)
	W23-14	0.43 (1.4) 0.43 (1.4)	0.002 0.002	0.20 0.10	0.004 (0.01) 0.009 (0.03)
T	W10-15	10.1 (33) 10.1 (33)	0.0006 0.0006	0.20 0.10	0.03 (0.1) 0.06 (0.2)
	W10-16	10.1 (33) 10.1 (33)	0.0006 0.0006	0.20 0.10	0.03 (0.1) 0.06 (0.2)
TX-TY	W15-22	15.2 (50) 15.2 (50)	0.0009 0.0009	0.20 0.10	0.07 (0.23) 0.14 (0.45)
	W10-18	54.8 (180) 54.8 (180)	0.0009 0.0009	0.20 0.10	0.25 (0.81) 0.49 (1.8)
U	W18-25	6.1 (20) 6.1 (20)	0.0007 0.0007	0.20 0.10	0.02 (0.07) 0.04 (0.14)
	W19-31	36.6 (120) 36.6 (120)	0.0007 0.0007	0.20 0.10	0.13 (0.42) 0.26 (0.84)

[a] Calculated using: $v = Ki/n$, where K = hydraulic conductivity, i = gradient, n = effective porosity, and Equation 1.

[b] Hydraulic conductivities were calculated from results of slug tests performed in wells indicated (Newcomer et al. 1990). Connelly et al. (1992b) found that hydraulic conductivities determined from slug tests may be an order of magnitude too low compared with hydraulic conductivities calculated from constant discharge tests.

[c] All of these wells are completed as 4-in. wells with stainless steel screens (0.10 or 0.20 slot) in the uppermost part of the unconfined aquifer beneath each site. Most 200 East Area wells are completed in the Hanford formation; most 200 West Area wells are completed in the Ringold Formation.

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5.1 NONRADIOACTIVE DANGEROUS WASTE LANDFILL

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The Nonradioactive Dangerous Waste Landfill (NRDWL) is a 4-ha (10-acre) inactive dangerous waste landfill located approximately 5.5 km (3.5 mi) southeast of the 200 East Area (see Figure 1-1, Chapter 1.0).

5.1.1 Facility Overview

The NRDWL, part of the Central Landfill Complex, which also includes the adjacent Solid Waste Landfill (SWL), received dangerous nonradioactive waste from 1975 to 1985. The NRDWL continued to receive asbestos waste until 1988 (DOE-RL 1990). It was agreed in 1989, as part of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1994), to close the NRDWL under the appropriate Washington State dangerous waste regulations (*Washington Administrative Code* [WAC] 173-303). The NRDWL is part of the 200-IU-3 operable unit, which also includes the adjacent SWL. A closure/postclosure plan was submitted to the Washington State Department of Ecology (Ecology) in 1990 (DOE-RL 1990). Groundwater monitoring at the NRDWL is controlled by the NRDWL groundwater monitoring plan (WHC 1993b).

An indicator parameter evaluation groundwater monitoring program was initiated at the NRDWL in late 1986 and early 1987 under interim-status regulations (40 CFR 265, Subpart F) as a result of an Ecology compliance order (Ecology and EPA 1986). Site characterization and establishment of the groundwater monitoring program are described in Weekes et al. (1987). Quarterly sampling at the NRDWL was concluded in the fourth quarter of 1989 and the initial monitoring network is currently on a semiannual sampling schedule. Quarterly sampling for the two monitoring wells completed in October 1992 (WHC 1993a) was completed in November 1993. The groundwater monitoring network for the NRDWL is shown in Figure 5.1-1.

The NRDWL lies above approximately 180 m (600 ft) of suprabasalt sediments consisting of the Hanford and Ringold Formations. The Hanford formation beneath the site consists of sands and gravels, with sands predominant near the surface and gravels dominating the deeper portions of the formation (Figure 5.1-2). Thin, discontinuous silt layers as well as clastic dikes are common in the upper part of the formation (Weekes et al. 1987). The water table occurs at a depth of approximately 38 m (125 ft) and approximately 18 m (60 ft) of Hanford formation is saturated. The deepest well at the NRDWL penetrated to a depth of 78 m (255 ft), bottoming in the top of Ringold Formation unit E (see Chapter 2.0). The upper Ringold Formation contains a thin, clay, silt-rich layer that may be locally confining (Weekes et al. 1987) and the two deep wells are screened immediately above that interval. The general stratigraphy of the sediments beneath the landfill is presented in Figure 5.1-2, and a more complete presentation of 600 Area geology and hydrology is presented in DOE-RL (1994a).

5.1.2 Summary of 1995 RCRA Activities

Scheduled semiannual sampling of the monitoring network was carried out in March and August of 1995.

Water levels were determined in all of the monitoring wells as part of the routine samplings in March and August of 1995. Water level determinations were carried out monthly throughout 1995 for all monitoring wells in the network.

The 1995 analytical results and water table elevation measurements for the NRDWL groundwater monitoring network are reported in RCRA quarterly reports (DOE-RL 1995b,1995c, 1995d, 1996).

5.1.3 Sampling and Analysis Program

The monitoring network at the NRDWL consists of nine wells, seven completed in late 1986 and early 1987, and two completed in 1992 (see Figure 5.1-1, WHC 1993a). There are three upgradient wells. Two of the upgradient wells (699-26-35A and 699-26-34A) are completed in the top of the saturated zone, at a depth of approximately 45 m (145 ft), in the Hanford formation. One upgradient well (699-26-35C) is completed immediately above a low permeability unit in the upper part of the Ringold Formation, approximately 21 m (70 ft) beneath the water table. There are six downgradient wells. Five of the downgradient wells (699-26-33, 699-26-34B, 699-25-34A, 699-25-34B, and 699-25-34D) are completed in the top of the saturated zone, at a depth of approximately 45 m (145 ft), in the Hanford formation. One downgradient well (699-25-33A) is completed immediately above a low-permeability unit in the upper part of the Ringold Formation, approximately 21 m (70 ft) beneath the water table. Monitoring well descriptions are provided in Table 5.1-1.

The NRDWL monitoring network is on a semiannual sampling schedule as required by 40 CFR 265. The constituent list (Table 5.1-2) for analysis consists of the contamination indicator parameters, the interim primary drinking water parameters, and the groundwater quality parameters. In addition, the list of analyses includes volatile halogenated hydrocarbons and tritium. Halogenated hydrocarbons were added to the constituent list both because of their presence at the adjacent SWL (Section 5.1.5) and because of their potential as contaminants from waste in the NRDWL. Tritium was added to the constituent list in 1989 to help determine groundwater flow directions and flow rates at the site. Tritium and elevated nitrate concentrations in groundwater at the NRDWL have sources in the 200 Areas.

5.1.4 Groundwater Chemistry

The following discussion concentrates on the contamination indicator parameters, tritium, nitrate, and chlorinated hydrocarbons. The indicator parameters are monitored because they are required by *Resource Conservation and Recovery Act of 1976* (RCRA) regulations; nitrate and tritium, which have an upgradient source, because of their potential role as groundwater tracers;

and chlorinated hydrocarbons because they may represent, to some extent, groundwater contamination originating from the NRDWL.

5.1.4.1 Constituents of Concern. Field pH values in shallow downgradient wells ranged from 7.5 to 8.0, while values in the shallow upgradient wells ranged from 7.4 to 8.2. pH values in the two deeper wells tended to be slightly higher, ranging from 8.0 to 8.3.

Field conductance values for the shallow downgradient wells ranged from 431 to 541 μmho/cm. Values for the upgradient wells ranged from 444 to 453 μmho/cm. Values for the deep upgradient well ranged from 370 to 417 μmho/cm and for the deep downgradient well from 330 to 332μmho/cm.

Concentrations for total organic carbon reported for the March 1995 sampling ranged from less than 110 to 225 ppb. Reported concentrations for the August 1995 sampling ranged from 155 to 250 ppb.

Reported values for total organic halogen (TOX) for the February 1995 sampling ranged from 6.9 to 11.4 ppb in the shallow downgradient wells and from 6.3 to 9.8 in the shallow upgradient wells. The value is 8.2 ppb for the deep upgradient well and 5.2 ppb for the deep downgradient wells. Reported values for the August 1995 sampling were all less than 6.9 ppb. The lower TOX values for August 1995 may be a result of laboratory bias. The two sets of analyses were done in different laboratories and the laboratory responsible for the August set has been consistently low on its TOX performance evaluation (PE) samples (see Appendix A, Section A.2).

Nitrate and tritium in the groundwater beneath the NRDWL are elevated as a result of plumes originating in the 200 East Area and moving to the southeast beneath the NRDWL. Nitrate values in the shallow monitoring wells, from February 1995 to August 1995, ranged from 23,000 to 26,000 ppb. Nitrate values in deep upgradient well 699-26-35C ranged from 23,000 to 24,000 ppb; nitrate values in deep downgradient well 699-25-33A ranged were 3,700 ppb for both analyses. Groundwater nitrate concentrations since 1987 are illustrated in Figure 5.1-3.

From February 1995 to August 1995, tritium values in shallow monitoring wells ranged from 118,000 to 179,000 pCi/L. Tritium concentrations in deep upgradient well 699-26-35C ranged from 39,200 to 45,300 pCi/L; deep downgradient well 699-25-33A concentrations ranged from 362 to 366 pCi/L. These tritium concentrations, with the exception of values from deep downgradient well 699-25-33A, exceed the primary groundwater standard of 20,000 pCi/L. The peak of a tritium pulse apparently has passed beneath the site (see Section 5.2.6) and tritium concentrations are currently declining (Figure 5.1-4).

Five chlorinated hydrocarbons have been detected in groundwater at the NRDWL during the period from February 1995 through August 1995; however, none exceeded U.S. Environmental Protection Agency drinking water standards. Chlorinated hydrocarbons with concentrations above detection limits are 1,1,1-trichloroethane (0.24 to 2.35 ppb), trichloroethylene (<0.08 to 0.57 ppb), tetrachloroethene (0.04 to 1.75 ppb), carbon tetrachloride (<0.04 to 2.0 ppb), and chloroform (<0.03 to 0.09 ppb).

1,1,1-trichloroethane and trichloroethylene are believed to be present in groundwater at the NRDWL principally as a result of vadose zone vapor transport from the adjacent SWL; however, a contribution from the NRDWL cannot be ruled out. Tetrachloroethene is present in vadose gas beneath the SWL and is the principal vadose gas contaminant around the chemical disposal trenches at the NRDWL; thus, there may be contributions from both sources. Carbon tetrachloride and chloroform may be a result of vadose zone contamination at the NRDWL. Distributions of chlorinated hydrocarbon concentrations along the compliance point boundaries of the NRDWL and SWL are presented in Section 5.2.5.2.

5.1.4.2 Statistical Evaluation. Statistical evaluations of data for this year at the NRDWL consisted of the required comparisons between upgradient and downgradient wells for any indication of contamination in the groundwater underlying the facility. Statistical methods are described in Appendix C. Statistical analyses required by 40 CFR 265.93(b) and WAC 173-303-400 were performed on background samples collected from November 1987 to July 1988; the results are presented in Table 5.1-3. This table lists the background average, background standard deviation, critical mean (or critical range, in the case of pH), and the upgradient/downgradient comparison values for the four contamination indicator parameters from the upgradient wells. The upgradient/downgradient comparison value is the value to which current and future averages of quadruplicate measurements are compared and is, in most cases, the critical mean or critical range. For the NRDWL, the calculated critical range for pH is so large that it is meaningless. An alternative range for upgradient/downgradient comparisons was calculated by using upgradient data collected from November 1987 to June 1992.

If the average constituent concentration for a downgradient well exceeds the upgradient/downgradient comparison value listed in Table 5.1-3, that parameter is considered statistically different from background. If the value is confirmed by subsequent verification sampling and analysis, the regulatory program is triggered into assessment.

Values for field pH, specific conductance, total organic carbon, and total organic halogen were all below their upgradient/downgradient comparison values for the sampling period.

5.1.5 Groundwater Flow

In addition to water table elevations determined at the time of groundwater sampling, regular measurements were made for all wells on a monthly schedule during 1995. The discussions of water table elevations, groundwater flow directions, and groundwater flow velocities are based on the regular monthly measurements. The 1995 water level measurements for the NRDWL monitoring network were reported in RCRA quarterly reports.

The NRDWL lies in a zone of very high transmissivity (Jacobson and Freshley 1990) and as a result there is a very low hydraulic gradient across the site. A map of the water table in the vicinity of the site, based on June 1995 data, is presented in Figure 5.1-5. This map illustrates the low hydraulic gradients in the vicinity of the NRDWL.

The water table in the vicinity of the NRDWL has apparently dropped approximately 1.5 m (5 ft) since December 1988; however, the exact decrease is difficult to estimate because of the scatter in the water level data. Data from the adjacent SWL, which shows much less scatter, indicates a considerable slowing in water table decrease and a drop of approximately 1.4 m (4 ft) over the same time interval (Section 5.2). This decrease in water table elevation, apparently a result of decreased water input to the 216-B-3 Pond, is illustrated in Figure 5.1-6, which shows hydrographs of the NRDWL wells based on monthly water level measurements.

The reason for the degree of scatter in the NRDWL water level data is uncertain. Water levels at the NRDWL and SWL are measured by the same people, using the same equipment and techniques; therefore measurement error does not seem likely. The case against measurement error is reinforced by the much lower variability in the two deep wells at the NRDWL, which were measured at the same time. It seems that the effect is real; however, the cause, whether aquifer inhomogeneity or some other effect, is unknown.

5.1.5.1 Groundwater Flow Directions. Hydraulic gradients across the NRDWL are on the order of 0.0001, yielding water level differences across the site that are well within the envelope of surveying and measurement error. In past years average groundwater flow directions could be estimated on the basis of water level measurements; however, the large scatter in groundwater elevation data have made this impossible for 1994 and 1995.

Groundwater flow directions, previously calculated from regular water level measurements for wells 699-26-35A, 699-26-33, and 699-25-34B have provided relatively consistent average flow direction, 62 ±10° east of north (DOE-RL 1994a), 65 ±20° east of north (DOE-RL 1991), and 67 to 90° east of north (Weekes et al. 1987). These values are in poor agreement with the groundwater flow direction of approximately 125° east of north, indicated by the nitrate and tritium plumes that pass through the area (DOE-RL 1991) and regional water table maps. The difference in flow directions indicated by the two techniques may indicate well survey problems; however, a resurvey by Kaiser Engineers Hanford in 1991 resulted in no significant change in well elevations.

Two well pairs (699-25-34A/699-25-33A and 699-26-35A/699-26-35C) sample the top of the unconfined aquifer and the top of the Ringold Formation. The lack of a detectable head difference in these well pairs indicates that any vertical gradient within the upper portion of the aquifer is quite small.

5.1.5.2 Rate of Flow. The rate of groundwater flow beneath the NRDWL is highly uncertain. The aquifer beneath the NRDWL is characterized by high hydraulic transmissivity and very low gradients. On the basis of site-specific aquifer testing and the observed hydraulic gradients, the expected groundwater velocities, based on Darcy law calculations, should be on the order of 1.2 to 1.8 m/d (4 to 6 ft/d) (Weekes et al. 1987). However, more direct velocity indicators, as discussed in the following paragraphs, indicate a range of much higher values.

Transport velocities in the 200 East Area, identified by contaminant transport within the Hanford formation, indicate groundwater flow velocities from 3 to 4.3 m/d (10 to 14 ft/d) (Wilber et al. 1983). Tracer tests in the area southeast of the 200 East Area indicated groundwater velocities in excess of 30 m/d (100 ft/d); however, they occurred at higher hydraulic gradients than exist today (Bierschenk 1959).

Tracking of the present tritium and nitrate plumes from wells several kilometers upgradient from well 699-24-33, which is located approximately 150 m (500 ft) east of the SWL, indicates contaminant transport rates of approximately 6 m/d (20 ft/d). Additional information on flow rate is provided by the recent decrease in nitrate and tritium concentrations across the site. Nitrate and tritium, which have upgradient sources, exhibit nearly identical time-concentration variation in upgradient and downgradient well pairs with quarterly sampling (see Section 5.2.6.2). This indicates that the time required for the contaminants to traverse the site is on the order of 3 months. This traverse time indicates groundwater transport rates of approximately 5.5 m/d (18 ft/d). The actual transport rate is probably controlled by zones of very high groundwater velocity within the Hanford formation that are missed or averaged out in normal aquifer testing.

5.1.5.3 Evaluation of Monitoring Well Network. The uncertainty in groundwater flow directions beneath the NRDWL makes the evaluation of the monitoring network more difficult. If the groundwater flows toward the southeast, as indicated by the nitrate and tritium plumes, the boundary between the NRDWL and SWL should be part of the compliance point. If the groundwater flows in a east-northeast direction, as indicated by the water level data, the northern boundary of the site should be part of the compliance point. The two monitoring wells along the north and south boundaries of the NRDWL, completed in 1992, solve this problem and provide Monitoring Efficiency Model (Jackson et al. 1991) efficiencies between 96 and 99%, depending on groundwater flow directions. The current shallow monitoring network is adequate; however, deep characterization and monitoring, as called for in the NRDWL groundwater monitoring plan (WHC 1993b), is still needed to fully characterize the aquifer beneath the site.

5.1.6 References

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Figure 5.1-1. Map of the Nonradioactive Dangerous Waste Landfill and Solid Waste Landfill Showing the Locations of Groundwater Monitoring Wells.

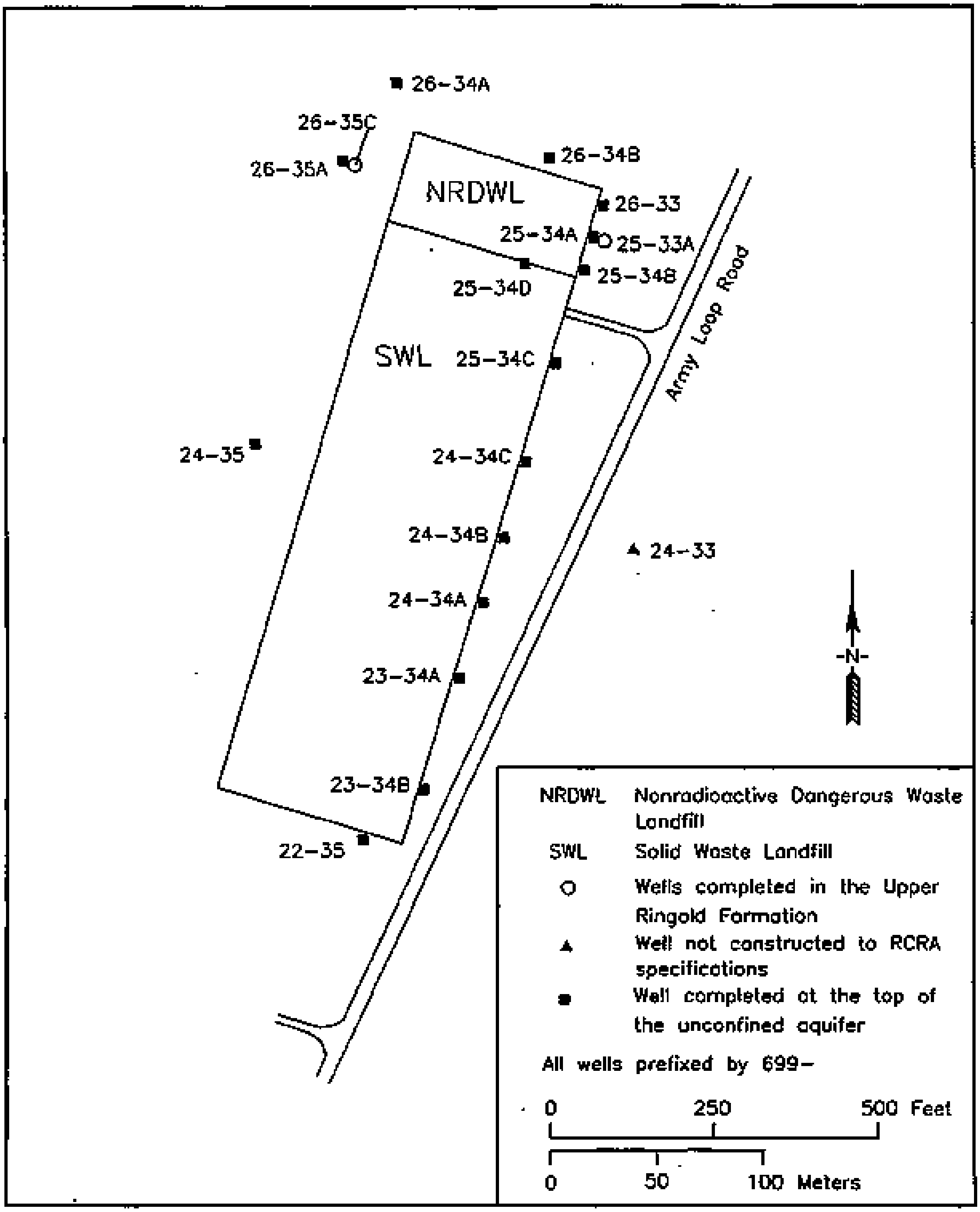

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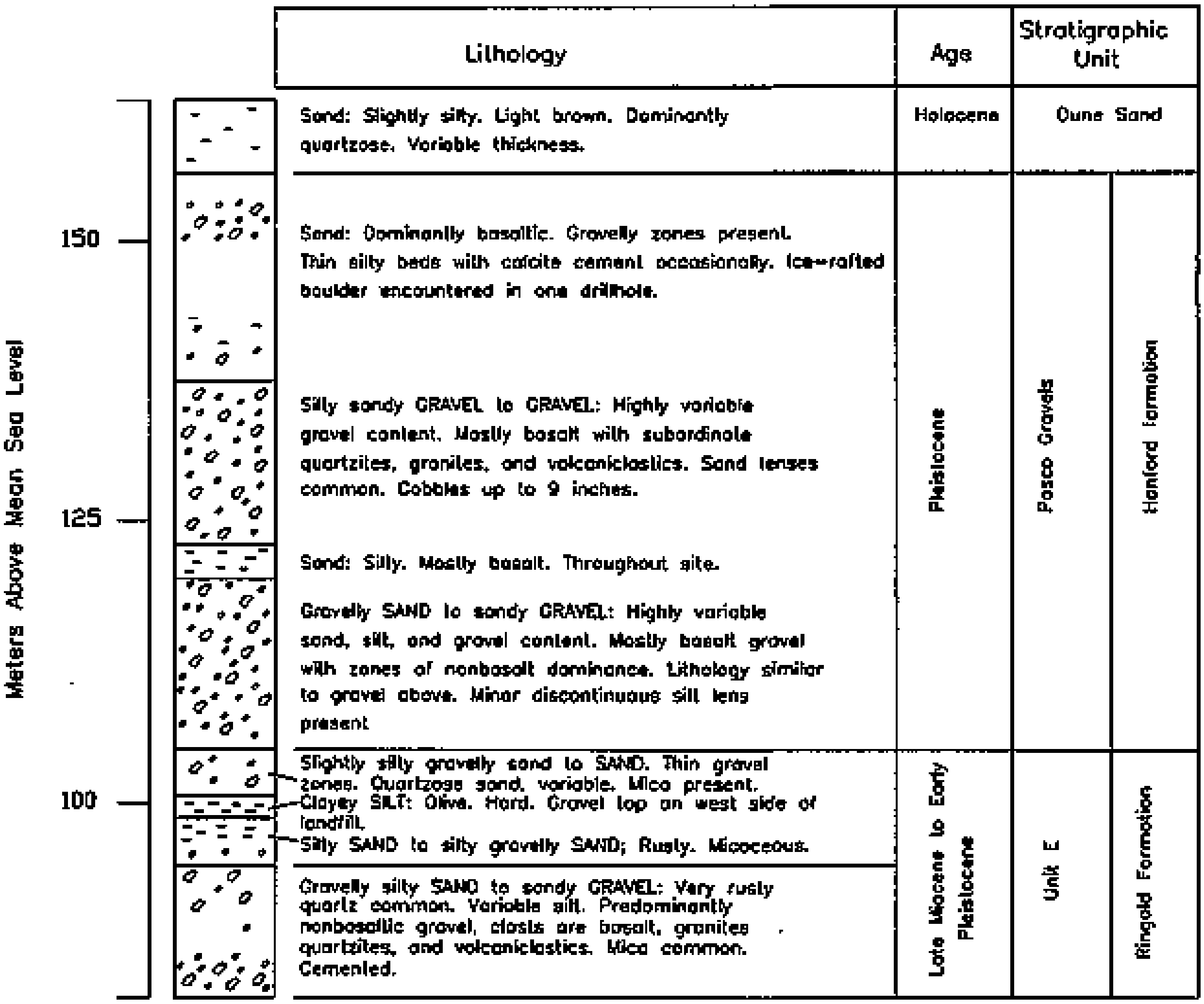
Figure 5.1-2. Generalized Stratigraphic Column for the Nonradioactive Dangerous Waste Landfill (modified from Weekes et al. 1987).



Lithology	Age	Stratigraphic Unit	
Sand: Slightly silty. Light brown. Dominantly quartzose. Variable thickness.	Holocene	Dune Sand	
Sand: Dominantly basaltic. Gravelly zones present. Thin silty beds with calcite cement occasionally. Ice-rafted boulder encountered in one drillhole.	Pleistocene	Pasco Gravels	Hanford formation
Silty sandy GRAVEL to GRAVEL: Highly variable gravel content. Mostly basalt with subordinate quartzites, granites, and volcaniclastics. Sand lenses common. Cobbles up to 9 inches.			
Sand: Silty. Mostly basalt. Throughout site.			
Gravelly SAND to sandy GRAVEL: Highly variable sand, silt, and gravel content. Mostly basalt gravel with zones of nonbasalt dominance. Lithology similar to gravel above. Minor discontinuous silt lens present			
Slightly silty gravelly sand to SAND. Thin gravel zones. Quartzose sand, variable. Mica present.	Late Miocene to Early Pleistocene	Unit E	Ringold Formation
Clayey SILT: Olive. Hard. Gravel top on west side of landfill.			
Silty SAND to silty gravelly SAND; Rusty. Micaceous.			
Gravelly silty SAND to sandy GRAVEL: Very rusty quartz common. Variable silt. Predominantly nonbasaltic gravel, clasts are basalt, granites quartzites, and volcaniclastics. Mica common. Cemented.			

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Figure 5.1-3. Time Series Plot of Nitrate Concentrations (ppb) in Shallow Monitoring Wells at the NRDWL.

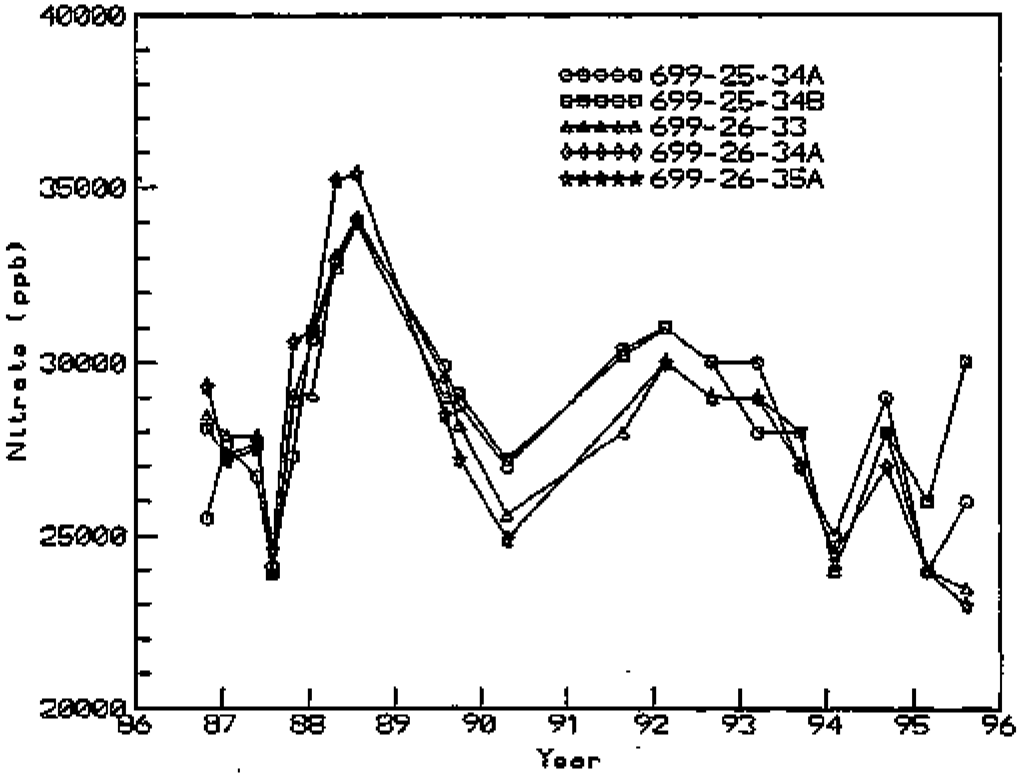


Figure 5.1-4. Time Series Plot of Tritium Concentrations (pCi/L) in Shallow Monitoring Wells at the NRDWL.

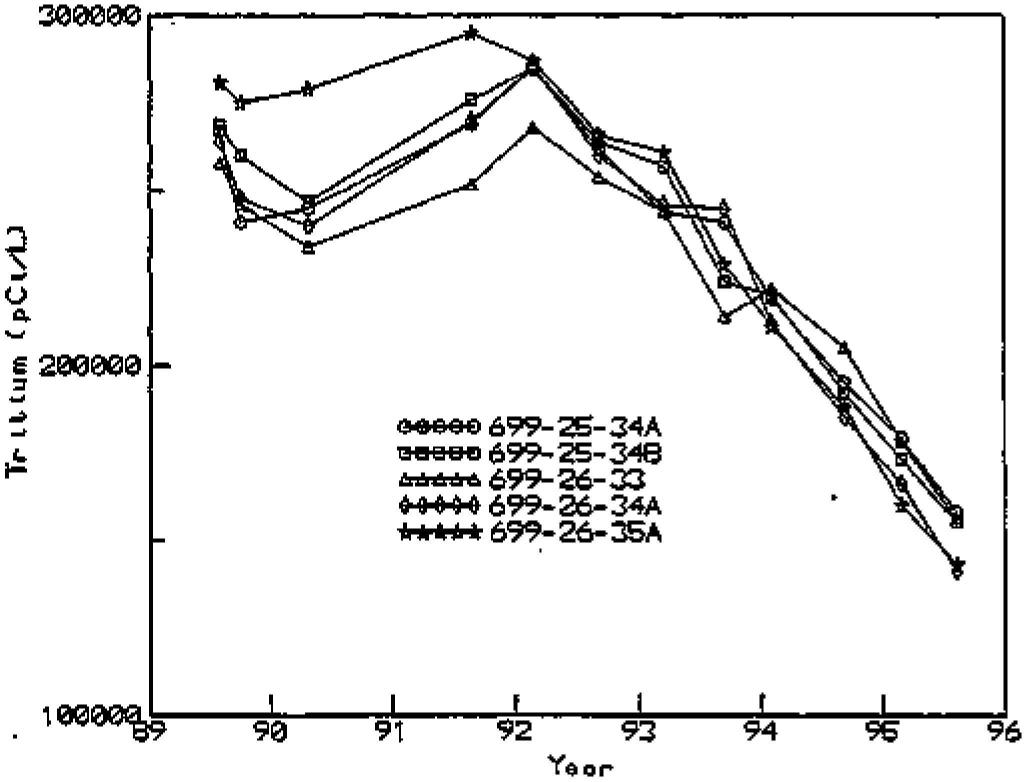


Figure 5.1-5. Water Table Map (Potentiometric Surface) for the Vicinity of the Nonradioactive Dangerous Waste Landfill Based on June 1995 Water Level Measurements (Datum is Mean Sea Level).

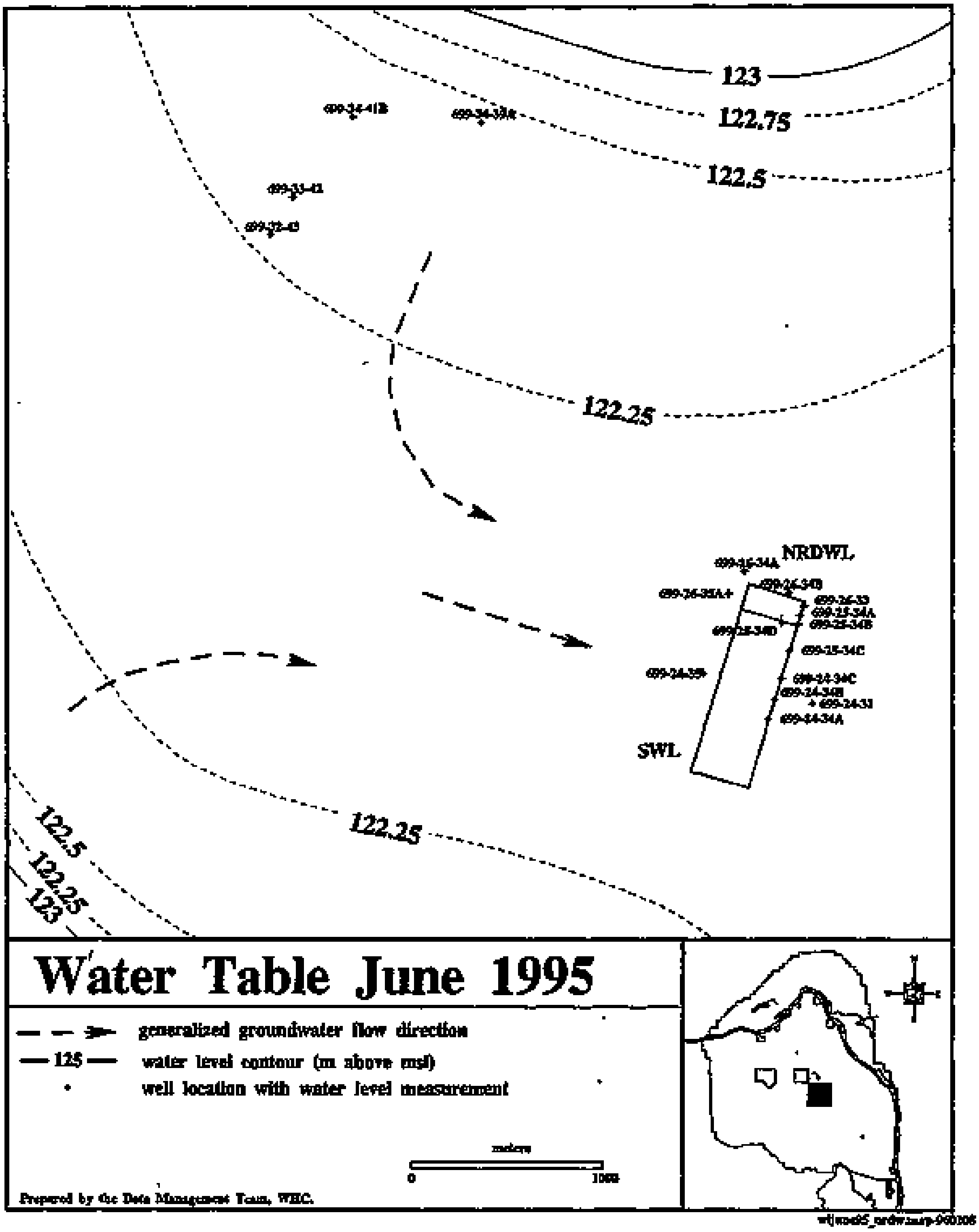
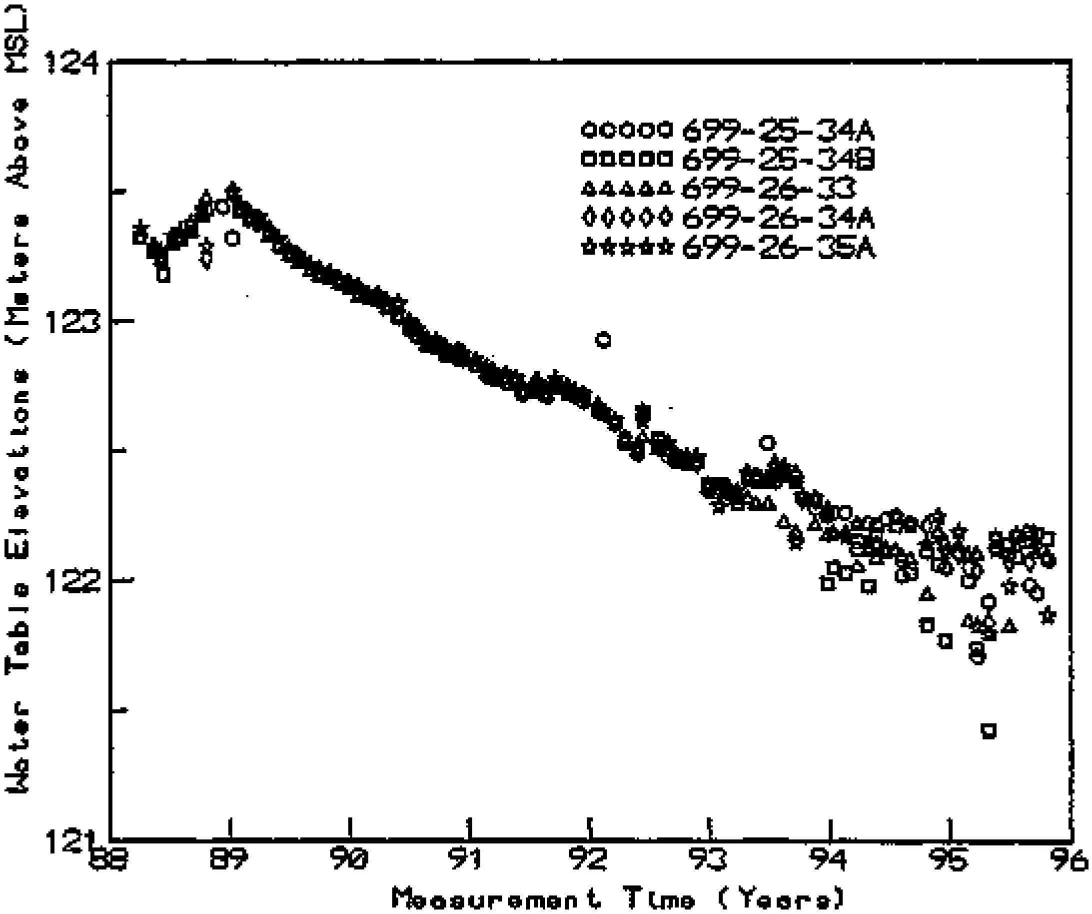


Figure 5.1-6. Hydrographs of Monthly Water Level Measurements (Meters Above Mean Sea Level) at the Nonradioactive Dangerous Waste Landfill.



organic

Table 5.1-1. Monitoring Wells Used for the Nonradioactive Dangerous Waste Landfill.

Well	Aquifer	Sampling frequency	Water levels	Well standard	Other networks
699-26-33^{86}	Top of unconfined	SA	M	RCRA	--
699-26-34A	Top of unconfined	SA	M	RCRA	--
699-26-34B^{92}	Top of unconfined	Q	M	RCRA	--
699-26-35A^{86}	Top of unconfined	SA	M	RCRA	SWL
699-26-35C^{87}	Top of LPU[a]	SA	M	RCRA	--
699-25-33A^{87}	Top of LPU[a]	SA	M	RCRA	--
699-25-34A^{86}	Top of unconfined	SA	M	RCRA	--
699-25-34B^{86}	Top of unconfined	SA	M	RCRA	--
699-25-34D^{92}	Top of unconfined	Q	M	RCRA	--

Notes: Shading denotes upgradient wells. Superscript number following well number denotes the year of installation.

[a] Low permeability unit in the upper Ringold Formation.

LPU = low permeability unit.
M = sampled or measured on a monthly basis.
Q = sampled or measured on a quarterly basis.
RCRA = well is constructed to RCRA-specified standards.
SA = sampled or measured on a semiannual basis.
SWL = Solid Waste Landfill.

Table 5.1-2. Constituent List for the Nonradioactive Dangerous Waste Landfill.

Contamination indicator parameters		
pH Specific conductance	Total organic carbon Total organic halogen	
Groundwater quality parameters		
Chloride	Manganese	Sodium

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5.2 SOLID WASTE LANDFILL

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The Solid Waste Landfill (SWL) is a disposal facility whose current activities are regulated under *Washington Administrative Code* (WAC) 173-304, "Minimum Functional Standards for Solid Waste Handling." The SWL is not a *Resource Conservation and Recovery Act of 1976* (RCRA) site and is included here for completeness. A permit application for operation of the site under WAC 173-304 was submitted to the Benton-Franklin District Health Department in 1991 (DOE-RL 1991a). Responsibility for the site was subsequently assumed by the Washington State Department of Ecology (Ecology) and a revised permit application was submitted to Ecology in 1993 (DOE-RL 1993b). As part of the permit review, Ecology requested that a corrective action program be established for the site. A corrective action plan (Hodges 1994) was submitted to Ecology in November 1994.

5.2.1 Facility Overview

The SWL is a 27-ha (66-acre) landfill facility located approximately 5.6 km (3.5 mi) southeast of the 200 East Area (see Figure 1-1, Chapter 1.0). The SWL, along with the adjacent Nonradioactive Dangerous Waste Landfill (NRDWL), are parts of the old Central Landfill Complex; however, the two facilities are now considered separately under different regulations. The SWL has been in operation since 1972 and has received principally solid waste including paper waste, construction debris, asbestos waste, and lunchroom waste. In addition to the solid waste, an estimated 3,800,000 to 5,700,000 L (1 to 1.5 Mgal) of sewage waste were discharged to trenches along the east and west sides of the SWL between 1975 and 1987, and approximately 380,000 L (100,000 gal) of Hanford Site bus-garage washwater was discharged to three short trenches along the west side of the site between 1985 and 1987. The present groundwater monitoring program was initiated in 1987 (Fruland et al. 1989). Current groundwater monitoring of the landfill is regulated under WAC 173-304 and is controlled by the SWL groundwater monitoring plan (WHC 1993). The stratigraphy of the Central Landfill Complex, including the SWL, is indicated in Figure 5.1-2. The geology and hydrology of the 600 Area are described in more detail in DOE-RL (1994).

5.2.2 Summary of 1995 Groundwater Monitoring Activities

Quarterly sampling of the groundwater monitoring network was carried out in November 1994 and March, May, and August 1995. Water level measurements were made in conjunction with the scheduled sampling. In addition, water level measurements were carried out monthly throughout the year.

5.2.3 Other Activities in 1995

A corrective action plan for the SWL (Hodges 1994) was approved by Ecology. At the same time, because of evidence that the SWL is contaminating groundwater, Ecology directed the U.S. Department of Energy, Richland

Operations Office (RL) to either line all future trenches or close the landfill. RL opted to close the landfill by March 1996. RL has since told Ecology that funding is not available for closure activities or corrective action at the SWL. Negotiation between Ecology and DOE/RL will determine the future course of action at the site.

5.2.4 Sampling and Analysis Program

The monitoring network at the SWL consists of two upgradient and seven downgradient, compliance-point wells (Figure 5.2-1). The monitoring wells are RCRA compliant with stainless steel casings and screens. The wells were completed at depths of approximately 44 m (145 ft) with screened intervals of 4.6 m (15 ft). The bottoms of the screens were set at 3 m (10 ft) below the water table (Fruland et al. 1989). Two wells completed in late 1993 were set with 10.7-m (35-ft) screens to allow for the expected decline in the water table. The wells are all equipped with HydroStar[1] pumps.

In addition, NRDWL upgradient well 699-26-35A is being monitored as an upgradient well for the SWL and an older non-RCRA well (699-24-33), located approximately 150 m (500 ft) east of the SWL, is sampled for indication of trends in groundwater chemistry and historical continuity. A description of the SWL monitoring wells is provided in Table 5.2-1.

The SWL is on a quarterly sampling program as required by WAC 173-304. The constituent list for analysis (Table 5.2-2) consists of the constituents and parameters required by WAC 173-304-490, volatile chlorinated hydrocarbons, tritium, and other constituents to aid in interpretation of groundwater chemistry.

5.2.5 Groundwater Chemistry

This section discusses the constituents required by WAC 173-304: chlorinated hydrocarbons, which are site-specific constituents, and tritium, which is monitored to provide information on groundwater flow direction and flow rate.

5.2.5.1 Constituents of Concern. Available analytical results for groundwater sampling events from November 1994 through August 1995 are presented in Appendix 5.2A. A summary of results for all required monitoring parameters is provided in Table 5.2-3. Results for chlorinated hydrocarbons are presented in Table 5.2-4. This section discusses the concentration ranges of constituents in downgradient wells and compares them to the tolerance interval values calculated in Section 5.2.5.3, where appropriate. Interpretations are provided in Section 5.2.5.2.

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[1] HydroStar is a registered trademark of Instruments Northwest, Inc.

5.2.5.1.1 Temperature. Average values for replicate temperature determinations measured during sampling range from 17.4 to 19.8 °C (63 to 67 °F). All measurements for the year are below the tolerance interval of 21 °C (70 °F). There is a tendency for the higher temperatures to occur at the north end of the site, near the axis of the tritium and nitrate plumes.

5.2.5.1.2 Conductivity. Average values for replicate conductivity measurements carried out during sampling range from 550 to 797 µmho/cm. Replicate averages for monitoring wells 699-22-35 and 699-23-34B exceed the Ecology Secondary Standard for "Public Water Supplies" (WAC 248-54) of 700 µmho/cm for all samplings. The tolerance interval value of 550 µmho/cm was exceeded for all samples from downgradient wells, with the exception of the March 1995 sampling of well 699-25-34C, which equalled the tolerance interval value.

5.2.5.1.3 pH. Average values for replicate pH measurements in downgradient wells, made at the time of sampling, range from 6.4 to 7.4. None of the pH measurements exceed the tolerance interval range of 6.2 to 8.5. As in the past, the lower values tend to occur in the southernmost downgradient monitoring wells.

5.2.5.1.4 Chloride. Chloride concentrations in downgradient wells range from 6,100 to 7,400 ppb during the reporting period. The tolerance interval value of 9,045 ppb was not exceeded during this period. There is a tendency for the higher values to occur in the northernmost wells.

5.2.5.1.5 Nitrate. Nitrate concentrations in the downgradient monitoring wells at the SWL range from 11,000 to 25,000 ppb for the reporting period. During this period the reported nitrate concentrations exceeded neither the tolerance interval concentration of 33,800 ppb nor the Ecology groundwater protection standard (WAC 173-200) of 45,000 ppb. The highest nitrate concentrations occur in the northernmost wells.

5.2.5.1.6 Nitrite. All nitrite analytical results are nondetects, reported as either <18 or <140 ppb for the reporting period.

5.2.5.1.7 Ammonium. Most results are nondetects, reported as <27 or <37 ppb. However, isolated values, ranging from 30 to 70 ppb were reported for both upgradient and downgradient wells.

5.2.5.1.8 Sulfate. Reported sulfate concentrations in downgradient wells range from 32,000 to 55,000 ppb for this reporting period. One sample, from the May sampling of well 699-22-35, exceeded the tolerance interval value of 51,500 ppb. None of the samples exceeded the Ecology groundwater protection standard of 250,000 ppb (WAC 173-200). There is a strong tendency for the highest sulfate concentrations to occur in the southernmost wells.

5.2.5.1.9 Dissolved Iron. Reported values for filtered iron in downgradiant wells range from <15 to 65 ppb during the reporting period. Reported filtered iron concentrations did not exceed the tolerance interval concentration of 78 ppb during the reporting period.

5.2.5.1.10 Dissolved Manganese. Filtered manganese results range from <0.55 to 4.7 ppb for the reporting period. None of the reported manganese concentrations exceeded the tolerance interval concentration of 11 ppb or the Ecology groundwater protection standard of 50 ppb.

5.2.5.1.11 Dissolved Zinc. Reported values for filtered zinc range from <3.7 to 28 ppb for the reporting period. Reported concentrations for filtered zinc did not exceed the tolerance interval concentration of 34 ppb or the Ecology groundwater protection standard of 5,000 ppb during the reporting period.

5.2.5.1.12 Chemical Oxygen Demand. Reported values for chemical oxygen demand are all below the method detection limit of 2.9 ppb and the tolerance interval concentration of 3 ppm for the reporting period.

5.2.5.1.13 Total Organic Carbon. Average (of replicates) total organic carbon (TOC) concentrations range from <110 to 300 ppb. The reported values do not exceed the tolerance interval concentration of 976 ppb.

5.2.5.1.14 Total Coliform. All reported values for total coliform are nondetects for this reporting period, reported as either <1 or <3.7 colony/100 mL.

5.2.5.1.15 Total Organic Halogen. TOX values range from <7 to 40 ppb (see Table 5.2-4). The analyses for the November 1994 and March 1995 are consistent with previous analyses; however, those for May and August 1995 are consistently lower. The low values reported for May and August may be a result of laboratory bias. The two sets of analyses were carried out at different laboratories and the laboratory responsible for the May and August results has returned low results for TOC performance assessment (PE) samples on previous occasions.

5.2.5.1.16 Chlorinated Hydrocarbons. Chlorinated hydrocarbons have been detected at the SWL in low concentrations (see Table 5.2-4). These include 1,1,1-trichloroethane (111-TCA), trichloroethene (TCE), tetrachloroethene (PCE), and 1,1-dichloroethane (11-DCA). Several of these constituents occur in low concentrations in the upgradient wells; however, the highest concentrations consistently occur in the downgradient wells, particularly toward the south end of the landfill. The trend of southward-increasing concentrations apparent in historical data is continued by concentration data for 111-TCA, TCE, and 11-DCA in the two new downgradient wells at the south end of the landfill. However, concentrations of PCE are lower in the two new wells.

Low concentrations of chloroform (0.04 - 0.35 ppb) have been detected in all downgradient wells during this reporting period. Carbon tetrachloride has been detected in two downgradient and both upgradient wells; cis-1,2-dichloroethene has been detected in four downgradient wells.

Concentrations have declined since the first detection of chlorinated hydrocarbon at the site; however, several of the constituents remain above the groundwater quality criteria (GWQC) set forth in WAC 173-200. The ranges of reported concentrations of chlorinated hydrocarbons at the SWL during this reporting period are given in Table 5.2-4. Reported concentrations for groundwater samples exceed the GWQC for PCE (0.8 ppb), 11-DCA (1 ppb), and carbon tetrachloride (0.3 ppb).

5.2.5.1.17 Tritium. Tritium was added to the SWL constituent list in 1989 as an aid in determining groundwater flow directions and flow rates at the SWL. Tritium concentrations in groundwater monitoring wells at the SWL have ranged from <56 to 218,000 pCi/L during the reporting period and are currently decreasing. The tritium concentrations in five SWL monitoring wells have been above the Washington State and U.S. Environmental Protection Agency primary drinking water standard (40 *Code of Federal Regulations* [CFR] 141) of 20,000 pCi/L during the current reporting period.

5.2.5.2 Interpretation of Groundwater Chemistry. Downgradient wells at the SWL have higher specific conductance, alkalinity, total carbon, and cation concentrations than upgradient wells. As indicated in DOE-RL (1991a, 1991b, 1992, 1993a, and 1994), this is believed to be a result of high vadose concentrations of carbon dioxide, resulting from the degradation of sewage material beneath the SWL. High vadose zone concentrations of carbon dioxide are indicated by the vadose zone gas surveys of Evans et al. (1989) and Jacques and Kerkow (1993). Solution of carbon dioxide in groundwater produces carbonic acid (H_2CO_3). Carbonic acid lowers groundwater pH, making it more reactive with aquifer materials. Reaction with aquifer materials, principally hydrolysis of silicates, results in the dissolution of cations with a resultant increase in groundwater pH. The aquifer materials in effect act as a pH buffer. The dissolution of carbon dioxide is indicated by concentrations of inorganic carbon (total carbon minus TOC) that are 30 to 40% higher in downgradient wells than in upgradient wells. At the ambient groundwater pH almost all of this inorganic carbon will exist in the form of the bicarbonate ion (HCO_3^-).

A number of chlorinated hydrocarbons have been detected in groundwater at the SWL, the most important being 111-TCA, PCE, TCE, and 11-DCA (see Table 5.2-4). 111-TCA occurs at the highest concentrations (Figure 5.2-2); however, it is far below the GWQC of WAC 173-200 (200 ppb). PCE occurs in the 1- to 4-ppb range (Figure 5.2-3), above the GWQC of 0.8 ppb in all downgradient wells. TCE occurs in the 1- to 3-ppb range (Figure 5.2-4) and is below the GWQC (3 ppb) for all wells in the downgradient network. 11-DCA occurs in the 0.5- to 5-ppb range (Figure 5.2-5) and has exceeded the GWQC (1 ppb) in all downgradient wells.

The southernmost monitoring wells at the SWL have had the highest concentrations of chlorinated hydrocarbons since the initiation of sampling in 1988. The concentrations generally increase from north to south along the line of downgradient wells, indicating that the highest source concentration is south of the area sampled by the southernmost downgradient well. This southward-increasing trend is extended by the two new downgradient wells for 111-TCA, TCE, and 11-DCA, but not for PCE. This demonstrates that the principal source for 11-TCA, TCE, and 11-DCA has probably migrated south of the SWL boundary. However, the principal source of PCE is probably still within the boundaries of the SWL.

The most likely cause of the widespread contamination with chlorinated hydrocarbons at the SWL, including upgradient wells and the adjacent NRDWL, is the dissolution of vadose zone vapors into groundwater. However, the source of the vadose zone vapors is somewhat uncertain. The source could be chlorinated hydrocarbons trapped within the vadose zone or dense nonaqueous phase liquids within the aquifer. Total inorganic carbon (total carbon minus

TOC) increases southward along with the chlorinated hydrocarbons. This correspondence suggests a link between the chlorinated hydrocarbon contaminants and the sewage waste, which is the most probable source of the elevated inorganic carbon in groundwater. Thus, the chlorinated hydrocarbons source(s) may be chlorinated hydrocarbons dissolved in sewage liquids that are migrating southward (down dip) along silt layers in the vadose zone.

In recent years the major concentration axes of the 200 East Area nitrate and tritium plumes have passed directly beneath the SWL (see figures 2-5 and 2-9). Tritium and nitrate concentrations in well 699-24-33, located approximately 150 m (500 ft) east (downgradient) of the SWL, are decreasing (Figure 5.2-6), indicating that a maximum in the plumes has passed beneath the SWL. This decrease in tritium concentrations is confirmed by reported concentrations in SWL monitoring wells. However, it also appears that the concentration axis of the tritium plume is shifting northward as it decreases (Figure 5.2-7), consistent with the plume interpretation presented by Dresel et al. (1994). This shift in plume axes is probably a result of decreasing effluent input to the 216-B-3 Pond (B Pond). Nitrate concentrations beneath the SWL exhibit a pattern similar to that of tritium and are currently decreasing.

5.2.5.3 Statistical Evaluation. Statistical evaluation of data consisted of the required comparisons between upgradient and downgradient wells for determining whether a significant change over background has occurred for constituents specified in WAC 173-304-490. WAC 173-304 does not require replicate analyses. Thus, the tolerance interval method, suitable for individual sample comparisons, was chosen because replicated analyses were not done for most of the constituents of concern. Statistical evaluations are described as follow.

Calculation of background summary statistics--Summary statistics were calculated using background samples for the site (DOE-RL 1993a, Appendix D, Table D10.1). The results are presented in Table 5.2-5. Some of the background data are below the contractual detection limits required of the U.S. Testing Company or below the contractually required quantitation limit. In cases where measured values are available (e.g., most of the TOC values), these values were used in calculating the summary statistics. In cases where the proportion of nondetects is between 15 and 50%, less-than values were replaced by half of their contractual detection limits and/or contractually required quantitation limits, and the usual calculations were performed (e.g., filtered iron). In cases where the proportion of nondetects is greater than 50%, summary statistics are not calculated (e.g., nitrite, ammonium, filtered zinc, filtered manganese, coliform, and chemical oxygen demand).

5.2.5.3.1 Testing the Assumption of Normality of Data. The tolerance interval defines a concentration range (from background well data) that contains at least a specified proportion (coverage) of the population with a specified probability (confidence level). There are two types of tolerance intervals: parametric and nonparametric. Parametric tolerance interval techniques are sensitive to the assumption that the data are drawn from a normal population. The statistical tests used for evaluating whether or not the data follow a specified distribution are called goodness-of-fit tests. The Lilliefors test is used to evaluate the fit of a hypothesized normal or lognormal distribution. Test procedures are described by Conover (1980).

STATGRAPHICS[1] (Version 4.2) was used to calculate the Lilliefors test statistics. If the data are not normal, the Lilliefors test was applied to the logarithm (natural logarithm) of the data to see if the transformed data are approximately normal. This is equivalent to testing the hypothesis that the concentration measurements follow a lognormal distribution. If the proportion of nondetects is more than 15%, a goodness-of-fit test is not performed and a nonparametric tolerance interval will be calculated to the extent possible.

Results of the Lilliefors test are presented in Table 5.2-6. Temperature, field pH, and chloride concentration measurements from background wells are approximately normally distributed. Specific conductance, TOC, nitrate, and sulfate concentrations are neither normal nor lognormal.

5.2.5.3.2 Establishing Background Levels. Tolerance intervals are constructed from the data on background wells. Both the upper and lower bounds of the interval (two sided) were calculated for field pH. For other constituents of concern only the upper bounds of the intervals (one sided) were calculated.

If a normal (or a lognormal) distribution is a reasonable approximation of the background concentrations, a parametric tolerance interval of the following form is calculated:

$$\text{T.I.} = \overline{X}_b \pm KS_b \text{ (two sided) or T.I} = \overline{X}_b + KS_b \text{ (one sided)} \qquad (1)$$

where:

$\overline{X}_b$ = Background mean

K = A normal tolerance factor, which depends on the number of background samples (n), coverage (P%), and confidence level (Y). A coverage of 95% and confidence level of 95% are recommended (EPA 1989). With n = 16, P = 95%, and Y = 95%, K is 2.523 (K is 2.566, if n = 15) for a one-sided normal tolerance interval (Natrella 1966)

S_b = Background standard deviation.

If background concentrations do not follow a normal or a lognormal distribution, a nonparametric tolerance interval can be constructed (Conover 1980). A two-sided nonparametric tolerance interval is just the range of the observed data. An upper one-sided nonparametric tolerance limit is the largest observation. The number of background samples determines the coverage (P%) and the probability level (Y) associated with that proportion. For a one-sided 95% (P = 95%) nonparametric tolerance interval with 95% (Y = 95%) probability, the number of background samples required is 59 (Conover 1980). With only 15 background samples (nitrate, filtered iron, and filtered zinc), the coverage is 85% and the confidence level is 90%. That is, the upper one-sided tolerance limit defined by the largest background concentration contains at least 85% of the background population with 90%

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[1] STATGRAPHICS is a trademark of Statistical Graphics Corporation.

probability. More background samples are needed if a larger coverage and/or a larger probability level are desired.

In cases where all of the background values are below the contractually established detection limits or where the proportion of nondetects is more than 15%, a limit of quantitation (LOQ) was also calculated using 1994 field blanks data or based on method detection limits (see Appendix A). Following the guidance in the *RCRA Ground Water Monitoring Technical Enforcement Guidance Document (TEGD)* (EPA 1986), it was decided that for cases where the calculated upper tolerance limit is below the LOQ, the LOQ will be used as the background threshold value (i.e., comparison value) between background and downgradient wells. This approach uses quality control data to target the limits of quantifiable data and provides a realistic approach for upgradient/downgradient well comparisons when a facility upgradient well yields values that are below the detection limit. In cases where LOQ is not available (e.g., coliform and chemical oxygen demand), the CRQLs were used as the background threshold values. Note that a narrower range for pH, after removing inconsistent pH values, is used as the comparison value. The resulting tolerance limits, LOQs, and background threshold values are also presented in Table 5.2-6.

5.2.5.3.3 Comparisons with Background Levels. Once the background threshold values are established, data from compliance-point wells were compared individually with these background concentration levels. If the background levels are exceeded, it is interpreted as providing evidence of statistically significant contamination.

The sampling results from 1995 were compared to the background levels established earlier. The results are presented in Table 5.2-4 and are discussed in Section 5.2.5.2. Values for specific conductance exceed the background level in downgradient wells 699-22-34, 699-23-34A, 699-23-34B, 699-24-34A, 699-24-34B, and 699-24-34C for all samplings during this reporting period and in downgradient well 699-25-34C in three samplings. This pattern of exceedances is similar to those observed from 1990 through 1994. In addition, the background threshold was exceeded for sulfate in downgradient well 699-22-35, and for filtered iron in upgradient well 699-24-35.

5.2.6 Groundwater Flow

Water table elevations were determined at the time of groundwater sampling; during 1995, monthly water level measurements were made for all SWL wells except the two new wells. The discussions of water table elevations, groundwater flow directions, and groundwater flow velocities are based on the monthly measurements. The 1995 water level measurements for the SWL monitoring network are listed in Appendix 5.2B.

5.2.6.1 Groundwater Flow Direction. The SWL lies in a zone of very high transmissivities (Jacobson and Freshley 1990) and, as a result, there is a very low hydraulic gradient across the site. A map of the water table in the vicinity of the site, based on June 1995 data, is presented in Figure 5.2-8. This map illustrates the low hydraulic gradients in the vicinity of the SWL. The zone of high transmissivities, which includes the SWL, extends to the northwest beneath the southeast corner of the 200 East Area. Groundwater flows into this zone from the B Pond mound to the north, and from the U Pond mound to the west. The principal source is apparently the input to B Pond, which strongly affects the water table elevations over a wide area, including the vicinity of the SWL.

The water table in the vicinity of the SWL has dropped more than 1.3 m (>4 ft) since December 1988, apparently as a result of decreased water input to B Pond, a trend that has slowed but has not stopped. This variation in the water table is illustrated in Figure 5.2-9, which depicts hydrographs of monthly water level measurements in SWL wells. These hydrographs indicate the low hydraulic gradient across the SWL.

Groundwater flow directions beneath the SWL are indicated by both the water level measurements and the paths of nitrate and tritium plumes that originate in the 200 East Area and pass beneath the SWL. The nitrate and tritium plumes in 1990 indicated that the principal direction of groundwater flow beneath the SWL was approximately 125° east of north (DOE-RL 1991b), a value confirmed by current groundwater chemistry data. The difference in water table elevation across the site is commonly on the order of 1 cm (0.03 ft), well within the error expected from well surveying and water table elevation measurements. However, flow directions based on water table elevations agree to some extent with the flow direction indicated by the plumes. Previous determinations using water level measurements yield flow directions ranging from 96 ±28° east of north to 139 ±15° east of north (DOE-RL 1991b, 1992, 1993a, 1994). Flow direction estimated from 1995 water level data, using wells 699-24-35, 699-25-34C, and 699-23-34A, and weeding out apparent fliers, is 115 ±25° east of north (n=8). The flow direction indicated by the contaminant plumes is probably the most accurate and the true groundwater flow direction is approximately 125° east of north.

5.2.6.2 Rate of Flow. The rate of groundwater flow beneath the SWL is highly uncertain. The aquifer beneath the SWL is characterized by high transmissivities and very low gradients. On the basis of site-specific aquifer testing and the observed hydraulic gradients, the expected groundwater velocities, calculated using the Darcy equation, should be on the order of 1.2 to 1.8 m/d (4 to 6 ft/d) (Weekes et al. 1987). However, more direct velocity indicators indicate a range of much higher values. Transport velocities in the 200 East Area, indicated by contaminant transport within the Hanford formation, display groundwater flow velocities between 3 and 4.3 m/d (10 to 14 ft/d) (Wilber et al. 1983). Tracer tests in the area southeast of the 200 East Area indicated groundwater velocities in excess of 30 m/d (100 ft/d); however, they occurred at higher hydraulic gradients than exist today (Bierschenk 1959). Tracking of the present tritium and nitrate plumes from wells several kilometers upgradient from well 699-24-33, east of the SWL, indicates contaminant transport rates of approximately 6 m/d (20 ft/d). Additional information on flow rate is provided by the recent decrease in nitrate and tritium concentrations across the site. Nitrate and tritium, which have upgradient sources, exhibit nearly identical time-concentration variation in upgradient and downgradient well pairs with quarterly sampling (Figure 5.2-10). The time required for the contaminants to traverse the site is on the order of 3 months. This traverse time indicates groundwater transport rates of approximately 5.5 m/d (18 ft/d). The actual transport rate is probably near 6 m/d (20 ft/d) and is controlled by zones of very high groundwater velocity within the Hanford formation that are missed or averaged out in normal aquifer testing.

5.2.6.3 Evaluation of Monitoring Well Network. Two downgradient wells were completed in December 1993, completing the shallow compliance-point monitoring network for the site. The presence of the two downgradient wells raises the Monitoring Efficiency Model (Jackson et al. 1991) monitoring efficiency for the site from 68 to 94%. Additional wells will be needed only if significant quantities of contaminants are shown to have migrated south of the site boundary (Hodges 1994).

5.2.7 References

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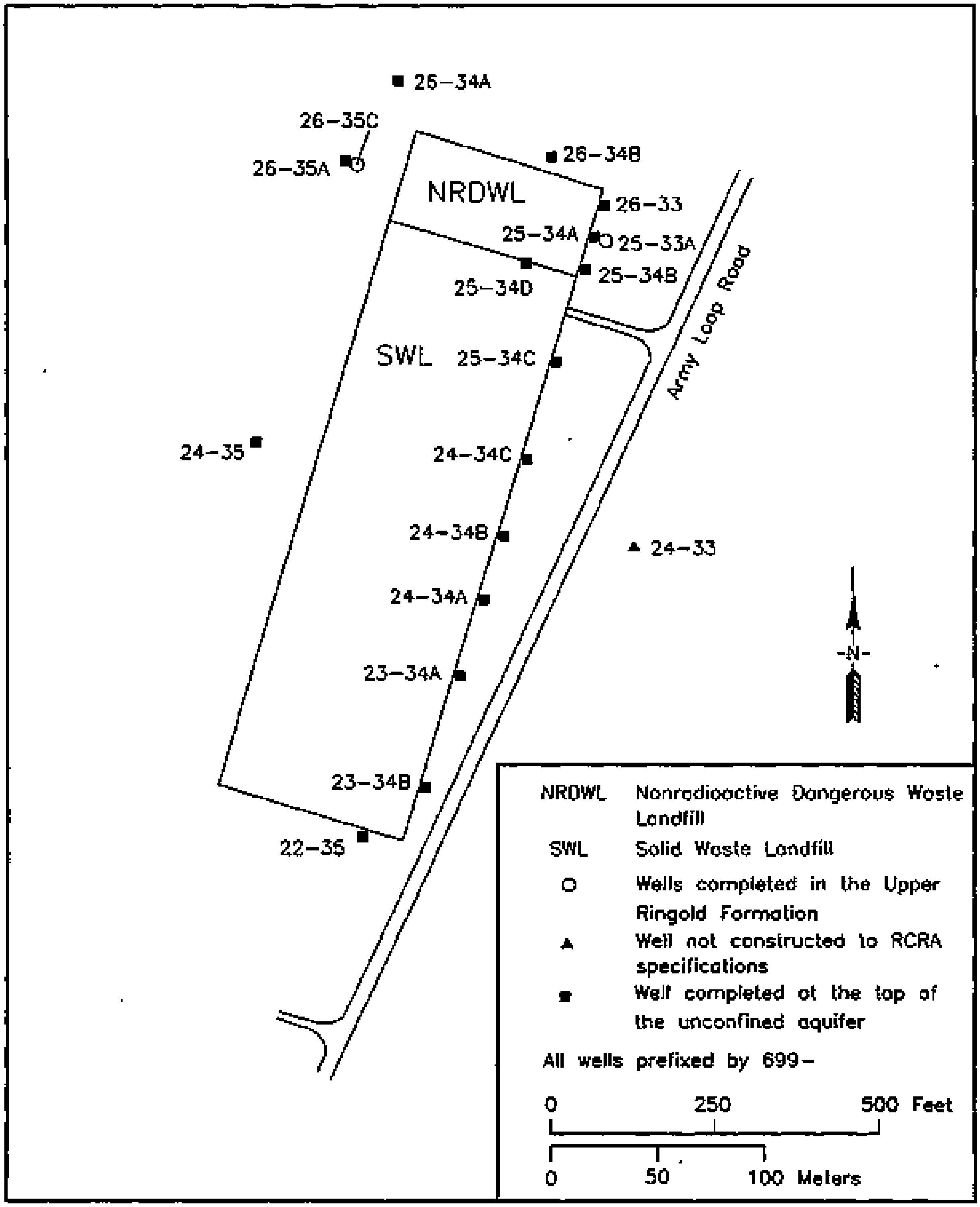
Figure 5.2-1. Map of the Solid Waste Landfill Showing the Locations of Groundwater Monitoring Wells.



fnh\swlnrdwl.dwg

Figure 5.2-2. Plot of 1,1,1-Trichloroethane Concentrations (ppb) in Downgradient Wells at the SWL and NRDWL for Selected 1994 and 1995 Data.

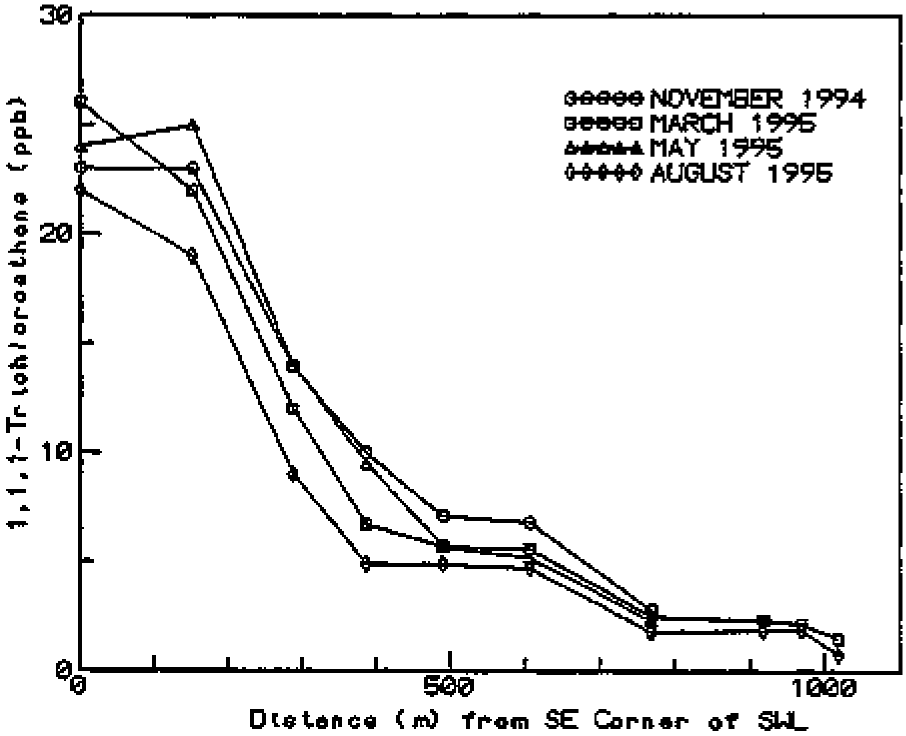


Figure 5.2-3. Plot of Tetrachloroethene (PCE) Concentrations (ppb) in Downgradient Wells at the SWL and NRDWL for Selected 1994 and 1995 Data.

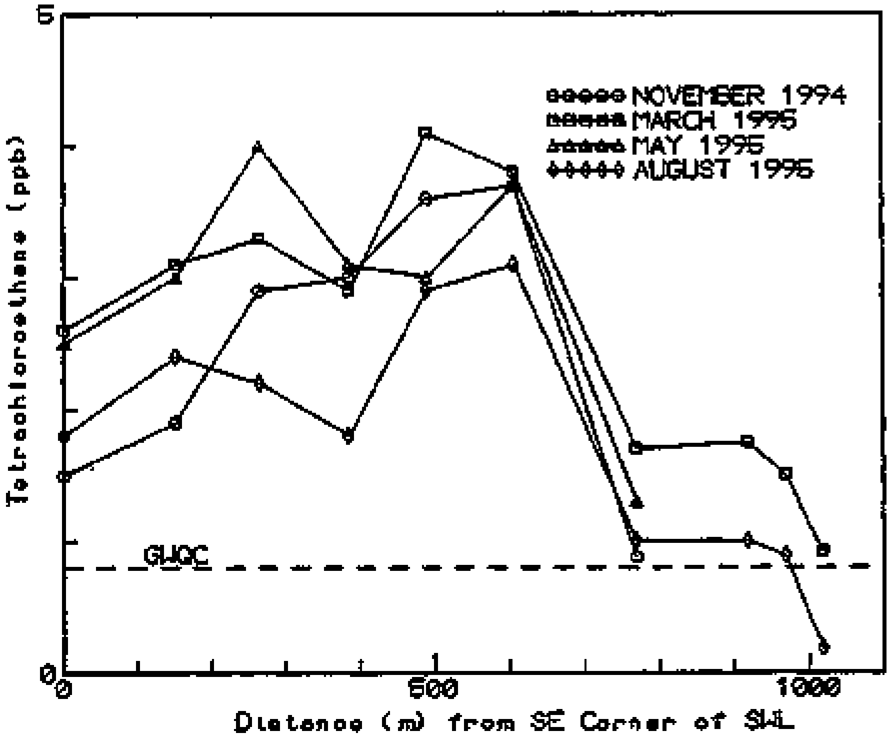


Figure 5.2-4. Plot of Trichloroethene (TCE) Concentrations (ppb) in Downgradient Wells at the SWL and NRDWL for Selected 1994 and 1995 Data.

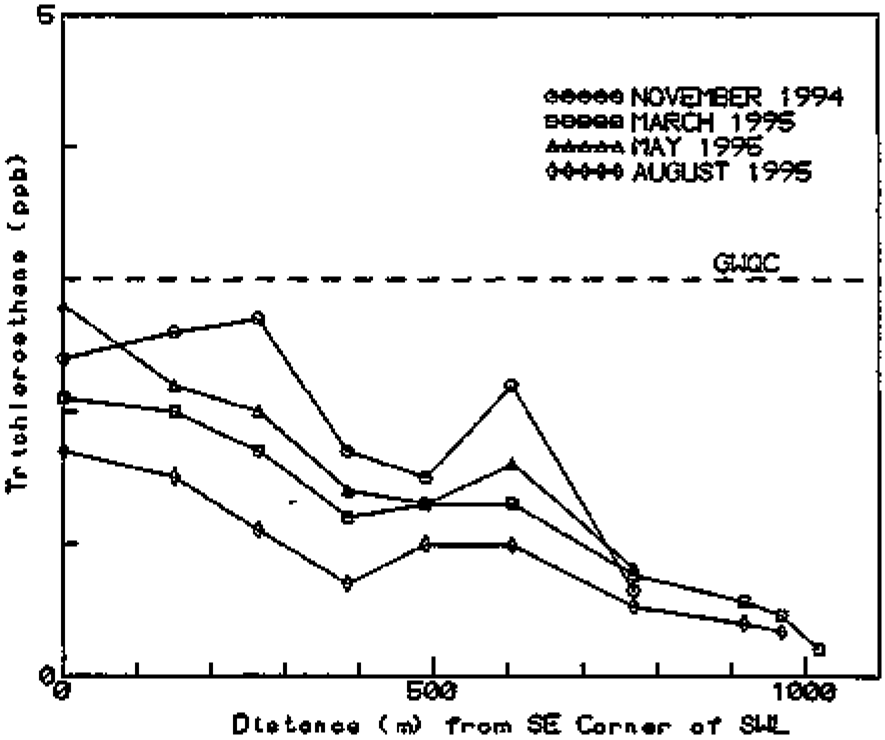


Figure 5.2-5. Plot of 1,1-Dichloroethane (11-DCA) Concentrations (ppb) in Downgradient Wells at the SWL and NRDWL for Selected 1994 and 1995 Data.

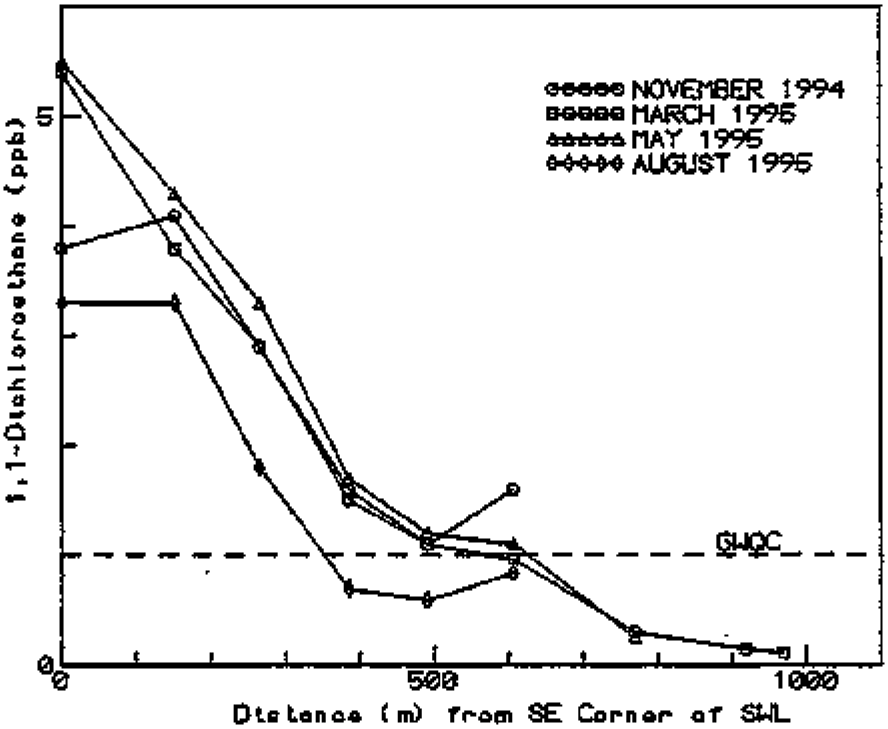


Figure 5.2-6. Time Series Plot of Tritium (pCi/L) and Nitrate (ppb) Concentrations in Downgradient Well 699-24-33.

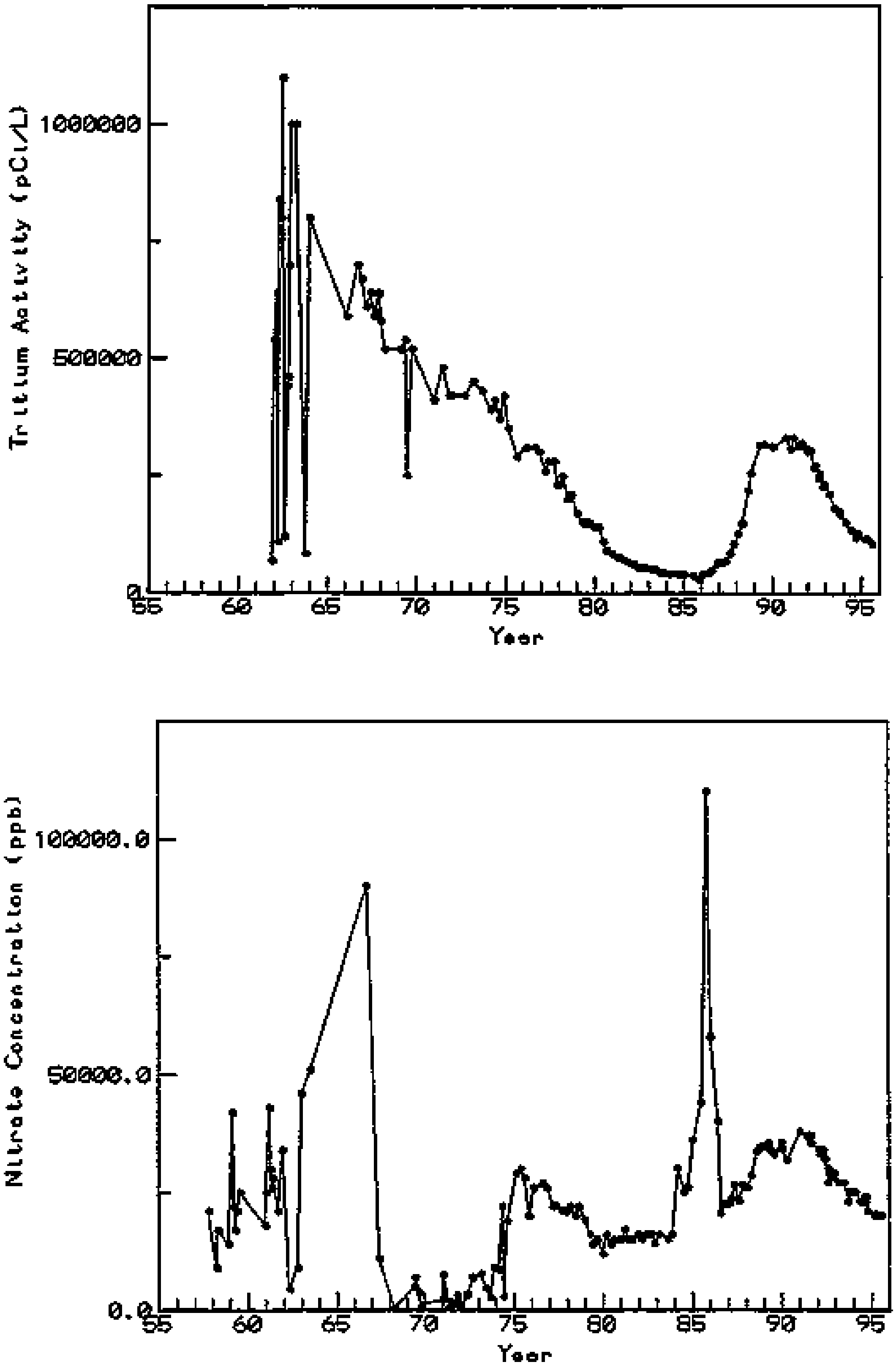


Figure 5.2-7. Plot of Tritium Concentrations (pCi/L) in Downgradient Monitoring Wells for the SWL and NRDWL.

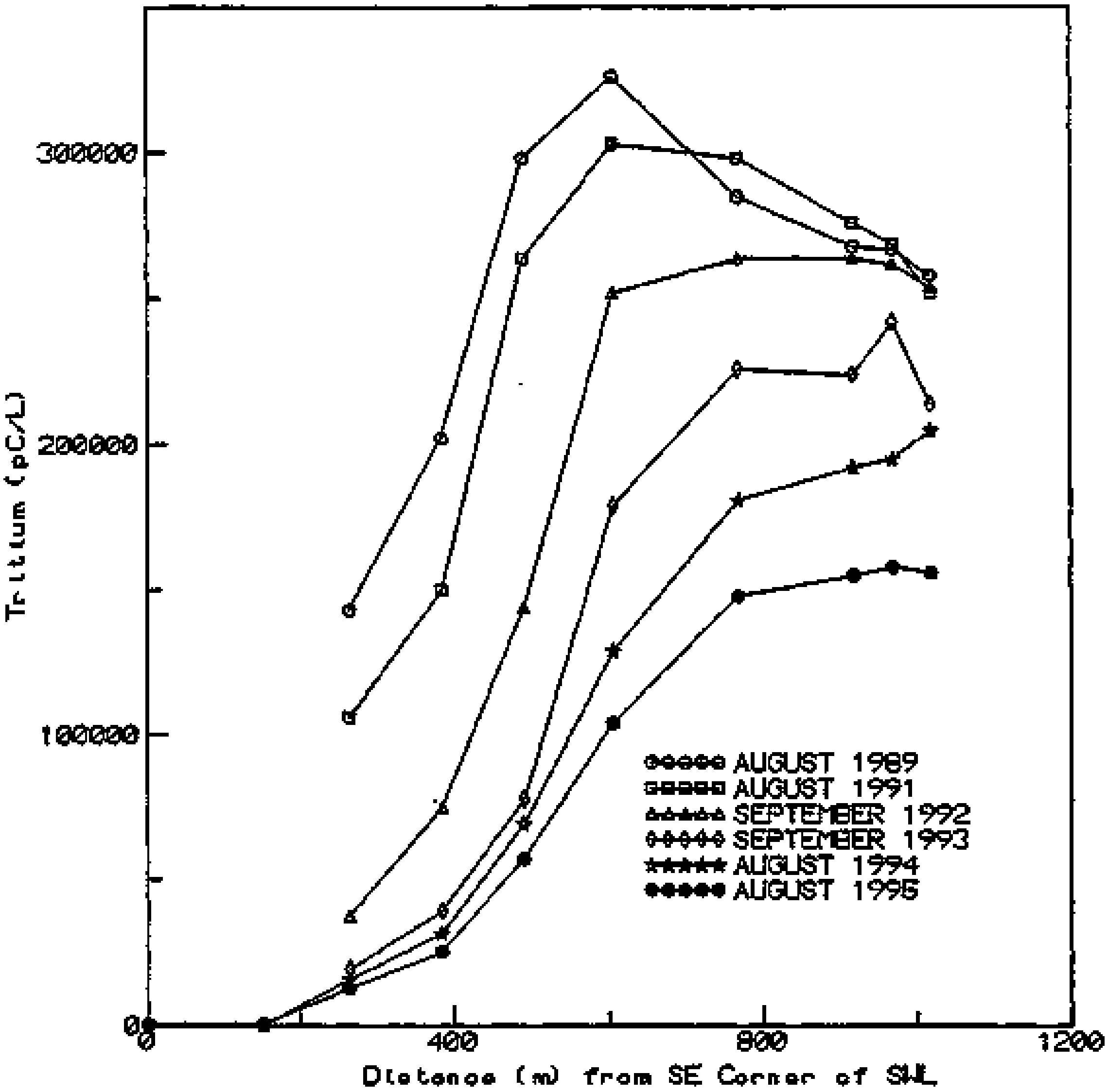


Figure 5.2-8. Water Table Map (Potentiometric Surface) for the Vicinity of the Solid Waste Landfill Based on June 1995 Water Table Measurements. (Datum is Mean Sea Level)

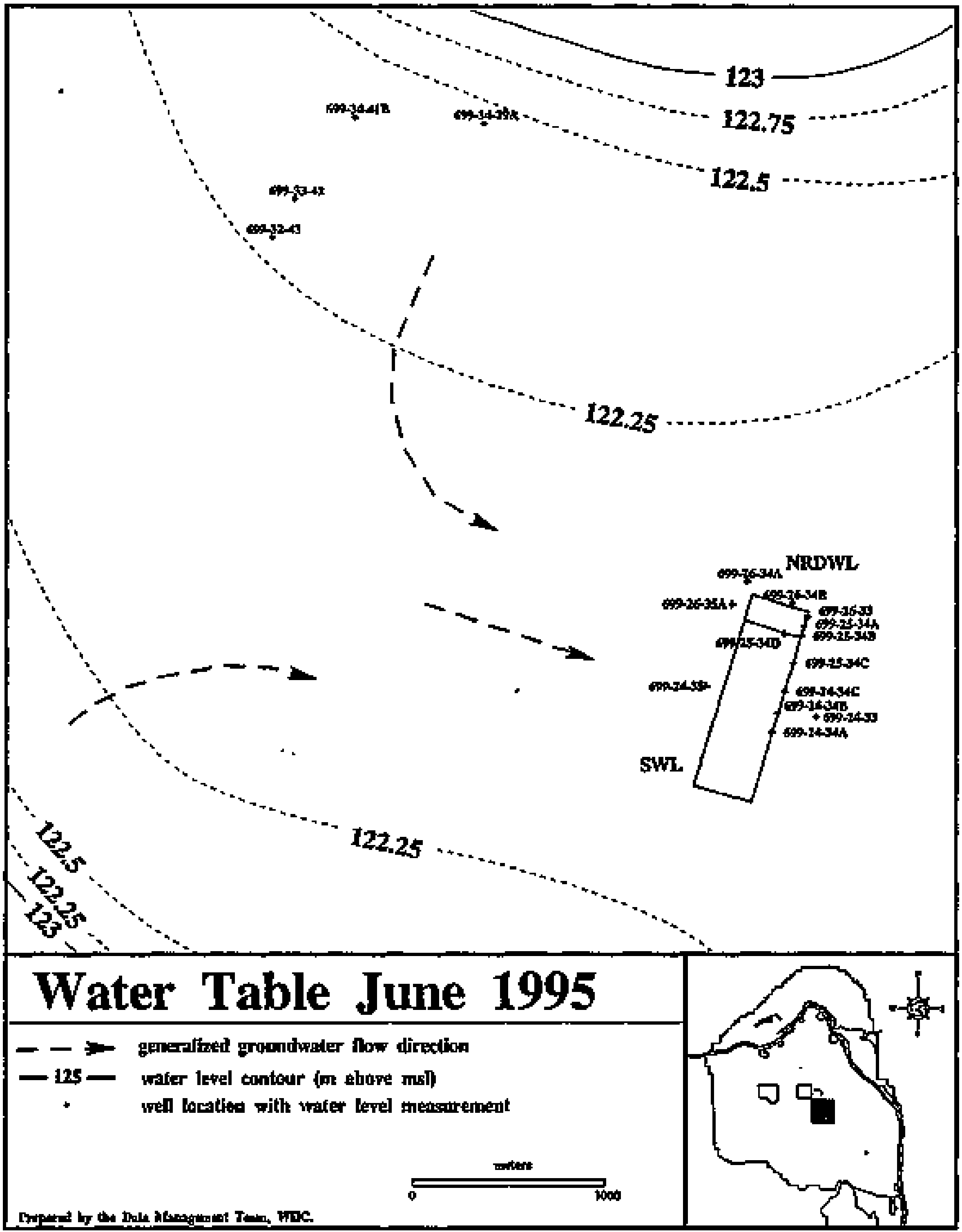


Figure 5.2-9. Hydrograph Showing Monthly Water Level Measurements (Meters Above Mean Sea Level) for the Solid Waste Landfill.

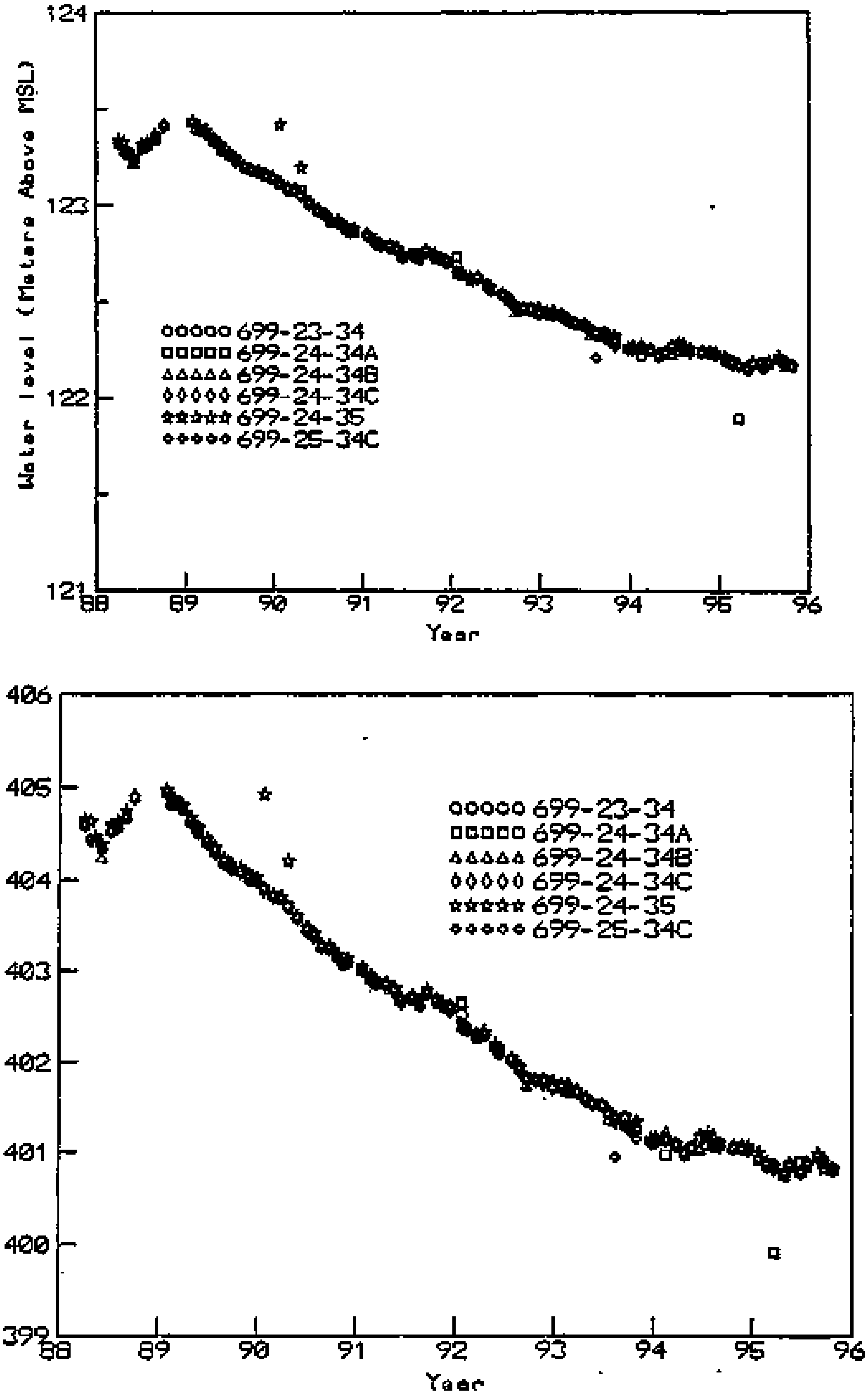


Figure 5.2-10. Time Series Plots of Tritium Concentrations (pCi/L) in Upgradient-Downgradient Well Pairs: (a) Wells 699-26-35A and 699-25-34C; (b) Wells 699-24-35 and 699-23-34A.

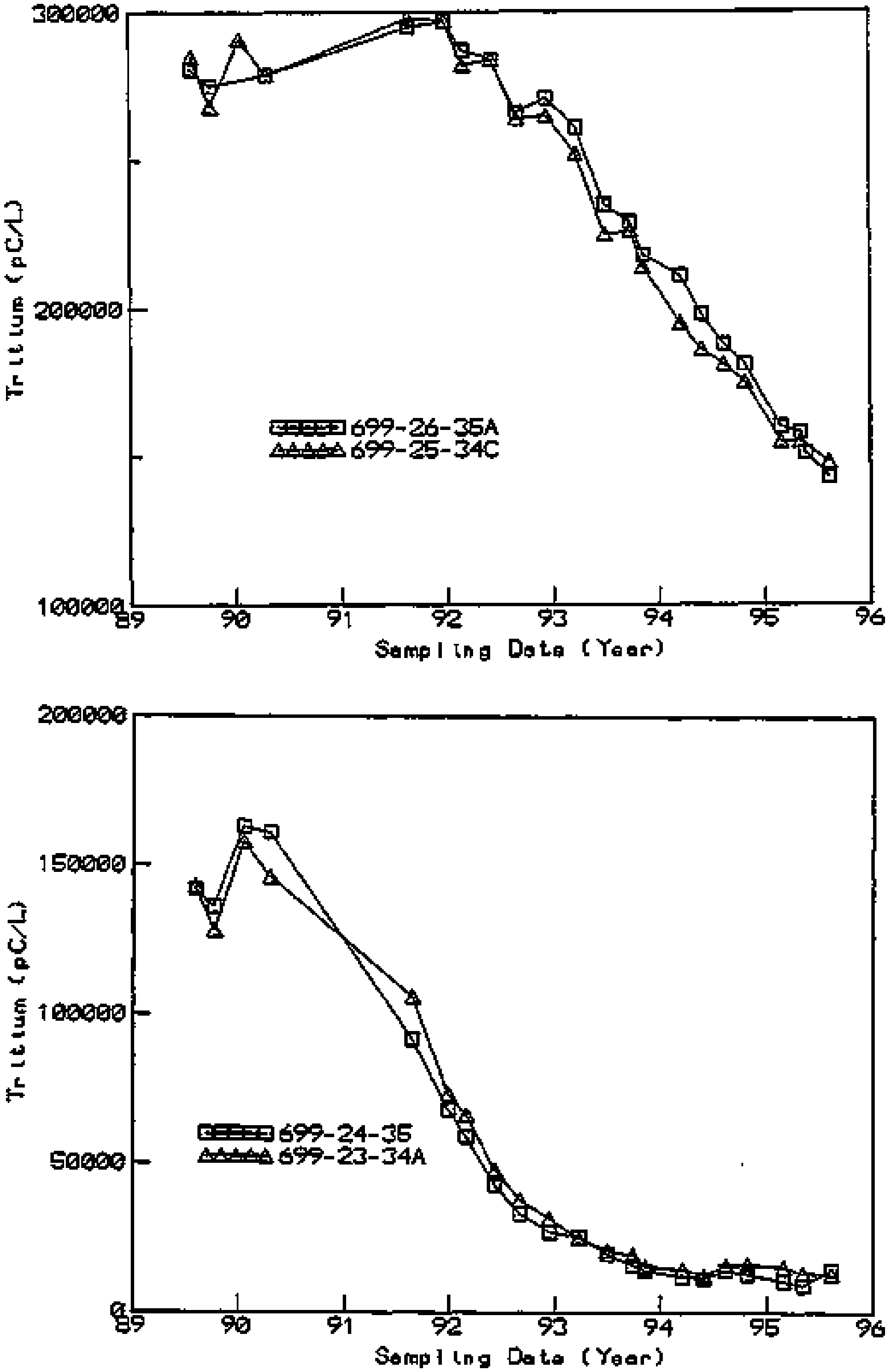


Table 5.2-1. Monitoring Wells Used for the Solid Waste Landfill.

Well	Aquifer	Sampling frequency	Water levels	Well standard	Other networks
699-22-35^{93}	Top of unconfined	Q	--	RCRA	--
699-23-34A^{87}	Top of unconfined	Q	M	RCRA	--
699-23-34B^{93}	Top of unconfined	Q	--	RCRA	--
699-24-33^{48}	Top of unconfined	Q^{a}	M	PRE	PNNL
699-24-35^{87}	Top of unconfined	Q	M	RCRA	--
699-24-34A^{87}	Top of unconfined	Q	M	RCRA	--
699-24-34B^{87}	Top of unconfined	Q	M	RCRA	--
699-24-34C^{87}	Top of unconfined	Q	M	RCRA	--
699-25-34C^{87}	Top of unconfined	Q	M	RCRA	--
699-26-35A^{86}	Top of unconfined	Q	M	RCRA	NRDWL

Notes: Shading denotes upgradient wells. Superscript following well number denotes the year of installation.

[a] Well is sampled for supporting data.

M = frequency on a monthly basis.
NRDWL = Nonradioactive Dangerous Waste Landfill.
PNNL = well is sampled by Pacific Northwest National Laboratory site-wide monitoring program.
PRE = well was constructed before RCRA-specified standards.
Q = frequency on a quarterly basis.
RCRA = well is constructed to RCRA-specified standards.

Table 5.2-2. Constituents Analyzed at the Solid Waste Landfill.

<table>
<tr><th colspan="3">Parameters and constituents required by WAC 173-304-490</th></tr>
<tr><td>Ammonia as nitrogen
Chemical oxygen demand
Chloride
Conductivity
Dissolved iron</td><td>Dissolved zinc
Dissolved manganese
Nitrate
Nitrite
pH</td><td>Sulfate
Temperature
Total coliform
Total organic carbon</td></tr>
<tr><th colspan="3">Site-specific constituents</th></tr>
<tr><td>1,1,1-Trichloroethane</td><td>Total organic halogen</td><td>Trichloroethylene</td></tr>
<tr><th colspan="3">Others</th></tr>
<tr><td colspan="3">Tritium</td></tr>
</table>

Table 5.2-3. Sampling Results for Required Constituents (WAC 173-304) at the Hanford Solid Waste Landfill November 1994 through August 1995. (3 sheets)

Constituent	TI[a]	Date	22-35	23-34A	23-34B	24-34A	24-34B	24-34C	24-35[b]	25-34C	26-35A[b]
Temperature (°C)	21.0	Nov/94	17.4	19.5	17.6	18.6	19.3	18.1	25	18.6	19.7
		Mar/95	16.6	16.9	17.8	18.4	16.8	18.1	16	19.4	19.2
		May/95	18.0	18.7	18.4	17.8	18.9	18.8	18.1	18.7	19.9
		Aug/95	18.3	18.6	18.2	19.3	19.1	19.8	18.4	19.4	20.4
Specific conductance (μmho/cm)	550	Nov/94	797^E	633^E	776^E	450^E	523^E	666^E	497	579^E	455
		Mar/95	758^E	644^E	755^E	631^E	617^E	661^E	506	550	445
		May/95	747^E	640^E	714^E	605^E	616^E	675^E	509	551^E	453
		Aug/95	766^E	659^E	739^E	611^E	624^E	710^E	504	568^E	450
Field pH	[6.2, 8.46]	Nov/94	6.9	6.8	6.8	6.8	6.8	6.4	7.3	7.4	6.7
		Mar/95	7.0	6.7	6.9	6.7	6.8	7.1	7.1	7.2	7.6
		May/95	6.6	6.7	6.9	6.8	6.8	7.0	7.1	7.3	7.4
		Aug/95	7.1	6.7	6.9	6.7	6.9	6.9	7.2	7.2	7.4
Total organic carbon (ppb)	976	Nov/94	175	135	182	148	125	168	162	168	125
		Mar/95	275	250	250	213	200	178	225	<110	<110
		May/95	300	<140	<140	<140	<140	<140	250	<140	<140
		Aug/95	250	250	250	240	200	300	150	150	200
Chloride (ppb)	9,045	Nov/94	6,200	6,200	6,100	6,400	6,800	7,200	6,000	7,000	6,900
		Mar/95	6,500	6,400	6,300	6,800	7,000	7,400	6,200	7,300	7,100
		May/95	6,400	6,100	6,200	6,400	6,800	7,300	5,900	7,300	7,100
		Aug/95	6,250	6,100	6,200	6,200	6,900	7,200	5,800	7,100	6,900
Nitrate (ppb)	33,800	Nov/94	13,000	11,000	12,000	13,000	16,000	21,000	11,000	25,000	25,000
		Mar/95	12,000	11,000	12,000	13,000	15,000	21,000	11,000	24,000	23,000
		May/95	13,000	12,000	12,000	12,000	15,000	21,000	11,000	24,000	23,000
		Aug/95	13,000	12,000	12,000	13,000	16,000	20,000	11,000	23,000	23,000
Nitrite (ppb)	631	Nov/94	<18	<18	<18	<18	<18	<18	<18	<18	<18
		Mar/95	<140	<140	<140	<140	<140	<140	<140	<140	<140
		May/95	<140	<140	<140	<140	<140	<140	<140	<140	<140
		Aug/95	<140	<140	<140	<140	<140	<140	<140	<140	<140

Table 5.2-3. Sampling Results for Required Constituents (WAC 173-304) at the Hanford Solid Waste Landfill November 1994 through August 1995. (3 sheets)

Constituent	TI[a]	Date	22-35	23-34A	23-34B	24-34A	24-34B[b]	24-34C	24-35	25-34C	26-35A[b]
Ammonium (ppb)	122	Nov/94	<37	60	<37	<37	<37	80	<37	<37	<37
		Mar/95	<27	70	60	<27	60	<27	60	60	<27
		May/95	30	<27	<27	<27	<27	<27	<27	<27	<27
		Aug/95	<27-30	30	30	30	<27	30	<27	40	40
Sulfate (ppb)	51,500	Nov/94	51,000	43,000	49,000	43,000	42,000	32,000	42,000	39,000	38,000
		Mar/95	49,000	42,000	50,000	43,000	42,000	40,000	41,000	39,000	38,000
		May/95	55,000[E]	44,000	51,000	44,000	43,000	42,000	43,000	44,000	38,000
		Aug/95	50,000	42,000	48,000	41,000	41,000	40,000	40,000	38,000	37,000
Iron, filtered (ppb)	78	Nov/95	34	37	49	65	45	31	19	23	<5.3
		Mar/95	33	23	28	29	29	28	25	35	12
		May/95	30	47	32	23	28	26	29	17	<8.9
		Aug/95	15	19	23	58	24	18	540[R]	15	15
Zinc, filtered (ppb)	34	Nov/94	11	<6.3	7.2	12	9.3	14	12	6.7	8.3
		Mar/95	<3.7	13	<3.7	<3.7	<3.7	12	<3.7	<3.7	<3.7
		May/95	8.6	7.6	<3.7	<3.7	28	22	<3.7	<3.7	53
		Aug/95	<3.7	<3.7	<3.7	<3.7	<3.7	<6.4	<3.7	<3.7	<3.7
Manganese, filtered (ppb)	11	Nov/94	3.0	4.7	3.2	3.3	1.5	3.7	1.5	2.2	<0.72
		Mar/95	1.4	1.0	0.89	0.83	<0.55	1.0	<0.55	<0.55	
		may/95	0.67		0.75	<0.55	<0.55	0.62	<0.55	<0.55	<0.55
		Aug/95		<0.55	0.81	1.3	1.4	<0.55	6.3	<0.55	<0.55
Chemical oxygen demand (ppb)	3	Nov/94	<2.6	<2.6	<2.6	<2.6	<2.6	<2.6	<2.6	<2.6	<2.6
		Mar/95	<2.9	2.8	<2.9	<2.9	<2.9	<2.9	<2.9	<2.9	<2.9
		May/95	<2.9	<2.9	<2.9	<2.9	<2.9	<2.9	<2.9	<2.9	<2.9
		Aug/95	<2.9	<2.9	<2.9	<2.9	<2.9	<2.9	<2.9	<2.9	<2.9

Table 5.2-3. Sampling Results for Required Constituents (WAC 173-304) at the Hanford Solid Waste Landfill November 1994 through August 1995. (3 sheets)

Constituent	TI[a]	Date	22-35	23-34A	23-34B	24-34A	24-34B[b]	24-34C	24-35	25-34C	26-35A[b]
Coliform bacteria (mpn)	16	Nov/94 Mar/95 May/95 Aug/94	<1 <1 <3.7 <1	<1 <1 <3.7 <1	<1 <1 <3.7 <1	<1 <1 <3.7 <1	<1 <1 <3.7 <1	<1 <1 <3.7 <1	<1 <1 <3.7 <1	<1 <1 <1 <1	<1 <1 <1 <1

[a] Numbers are obtained from Table 5.2-6 (Background threshold value column).

[b] Upgradient wells.

[E] Exceeding background threshold values (downgradient well only).

[R] A request for analytical data evaluation has been filed.

< = data values are less than the contractually required quantitation limit (CRQL). The number given is the respective CRQL.

NA = not available.

TI = tolerance interval (see Section 5.2.5.3).

Table 5.2-4. Ranges of Concentrations (ppb) of Chlorinated Hydrocarbons in Groundwater at the Solid Waste Landfill from November 1994 to August 1995.

	22-35*	23-34A	23-34B	24-34A	24-34B	24-34C	25-34C	24-35	26-35A
1,1,1 Trichloroethane	21-26	9-14	19-25	4.9-10	4.9-7.1	4.7-6.8	1.8-2.8	1.9-4.4	0.99-1.3
Trichloroethene	1.7-2.8	1.1-2.7	1.5-2.6	0.7-1.7	1.0-1.5	0.99-2.2	0.53-0.82	<0.08-0.23	0.12-0.17
Tetrachloroethene	1.8-2.6	2.2-3.3	1.9-3.1	1.8-3.1	2.9-4.1	3.1-3.8	0.69-1.3	0.38-1.2	0.38-1.1
1,1-Dichloroethane	3.2-5.4	1.8-3.3	3.3-4.3	0.69-1.7	0.59-1.2	0.84-1.6	<0.05-0.30	<0.05-0.08	<0.05-<0.06
Chloroform	<0.03-0.35	<0.03-0.1	0.03-0.24	<0.03-0.05	<0.04-0.04	<0.03-0.06	<0.03-0.11	<0.03-<0.04	<0.03-<0.04
Carbon tetrachloride	<0.04-0.08	<0.04-<0.08	<0.04-1.2	<0.04-0.41	<0.04-<0.08	<0.04-<0.08	<0.04-0.45	<0.04-<0.08	0.31-2.0
1,1,2-Trichloroethane	<0.07-<0.08	<0.07-<0.08	<0.07-<0.08	<0.07-<0.08	<0.07-<0.08	<0.07-<0.08	<0.07-<0.08	<0.07-<0.08	<0.07-<0.08
1,2-Dichloroethane	<0.03-<0.05	<0.03-<0.05	<0.03-<0.05	<0.03-<0.05	<0.03-<0.05	<0.03-<0.05	<0.03-<0.05	<0.03-<0.05	<0.03-<0.05
Cis-1,2-Dichloroethene	<0.05-<0.11	<0.05-<0.11	<0.05-<0.11	<0.05-0.1	<0.05-<0.11	<0.05-0.05	<0.05-0.23	<0.05-<0.11	<0.05-<0.11
Trans-Dichloroethene	<0.05-<0.07	<0.05-<0.07	<0.05-<0.07	<0.05-<0.07	<0.05-<0.07	<0.05-<0.07	<0.05-<0.07	<0.05-<0.07	<0.05-<0.07
Total organic halogen	20-40	15-27	23-36	9-20	<7-16	7-19	<7-11	<7-12	<7-10

*All well numbers prefixed by 699-.

Table 5.2-5. Summary Statistics for the Background Monitoring Constituent Parameter Data for the Solid Waste Landfill.

Constituent	n	GT	LT	Mean	Median	Std. Dev.	CV (%)	Min.	Max.
Temperature[a]	22	22	0	18.7	18.8	1.00	5.4	16	20.4
Specific[a] conductance	38	38	0	385.3	397	68.9	17.9	206	550
Field pH Field pH[b]	38 36	38 36	0 0	7.23 7.33	7.29 7.31	0.62 0.46	8.5 6.3	5.4 6.08	8.45 8.45
Total organic carbon[c,d]	38	0	38	421.6	468	142.9	33.9	32	750
Chloride	36	36	0	7,341	7,280	798.4	10.9	6,000	8,660
Nitrate	36	36	0	25,929	27,725	5,139.2	19.8	16,000	33,800
Nitrite	24	0	24	BDL	BDL	NC	NC	BDL	BDL
Ammonium	24	4	20	BDL	BDL	NC	NC	BDL	100
Sulfate	36	36	0	44,169	46,000	4,695.0	10.6	34,000	51,500
Iron[d], filtered	29	16	13	33.3	28	19.3	58.0	BDL	78
Zinc, filtered	29	14	15	BDL	BDL	NC	NC	BDL	34
Manganese, filtered	29	1	28	BDL	BDL	NC	NC	BDL	11
Coliform[a] bacteria	29	2	27	BDL	BDL	NC	NC	BDL	16
Chemical oxygen demand	8	0	8	BDL	BDL	NC	NC	BDL	BDL

[a] Measuring unit for temperature is °C; conductivity is µmho/cm; coliform bacteria is colonies/100 mL; all chemical components are in ppb.

[b] Inconsistent pH values of 5.4 and 5.5 were excluded.

[c] Indicates that statistics were calculated from values reported below contractually required detection limit (CRDL).

[d] Less than detection values were replaced by one-half of the CRDL in the calculation of summary statistics.

BDL = below CRDL.
CV = coefficient of variation.
GT = number of samples that are greater than the CRQL.
LT = number of samples that are less than the CRQL.
n = total number of samples.
NC = not calculated because of insufficient measured values.

Table 5.2-6. Results of Lilliefors Test for Normality and Background Threshold Values for the Solid Waste Landfill.

Constituent (unit)	Test statistic (raw data)	Test statistic (log value)	Upper tolerance limit	Background threshold value[a]
Temperature (°C)	0.115 n.s.	NA	21.0[b]	21.0
Specific conductance (µmho/cm)	0.162 s	0.207 s.	550[c]	550
Field pH Field pH[e]	0.140 n.s. 0.089 n.s.	NA NA	[5.7, 8.75][b] [6.2,8.46][b]	[6.2, 8.46]
Total organic carbon (ppb)	0.191 s.	0.181 s.	750[c] 976[d]	976
Chloride (ppb)	0.104 n.s.	NA	9,045[b]	9,045
Nitrate (ppb)	0.168 s.	0.195 s.	33,800[c]	33,800
Nitrite (ppb)	NC	NC	631[d]	631
Ammonium (ppb)	NC	NC	122[c] 122[d]	122
Sulfate (ppb)	0.179 s.	0.190 s.	51,500[c]	51,500
Iron, filtered (ppb)	NC	NC	78[c] 40[d]	78[c,d]
Zinc, filtered (ppb)	NC	NC	34[c] 16.7[d]	34
Manganese, filtered (ppb)	NC	NC	11[c] 2.5[d]	11
Coliform (mpn)	NC	NC	16[c] 1[e]	16
Chemical oxygen demand	NC	NC	3[e]	3

[a] Background threshold value for each constituent is the larger of the upper tolerance limit or the applicable limit of quantitation (LOQ).

[b] Based on normal distribution.

[c] Maximum value reported.

[d] Based on LOQ (see Appendix A).

[e] Based on contractually required detection limit (see Table 5.2-5 and its footnotes).

NA = not applicable.
NC = not calculated because of insufficient measured values.
n.s. = not significant at 0.05 level of significance.
s. = significant at 0.05 level of significance.

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APPENDIX 5.2A

GROUNDWATER DATA

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5.2A.0 GROUNDWATER DATA

5.2A.1 DATA TABLES

Four different formats are used to display water level measurements and groundwater sample analytical results (Tables 5.2A-1 through 5.2A-3). This section describes the meaning of each table column heading, defines the abbreviations used, explains the data qualifiers and flags, and lists analysis method codes and relevant regulatory standards.

In the table, results below the contractually required quantitation limits (CRQL), but above the method detection limit (MDL), are reported with the measured value followed by an L qualifier. Results below the MDL are reported with the MDL value followed by a U qualifier. MDLs are determined semiannually. In the summary tables only the most recent MDL values are referenced; however, in the data tables the analytical values are referenced to the MDL appropriate for the time of analysis.

5.2A.1.1 Water Level Measurement Report

The Water Level Measurement Report has four columns as follows:

- Well--Well in which measurement was made.
- Date--Date of measurement.
- Depth to water--Depth, in feet, from well casing reference point to top of water in well.
- Water level--Elevation, in feet above mean sea level, of water level computed by subtracting depth to water from casing reference elevation.

Wells are grouped according to the zone that they monitor beginning with the top of the unconfined aquifer and continuing downward to the confined aquifer.

Only measurements made during the reporting period are included in the tables. In addition to measurements made during sampling, which are marked with an asterisk (*), measurements are routinely performed at other times to permit collection of data for an entire network within a 1- or 2-day time period.

Data that are judged to be suspect are flagged with '+' in the table. Before data are designated as suspect, checks are conducted to determine if a transcription error occurred between the field sheet and the electronic database.

Section 5.2A.1.5.

5.2A.1.2 Constituent List and Summary of Results

The Constituent List and Summary of Results table (Summary table) is the first of three tables that present the results of groundwater sample analyses. The Summary table displays statistics based on the complete data set for the reporting period.

The fields in the Summary table are as follows:

- Constituent name--Name of the analyzed constituent being summarized; the Short name is an abbreviation used in the Constituents with at Least One Value Above the CRQL table (Section 5.2A.1.3); the (Method), when present, is a code (Section 5.2A.1.5) used to distinguish between different analytical methods for the same constituent.
- Units--Units in which the MDL and drinking water standards (DWS) are reported in this table.
- Laboratory MDL--MDL imposed on the laboratory. This field is blank for radionuclides where the CRQL is defined as the value of the total error reported by the laboratory for each result.
- Drinking water standard limit/agency--The DWS used for comparison to the reported results; see Section 5.2A.1.5 for Agency definitions and a complete listing of standards used.
- Number of samples--Total is the number of sample results from all wells in the project contained in the complete data set for that constituent; >MDL is the number of results that exceed the MDL; >DWS is the number of results that exceed the listed DWS.

Summarized constituents are grouped as contamination indicator parameters (CIP), drinking water parameters

5.2A.1.5 Codes and Abbreviations

Abbreviations--The abbreviations used in the data tables are as follows:

COL	coliform colonies per 100 milliliters
CRQL	contractually required quantitation limit
DWS	drinking water standard
ft	feet
MDL	method detection limit
msl	mean sea level
NTU	nephelometric turbidity unit
pCi/L	picocuries per liter
ppb	parts per billion
ppm	parts per million
μmho	micromhos per centimeter.

Agencies and suffixes--Agency codes and DWS suffixes identify the regulatory origin of the standard of the DWS. Agency codes are used in the Summary table, and DWS suffixes are used in the Above MDL and CIP tables. The codes are defined as follows:

Agency	Suffix	Regulatory basis

Quality control flags:

H - Laboratory holding time exceeded
P - Potential problem; see text associated with table
Q - Result associated with suspect quality control data
F - Suspect data currently under review
R - Reviewed data that have been rejected
Y - Reviewed data that continue to be suspect
G - Reviewed data that are considered to be valid
+ - Suspect water level data currently under review
* - MDL is greater than DWS, so exceedance of DWS is undetermined.

Analysis method codes--Analysis method codes are used as an abbreviation for the laboratory method used to perform an analysis. A complete listing of the analysis method codes used in the Summary and Above MDL tables is shown in Table 5.2A-4.

DWSs--DWSs are used in all of the chemistry tables to provide a standard with which to compare sample results.

5.2A.2 REFERENCES

40 CFR 141, "National Primary Drinking Water Regulations," *Code of Federal Regulations*, as amended.

40 CFR 143, "National Secondary Drinking Water Regulations," *Code of Federal Regulations*, as amended.

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EPA, 1979, *Methods for Chemical Analysis of Water and Waste*, EPA-600/4-79-020, U.S. Environmental Protection Agency, Cincinnati, Ohio.

EPA, 1986, *Test Methods for Evaluating Solid Waste*, SW-846, Third Edition, U.S. Environmental Protection Agency, Washington, D.C.

Table 5.2A-1. Constituent List and Summary of Results for the Solid Waste Landfill
Data for Reporting Period November 1, 1994 through September 30, 1995.
(sheet 1 of 3)

CONTAMINATION INDICATOR PARAMETERS

Constituent Name				Lab	DWS		Number of Samples		
Short	(Method)	Full	Units	MDL	Limit	Agency	Total	>MDL	>DWS
CONDUCT	34	Conductivity, field	umhos				164	164	
CONDUCT	73	Conductivity, lab	umhos				31	31	
TOC		Total organic carbon	ppb	140			168	111	
TOX		Total organic halogen	ppb	6.9			168	132	
PH	93	pH, field	pH		6.5-8.5	EPAS	164	164	5
PH	125	pH, lab	pH		6.5-8.5	EPAS	42	42	0

DRINKING WATER PARAMETERS

Constituent Name				Lab	DWS		Number of Samples		
Short	(Method)	Full	Units	MDL	Limit	Agency	Total	>MDL	>DWS
FBARIUM		Barium, filtered	ppb	1.4	2000	EPA	42	42	0
FCADMIU		Cadmium, filtered	ppb	.98	5	EPA	42	6	0
FCHROMI		Chromium, filtered	ppb	3.7	100	EPA	42	39	1
FLUORID		Fluoride	ppb	52	4000	EPA	42	42	0
ALPHA		Gross alpha	pCi/L		15	EPA	42	42	0
NITRATE		Nitrate	ppb	120	45000	EPA	42	42	0

GROUNDWATER QUALITY PARAMETERS

Constituent Name				Lab	DWS		Number of Samples		
Short	(Method)	Full	Units	MDL	Limit	Agency	Total	>MDL	>DWS
CHLORID		Chloride	ppb	110	250000	EPAS	42	42	0
FIRON		Iron, filtered	ppb	8.9	300	EPAS	42	40	1
FMANGAN		Manganese, filtered	ppb	.55	50	EPAS	42	24	0
LPHENOL		Phenol	ppb	.58			1	0	
FSODIUM		Sodium, filtered	ppb	44			42	42	
SULFATE		Sulfate	ppb	130	250000	EPAS	42	42	0

SITE SPECIFIC AND OTHER CONSTITUENTS

Constituent Name				Lab	DWS		Number of Samples		
Short	(Method)	Full	Units	MDL	Limit	Agency	Total	>MDL	>DWS
111-T		1,1,1-Trichloroethane	ppb	.061	200	EPA	42	42	0
112-T		1,1,2-Trichloroethane	ppb	.068	5	EPA	42	0	0
11-DIC		1,1-Dichloroethane	ppb	.047			42	33	

Table 5.2A-1. Constituent List and Summary of Results for the Solid Waste Landfill
Data for Reporting Period November 1, 1994 through September 30, 1995.
(sheet 2 of 3)

Constituent Name				Lab	DWS		Number of Samples		
Short	(Method)	Full	Units	MDL	Limit	Agency	Total	>MDL	>DWS
12-DIC		1,2-Dichloroethane	ppb	.049	5	EPA	42	0	0
14-dben		1,4-Dichlorobenzene	ppb	.056	75	EPA	42	16	0
246-TRP		2,4,6-Trichlorophenol	ppb	.8			1	0	
24-dchp		2,4-Dichlorophenol	ppb	.43			1	0	
DIMPHEN		2,4-Dimethylphenol	ppb	.62			1	0	
DINPHEN		2,4-Dinitrophenol	ppb	6.8			1	0	
26-DCHP		2,6-Dichlorophenol	ppb	.52			1	0	
CHLPHEN		2-Chlorophenol	ppb	.6			1	0	
2NITPH		2-Nitrophenol	ppb	.6			1	0	
BUTDINP		2-sec-Butyl-4,6-dinitrophenol(DN	ppb	.41	7	EPA	1	0	0
46DN2MP		4,6-Dinitro-2-methylphenol	ppb	.84			1	0	
CHLCRES		4-Chloro-3-methylphenol	ppb	.52			1	0	
NITPHEN		4-Nitrophenol	ppb	.49			1	0	
ALKALIN		Alkalinity	ppb	3500			42	42	
FALUMIN		Aluminum, filtered	ppb	31	200	EPAS	42	4	0
AMMONIU		Ammonium ion	ppb	37			42	18	
FANTIMO		Antimony, filtered	ppb	24	6	EPA	42	0	42*
BENZENE		Benzene	ppb	.059	5	EPA	42	1	0
FBERYLL		Beryllium, filtered	ppb	.63	4	EPA	42	0	0
BROMIDE		Bromide	ppb	72			42	6	
FCALCIU		Calcium, filtered	ppb	41			42	42	
TETRANE		Carbon tetrachloride	ppb	.042	5	EPA	42	11	0
COD		Chemical oxygen demand	ppb	2900			42	1	
CHLFORM		Chloroform	ppb	.029			42	17	
FCOBALT		Cobalt, filtered	ppb	5.3			42	1	
COLIFORM		Coliforms	COL				10	0	
FCOPPER		Copper, filtered	ppb	2.1	1000	EPAS	42	7	0
CRESOLS		Cresols (methylphenols)	ppb	1.7			1	0	
ETHBENZ		Ethylbenzene	ppb	.034	700	EPA	42	0	0
BETA		Gross beta	pCi/L				42	42	
I-129		Iodine-129	pCi/L		1	EPA	4	4	1
FMAGNES		Magnesium, filtered	ppb	26			42	42	
METHYCH		Methylene chloride	ppb	.084	5	EPA	42	0	0
FNICKEL		Nickel, filtered	ppb	11	100	EPA	42	7	0
NITRITE		Nitrite	ppb	140	4000	EPA	42	0	0
PENTCHP		Pentachlorophenol	ppb	.48	1	EPA	1	0	0
PHOSPHA		Phosphate	ppb	340			42	0	
FPOTASS		Potassium, filtered	ppb	390			42	42	
FSILVER		Silver, filtered	ppb	5.5	100	EPAS	42	0	0
FSTRONUM		Strontium, Filtered	ppb	.31			9	9	
TC-99		Technetium-99	pCi/L		900	EPA	2	2	0
TMP		Temperature	DegC				152	152	
PERCENE		Tetrachloroethene	ppb	.035	5	EPA	42	42	0
TETPHNL		Tetrachlorophenols	ppb	.52			1	0	
FTIN		Tin, filtered	ppb	30			42	0	

Table 5.2A-1. Constituent List and Summary of Results for the Solid Waste Landfill
Data for Reporting Period November 1, 1994 through September 30, 1995.
(sheet 3 of 3)

Constituent Name				Lab	DWS		Number of Samples		
Short	(Method)	Full	Units	MDL	Limit	Agency	Total	>MDL	>DWS
TOLUENE		Toluene	ppb	.048	1000	EPA	42	1	0
TC		Total Carbon	ppb	170			42	42	
TDS		Total dissolved solids	ppb		500000	EPAS	42	42	0
TRICENE		Trichloroethene	ppb	.075	5	EPA	42	41	0
TRIPHNL		Trichlorophenols	ppb	.56			1	0	
TRITIUM		Tritium	pCi/L		20000	EPA	44	41	26
TURBID	111	Turbidity	NTU				30	30	
TURBID	126	Turbidity	NTU				21	21	
FVANADI		Vanadium, filtered	ppb	1.9			42	42	
VINYIDE		Vinyl chloride	ppb	.25	2	EPA	42	0	0
XYLENE		Xylenes (total)	ppb	.085	10000	EPA	42	0	0
FZINC		Zinc, filtered	ppb	3.7	5000	EPAS	42	20	0
CIS12DE		cis-1,2-Dichloroethylene	ppb	.049	70	EPA	42	4	0
TRANDCE		trans-1,2-Dichloroethylene	ppb	.045	100	EPA	42	0	0

Table 5.2A-2. Constituents with at Least One Detected Value for the Solid Waste Landfill
Data for Reporting Period November 1, 1994 through September 30, 1995.
(sheet 1 of 23)

Well Name	Collection Date	Sample Number	111-T 25/ppb .061/200	11-DIC 26/ppb .047/.	14-dben 35/ppb .056/75	ALKALIN 357/ppb 3500/.
699-22-35	11/02/94	B0D638	23.00	3.80	.06 U	330000.00
699-22-35	3/01/95	B0DQP8	26.00	5.40	.06 U	350000.00
699-22-35	5/18/95	B0FJW1	24.00	5.10	.06 U	340000.00 D
699-22-35	8/14/95	B0G9X4	22.00	3.20	.06 U	330000.00 D
699-22-35	8/14/95	B0G9Z6	21.00	3.30	.06 U	340000.00 D
699-23-34A	11/02/94	B0D643	14.00	2.90	.26 L	270000.00
699-23-34A	3/01/95	B0DQQ3	12.00	2.90	.38 L	290000.00
699-23-34A	5/18/95	B0FJW6	14.00	3.30	.48 L	280000.00 D
699-23-34A	8/14/95	B0GB16	9.00	1.80	.23	280000.00 D
699-23-34B	11/02/94	B0D648	23.00	4.10	.06 U	320000.00
699-23-34B	3/02/95	B0DQQ8	23.00	3.80	.16 L	330000.00
699-23-34B	5/18/95	B0FJX1	25.00	4.30	.09 L	330000.00 D
699-23-34B	8/14/95	B0GB21	19.00	3.30	.07 L	330000.00 D
699-24-33	11/02/94	B0D653	4.80	.45 L	.06 U	270000.00
699-24-33	3/01/95	B0DQR3	4.40	.73 L	.06 U	270000.00
699-24-33	3/01/95	B0DQR4	4.70	.72 L	.06 L	270000.00
699-24-33	5/19/95	B0FJX6	4.60	.79 LY	.06 U	280000.00 D
699-24-33	8/14/95	B0GB44	3.80	.28	.06 U	270000.00 D
699-24-34A	11/01/94	B0D662	10.00	1.60	.36 L	240000.00
699-24-34A	3/02/95	B0DQS3	6.70	1.50	.24 L	260000.00
699-24-34A	5/18/95	B0FJY1	9.50	1.70	.19 L	260000.00 D
699-24-34A	8/14/95	B0GB76	4.90	.69	.07 L	270000.00 D
699-24-34B	11/01/94	B0D667	7.10	1.10	.43 L	260000.00
699-24-34B	3/01/95	B0DQS8	5.70	1.10	.21 L	260000.00
699-24-34B	5/19/95	B0FJY6	5.70	1.20 Y	.17 L	270000.00 D
699-24-34B	8/15/95	B0GB81	4.90	.59	.08 L	290000.00 D
699-24-34C	11/02/94	B0D672	6.80	1.60	.06 U	300000.00
699-24-34C	3/01/95	B0DQT3	5.60	.96 L	.06 U	280000.00
699-24-34C	5/18/95	B0FJZ1	5.20	1.10	.06 U	300000.00 D
699-24-34C	8/14/95	B0GB86	4.70	.84	.06 U	320000.00 D
699-24-35	11/01/94	B0D677	4.40	.06 U	.06 U	190000.00
699-24-35	3/01/95	B0DQT8	2.90	.08 L	.06 U	210000.00
699-24-35	5/18/95	B0FJ26	2.10	.05 U	.06 U	210000.00 D
699-24-35	8/11/95	B0GB93	1.90	.05 U	.06 U	200000.00
699-25-34C	11/02/94	B0D682	2.80	.06 U	.06 U	220000.00
699-25-34C	3/02/95	B0DQV3	2.50	.30 L	.06 U	220000.00
699-25-34C	5/18/95	B0FK01	2.30	.25 L	.06 U	220000.00 D
699-25-34C	8/14/95	B0GB98	1.80	.05 U	.06 U	220000.00 D
699-26-35A	11/01/94	B0D687	1.10	.06 U	.06 U	160000.00
699-26-35A	2/28/95	B0DQV8	1.30	.05 U	.06 U	160000.00
699-26-35A	5/22/95	B0FK06	1.10	.05 U	.06 U	160000.00
699-26-35A	8/11/95	B0G9Y7	.99	.05 U	.06 U	160000.00

Table 5.2A-2. Constituents with at Least One Detected Value for the Solid Waste Landfill Data for Reporting Period November 1, 1994 through September 30, 1995.

(sheet 2 of 23)

Well Name	Collection Date	Sample Number	111-T 25/ppb .061/200	11-DIC 25/ppb .047/.	14-dben 25/ppb .056/75	ALKALIN 357/ppb 3500/.

Well Name	Collection Date	Sample Number	FALUMIN 34/ppb 31/200s	AMMONIU 129/ppb 27/.	FBARIUM 34/ppb 1.4/2000	BENZENE 26/ppb .059/5
699-22-35	11/02/94	B0D638		37.00 U		.01 U
699-22-35	11/02/94	B0D642	26.00 U		110.00	
699-22-35	3/01/95	B0DQP8		27.00 U		.06 U
699-22-35	3/01/95	B0DQQ2	31.00 U		110.00	
699-22-35	5/18/95	B0FJW1		30.00 L		.06 U
699-22-35	5/18/95	B0FJW5	35.00 L		120.00	
699-22-35	8/14/95	B0G9X4		30.00 L		.06 U
699-22-35	8/14/95	B0G9X8	31.00 U		120.00	
699-22-35	8/14/95	B0G9Z6		37.00 U		.06 U
699-22-35	8/14/95	B0GB00	31.00 U		120.00	
699-23-34A	11/02/94	B0D643		60.00 L		.01 U
699-23-34A	11/02/94	B0D647	26.00 U		91.00	
699-23-34A	3/01/95	B0DQQ3		70.00 BL		.06 U
699-23-34A	3/01/95	B0DQQ7	31.00 U		90.00	
699-23-34A	5/18/95	B0FJW6		27.00 U		.06 U
699-23-34A	5/18/95	B0FJX0	31.00 U		56.00	
699-23-34A	8/14/95	B0GB18		30.00 L		.06 U
699-23-34A	8/14/95	B0GB22	31.00 U		86.00	
699-23-34B	11/02/94	B0D648		37.00 U		.09 L
699-23-34B	11/02/94	B0D652	26.00 U		110.00	
699-23-34B	3/02/95	B0DQQ8		60.00 BL		.06 U
699-23-34B	3/02/95	B0DQR2	31.00 U		110.00	
699-23-34B	5/18/95	B0FJX1		37.00 U		.06 U
699-23-34B	5/18/95	B0FJX5	31.00 U		120.00	
699-23-34B	8/14/95	B0GB31		30.00 L		.06 U
699-23-34B	8/14/95	B0GB35	31.00 U		120.00	
699-24-33	11/02/94	B0D653		37.00 U		.01 U
699-24-33	11/02/94	B0D661	26.00 U		73.00	
699-24-33	3/01/95	B0DQR3		40.00 BLQ		.06 U
699-24-33	3/01/96	B0DQR4		60.00 BLQ		.06 U
699-24-33	3/01/96	B0DQS1	31.00 U		76.00	
699-24-33	3/01/95	B0DQS2	31.00 U		75.00	
699-24-33	5/19/95	B0FJX6		27.00 U		.06 U
699-24-33	5/19/95	B0FJZ0	31.00 U		80.00	
699-24-33	8/14/95	B0GB44		30.00 L		.06 U
699-24-33	8/14/95	B0GB48	31.00 U		77.00	
699-24-34A	11/01/94	B0D662		37.00 U		.01 UQ

Table 5.2A-2. Constituents with at Least One Detected Value for the Solid Waste Landfill Data for Reporting Period November 1, 1994 through September 30, 1995.
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Well Name	Collection Date	Sample Number	FALUMIN 34/ppb 31/2000	AMMONIU 129/ppb 27/.	FBARIUM 34/ppb 1.4/2000	BENZENE 25/ppb .059/5
699-24-34A	11/01/94	B0D666	26.00 U		74.00	
699-24-34A	3/02/95	B0DQ53		27.00 U		.06 U
699-24-34A	3/02/95	B0DQ57	31.00 U		74.00	
699-24-34A	5/18/95	B0FJY1		27.00 U		.06 U
699-24-34A	5/18/95	B0FJY5	31.00 U		78.00	
699-24-34A	8/14/95	B0GB76		30.00 L		.06 U
699-24-34A	8/14/95	B0GB80	31.00 U		78.00	
699-24-34B	11/01/94	B0D667		37.00 U		.01 UQ
699-24-34B	11/01/94	B0D671	26.00 U		77.00	
699-24-34B	3/01/95	B0DQ58		60.00 BL		.06 U
699-24-34B	3/01/95	B0DQT2	31.00 U		76.00	
699-24-34B	5/19/95	B0FJZ0	33.00 L		77.00	
699-24-34B	5/19/95	B0FJY6		27.00 U		.06 U
699-24-34B	8/15/95	B0GB81		27.00 U		.06 U
699-24-34B	8/15/95	B0GB85	31.00 U		84.00	
699-24-34C	11/02/94	B0D672		80.00 L		.01 U
699-24-34C	11/02/94	B0D676	26.00 U		66.00	
699-24-34C	3/01/95	B0DQT3		27.00 U		.06 U
699-24-34C	3/01/95	B0DQT7	31.00 U		62.00	
699-24-34C	5/18/95	B0FJZ1		27.00 U		.06 U
699-24-34C	5/18/95	B0FJZ5	31.00 U		62.00	
699-24-34C	8/14/95	B0GB86		30.00 L		.06 U
699-24-34C	8/14/95	B0GB90	31.00 U		67.00	
699-24-35	11/01/94	B0D677		37.00 U		.01 UQ
699-24-35	11/01/94	B0D681	26.00 U		58.00	
699-24-35	3/01/95	B0DQT8		60.00 BL		.06 U
699-24-35	3/01/95	B0DQV2	31.00 U		57.00	
699-24-35	5/18/95	B0FJZ6		27.00 U		.06 U
699-24-35	5/18/95	B0FK00	35.00 L		60.00	
699-24-35	8/11/95	B0GB93		27.00 U		.06 U
699-24-35	8/11/95	B0GB97	31.00 U		56.00	
699-25-34C	11/02/94	B0D682		37.00 U		.01 U
699-25-34C	11/02/94	B0D686	26.00 U		55.00	
699-25-34C	3/02/95	B0DQV3		60.00 BL		.06 U
699-25-34C	3/02/95	B0DQV7	31.00 U		55.00	
699-25-34C	5/18/95	B0FK01		27.00 U		.06 U
699-25-34C	5/18/95	B0FK05	34.00 L		56.00	
699-25-34C	8/14/95	B0GB98		40.00 L		.06 U
699-25-34C	8/14/95	B0GB83	31.00 U		58.00	
699-26-35A	11/01/94	B0D687		37.00 U		.01 UQ
699-26-35A	11/01/94	B0D691	26.00 U		38.00	
699-26-35A	2/28/95	B0DQV8		27.00 U		.06 U
699-26-35A	2/28/95	B0DQW2	31.00 U		39.00	
699-26-35A	5/22/95	B0FK06		27.00 U		.06 U

Table 5.2A-2. Constituents with at Least One Detected Value for the Solid Waste Landfill Data for Reporting Period November 1, 1994 through September 30, 1995.
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Well Name	Collection Date	Sample Number	FALUMIN 34/ppb 31/200s	AMMONIU 129/ppb 27/.	FBARIUM 34/ppb 1.4/2000	BENZENE 25/ppb .059/5
699-26-35A	5/22/95	B0FK10	31.00 U		38.00	
699-26-35A	8/11/95	B0G9V4		40.00 L		
699-26-35A	8/11/95	B0G9Y7				.06 U
699-26-35A	8/11/95	B0G9Z1	31.00 U		39.00	

Well Name	Collection Date	Sample Number	BROMIDE 124/ppb 72/.	FCADMIU 34/ppb .98/5	FCALCIU 34/ppb 41/.	TETRANE 25/ppb .042/5
699-22-35	11/02/94	B0D638	45.00 L			.08 U
699-22-35	11/02/94	B0D642		3.30 U	99000.00	
699-22-35	3/01/95	B0DQP8	60.00 L			.04 U
699-22-35	3/01/95	B0DQQ2		.98 U	100000.00	
699-22-35	5/18/95	B0FJW1	72.00 U			.08 L
699-22-35	5/18/95	B0FJW5		1.20 L	100000.00	
699-22-35	8/14/95	B0G9X4	80.00 L			.04 U
699-22-35	8/14/95	B0G9X8		1.10 L	100000.00	
699-22-35	8/14/95	B0G9Z6	72.00 U			.04 U
699-22-35	8/14/95	B0GB00		1.30 L	100000.00	
699-23-34A	11/02/94	B0D643	47.00 L			.08 U
699-23-34A	11/02/94	B0D647		3.30 U	86000.00	
699-23-34A	3/01/95	B0DQQ3	60.00 L			.04 U
699-23-34A	3/01/95	B0DQQ7		.98 U	82000.00	
699-23-34A	5/18/95	B0FJW6	72.00 U			.04 U
699-23-34A	5/18/95	B0FJX0		.98 U	85000.00	
699-23-34A	8/14/95	B0GB18	100.00 L			.04 U
699-23-34A	8/14/95	B0GB22		1.00 L	72000.00	
699-23-34B	11/02/94	B0D648	46.00 L			.08 U
699-23-34B	11/02/94	B0D652		3.30 U	100000.00	
699-23-34B	3/02/95	B0DQQ8	60.00 L			1.20
699-23-34B	3/02/95	B0DQR2		.98 U	95000.00	
699-23-34B	5/18/95	B0FJX1	72.00 U			.04 U
699-23-34B	5/18/95	B0FJX5		.98 U	99000.00	
699-23-34B	8/14/95	B0GB31	100.00 L			.04 U
699-23-34B	8/14/95	B0GB35		.98 U	100000.00	
699-24-33	11/02/94	B0D653	51.00 L			.08 U
699-24-33	11/02/94	B0D661		3.30 U	84000.00	
699-24-33	3/01/95	B0DQR3	50.00 L			.04 UQ
699-24-33	3/01/95	B0DQR4	50.00 L			.50 LQ
699-24-33	3/01/95	B0DQS1		.98 U	84000.00	
699-24-33	3/01/95	B0DQS2		.98 U	83000.00	
699-24-33	5/19/95	B0FJX6	72.00 U			.58 L

Table 5.2A-2. Constituents with at Least One Detected Value for the Solid Waste Landfill Data for Reporting Period November 1, 1994 through September 30, 1995.

(sheet 5 of 23)

Well Name	Collection Date	Sample Number	BROMIDE 124/ppb 72/.	FCADMIU 34/ppb .98/5	FCALCIU 34/ppb 41/.	TETRANE 25/ppb .042/5
699-24-33	5/19/95	B0FJZ0		.98 U	79000.00	
699-24-33	8/14/95	B0GB44	72.00 U			.04 U
699-24-33	8/14/95	B0GB48		.98 U	83000.00	
699-24-34A	11/01/94	B0D662	53.00 L			.08 U
699-24-34A	11/01/94	B0D666		3.30 U	78000.00	
699-24-34A	3/02/95	B0DQS3	60.00 L			.41 L
699-24-34A	3/02/95	B0DQS7		.98 U	75000.00	
699-24-34A	5/18/95	B0FJY1	72.00 U			.04 U
699-24-34A	5/18/95	B0FJY5		.98 U	77000.00	
699-24-34A	8/14/95	B0GB76	72.00 U			.04 U
699-24-34A	8/14/95	B0GB80		.98 U	76000.00	
699-24-34B	11/01/94	B0D667	56.00 L			.08 U
699-24-34B	11/01/94	B0D671		3.30 U	82000.00	
699-24-34B	3/01/95	B0DQS8	50.00 L			.04 U
699-24-34B	3/01/95	B0DQT2		.98 U	78000.00	
699-24-34B	5/19/95	B0FJY0		.98 U	84000.00	
699-24-34B	5/19/95	B0FJY6	80.00 L			.04 U
699-24-34B	8/15/95	B0GB81	100.00 L			.04 U
699-24-34B	8/15/95	B0GB85		.98 U	81000.00	
699-24-34C	11/02/94	B0D672	54.00 L			.08 U
699-24-34C	11/02/94	B0D676		3.30 U	97000.00	
699-24-34C	3/01/95	B0DQT3	60.00 L			.04 U
699-24-34C	3/01/95	B0DQT7		.98 U	90000.00	
699-24-34C	5/18/95	B0FJZ1	72.00 U			.04 U
699-24-34C	5/18/95	B0FJZ5		.98 U	90000.00	
699-24-34C	8/14/95	B0GB86	72.00 U			.04 U
699-24-34C	8/14/95	B0GB90		1.60 L	93000.00	
699-24-35	11/01/94	B0D677	53.00 L			.08 U
699-24-35	11/01/94	B0D681		3.30 U	61000.00	
699-24-35	3/01/95	B0DQT8	60.00 L			.04 U
699-24-35	3/01/95	B0DQV2		.98 U	60000.00	
699-24-35	5/18/95	B0FJZ6	72.00 U			.04 U
699-24-35	5/18/95	B0FK00		.98 U	60000.00	
699-24-35	8/11/95	B0GB93	72.00 U			.04 U
699-24-35	8/11/95	B0GB97		.98 U	60000.00	
699-25-34C	11/02/94	B0D682	45.00 L			.08 U
699-25-34C	11/02/94	B0D686		3.30 U	69000.00	
699-25-34C	3/02/95	B0DQV3	100.00 L			.46 L
699-25-34C	3/02/95	B0DQV7		.98 U	65000.00	
699-25-34C	5/18/95	B0FK01	72.00 U			.45 L
699-25-34C	5/18/95	B0FK05		.98 U	65000.00	
699-25-34C	8/14/95	B0GB98	72.00 U			.04 U
699-25-34C	8/14/95	B0GBB2		.98 U	66000.00	
699-26-35A	11/01/94	B0D687	47.00 L			.31 L

Table 5.2A-2. Constituents with at Least One Detected Value for the Solid Waste Landfill
Data for Reporting Period November 1, 1994 through September 30, 1995.
(sheet 6 of 23)

Well Name	Collection Date	Sample Number	BROMIDE 124/ppb 72/.	FCADMIU 34/ppb .98/5	FCALCIU 34/ppb 41/.	TETRANE 25/ppb .042/5
699-26-35A	11/01/94	B0D691		3.30 U	48000.00	
699-26-35A	2/28/95	B0DQV8	60.00 L			.41 L
699-26-35A	2/28/95	B0DQW2		.98 U	48000.00	
699-26-35A	5/22/95	B0FK06	72.00 U			.35 L
699-26-35A	5/22/95	B0FK10		.98 U	48000.00	
699-26-35A	8/11/95	B0G9Y7	72.00 U			2.00
699-26-35A	8/11/95	B0G9Z1		.98 U	48000.00	

Well Name	Collection Date	Sample Number	COD 356/ppb 2900/.	CHLORID 124/ppb 110/2600008	CHLFORM 25/ppb .029/.	FCHROMI 34/ppb 3.7/100
699-22-35	11/02/94	B0D638	2600.00 U	6200.00	.04 U	
699-22-35	11/02/94	B0D642				7.20 BL
699-22-35	3/01/95	B0DQP8	2900.00 U	6500.00 BQ	.35 L	
699-22-35	3/01/95	B0DQQ2				3.70 U
699-22-35	5/18/95	B0FJW1	2900.00 U	6400.00	.29 L	
699-22-35	5/18/95	B0FJW5				6.70 L
699-22-35	8/14/95	B0G9X4	2900.00 U	6300.00	.03 U	
699-22-35	8/14/95	B0G9X8				4.00 L
699-22-35	8/14/95	B0G9Z6	2900.00 U	6200.00	.03 U	
699-22-35	8/14/95	B0GB00				4.00 L
699-23-34A	11/02/94	B0D643	2600.00 U	6200.00	.04 U	
699-23-34A	11/02/94	B0D647				7.50 BL
699-23-34A	3/01/95	B0DQQ3	2800.00 L	6400.00 BQ	.10 L	
699-23-34A	3/01/95	B0DQQ7				5.60 L
699-23-34A	5/18/95	B0FJW6	2900.00 U	6100.00	.10 L	
699-23-34A	5/18/95	B0FJX0				8.20 L
699-23-34A	8/14/95	B0GB18	2900.00 U	6100.00	.03 U	
699-23-34A	8/14/95	B0GB22				5.10 L
699-23-34B	11/02/94	B0D648	2600.00 U	6100.00	.04 U	
699-23-34B	11/02/94	B0D652				5.90 BL
699-23-34B	3/02/95	B0DQQ8	2900.00 U	6300.00 B	.21 L	
699-23-34B	3/02/95	B0DQR2				3.70 U
699-23-34B	5/18/95	B0FJX1	2900.00 U	6200.00	.24 L	
699-23-34B	5/18/95	B0FJX5				5.60 L
699-23-34B	8/14/95	B0GB31	2900.00 U	6200.00	.03 U	
699-23-34B	8/14/95	B0GB35				3.70 U
699-24-33	11/02/94	B0D653	7000.00	7000.00	.04 U	
699-24-33	11/02/94	B0D661				11.00 BL
699-24-33	3/01/95	B0DQR3	2900.00 U	7200.00 BQ	.04 L	
699-24-33	3/01/95	B0DQR4	2900.00 U	7200.00 BQ	.05 L	

Table 5.2A-2. Constituents with at Least One Detected Value for the Solid Waste Landfill
Data for Reporting Period November 1, 1994 through September 30, 1995.
(sheet 7 of 23)

Well Name	Collection Date	Sample Number	COD 356/ppb 2900/.	CHLORID 124/ppb 110/250000s	CHLFORM 25/ppb .029/.	FCHROMI 34/ppb 3.7/100
699-24-33	3/01/95	B0DQS1				9.60 L
699-24-33	3/01/95	B0DQS2				8.30 L
699-24-33	5/19/95	B0FJX6	2900.00 U	7200.00	.05 L	
699-24-33	5/19/95	B0FJZ0				9.40 L
699-24-33	8/14/95	B0GB44	2900.00 U	7100.00	.03 U	
699-24-33	8/14/95	B0GB48				10.00
699-24-34A	11/01/94	B0D662	2600.00 U	6400.00	.04 U	
699-24-34A	11/01/94	B0D666				14.00 BL
699-24-34A	3/02/95	B0DQS3	2900.00 U	6800.00 B	.05 L	
699-24-34A	3/02/95	B0DQS7				6.50 L
699-24-34A	5/18/95	B0FJY1	2900.00 U	6400.00	.03 L	
699-24-34A	5/18/95	B0FJY5				6.60 L
699-24-34A	8/14/95	B0GB76	2900.00 U	6200.00	.03 U	
699-24-34A	8/14/95	B0GB80				6.90 L
699-24-34B	11/01/94	B0D667	2600.00 U	6800.00	.04 U	
699-24-34B	11/01/94	B0D671				9.20 BL
699-24-34B	3/01/95	B0DQS8	2900.00 U	7000.00 BQ	.04 L	
699-24-34B	3/01/95	B0DQT2				8.80 L
699-24-34B	5/19/95	B0FJY0				13.00 L
699-24-34B	5/19/95	B0FJY6	2900.00 U	6800.00	.04 L	
699-24-34B	8/15/95	B0GB81	2900.00 U	6900.00	.03 L	
699-24-34B	8/15/95	B0GB85				6.40 L
699-24-34C	11/02/94	B0D672	2600.00 U	7200.00	.04 U	
699-24-34C	11/02/94	B0D676				9.80 BL
699-24-34C	3/01/95	B0DQT3	2900.00 U	7400.00 BQ	.06 L	
699-24-34C	3/01/95	B0DQT7				9.60 L
699-24-34C	5/18/95	B0FJZ1	2900.00 U	7300.00	.03 U	
699-24-34C	5/18/95	B0FJZ5				11.00 L
699-24-34C	8/14/95	B0GB86	2900.00 U	7200.00	.03 U	
699-24-34C	8/14/95	B0GB90				8.70 L
699-24-35	11/01/94	B0D677	2600.00 U	6000.00	.04 U	
699-24-35	11/01/94	B0D681				9.50 BL
699-24-35	3/01/95	B0DQT8	2900.00 U	6200.00 BQ	.03 U	
699-24-35	3/01/95	B0DQV2				6.10 L
699-24-35	5/18/95	B0FJZ6	2900.00 U	5900.00	.03 U	
699-24-35	5/18/95	B0FK00				7.60 L
699-24-35	8/11/95	B0GB93	2900.00 U	5800.00	.03 U	
699-24-35	8/11/95	B0GB97				130.00 F
699-25-34C	11/02/94	B0D682	2600.00 U	7000.00	.04 U	
699-25-34C	11/02/94	B0D686				13.00 BL
699-25-34C	3/02/95	B0DQV3	2900.00 U	7300.00 B	.11 L	
699-25-34C	3/02/95	B0DQV7				15.00 L
699-25-34C	5/18/95	B0FK01	2900.00 U	7300.00	.08 L	
699-25-34C	5/18/95	B0FK05				18.00 L

Table 5.2A-2. Constituents with at Least One Detected Value for the Solid Waste Landfill
Data for Reporting Period November 1, 1994 through September 30, 1995.
(sheet 8 of 23)

Well Name	Collection Date	Sample Number	COD 356/ppb 2900/.	CHLORID 124/ppb 110/250000s	CHLFORM 25/ppb .029/.	FCHROMI 34/ppb 3.7/100
699-25-34C	8/14/95	B0GB98	2900.00 U	7100.00	.03 U	
699-25-34C	8/14/95	B0GBB2				17.00
699-26-35A	11/01/94	B0D687	2600.00 U	6900.00	.04 U	
699-26-35A	11/01/94	B0D691				20.00 BL
699-26-35A	2/28/95	B0DQV8	2900.00 U	7100.00 BQ	.03 U	
699-26-35A	2/28/95	B0DQW2				17.00 L
699-26-35A	5/22/95	B0FK06	2900.00 U	7100.00	.03 U	
699-26-35A	5/22/95	B0FK10				19.00 L
699-26-35A	8/11/95	B0G9V4	2900.00 U			
699-26-35A	8/11/95	B0G9Y7		6900.00	.03 U	
699-26-35A	8/11/95	B0G9Z1				19.00 L

Well Name	Collection Date	Sample Number	FCOBALT 34/ppb 5.3/.	FCOPPER 34/ppb 2.1/1000s	FLUORID 124/ppb 52/4000'	ALPHA 135/pCi/L ./15
699-22-35	11/02/94	B0D638			1000.00	6.40
699-22-35	11/02/94	B0D642	5.90 U	4.10 U		
699-22-35	3/01/95	B0DQP8			1000.00 Q	7.67
699-22-35	3/01/95	B0DQQ2	5.30 U	2.10 U		
699-22-35	5/18/95	B0FJW1			900.00	6.52
699-22-35	5/18/95	B0FJW5	5.30 U	2.50 L		
699-22-35	8/14/95	B0G9X4			1000.00	3.06 Q
699-22-35	8/14/95	B0G9X8	5.30 U	2.10 U		
699-22-35	8/14/95	B0G9Z6			1000.00	7.73 Q
699-22-35	8/14/95	B0GB00	5.30 U	2.10 U		
699-23-34A	11/02/94	B0D643			1300.00	5.83
699-23-34A	11/02/94	B0D647	5.90 U	4.10 U		
699-23-34A	3/01/95	B0DQQ3			1100.00 Q	4.11
699-23-34A	3/01/95	B0DQQ7	5.30 U	7.00 L		
699-23-34A	5/18/95	B0FJW6			1100.00	4.36
699-23-34A	5/18/95	B0FJX0	5.30 U	2.90 L		
699-23-34A	8/14/95	B0GB18			1200.00	5.02
699-23-34A	8/14/95	B0GB22	6.30 U	2.10 U		
699-23-34B	11/02/94	B0D648			1100.00	7.72
699-23-34B	11/02/94	B0D652	7.50 L	4.10 U		
699-23-34B	3/02/95	B0DQQ8			1100.00	4.32
699-23-34B	3/02/95	B0DQR2	5.30 U	2.10 U		
699-23-34B	5/18/95	B0FJX1			1100.00	6.03
699-23-34B	5/18/95	B0FJX5	5.30 U	2.10 U		
699-23-34B	8/14/95	B0GB31			1100.00	4.20
699-23-34B	8/14/95	B0GB35	5.30 U	2.10 U		

Table 5.2A-2. Constituents with at Least One Detected Value for the Solid Waste Landfill
Data for Reporting Period November 1, 1994 through September 30, 1995.
(sheet 9 of 23)

Well Name	Collection Date	Sample Number	FCOBALT 34/ppb 5.3/.	FCOPPER 34/ppb 2.1/1000s	FLUORID 124/ppb 52/4000	ALPHA 135/pCi/L ./15
699-24-33	11/02/94	B0D653			1000.00	5.72
699-24-33	11/02/94	B0D661	5.90 U	4.10 U		
699-24-33	3/01/95	B0DQR3			900.00 Q	3.89 Q
699-24-33	3/01/95	B0DQR4			900.00 Q	2.00 Q
699-24-33	3/01/95	B0DQS1	5.30 U	2.10 U		
699-24-33	3/01/95	B0DQS2	5.30 U	2.10 U		
699-24-33	5/19/95	B0FJX6			1000.00	7.46
699-24-33	5/19/95	B0FJZ0	5.30 U	2.10 U		
699-24-33	8/14/95	B0GB44			900.00	4.17
699-24-33	8/14/95	B0GB48	5.30 U	2.10 U		
699-24-34A	11/01/94	B0D662			1300.00	5.22
699-24-34A	11/01/94	B0D666	5.90 U	4.10 U		
699-24-34A	3/02/95	B0DQS3			1100.00	2.46
699-24-34A	3/02/95	B0DQS7	5.30 U	2.10 U		
699-24-34A	5/18/95	B0FJY1			1100.00	6.88
699-24-34A	5/18/95	B0FJY5	5.30 U	2.10 U		
699-24-34A	8/14/95	B0GB76			1000.00	3.99
699-24-34A	8/14/95	B0GB80	5.30 U	2.10 U		
699-24-34B	11/01/94	B0D667			1200.00	3.23
699-24-34B	11/01/94	B0D671	5.90 U	4.10 U		
699-24-34B	3/01/95	B0DQS8			1000.00 Q	2.60
699-24-34B	3/01/95	B0DQT2	5.30 U	2.10 U		
699-24-34B	5/19/95	B0FJY0	5.30 U	2.10 U		
699-24-34B	5/19/95	B0FJY6			1100.00	2.07
699-24-34B	8/15/95	B0GB81			1100.00	5.35
699-24-34B	8/15/95	B0GB85	5.30 U	2.10 U		
699-24-34C	11/02/94	B0D672			1100.00	4.41
699-24-34C	11/02/94	B0D676	5.90 U	4.10 U		
699-24-34C	3/01/95	B0DQT3			900.00 Q	3.70
699-24-34C	3/01/95	B0DQT7	5.30 U	2.10 U		
699-24-34C	5/18/95	B0FJ21			1000.00	2.62
699-24-34C	5/18/95	B0FJ25	5.30 U	2.50 L		
699-24-34C	8/14/95	B0GB86			1000.00	2.98
699-24-34C	8/14/95	B0GB90	5.30 U	2.10 U		
699-24-35	11/01/94	B0D677			1000.00	5.05
699-24-35	11/01/94	B0D681	5.90 U	4.10 U		
699-24-35	3/01/95	B0DQT8			800.00 Q	4.49
699-24-35	3/01/95	B0DQV2	5.30 U	2.10 U		
699-24-35	5/18/95	B0FJ26			800.00	3.23
699-24-35	5/18/95	B0FK00	5.30 U	2.90 L		
699-24-35	8/11/95	B0GB93			800.00	2.94
699-24-35	8/11/95	B0GB97	5.30 U	20.00 F		
699-25-34C	11/02/94	B0D682			1000.00	3.28
699-25-34C	11/02/94	B0D686	5.90 U	4.10 U		

Table 5.2A-2. Constituents with at Least One Detected Value for the Solid Waste Landfill Data for Reporting Period November 1, 1994 through September 30, 1995.
(sheet 10 of 23)

Well Name	Collection Date	Sample Number	FCOBALT 34/ppb 5.3/.	FCOPPER 34/ppb 2.1/1000s	FLUORID 124/ppb 52/4000	ALPHA 135/pCi/L ./15
699-25-34C	3/02/95	B0DQV3			800.00	3.08
699-25-34C	3/02/95	B0DQV7	5.30 U	2.10 U		
699-25-34C	5/18/95	B0FK01			800.00	3.03
699-25-34C	5/18/95	B0FK05	5.30 U	2.10 U		
699-25-34C	8/14/95	B0GB98			900.00	4.32
699-25-34C	8/14/95	B0GBB2	5.30 U	2.10 U		
699-26-35A	11/01/94	B0D687			600.00	4.97
699-26-35A	11/01/94	B0D691	5.90 U	4.10 U		
699-26-35A	2/28/95	B0DQV8			800.00 Q	3.74
699-26-35A	2/28/95	B0DQW2	5.30 U	2.10 U		
699-26-35A	5/22/95	B0FK06			700.00	2.40
699-26-35A	5/22/95	B0FK10	5.30 U	2.10 U		
699-26-35A	8/11/95	B0G9Y7			700.00	4.58
699-26-35A	8/11/95	B0G9Z1	5.30 U	2.40 L		

Well Name	Collection Date	Sample Number	BETA 136/pCi/L ./.	I-129 139/pCi/L ./1	FIRON 34/ppb 8.9/300s	FMAGNES 34/ppb 26/.
699-22-35	11/02/94	B0D638	10.50			
699-22-35	11/02/94	B0D642			34.00	23000.00
699-22-35	3/01/95	B0DQP8	9.76			
699-22-35	3/01/95	B0DQQ2			33.00 Q	23000.00
699-22-35	4/28/95	B0F873		.07		
699-22-35	5/18/95	B0FJW1	12.00			
699-22-35	5/18/95	B0FJW5			30.00	24000.00
699-22-35	8/14/95	B0G9X4	10.80			
699-22-35	8/14/95	B0G9X8			14.00 L	24000.00
699-22-35	8/14/95	B0G9Z6	10.60			
699-22-35	8/14/95	B0GB00			16.00 L	24000.00
699-23-34A	11/02/94	B0D643	10.80			
699-23-34A	11/02/94	B0D647			37.00	18000.00
699-23-34A	12/16/94	B0DGK6		.23		
699-23-34A	3/01/95	B0DQQ3	9.97			
699-23-34A	3/01/95	B0DQQ7			23.00 Q	16000.00
699-23-34A	5/18/95	B0FJW6	10.10			
699-23-34A	5/18/95	B0FJX0			47.00	19000.00
699-23-34A	8/14/95	B0GB18	9.49			
699-23-34A	8/14/95	B0GB22			19.00 L	16000.00
699-23-34B	11/02/94	B0D648	11.20			
699-23-34B	11/02/94	B0D652			49.00	20000.00
699-23-34B	12/16/94	B0DGK7		.26		

Table 5.2A-2. Constituents with at Least One Detected Value for the Solid Waste Landfill
Data for Reporting Period November 1, 1994 through September 30, 1995.
(sheet 11 of 23)

Well Name	Collection Date	Sample Number	BETA 136/pCi/L ./.	I-129 139/pCi/L ./1	FIRON 34/ppb 8.9/300s	FMAGNES 34/ppb 26/.
699-23-34B	3/02/95	B0DQQ8	12.60			
699-23-34B	3/02/95	B0DQR2			28.00 Q	20000.00
699-23-34B	5/18/95	B0FJX1	9.75			
699-23-34B	5/18/95	B0FJX5			32.00	21000.00
699-23-34B	8/14/95	B0GB31	8.76			
699-23-34B	8/14/95	B0GB35			23.00 L	21000.00
699-24-33	11/02/94	B0D653	15.40			
699-24-33	11/02/94	B0D661			9.60 L	18000.00
699-24-33	3/01/95	B0DQR3	15.50			
699-24-33	3/01/95	B0DQR4	14.10			
699-24-33	3/01/95	B0DQS1			16.00 LQ	19000.00
699-24-33	3/01/95	B0DQS2			21.00 Q	19000.00
699-24-33	5/19/95	B0FJX6	11.50			
699-24-33	5/19/95	B0FJZ0			21.00	18000.00
699-24-33	8/14/95	B0GB44	11.20			
699-24-33	8/14/95	B0GB48			13.00 L	19000.00
699-24-34A	11/01/94	B0D662	11.40			
699-24-34A	11/01/94	B0D666			65.00	17000.00
699-24-34A	3/02/95	B0DQS3	10.60			
699-24-34A	3/02/95	B0DQS7			29.00 Q	17000.00
699-24-34A	5/18/95	B0FJY1	10.70			
699-24-34A	5/18/95	B0FJY5			23.00	18000.00
699-24-34A	8/14/95	B0GB76	9.82			
699-24-34A	8/14/95	B0GB80			58.00	17000.00
699-24-34B	11/01/94	B0D667	11.10			
699-24-34B	11/01/94	B0D671			45.00	18000.00
699-24-34B	3/01/95	B0DQS8	13.00			
699-24-34B	3/01/95	B0DQT3			29.00 Q	17000.00
699-24-34B	5/19/95	B0FJY0			28.00	19000.00
699-24-34B	5/19/95	B0FJY6	11.40			
699-24-34B	8/15/95	B0GB81	12.30			
699-24-34B	8/15/95	B0GB85			24.00 BL	18000.00
699-24-34C	11/02/94	B0D672	11.90			
699-24-34C	11/02/94	B0D676			31.00	20000.00
699-24-34C	3/01/95	B0DQT3	15.30			
699-24-34C	3/01/95	B0DQT7			28.00 Q	19000.00
699-24-34C	5/18/95	B0FJZ1	26.80			
699-24-34C	5/18/95	B0FJZ5			26.00	19000.00
699-24-34C	8/14/95	B0GB86	11.70			
699-24-34C	8/14/95	B0GB90			18.00 L	19000.00
699-24-35	11/01/94	B0D677	12.30			
699-24-35	11/01/94	B0D681			19.00 L	14000.00
699-24-35	3/01/95	B0DQT8	9.78			
699-24-35	3/01/95	B0DQV2			25.00 Q	14000.00

Table 5.2A-2. Constituents with at Least One Detected Value for the Solid Waste Landfill
Data for Reporting Period November 1, 1994 through September 30, 1995.
(sheet 12 of 23)

Well Name	Collection Date	Sample Number	BETA 136/pCi/L ./.	I-129 139/pCi/L ./1	FIRON 34/ppb 8.9/300s	FMAGNES 34/ppb 26/.
699-24-35	5/18/95	B0FJZ6	8.93			
699-24-35	5/18/95	B0FK00			29.00	14000.00
699-24-35	8/11/95	B0GB93	10.30			
699-24-35	8/11/95	B0GB97			540.00 BQF	14000.00
699-25-34C	11/02/94	B0D682	14.10			
699-25-34C	11/02/94	B0D686			23.00	16000.00
699-25-34C	3/02/95	B0DQV3	13.20			
699-25-34C	3/02/95	B0DQV7			35.00 Q	16000.00
699-25-34C	5/18/95	B0FK01	13.80			
699-25-34C	5/18/95	B0FK05			17.00 L	17000.00
699-25-34C	8/14/95	B0GB98	17.60			
699-25-34C	8/14/95	B0GBB2			15.00 L	16000.00
699-26-35A	11/01/94	B0D687	14.30			
699-26-35A	11/01/94	B0D691			6.24 U	13000.00
699-26-35A	2/28/95	B0DQV8	15.40			
699-26-35A	2/28/95	B0DQW2			12.00 LQ	13000.00
699-26-35A	5/03/95	B0F873		2.85		
699-26-35A	5/22/95	B0FK06	14.10			
699-26-35A	5/22/95	B0FK10			8.90 U	13000.00
699-26-35A	8/11/95	B0G9Y7	15.10			
699-26-35A	8/11/95	B0G9Z1			15.00 BLQ	13000.00

Well Name	Collection Date	Sample Number	FMANGAN 34/ppb .55/50s	FNICKEL 34/ppb 11/100	NITRATE 124/ppb 120/45000	FPOTASS 34/ppb 390/.
699-22-35	11/02/94	B0D638			13000.00 DQ	
699-22-35	11/02/94	B0D642	3.00 L	19.00 L		9300.00
699-22-35	3/01/95	B0DQP8			12000.00 DQ	
699-22-35	3/01/95	B0DQQ2	1.40 L	11.00 U		9500.00
699-22-35	5/18/95	B0FJW1			13000.00 D	
699-22-35	5/18/95	B0FJW5	.67 L	11.00 U		9000.00
699-22-35	8/14/95	B0G9X4			13000.00 D	
699-22-35	8/14/95	B0G9X8	.55 U	11.00 U		9300.00
699-22-35	8/14/95	B0G9Z6			13000.00 D	
699-22-35	8/14/95	B0GB00	.63 L	11.00 U		9600.00
699-23-34A	11/02/94	B0D643			11000.00 DQ	
699-23-34A	11/02/94	B0D647	4.70 L	13.00 U		8300.00
699-23-34A	3/01/95	B0DQQ3			11000.00 DQ	
699-23-34A	3/01/95	B0DQQ7	1.00 L	48.00		8300.00
699-23-34A	5/18/95	B0FJW6			12000.00 D	
699-23-34A	5/18/95	B0FJX0	1.10 L	11.00 U		7800.00

Table 5.2A-2. Constituents with at Least One Detected Value for the Solid Waste Landfill Data for Reporting Period November 1, 1994 through September 30, 1995.
(sheet 13 of 23)

Well Name	Collection Date	Sample Number	FMANGAN 34/ppb .55/50s	FNICKEL 34/ppb 11/100	NITRATE 124/ppb 120/45000	FPOTASS 34/ppb 390/.
699-23-34A	8/14/95	B0GB18			12000.00 D	
699-23-34A	8/14/95	B0GB22	.55 U	11.00 U		7400.00
699-23-34B	11/02/94	B0D648			12000.00 DQ	
699-23-34B	11/02/94	B0D652	3.20 L	13.00 L		8400.00
699-23-34B	3/02/95	B0DQQ8			12000.00 D	
699-23-34B	3/02/95	B0DQR2	.89 L	11.00 U		8700.00
699-23-34B	5/18/95	B0FJX1			12000.00 D	
699-23-34B	5/18/95	B0FJX5	.75 L	11.00 U		8100.00
699-23-34B	8/14/95	B0GB31			12000.00 D	
699-23-34B	8/14/95	B0GB35	.81 L	11.00 U		8900.00
699-24-33	11/02/94	B0D653			21000.00 DQ	
699-24-33	11/02/94	B0D661	.72 U	13.00 U		7900.00
699-24-33	3/01/95	B0DQR3			20000.00 DQ	
699-24-33	3/01/95	B0DQR4			20000.00 DQ	
699-24-33	3/01/95	B0DQS1	.65 L	11.00 U		8400.00
699-24-33	3/01/95	B0DQS2	.55 U	11.00 U		8200.00
699-24-33	5/19/95	B0FJX6			20000.00 D	
699-24-33	5/19/95	B0FJZ0	.62 L	11.00 U		7400.00
699-24-33	8/14/95	B0GB44			20000.00 D	
699-24-33	8/14/95	B0GB48	.55 U	11.00 U		7900.00
699-24-34A	11/01/94	B0D662			13000.00 DQ	
699-24-34A	11/01/94	B0D666	3.30 L	15.00 L		7800.00
699-24-34A	3/02/95	B0DQS3			13000.00 D	
699-24-34A	3/02/95	B0DQS7	.83 L	11.00 U		8300.00
699-24-34A	5/18/95	B0FJY1			12000.00 D	
699-24-34A	5/18/95	B0FJY5	.55 U	11.00 U		7400.00
699-24-34A	8/14/95	B0GB76			13000.00 D	
699-24-34A	8/14/95	B0GB80	1.30 L	11.00 U		8000.00
699-24-34B	11/01/94	B0D667			16000.00 DQ	
699-24-34B	11/01/94	B0D671	1.50 L	13.00 U		7800.00
699-24-34B	3/01/95	B0DQS8			15000.00 DQ	
699-24-34B	3/01/95	B0DQT2	.55 U	11.00 U		7900.00
699-24-34B	5/19/95	B0FJY0	.55 U	11.00 U		7400.00
699-24-34B	5/19/95	B0FJY6			15000.00 D	
699-24-34B	8/15/95	B0GB81			16000.00 D	
699-24-34B	8/15/95	B0GB85	1.40 BL	11.00 U		8300.00
699-24-34C	11/02/94	B0D672			21000.00 DQ	
699-24-34C	11/02/94	B0D676	3.70 L	18.00 L		8100.00
699-24-34C	3/01/95	B0DQT3			21000.00 DQ	
699-24-34C	3/01/95	B0DQT7	1.00 L	11.00 U		8100.00
699-24-34C	5/18/95	B0FJZ1			21000.00 D	
699-24-34C	5/18/95	B0FJZ5	.62 L	11.00 U		7200.00
699-24-34C	8/14/95	B0GB86			20000.00 D	
699-24-34C	8/14/95	B0GB90	.55 U	11.00 U		8500.00

Table 5.2A-2. Constituents with at Least One Detected Value for the Solid Waste Landfill Data for Reporting Period November 1, 1994 through September 30, 1995.
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Well Name	Collection Date	Sample Number	FMANGAN 34/ppb .56/50s	FNICKEL 34/ppb 11/100	NITRATE 124/ppb 120/45000	FPOTASS 34/ppb 390/.
699-24-35	11/01/94	B0D677			11000.00 DQ	
699-24-35	11/01/94	B0D681	1.50 L	15.00 L		7500.00
699-24-35	3/01/95	B0DQT8			11000.00 DQ	
699-24-35	3/01/95	B0DQV2	.55 U	11.00 U		7700.00
699-24-35	5/18/95	B0FJZ6			11000.00 D	
699-24-35	5/18/95	B0FK00	.55 U	11.00 U		7100.00
699-24-35	8/11/95	B0GB93			11000.00 D	
699-24-35	8/11/95	B0GB97	6.30 LF	80.00 F		7300.00
699-25-34C	11/02/94	B0D682			25000.00 DQ	
699-25-34C	11/02/94	B0D686	2.20 L	13.00 U		7200.00
699-25-34C	3/03/95	B0DQV3			24000.00 D	
699-25-34C	3/03/95	B0DQV7	.55 U	11.00 U		7600.00
699-25-34C	5/18/95	B0FK01			24000.00 D	
699-25-34C	5/18/95	B0FK05	.55 U	11.00 U		6800.00
699-25-34C	8/14/95	B0GB98			23000.00 D	
699-25-34C	8/14/95	B0GB82	.55 U	11.00 U		7800.00
699-26-35A	11/01/94	B0D687			25000.00 DQ	
699-26-35A	11/01/94	B0D691	.72 U	13.00 U		6600.00
699-26-35A	2/28/95	B0DQV8			23000.00 DQ	
699-26-35A	2/28/95	B0DQW2	.55 U	11.00 U		6900.00
699-26-35A	5/22/95	B0FK06			23000.00 D	
699-26-35A	5/22/95	B0FK10	.55 U	11.00 U		5700.00
699-26-35A	8/11/95	B0G9Y7			23000.00 D	
699-26-35A	8/11/95	B0G9Z1	.55 U	11.00 U		6800.00

Well Name	Collection Date	Sample Number	FSODIUM 34/ppb 44/.	FSTRONUM 34/ppb .31/.	SULFATE 124/ppb 130/250000s	TC-99 143/pCi/L ./900
699-22-35	11/03/94	B0D638			51000.00 D	
699-22-35	11/03/94	B0D642	24000.00			
699-22-35	3/01/95	B0DQP8			49000.00 D	
699-22-35	3/01/95	B0DQQ2	24000.00 Q			
699-22-35	5/18/95	B0FJW1			55000.00 D	
699-22-35	5/18/95	B0FJW5	36000.00 Q			
699-22-35	8/14/95	B0G9X4			50000.00 D	
699-22-35	8/14/95	B0G9X8	26000.00 Q	480.00		
699-22-35	8/14/95	B0G9Z6			60000.00 D	
699-22-35	8/14/95	B0GB00	25000.00 Q	470.00		
699-23-34A	11/02/94	B0D643			43000.00 D	
699-23-34A	11/02/94	B0D647	22000.00			
699-23-34A	12/16/94	B0DGK6				10.50

Table 5.2A-2. Constituents with at Least One Detected Value for the Solid Waste Landfill
Data for Reporting Period November 1, 1994 through September 30, 1995.
(sheet 15 of 23)

Well Name	Collection Date	Sample Number	FSODIUM 34/ppb 44/.	FSTRONUM 34/ppb .31/.	SULFATE 124/ppb 130/250000s	TC-99 143/pCi/L ./900
699-23-34A	3/01/95	B0DQQ3			42000.00 D	
699-23-34A	3/01/95	B0DQQ7	23000.00 Q			
699-23-34A	5/18/95	B0FJH6			44000.00 D	
699-23-34A	5/18/95	B0FJX0	24000.00 Q			
699-23-34A	8/14/95	B0GB18			42000.00 D	
699-23-34A	8/14/95	B0GB22	21000.00 Q	310.00		
699-23-34B	11/02/94	B0D648			49000.00 D	
699-23-34B	11/02/94	B0D652	23000.00			
699-23-34B	12/16/94	B0DGR7				4.09
699-23-34B	3/02/95	B0DQQ8			50000.00 D	
699-23-34B	3/02/95	B0DQR2	24000.00 Q			
699-23-34B	5/18/95	B0FJX1			51000.00 D	
699-23-34B	5/18/95	B0FJX5	25000.00 Q			
699-23-34B	8/14/95	B0GB31			48000.00 D	
699-23-34B	8/14/95	B0GB35	25000.00 Q	430.00		
699-24-33	11/02/94	B0D653			41000.00 D	
699-24-33	11/02/94	B0D661	23000.00			
699-24-33	3/01/95	B0DQR3			40000.00 D	
699-24-33	3/01/95	B0DQR4			40000.00 D	
699-24-33	3/01/95	B0DQS1	24000.00 Q			
699-24-33	3/01/95	B0DQS2	24000.00 Q			
699-24-33	5/19/95	B0FJX6			42000.00 D	
699-24-33	5/19/95	B0FJZ0	25000.00 Q			
699-24-33	8/14/95	B0GB44			40000.00 D	
699-24-33	8/14/95	B0GB48	25000.00 Q	350.00		
699-24-34A	11/01/94	B0D662			43000.00 D	
699-24-34A	11/01/94	B0D666	22000.00			
699-24-34A	3/02/95	B0DQS3			43000.00 D	
699-24-34A	3/02/95	B0DQS7	23000.00 Q			
699-24-34A	5/18/95	B0FJY1			44000.00 D	
699-24-34A	5/18/95	B0FJY5	24000.00 Q			
699-24-34A	8/14/95	B0GB76			41000.00 D	
699-24-34A	8/14/96	B0GB80	24000.00 Q	310.00		
699-24-34B	11/01/94	B0D667			42000.00 D	
699-24-34B	11/01/94	B0D671	22000.00			
699-24-34B	3/01/95	B0DQS8			42000.00 D	
699-24-34B	3/01/95	B0DQT2	23000.00 Q			
699-24-34B	5/19/95	B0FJY0	25000.00 Q			
699-24-34B	5/19/96	B0FJY6			43000.00 D	
699-24-34B	8/16/95	B0GB81			41000.00 D	
699-24-34B	8/15/95	B0GB85	25000.00 Q	330.00		
699-24-34C	11/02/94	B0D672			32000.00 D	
699-24-34C	11/02/94	B0D676	23000.00			
699-24-34C	3/01/95	B0DQT3			40000.00 D	

Table 5.2A-2. Constituents with at Least One Detected Value for the Solid Waste Landfill
Data for Reporting Period November 1, 1994 through September 30, 1995.
(sheet 16 of 23)

Well Name	Collection Date	Sample Number	FSODIUM 34/ppb 44/.	FSTRONUM 34/ppb .31/.	SULFATE 124/ppb 130/250000s	TC-99 143/pCi/L ./900
699-24-34C	3/01/95	B0DQT7	24000.00 Q			
699-24-34C	5/18/95	B0FJZ1			42000.00 D	
699-24-34C	5/18/95	B0FJZ5	25000.00 Q			
699-24-34C	8/14/95	B0GB86			40000.00 D	
699-24-34C	8/14/95	B0GB90	25000.00 Q	370.00		
699-24-35	11/01/94	B0D677			42000.00 D	
699-24-35	11/01/94	B0D681	22000.00			
699-24-35	3/01/95	B0DQT8			41000.00 D	
699-24-35	3/01/95	B0DQV2	22000.00 Q			
699-24-35	5/18/95	B0FJZ6			43000.00 D	
699-24-35	5/18/95	B0FK00	24000.00 Q			
699-24-35	8/11/95	B0GB93			40000.00 D	
699-24-35	8/11/95	B0GB97	22000.00 Q			
699-25-34C	11/02/94	B0D682			39000.00 D	
699-25-34C	11/02/94	B0D686	23000.00			
699-25-34C	3/02/95	B0DQV3			39000.00 D	
699-25-34C	3/03/95	B0DQV7	25000.00 Q			
699-26-34C	5/18/95	B0FK01			44000.00 D	
699-26-34C	5/18/95	B0FK05	26000.00 Q			
699-26-34C	8/14/95	B0GB98			38000.00 D	
699-26-34C	8/14/95	B0GBB2	26000.00 Q	290.00		
699-26-35A	11/01/94	B0D687			38000.00 D	
699-26-35A	11/01/94	B0D691	23000.00			
699-26-35A	2/28/95	B0DQV8			38000.00 D	
699-26-35A	2/28/95	B0DQW2	24000.00 Q			
699-26-35A	5/23/95	B0FK06			38000.00 D	
699-26-35A	5/23/95	B0FK10	24000.00 Q			
699-26-35A	8/11/95	B0G9Y7			37000.00 D	
699-26-35A	8/11/95	B0G9Z1	23000.00 Q			

Well Name	Collection Date	Sample Number	TMP 170/DegC ./.	PERCENE 25/ppb .035/5	TOLUENE 25/ppb .048/1000	TC 113/ppb 170/.
699-22-35	11/02/94	B0D638	17.40	1.50	.02 U	76000.00 D
699-22-35	3/01/95	B0DQP8	16.70	2.60	.05 U	91000.00
699-22-35	3/01/95	B0DQP9	16.60			
699-22-35	3/01/95	B0DQQ0	16.60			
699-22-35	3/01/95	B0DQQ1	16.60			
699-22-35	4/28/95	B0F872	17.50			
699-22-35	5/18/95	B0FJW1	18.00	2.50	.05 U	89000.00 D
699-22-35	5/18/95	B0FJW2	18.00			

Table 5.2A-2. Constituents with at Least One Detected Value for the Solid Waste Landfill
Data for Reporting Period November 1, 1994 through September 30, 1995.
(sheet 17 of 23)

Well Name	Collection Date	Sample Number	TMP 170/DegC ./.	PERCENE 25/ppb .035/5	TOLUENE 25/ppb .048/1000	TC 113/ppb 170/.
699-22-35	5/18/95	B0FJW3	18.00			
699-22-35	5/18/95	B0FJW4	18.00			
699-22-35	8/14/95	B0G9X4		1.80	.05 U	90000.00 D
699-22-35	8/14/95	B0G9Z6	18.30	1.80	.05 U	68000.00 D
699-22-35	8/14/95	B0G9Z7	18.30			
699-22-35	8/14/95	B0G9Z8	18.30			
699-22-35	8/14/95	B0G9Z9	18.30			
699-23-34A	11/02/94	B0D643	19.50	2.90	.02 U	66000.00 B
699-23-34A	12/16/94	B0DGK6	17.40			
699-23-34A	3/01/95	B0DQQ3	16.90	3.30	.05 U	75000.00
699-23-34A	3/01/95	B0DQQ4	16.90			
699-23-34A	3/01/95	B0DQQ5	16.90			
699-23-34A	3/01/95	B0DQQ6	16.90			
699-23-34A	5/18/95	B0FJW6	18.60	4.00	.06 U	76000.00 D
699-23-34A	5/18/95	B0FJW7	18.70			
699-23-34A	5/18/95	B0FJW8	18.70			
699-23-34A	5/18/95	B0FJW9	18.70			
699-23-34A	8/14/95	B0GB18	18.60	2.20	.06 U	78000.00 D
699-23-34A	8/14/95	B0GB19	18.50			
699-23-34A	8/14/95	B0GB20	18.60			
699-23-34A	8/14/95	B0GB21	18.60			
699-23-34B	11/02/94	B0D648	17.60	1.90	.05 L	75000.00 B
699-23-34B	12/16/94	B0DGK7	17.60			
699-23-34B	3/02/95	B0DQQ8	17.70	3.10	.05 U	84000.00
699-23-34B	3/02/95	B0DQQ9	17.80			
699-23-34B	3/02/95	B0DQR0	17.90			
699-23-34B	3/02/95	B0DQR1	17.90			
699-23-34B	5/18/95	B0FJX1	18.50	3.00	.05 U	82000.00 D
699-23-34B	5/18/95	B0FJX2	18.40			
699-23-34B	5/18/95	B0FJX3	18.40			
699-23-34B	5/18/95	B0FJX4	18.30			
699-23-34B	8/14/95	B0GB31	18.10	2.40	.05 U	87000.00 D
699-23-34B	8/14/95	B0GB32	18.10			
699-23-34B	8/14/95	B0GB33	18.20			
699-23-34B	8/14/95	B0GB34	18.20			
699-24-33	11/02/94	B0D653	20.60	2.20	.02 U	65000.00 B
699-24-33	3/01/95	B0DQR3	19.20	3.10	.06 U	64000.00 D
699-24-33	3/01/95	B0DQR4	19.30	3.20	.05 U	65000.00 D
699-24-33	3/01/95	B0DQR5	19.30			
699-24-33	3/01/95	B0DQR6	19.30			
699-24-33	5/19/95	B0FJX6	19.30	2.80	.05 U	73000.00 D
699-24-33	5/19/95	B0FJX7	19.30			
699-24-33	5/19/95	B0FJX8	19.30			
699-24-33	5/19/95	B0FJX9	19.20			

Table 5.2A-2. Constituents with at Least One Detected Value for the Solid Waste Landfill
Data for Reporting Period November 1, 1994 through September 30, 1995.
(sheet 18 of 23)

Well Name	Collection Date	Sample Number	TMP 170/DegC ./.	PERCENE 25/ppb .035/5	TOLUENE 25/ppb .048/1000	TC 113/ppb 170/.
699-24-33	8/14/95	B0GB44	19.80	2.40	.05 U	72000.00 D
699-24-33	8/14/95	B0GB45	19.80			
699-24-33	8/14/95	B0GB46	19.80			
699-24-33	8/14/95	B0GB47	19.80			
699-24-34A	11/01/94	B0D662	18.60	3.00	.02 U	75000.00 B
699-24-34A	11/01/94	B0D663	18.60			
699-24-34A	11/01/94	B0D664	18.60			
699-24-34A	11/01/94	B0D665	18.60			
699-24-34A	3/02/95	B0DQS3	18.30	2.90	.06 U	66000.00
699-24-34A	3/02/95	B0DQS4	18.30			
699-24-34A	3/02/95	B0DQS5	18.40			
699-24-34A	3/02/95	B0DQS6	18.40			
699-24-34A	5/18/95	B0FJY1	18.80	3.10	.06 U	68000.00 D
699-24-34A	5/18/95	B0FJY2	18.90			
699-24-34A	5/18/95	B0FJY3	18.90			
699-24-34A	5/18/95	B0FJY4	19.00			
699-24-34A	8/14/95	B0GB76	19.30	1.80	.05 U	71000.00 D
699-24-34A	8/14/95	B0GB77	19.30			
699-24-34A	8/14/95	B0GB78	19.30			
699-24-34A	8/14/95	B0GB79	19.30			
699-24-34B	11/01/94	B0D667	19.30	3.60	.02 U	62000.00 B
699-24-34B	11/01/94	B0D668	19.30			
699-24-34B	11/01/94	B0D669	19.30			
699-24-34B	11/01/94	B0D670	19.10			
699-24-34B	3/01/95	B0DQS8	16.30	4.10	.05 U	68000.00
699-24-34B	3/01/95	B0DQS9	16.80			
699-24-34B	3/01/95	B0DQT0	17.10			
699-24-34B	3/01/95	B0DQT1	17.20			
699-24-34B	5/19/95	B0FJY6	17.70	3.00	.05 U	71000.00 D
699-24-34B	5/19/95	B0FJY7	17.80			
699-24-34B	5/19/95	B0FJY8	17.90			
699-24-34B	5/19/95	B0FJY9	17.90			
699-24-34B	8/15/95	B0GB81	19.00	2.90	.05 U	74000.00 D
699-24-34B	8/15/95	B0GB82	19.00			
699-24-34B	8/15/95	B0GB83	19.00			
699-24-34B	8/15/95	B0GB84	19.10			
699-24-34C	11/02/94	B0D672	18.10	3.70	.02 U	75000.00 B
699-24-34C	11/02/94	B0D673	18.10			
699-24-34C	11/02/94	B0D674	18.10			
699-24-34C	11/02/94	B0D675	18.10			
699-24-34C	3/01/95	B0DQT3	18.10	3.80	.05 U	69000.00 D
699-24-34C	3/01/95	B0DQT4	18.10			
699-24-34C	3/01/95	B0DQT5	18.10			
699-24-34C	3/01/95	B0DQT6	18.10			

Table 5.2A-2. Constituents with at Least One Detected Value for the Solid Waste Landfill
Data for Reporting Period November 1, 1994 through September 30, 1995.
(sheet 19 of 23)

Well Name	Collection Date	Sample Number	TMP 170/DegC ./.	PERCENE 25/ppb .035/S	TOLUENE 25/ppb .048/1000	TC 113/ppb 170/.
699-24-34C	5/18/95	B0FJZ1	18.80	3.70	.05 U	80000.00 D
699-24-34C	5/18/95	B0FJZ2	18.90			
699-24-34C	5/18/95	B0FJZ3	19.00			
699-24-34C	5/18/95	B0FJZ4	18.60			
699-24-34C	8/14/95	B0GB86	19.50	3.10	.05 U	79000.00 D
699-24-34C	8/14/95	B0GB87	19.70			
699-24-34C	8/14/95	B0GB88	19.90			
699-24-34C	8/14/95	B0GB89	20.10			
699-24-35	11/01/94	B0D677	25.00	1.20	.02 L	48000.00
699-24-35	11/01/94	B0D678	25.00			
699-24-35	11/01/94	B0D679	25.00			
699-24-35	11/01/94	B0D680	25.00			
699-24-35	3/01/95	B0DQT8	15.40	1.20	.05 U	51000.00
699-24-35	3/01/95	B0DQT9	16.10			
699-24-35	3/01/95	B0DQV0	16.30			
699-24-35	3/01/95	B0DQV1	16.30			
699-24-35	5/18/95	B0FJZ6	18.00	.62	.05 U	52000.00 D
699-24-35	5/18/95	B0FJZ7	18.00			
699-24-35	5/18/95	B0FJZ8	18.10			
699-24-35	5/18/95	B0FJZ9	18.10			
699-24-35	8/11/95	B0GB93	18.30	.38	.05 U	53000.00 D
699-24-35	8/11/95	B0GB94	18.30			
699-24-35	8/11/95	B0GB95	18.30			
699-24-35	8/11/95	B0GB96	18.40			
699-25-34C	11/02/94	B0D682	18.60	.68	.02 U	52000.00 D
699-25-34C	11/02/94	B0D683	18.60			
699-25-34C	11/02/94	B0D684	18.60			
699-25-34C	11/02/94	B0D685	18.60			
699-25-34C	3/02/95	B0DQV3	19.30	1.70	.05 U	54000.00 D
699-25-34C	3/02/95	B0DQV4	19.40			
699-25-34C	3/02/95	B0DQV5	19.40			
699-25-34C	3/02/95	B0DQV6	19.50			
699-25-34C	5/18/95	B0FK01	18.70	1.30	.05 U	56000.00 D
699-25-34C	5/18/95	B0FK02	18.60			
699-25-34C	5/18/95	B0FK03	18.70			
699-25-34C	5/18/95	B0FK04	18.80			
699-25-34C	8/14/95	B0GB98	19.40	1.00	.05 U	57000.00 D
699-25-34C	8/14/95	B0GB99	19.40			
699-25-34C	8/14/95	B0GBB0	19.40			
699-25-34C	8/14/95	B0GBB1	19.40			
699-26-35A	11/01/94	B0D687	19.70	.69	.02 U	38000.00
699-26-35A	11/01/94	B0D688	19.70			
699-26-35A	11/01/94	B0D689	19.70			
699-26-35A	11/01/94	B0D690	19.70			

Table 5.2A-3. Constituents with at Least One Detected Value for the Solid Waste Landfill
Data for Reporting Period November 1, 1994 through September 30, 1995.
(sheet 20 of 23)

Well Name	Collection Date	Sample Number	TMP 170/DegC ./.	PERCENE 25/ppb .035/5	TOLUENE 25/ppb .048/1000	TC 113/ppb 170/.
699-26-35A	2/28/95	B0DQV8	19.10	1.10	.05 U	40000.00
699-26-35A	2/28/95	B0DQV9	19.20			
699-26-35A	2/28/95	B0DQW0	19.20			
699-26-35A	2/28/95	B0DQW1	19.10			
699-26-35A	5/03/95	B0F873	20.10			
699-26-35A	5/22/95	B0FK06	19.70	.38 L	.05 U	39000.00 D
699-26-35A	5/22/95	B0FK07	20.00			
699-26-35A	5/22/95	B0FK08	20.00			
699-26-35A	5/22/95	B0FK09	20.00			
699-26-35A	8/11/95	B0G9Y7	20.30	.38	.05 U	41000.00 D
699-26-35A	8/11/95	B0G9Y8	20.30			
699-26-35A	8/11/95	B0G9Y9	20.50			
699-26-35A	8/11/95	B0G9Z0	20.50			

Well Name	Collection Date	Sample Number	TDS 65/ppb ./5000000	TRICENE 25/ppb .075/5	TRITIUM 142/pCi/L ./20000	TURBID 111/NTU ./.
699-22-35	11/02/94	B0D638	460000.00	2.40	108.00 U	
699-22-35	3/01/95	B0DQP8	470000.00	2.10	55.80 U	1.66
699-22-35	4/28/95	B0F872			-12.80	
699-22-35	5/18/95	B0FJW1	470000.00	2.80	162.00 U	.63
699-22-35	8/14/95	B0G9X4	460000.00	1.70	203.00	
699-22-35	8/14/95	B0G9Z6	470000.00	1.60	328.00	.77
699-23-34A	11/02/94	B0D643	400000.00	2.70	16100.00	
699-23-34A	3/01/95	B0DQQ3	400000.00	1.70	15300.00	.99
699-23-34A	5/18/95	B0FJW6	410000.00	2.00	13200.00	.36
699-23-34A	8/14/95	B0GB18	400000.00	1.10	12900.00	.78
699-23-34B	11/02/94	B0D648	460000.00	2.60	432.00	
699-23-34B	3/02/95	B0DQQ8	470000.00	2.00	327.00	.93
699-23-34B	5/18/95	B0FJX1	450000.00	2.20	348.00	.38
699-23-34B	8/14/95	B0GB31	460000.00	1.60	448.00	.61
699-24-33	11/02/94	B0D653	420000.00	1.30	126000.00	
699-24-33	3/01/95	B0DQR3	400000.00	1.30	116000.00	.24
699-24-33	3/01/95	B0DQR4	410000.00	1.20	116000.00	
699-24-33	5/19/95	B0FJX6	410000.00	1.10	114000.00	.18
699-24-33	8/14/95	B0GB44	410000.00	.85	105000.00	.70
699-24-34A	11/01/94	B0D662	390000.00	1.70	31800.00	
699-24-34A	3/02/95	B0DQS3	390000.00	1.20	29700.00	.29
699-24-34A	5/18/95	B0FJY1	380000.00	1.40	24500.00	.27
699-24-34A	8/14/95	B0GB76	380000.00	.70	26400.00	.69
699-24-34B	11/01/94	B0D667	380000.00	1.50	67400.00	

Table 5.2A-2. Constituents with at Least One Detected Value for the Solid Waste Landfill Data for Reporting Period November 1, 1994 through September 30, 1995.
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Well Name	Collection Date	Sample Number	TDS 65/ppb ./500000s	TRICENE 25/ppb .075/5	TRITIUM 142/pCi/L ./20000	TURBID 111/NTU ./.
699-24-34B	3/01/95	B0DQS8	390000.00	1.30	59600.00	.93
699-24-34B	5/19/95	B0FJY6	380000.00	1.30	52800.00	.17
699-24-34B	8/15/95	B0GB81	440000.00	1.00	57300.00	1.11
699-24-34C	11/02/94	B0D672	450000.00	2.20	126000.00	
699-24-34C	3/01/95	B0DQT3	420000.00	1.30	117000.00	.47
699-24-34C	5/18/95	B0FJZ1	420000.00	1.60	114000.00	3.93
699-24-34C	8/14/95	B0GB85	440000.00	.99	104000.00	1.13
699-24-35	11/01/94	B0D677	340000.00	.30 L	12800.00	
699-24-35	3/01/95	B0DQT8	320000.00	.23 L	10500.00	1.30
699-24-35	5/18/95	B0FJZ6	330000.00	.17 L	9100.00	1.18
699-24-35	8/11/95	B0GB93	330000.00	.08 U	14400.00	1.29
699-25-34C	11/02/94	B0D682	360000.00	.65 L	175000.00	
699-25-34C	3/02/95	B0DQV3	350000.00	.77 L	155000.00	.60
699-25-34C	5/18/95	B0FK01	350000.00	.82 L	155000.00	.58
699-25-34C	8/14/95	B0GB98	360000.00	.53	148000.00	.62
699-26-35A	11/01/94	B0D687	320000.00	.12 L	181000.00	
699-26-35A	2/28/95	B0DQV8	290000.00	.17 L	160000.00	1.16
699-26-35A	5/03/95	B0F873			158000.00	
699-26-35A	5/22/95	B0FK06	300000.00	.15 L	151000.00	.10
699-26-35A	8/21/95	B0G9Y7	310000.00	.13 L	143000.00	.76

Well Name	Collection Date	Sample Number	TURBID 126/NTU ./.	FVANADI 34/ppb 1.9/.	FZINC 34/ppb 3.7/5000s	CIS12DE 25/ppb .049/70
699-22-35	11/02/94	B0D638	3.10 Q			.11 U
699-22-35	11/02/94	B0D642		7.80 L	11.00	
699-22-35	3/01/95	B0DQP8	.66 Q			.05 U
699-22-35	3/01/95	B0DQQ2		8.40 L	3.70 UQ	
699-22-35	5/18/95	B0FJW1				.05 U
699-22-35	5/18/95	B0FJW5		6.90 L	8.60 L	
699-22-35	8/14/95	B0G9X4				.05 U
699-22-35	8/14/95	B0G9X8		8.90 L	3.70 U	
699-22-35	8/14/95	B0G9Z6				.05 U
699-22-35	8/14/95	B0GB00		11.00	3.70 U	
699-23-34A	11/02/94	B0D643	.50 Q			.11 U
699-23-34A	11/02/94	B0D647		8.30 L	6.30 U	
699-23-34A	3/01/95	B0DQQ3	.61 Q			.05 U
699-23-34A	3/01/95	B0DQQ7		10.00 L	13.00 Q	
699-23-34A	5/18/95	B0FJW6				.06 U
699-23-34A	5/18/95	B0FJX0		7.70 L	7.60 L	
699-23-34A	8/14/95	B0GB19				.05 U

Table 5.2A-2. Constituents with at Least One Detected Value for the Solid Waste Landfill
Data for Reporting Period November 1, 1994 through September 30, 1995.
(sheet 22 of 23)

Well Name	Collection Date	Sample Number	TURBID 126/NTU ./.	FVANADI 34/ppb 1.9/.	FZINC 34/ppb 3.7/5000s	CIS12DE 25/ppb .049/70
699-23-34A	8/14/95	B0GB23		9.00 L	3.70 U	
699-23-34B	11/02/94	B0D648	2.60 Q			.11 U
699-23-34B	11/02/94	B0D652		8.00 L	7.20 L	
699-23-34B	3/02/95	B0DQQ8	.65 Q			.05 U
699-23-34B	3/02/95	B0DQR2		8.30 L	3.70 UQ	
699-23-34B	5/18/95	B0FJX1				.05 U
699-23-34B	5/18/95	B0FJX5		6.40 L	3.70 U	
699-23-34B	8/14/95	B0GB31				.05 U
699-23-34B	8/14/95	B0GB35		6.70 L	3.70 U	
699-24-33	11/02/94	B0D653	1.10 Q			.11 U
699-24-33	11/02/94	B0D661		12.00 L	16.00	
699-24-33	3/01/95	B0DQR3	.20 Q			.05 U
699-24-33	3/01/95	B0DQR4	.23 Q			.05 U
699-24-33	3/01/95	B0DQS1		13.00 L	11.00 Q	
699-24-33	3/01/95	B0DQS2		13.00 L	13.00 Q	
699-24-33	5/19/95	B0FJX6				.05 U
699-24-33	5/19/95	B0FJZ0		8.90 L	3.70 U	
699-24-33	8/14/95	B0GB44				.05 U
699-24-33	8/14/95	B0GB48		13.00	6.70 L	
699-24-34A	11/01/94	B0D662	1.80 Q			.11 U
699-24-34A	11/01/94	B0D666		12.00 L	12.00	
699-24-34A	3/02/95	B0DQS3	.61 Q			.05 U
699-24-34A	3/02/95	B0DQS7		12.00 L	3.70 UQ	
699-24-34A	5/18/95	B0FJY1				.10 L
699-24-34A	5/18/95	B0FJY5		10.00 L	3.70 U	
699-24-34A	8/14/95	B0GB76				.05 U
699-24-34A	8/14/95	B0GB80		13.00	3.70 U	
699-24-34B	11/01/94	B0D667	1.20 Q			.11 U
699-24-34B	11/01/94	B0D671		10.00 L	9.30 L	
699-24-34B	3/01/95	B0DQS8	1.10 Q			.05 U
699-24-34B	3/01/95	B0DQT2		10.00 L	3.70 UQ	
699-24-34B	5/19/95	B0FJY0		10.00 L	28.00	
699-24-34B	5/19/95	B0FJY6				.10 L
699-24-34B	8/15/95	B0GB81				.05 U
699-24-34B	8/15/95	B0GB85		12.00	3.70 U	
699-24-34C	11/02/94	B0D672	2.60 Q			.11 U
699-24-34C	11/02/94	B0D676		11.00 L	14.00	
699-24-34C	3/01/95	B0DQT3	.49 Q			.05 U
699-24-34C	3/01/95	B0DQT7		11.00 L	12.00 Q	
699-24-34C	5/18/95	B0FJZ1				.05 L
699-24-34C	5/18/95	B0FJZ5		9.80 L	22.00	
699-24-34C	8/14/95	B0GB86				.05 U
699-24-34C	8/14/95	B0GB90		12.00	6.40 L	
699-24-35	11/01/94	B0D677	.75 Q			.11 U

Table 5.2A-2. Constituents with at Least One Detected Value for the Solid Waste Landfill Data for Reporting Period November 1, 1994 through September 30, 1995.
(sheet 23 of 23)

Well Name	Collection Date	Sample Number	TURBID 126/NTU ./.	FVANADI 34/ppb 1.9/.	FZINC 34/ppb 3.7/5000s	CIS12DE 25/ppb .049/70
699-24-35	11/01/94	B0D681		13.00 L	12.00	
699-24-35	3/01/95	B0DQT8	.84 Q			.05 U
699-24-35	3/01/95	B0DQV2		13.00 L	3.70 UQ	
699-24-35	5/18/95	B0FJ26				.05 U
699-24-35	5/18/95	B0FK00		11.00 L	3.70 U	
699-24-35	8/11/95	B0GB92				.05 U
699-24-35	8/11/95	B0GB97		13.00 L	3.70 U	
699-25-34C	11/02/94	B0D682	2.00 Q			.22 L
699-25-34C	11/02/94	B0D686		14.00 L	6.70 L	
699-25-34C	3/02/95	B0DQV3	.35 Q			.05 U
699-25-34C	3/02/95	B0DQV7		15.00 L	3.70 UQ	
699-25-34C	5/18/95	B0FK01				.05 U
699-25-34C	5/18/95	B0FK05		11.00 L	3.70 U	
699-25-34C	8/14/95	B0GB98				.05 U
699-25-34C	8/14/95	B0GBB2		15.00	3.70 U	
699-26-35A	11/01/94	B0D687	.39 Q			.11 U
699-26-35A	11/01/94	B0D691		19.00 L	8.30 L	
699-26-35A	2/28/95	B0DQV8	.53			.05 U
699-26-35A	2/28/95	B0DQW2		18.00 L	3.70 UQ	
699-26-35A	5/22/95	B0FK06				.05 U
699-26-35A	5/22/95	B0FK10		14.00 L	53.00 B	
699-26-35A	8/11/95	B0G9Y7				.05 U
699-26-35A	8/11/95	B0G921		18.00 L	3.70 U	

Table 5.2A-3. Contamination Indicator Parameters for the Solid Waste Landfill
Data for Reporting Period November 1, 1994 through September 30, 1995.
(sheet 1 of 5)

Well Name	Collection Date	Sample Number	COND FIELD uMho 1/.	COND LAB uMho 1/.	pH FIELD .01/6.5-8.5s	pH LAB .01/6.5-8.5a	TOC ppb */.	TOX ppb */.
699-22-35	11/02/94	B0D638	797	730	6.94	7.20	150 L	41.7
		B0D639	797		6.89		200 L	42.9
		B0D640	800		6.86		150 L	35.7
		B0D641	795		6.84		200 L	39.4
	3/01/95	B0DQP8	758	750	7.00	7.00	200 L	
		B0DQP9	758		7.01		300 L	45.0
		B0DQQ0	757		7.02		300 L	42.6
		B0DQQ1	757		7.00		300 L	40.5
		B0F6C1						54.4
	4/28/95	B0F873	544		6.86			
	5/18/95	B0FJW1	747	750	6.59	7.00	400 L	20.0
		B0FJW2	748		6.60		300 L	20.0
		B0FJW3	746		6.59		200 L	30.0
		B0FJW4	748		6.60		300 L	30.0
	8/14/95	B0G9X4				7.10	200 L	20.0
		B0G9X5					300 L	20.0
		B0G9X6					200 L	20.0
		B0G9X7					200 L	20.0
		B0G9Z6	767		7.00	7.20	200 L	20.0
		B0G9Z7	766		7.00		300 L	20.0
		B0G9Z8	765		7.00		200 L	20.0
		B0G9Z9	766		7.01		200 L	20.0
699-23-34A	11/02/94	B0D643	633	640	6.84	6.90	200 L	27.2
		B0D644	633		6.82		110 L	21.0
		B0D645	632		6.82		110 U	24.5
		B0D646	632		6.82		120 L	23.3
	12/16/94	B0DGK6	667		6.26			
	3/01/95	B0DQQ3	642	630	6.72	6.80	200 L	
		B0DQQ4	644		6.74		300 L	25.4
		B0DQQ5	644		6.75		200 L	29.1
		B0DQQ6	644		6.74		300 L	27.5
		B0F6C2						26.3
	5/18/95	B0FJW5	641	640	6.70	6.70	140 U	10.0
		B0FJW7	642		6.70		140 U	10.0
		B0FJW8	639		6.70		140 U	9.0 L
		B0FJW9	639		6.69		140 U	10.0
	8/14/95	B0GB18	663		6.70	6.80	200 L	10.0
		B0GB19	660		6.69		200 L	10.0
		B0GB20	658		6.68		200 L	20.0
		B0GB21	654		6.67		300 L	20.0
699-23-34B	11/02/94	B0D648	774	710	6.99	7.10	200 L	33.8
		B0D649	772		6.97		200 L	33.9
		B0D650	776		6.61		130 L	35.4
		B0D651	781		6.59		200 L	39.1

Table 5.2A-3. Contamination Indicator Parameters for the Solid Waste Landfill
Data for Reporting Period November 1, 1994 through September 30, 1995.
(sheet 2 of 5)

Well Name	Collection Date	Sample Number	COND FIELD umho 1/.	COND LAB umho 1/.	pH FIELD .01/6.5-8.5s	pH LAB .01/6.5-8.5s	TOC ppb */.	TOX ppb "/.
699-23-34B	12/16/94	B0DQK7	667		8.03			
	3/02/95	B0DQQ8	754	710	6.89	7.00	200 L	
		B0DQQ9	755		6.89		300 L	35.1
		B0DQR0	755		6.89		200 L	35.3
		B0DQR1	754		6.88		300 L	35.0
		B0F6J9						38.0
	5/18/95	B0FJX1	716	710	6.92	6.90	140 U	10.0
		B0FJX2	714		6.92		140 U	20.0
		B0FJX3	714		6.91		140 U	20.0
		B0FJX4	713		6.91		140 U	20.0
	8/14/95	B0GB31	740		6.88	7.00	200 L	20.0
		B0GB32	740		6.87		300 L	20.0
		B0GB33	740		6.87		300 L	30.0
		B0GB34	738		6.87		200 L	20.0
699-24-33	11/02/94	B0D653	655	640	7.18	7.30	800 L	14.1
		B0D654	656		7.19		800 L	10.1
		B0D655	656		7.18		900 L	17.4
		B0D656	655		7.17		800 L	13.8
	3/01/95	B0DQR3	650	650	7.26	7.20	400 L	
		B0DQR4	649	650	7.27	7.20	400 L	
		B0DQR5	648		7.26		400 L	15.1
		B0DQR6	648		7.26		500 L	14.9 Q
		B0DQR7					400 L	11.0 Q
		B0DQR8					400 L	14.2
		B0DQR9					400 L	11.0
		B0DQS0					400 L	14.9
		B0F6C3						12.4
		B0F6C4						16.0
	5/19/95	B0FJX6	650	640	7.08	7.30	200 L	6.9 U
		B0FJX7	649		7.08		140 U	6.9 U
		B0FJX8	649		7.07		140 U	6.9 U
		B0FJX9	652		7.07		140 U	6.9 U
	8/14/95	B0GB44	651		7.09	7.20	200 L	10.0
		B0GB45	651		7.09		200 L	10.0 L
		B0GB46	651		7.07		140 L	10.0
		B0GB47	661		7.04		200 L	10.0 L
699-24-34A	11/01/94	B0D662	452	600	6.80	7.30	110 U	18.2
		B0D663	450		6.79		130 L	16.7
		B0D664	450		6.78		200 L	21.9
		B0D665	450		6.77		150 L	19.9
	3/02/96	B0DQS3	632	590	6.69	6.90	150 L	
		B0DQS4	631		6.69		200 L	21.9
		B0DQS5	631		6.69		200 L	17.1
		B0DQS6	631		6.69		300 L	18.8

Table 5.2A-3. Contamination Indicator Parameters for the Solid Waste Landfill
Data for Reporting Period November 1, 1994 through September 30, 1995.
(sheet 3 of 5)

Well Name	Collection Date	Sample Number	COND FIELD uMho 1/.	COND LAB uMho 1/.	pH FIELD .01/6.5-8.5s	pH LAB .01/6.6-8.6s	TOC ppb */.	TOX ppb */.
699-24-34A	3/02/95	B0F6K0						20.4
	5/18/95	B0FJY1	604	600	6.74	6.80	140 U	10.0
		B0FJY2	605		6.74		140 U	8.0 L
		B0FJY3	604		6.75		140 U	6.9 U
		B0FJY4	605		6.76		140 U	10.0
	8/14/95	B0GB76	610		6.62	6.90	400 L	10.0
		B0GB77	611		6.69		200 L	9.0 L
		B0GB78	610		6.70		140 U	8.0 L
		B0GB79	612		6.71		200 L	7.0 L
699-24-34B	11/01/94	B0D667	618	620	6.78	7.30	110 U	20.1
		B0D668	522		6.77		140 L	12.3
		B0D669	525		6.76		120 L	20.2
		B0D670	525		6.75		130 L	12.4
	3/01/95	B0DQS8	617	610	6.79	6.90	200 L	
		B0DQS9	617		6.77		200 L	16.6
		B0DQT0	617		6.76		200 L	15.2
		B0DQT1	616		6.76		200 L	16.1
		B0F6C5						17.3
	5/19/95	B0FJY6	616	610	6.77	6.90	140 U	6.9 U
		B0FJY7	616		6.77		140 U	6.9 U
		B0FJY8	616		6.76		140 U	9.0 L
		B0FJY9	616		6.75		200 L	6.9 U
	8/15/95	B0GB81	624		6.89	6.90	200 L	8.0 L
		B0GB82	624		6.89		200 L	8.0 L
		B0GB83	624		6.89		200 L	6.9 U
		B0GB84	624		6.89		200 L	6.9 U
699-24-34C	11/02/94	B0D672	662	700	6.30	7.10	140 L	20.4
		B0D673	664		6.39		200 L	16.5
		B0D674	668		6.43		130 L	17.6
		B0D675	670		6.46		200 L	22.5
	3/01/95	B0DQT3	664	670	7.09	7.20	110 L	
		B0DQT4	660		7.10		200 L	14.4
		B0DQT5	659		7.10		200 LB	12.0
		B0DQT6	661		7.10		200 LB	7.1
		B0F6B9						13.1
	5/18/95	B0FJZ1	671	680	7.03	7.00	140 U	6.9 U
		B0FJZ2	670		7.03		140 U	8.0 L
		B0FJZ3	671		7.03		140 U	6.9 U
		B0FJZ4	686		7.04		140 U	7.0 L
	8/14/95	B0GB86	705		6.87	7.10	200 L	6.9 U
		B0GB87	710		6.89		200 L	10.0
		B0GB88	710		6.88		400 L	8.0 L
		B0GB89	710		6.88		200 L	9.0 L
699-24-35	11/01/94	B0D677	475	500	7.34	7.80	110 U	12.1

Table 5.2A-3. Contamination Indicator Parameters for the Solid Waste Landfill
Data for Reporting Period November 1, 1994 through September 30, 1995.
(sheet 4 of 5)

Well Name	Collection Date	Sample Number	COND FIELD uMho 1/.	COND LAB uMho 1/.	pH FIELD .01/6.5-8.5s	pH LAB .01/6.5-8.5s	TOC ppb */.	TOX ppb */.
699-24-35	11/01/94	B0D678	475		7.31		140 L	12.4
		B0D679	477		7.29		200 L	9.2
		B0D680	478		7.28		200 L	13.7
	3/01/95	B0DQT8	498	510	7.11	7.30	200 L	12.3
		B0DQT9	496		7.12		200 L	15.3
		B0DQV0	496		7.12		300 L	9.9
		B0DQV1	497		7.11		200 L	8.0
	5/16/95	B0FJ26	509	500	7.11	7.40	200 L	6.9 U
		B0FJ27	509		7.11		300 L	6.9 U
		B0FJ28	508		7.12		300 L	9.0 L
		B0FJ29	508		7.12		200 L	6.9 U
	8/11/95	B0GB93	504		7.16	7.20	140 U	6.9 U
		B0GB94	503		7.17		140 U	6.9 U
		B0GB95	503		7.16		200 L	6.9 U
		B0GB96	504		7.18		200 L	6.9 U
699-25-34C	11/02/94	B0D682	545	560	7.11	7.40	140 L	11.2
		B0D683	542		7.12		130 L	8.9
		B0D684	540		7.12		200 L	12.6
		B0D685	540		7.13		200 L	8.6
	3/02/95	B0DQV3	579	530	7.21	7.40	140 U	
		B0DQV4	579		7.31		120 L	10.0
		B0DQV5	579		7.21		140 U	8.6
		B0DQV6	579		7.21		140 U	10.3
		B0F6K1						13.3
	5/18/95	B0FK01	551	550	7.32	7.30	200 L	6.9 U
		B0FK02	551		7.29		140 U	6.9 U
		B0FK03	551		7.26		140 U	6.9 U
		B0FK04	551		7.24		140 U	6.9 U
	8/14/95	B0GB98	568		7.16	7.30	200 L	6.9 U
		B0GB99	568		7.16		200 L	6.9 U
		B0GBB0	568		7.16		200 L	6.9 U
		B0GBB1	568		7.15		140 U	6.9 U
699-26-35A	11/01/94	B0D687	436	450	6.65	8.00	130 L	10.1
		B0D688	442		6.69		110 U	8.4
		B0D689	442		6.73		150 L	10.1
		B0D690	443		6.75		110 U	9.2
	2/28/95	B0DQV8	465	450	7.56	8.20	140 U	
		B0DQV9	454		7.56		130 L	12.5
		B0DQW0	454		7.56		140 U	9.5
		B0DQW1	455		7.55		140 U	9.5
		B0F6B8						7.8
	5/03/95	B0F873	435		7.28			
	5/22/95	B0FK06	452	450	7.43	7.50	140 U	6.9 U
		B0FK07	454		7.42		140 U	6.9 U

Table 5.2A-3. Contamination Indicator Parameters for the Solid Waste Landfill
Data for Reporting Period November 1, 1994 through September 30, 1995.
(Sheet 5 of 5)

Well Name	Collection Date	Sample Number	COND FIELD uMho 1/.	COND LAB uMho 1/.	pH FIELD .01/6.5-8.5s	pH LAB .01/6.5-8.5s	TOC ppb */.	TOX ppb */.
699-26-35A	5/22/96	B0FK08	452		7.42		140 L	6.9 U
		B0FK09	453		7.42		140 U	6.9 U
	8/11/95	B0G9Y7	450		7.42	7.90	140 U	6.9 U
		B0G9Y8	450		7.42		200 L	6.9 U
		B0G9Y9	450		7.41		300 L	6.9 U
		B0G9Z0	451		7.42		150 L	6.9 U

* Detection limits for TOC and TOX vary depending on the performing laboratory.

APPENDIX 5.2B

WATER LEVEL MEASUREMENTS

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Table 5.2B-1. Water Level Measurement Report
Solid Waste Landfill Monitoring Wells.
(sheet 1 of 5)

Well	Date	Depth to water (ft)	Water level elevation above msl	
			(ft)	(m)
699-22-35	11/02/94	132.97*	401.00	122.22
	3/01/95	133.12*	400.85	122.18
	3/20/95	133.03	400.94	122.21
	4/25/95	133.28	400.69	122.13
	5/17/95	133.16	400.81	122.17
	6/29/95	133.23	400.74	122.15
	7/21/95	133.15	400.82	122.17
	8/14/95	133.20*	400.77	122.15
	8/30/95	133.06	400.91	122.20
	9/22/95	133.15	400.82	122.17
699-23-34A	11/02/94	131.80*	401.06	122.24
	11/28/94	131.83	401.03	122.23
	12/15/94	131.84	401.02	122.23
	1/24/95	131.94	400.92	122.20
	2/24/95	131.99	400.87	122.19
	3/01/95	131.97*	400.89	122.19
	3/20/95	132.00	400.86	122.18
	4/25/95	132.09	400.77	122.15
	5/17/95	132.01	400.85	122.18
	6/29/95	132.08	400.78	122.16
	7/21/95	131.99	400.87	122.19
	8/14/95	132.04*	400.82	122.17
	8/30/95	131.90	400.96	122.21
	9/22/95	131.95	400.91	122.20
699-23-34B	11/02/94	132.48*	401.02	122.23
	3/02/95	132.66*	400.84	122.18
	3/20/95	132.71	400.79	122.16
	4/25/95	132.77	400.73	122.14
	5/17/95	132.68	400.82	122.17
	6/29/95	132.74	400.76	122.15
	7/21/95	132.66	400.84	122.18
	8/14/95	132.53*	400.97	122.22
	8/30/95	132.57	400.93	122.20

Table 5.2B-1. Water Level Measurement Report Solid Waste Landfill Monitoring Wells.
(sheet 2 of 5)

Well	Date	Depth to water (ft)	Water level elevation above msl (ft)	(m)
699-24-33	11/02/94	123.40*	400.87	122.19
	11/28/94	123.22	401.05	122.24
	12/15/94	123.24	401.03	122.23
	1/24/95	123.32	400.95	122.21
	2/24/95	123.40	400.87	122.19
	3/01/95	123.43*	400.84	122.18
	3/20/95	123.42	400.85	122.18
	4/25/95	123.47	400.80	122.16
	5/17/95	123.43	400.84	122.18
	6/29/95	123.37	400.90	122.19
	7/21/95	123.39	400.88	122.19
	8/14/95	123.33*	400.94	122.21
	8/30/95	123.30	400.97	122.22
	9/22/95	123.37	400.90	122.19
699-24-34A	11/01/94	132.76*	401.12	122.26
	11/28/94	132.84	401.04	122.24
	12/15/94	132.86	401.02	122.23
	1/24/95	132.97	400.91	122.20
	2/24/95	133.03	400.85	122.18
	3/02/95	132.02*	401.86	122.49
	3/20/95	133.97	399.91	121.89
	4/25/95	133.13	400.75	122.15
	5/17/95	133.03	400.85	122.18
	6/29/95	132.99	400.89	122.19
	7/21/95	133.02	400.86	122.18
	8/14/95	132.89*	400.99	122.22
	8/30/95	132.93	400.95	122.21
	9/22/95	132.99	400.89	122.19

Table 5.2B-1. Water Level Measurement Report
Solid Waste Landfill Monitoring Wells.
(sheet 3 of 5)

Well	Date	Depth to water (ft)	Water level elevation above msl (ft)	Water level elevation above msl (m)
699-24-34B	11/01/94	132.39*	401.11	122.26
	11/28/94	132.43	401.07	122.25
	12/15/94	132.45	401.05	122.24
	1/24/95	132.55	400.95	122.21
	2/24/95	132.61	400.89	122.19
	3/01/95	132.60*	400.90	122.19
	3/20/95	132.65	400.85	122.18
	4/25/95	132.71	400.79	122.16
	5/17/95	132.62	400.88	122.19
	6/29/95	132.69	400.81	122.17
	7/21/95	132.61	400.89	122.19
	8/15/95	132.66*	400.84	122.18
	8/30/95	132.52	400.98	122.22
	9/22/95	132.57	400.93	122.20
699-24-34C	11/02/94	131.50*	401.09	122.25
	11/28/94	131.54	401.05	122.24
	12/15/94	131.57	401.02	122.23
	1/24/95	131.66	400.93	122.20
	2/24/95	131.73	400.86	122.18
	3/01/95	131.71*	400.88	122.19
	3/20/95	131.77	400.82	122.17
	4/25/95	131.82	400.77	122.15
	5/17/95	131.73	400.86	122.18
	6/29/95	131.81	400.78	122.16
	7/21/95	131.71	400.88	122.19
	8/14/95	131.59*	401.00	122.22
	8/30/95	131.63	400.96	122.21
	9/22/95	131.69	400.90	122.19

Table 5.2B-1. Water Level Measurement Report
Solid Waste Landfill Monitoring Wells.
(sheet 4 of 5)

Well	Date	Depth to water (ft)	Water level elevation above msl (ft)	
			(ft)	(m)
699-24-35	11/01/94	137.71*	401.10	122.26
	11/28/94	137.75	401.06	122.24
	12/15/94	137.75	401.06	122.24
	1/24/95	137.81	401.00	122.22
	2/24/95	137.92	400.89	122.19
	3/01/95	137.96*	400.85	122.18
	3/20/95	137.96	400.85	122.18
	4/25/95	138.03	400.78	122.16
	5/17/95	137.94	400.87	122.19
	6/29/95	138.01	400.80	122.16
	7/21/95	137.92	400.89	122.19
	8/11/95	137.99*	400.82	122.17
	8/30/95	137.82	400.99	122.22
	9/22/95	137.99	400.82	122.17
699-25-34C	11/02/94	134.38*	401.08	122.25
	11/28/94	134.42	401.04	122.24
	12/15/94	134.44	401.02	122.23
	1/24/95	134.54	400.92	122.20
	2/24/95	134.59	400.87	122.19
	3/02/95	134.58*	400.88	122.19
	3/20/95	134.65	400.81	122.17
	4/25/95	134.68	400.78	122.16
	5/17/95	134.60	400.86	122.18
	6/29/95	134.67	400.79	122.16
	7/21/95	134.58	400.88	122.19
	8/14/95	134.65*	400.81	122.17
	8/30/95	134.50	400.96	122.21
	9/22/95	134.58	400.88	122.19

Table 5.2-B-1. Water Level Measurement Report
Solid Waste Landfill Monitoring Wells.
(sheet 5 of 5)

Well	Date	Depth to water (ft)	Water level elevation above msl	
			(ft)	(m)
699-26-35A	11/01/94	131.68*	400.98	122.22
	11/28/94	131.59	401.07	122.25
	12/15/94	132.03	400.63	122.11
	1/24/95	131.79	400.87	122.19
	2/24/95	132.06	400.60	122.10
	2/28/95	131.45*	401.21	122.29
	3/20/95	132.95	399.71	121.83
	4/25/95	133.05	399.61	121.80
	5/17/95	132.00	400.66	122.12
	6/29/95	132.45	400.21	121.98
	7/21/95	131.80	400.86	122.18
	8/11/95	131.30*	401.36	122.33
	8/30/95	131.81	400.85	122.18
	9/22/95	131.98	400.68	122.13

NOTES:
1. Water level elevations are calculated by subtracting the measured depth-to-water from the surveyed elevation for the well.
2. Depth-to-water values are transcribed from field records.
3. Measurements marked with an '*' were taken at the time of sampling.
4. Measurements marked with a '+' are outside of the expected range, and are suspected of error.

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6.1 300 AREA PROCESS TRENCH

J. W. Lindberg
Westinghouse Hanford Company

The groundwater near the 300 Area Process Trenches (APT) has been monitored by a *Resource Conservation and Recovery Act of 1976* (RCRA) interim-status groundwater quality assessment well network since June 1985. The site continues to be regulated by the interim-status regulations under the Hanford Facility RCRA Permit (September 28, 1995, Ecology 1994). Monitoring wells were constructed in response to a *Consent Agreement and Compliance Order* issued jointly by the Washington State Department of Ecology and the U.S. Environmental Protection Agency (Ecology and EPA 1986). The 300 Area Process Trenches are located within the *Comprehensive Environmental Response, Compensation and Liability Act of 1980* (CERCLA) operable units 300-FF-1 and 300-FF-5. Currently the 300 Area Process Trenches are in the groundwater quality assessment stage of monitoring as discussed in the groundwater monitoring compliance plan (Schalla 1988). A revised groundwater monitoring plan has been written in anticipation of the site going into final status early next year. The existing closure/post-closure plan for the 300 Area Process Trenches is described in DOE (1985).

6.1.1 Facility Overview

The 300 Area Process Trenches are located in the northern portion of the 300 Area (Figure 6.1-1 and 1-1), the nuclear fuels fabrication area at the Hanford Site. The two unlined trenches were constructed in 1975. From 1975 until the shutdown of fuel fabrication in 1987 and other 300 Area operations in 1988, the trenches were used for the disposal of most liquid wastes generated in the 300 Area. The liquid waste was known or suspected of including the following (Schalla et al. 1988):

Uranium, or other alpha emitters
At least one beta emitter
Chloride
Nitrate
Perchloroethylene (PCE)
Barium

Sodium
Iron
Sulfate
Copper
Ammonium
Vanadium

Potassium
Chloroform
Mythyl chloride
TCE
CIS-DCE

The discharge rate reached a maximum of about 7,600 L/min (2,000 gal/min). Since 1988, the wastewater has consisted of cooling water with small quantities of nonhazardous maintenance and process waste. In July 1991, the trenches were modified as part of an expedited response action (ERA). The modifications of the trenches involved removing bottom sediment from the inflow end of the trench and placing it at the opposite end of the trench behind a berm. The trenches were used on an alternating, as-needed basis. The west trench was rendered inoperable on November 20, 1992. Subsequently, the east trench received all discharges. Average discharge to the east trench was about 850 L/min (225 gal/min) in the later years of operation. In December 1994, the trenches were administratively isolated and all discharges were terminated. Complete physical isolation occurred one month later (January 1995).

From the surface downward, the geologic units include the Hanford formation, the Ringold Formation, and the Columbia River Basalts. The Hanford formation is 9 to 12 m thick and is composed of gravelly sand and sandy gravel. The Ringold Formation is approximately 40 m thick and comprises of two major units. The upper half is interbedded sandy gravels, gravelly sands, and silty sand. The lower half is sandy and clayey silt, and is called the lower mud unit. Flows of Columbia River Basalt and intercalated beds of the Ellensburg Formation underlie the Ringold Formation lower mud unit.

The water table is close to the position of the Hanford-Ringold formations contact, but near the river it rises and falls in response to river level. During average to low river stages, groundwater in the unconfined aquifer enters the 300 Area from the northwest and southwest, flows through the 300 Area in a west-to-east or northwest-to-southeast direction, and eventually flows into the river. During high water stages the water table can be quickly raised above the Hanford-Ringold formations contact near the river, and groundwater may temporarily flow in a reversed direction. Channeling in the top of the Ringold Formation further complicates the direction and flow rate of groundwater in the unconfined aquifer. Confined aquifers at depth (below the confining lower mud unit) have an overall greater amount of pressure than the overlying unconfined aquifer, causing any interaquifer flow to be in an upward direction.

6.1.2 Summary of 1995 Activities

Wells in the monitoring network are sampled semiannually. They were sampled during the period of October 5-10, 1994, and June 1-5, 1995. In addition to regular sampling events, one well (399-1-17A) is sampled four times per year for a limited list of analytes. Besides the October and June sampling, it was sampled December 15, 1994, and April 5, 1995. Water level measurements were collected monthly for network and additional wells, but starting in September 1995 the frequency was changed to quarterly. The frequency was reduced to quarterly because an adequate amount of data already have been collected to fully characterize the effect on the 300 Area groundwater system caused by a fluctuating river level. In addition, water levels are measured during sampling for monitoring network wells.

6.1.3 Sampling and Analysis Program

The general groundwater monitoring program is described in the groundwater monitoring compliance plan (Schalla 1988). Sampling of 300 Area wells is coordinated with the 300-FF-5 CERCLA program so that well trips can be reduced and data are shared.

Currently, the monitoring network for the process trenches has 11 wells. The locations of these wells are shown in Figure 6.1-1. A list of these 11 wells, other wells, and their uses are presented in Table 6.1-1. Groundwater samples are collected semiannually at all wells in the network except well 399-1-17A. Well 399-1-17A is sampled four time per year to monitor changes in groundwater quality near the process trench.

Available analytical results have been reported in the quarterly reports (Lindberg 1994, 1995a, 1995b, and 1996). Analytical constituents are listed in Table 6.1-2.

6.1.4 Groundwater Chemistry

The process trenches are located near other liquid disposal facilities in the 300 Area. Because of the proximity to the North Process Ponds (no longer in service) and sanitary sewer lines, as well as other facilities downgradient from the process trenches, it is difficult to determine constituents in the groundwater that can be directly attributed to the process trenches.

6.1.4.1 Concentration Histories of Waste Indicators. The drinking water parameter gross alpha (DWS 15 pCi/L) is consistently elevated in seven wells, 399-1-10, 1-11, 1-12, 1-16A, 1-17A, 2-1, and 3-10. Concentrations range from 16.5 pCi/L in well 399-3-10 to 137 pCi/L in well 399-1-17A. Gross alpha is elevated in the same wells in which uranium concentration is elevated.

The groundwater quality parameters filtered iron (DWS 300 ppb) and filtered manganese (DWS 50 ppb) are above drinking water standards in wells 399-1-16B and 1-17B. Exceedances of iron range from 340 to 420 ppb. Exceedances of manganese range from 62 to 82 ppb. These wells are screened at the bottom of the unconfined aquifer downgradient of the process trenches. Higher concentrations of iron and manganese in these wells does not necessarily indicate that the process trenches are the source. The elevated iron and manganese concentrations observed in the deep unconfined aquifer are probably influenced by chemical reducing conditions (i.e., the absence of oxygen and negative oxidation-reduction potentials). A similar relationship between sampling depth and concentration profiles for redox-sensitive species has been documented in Johnson et al. (1994).

Concentrations of site-specific parameters trichloroethylene (TCE) and cis-1,2-dichloroethylene (DCE) remain elevated in well 399-1-16B. Elevated concentrations of these contaminants in well 399-1-16B could indicate a contaminant source because well 399-1-16B is screened in the lower portion of the unconfined aquifer and the insoluble phase of these contaminants is more dense than water. The concentrations of TCE (DWS 5 ppb) is on a downward trend (Figures 6.1-2), and concentration of DCE (DWS 70 ppb), a degradation product of TCE, is on an upward trend (Figure 6.1-3). The concentration of TCE is down to 1.5 ppb, whereas DCE concentration rose to 100 ppb.

Like gross alpha, uranium concentration remains high in seven network wells. The wells are 399-1-10A, 1-11, 1-12, 1-16A, 1-17A, 2-1, and 3-10. Results from these wells ranged from a low of 9.17 ppb (Oct. 1994) to 179 ppb (June 1995), both in the same well, 399-1-17A. Presumably, the uranium is responsible for the high gross alpha in the same wells. Figure 6.1-4 shows the historical trend for uranium concentration in well 399-1-17A. Uranium concentration dropped dramatically in 1991 as a result of the ERA. The rise since early 1995 is probably caused by the lack of dilution by process trench discharge water.

Concentrations of TOX (a contamination indicator parameter) are elevated in three network wells, probably in response to degradation products of TCE and DCE. Wells 399-1-16B, 399-1-17A, and 399-1-14A have TOX results that range from 11.7 to 107.0 ppb. Since the 300 APT is in RCRA assessment monitoring, contamination indicator parameters are not statistically compared to background well results. However, samples are still analyzed for TOX to help in the monitoring for TCE and DCE.

6.1.4.2 Distribution of Waste Constituents. Gross alpha and uranium are elevated in seven network wells. Presumably, it is the uranium that causes the increase in gross alpha concentration. Figure 6-1.5 shows the uranium plume in the vicinity of the 300 APT during June 1995. The plume extended to the south during June, rather than strictly southeast, because the groundwater flows southwest at that time of the year (see Section 6.1.5.1 on groundwater flow).

The remainder of the elevated constituents related to the 300 APT during 1995 are confined to three or fewer wells each. Filtered iron and manganese are elevated in the two wells of the monitoring network that are screened in the lower portion of the unconfined aquifer (wells 399-1-16B and 17B). The elevated iron and manganese concentrations in these deeper wells are probably influenced by chemical-reducing conditions such as the absence of oxygen and negative oxidation-reduction potential (Lindberg et al. 1995). A similar relationship between sampling depth and concentration profiles for redox-sensitive species has been documented in Johnson and Chou 1994. Trichloroethylene (TCE) and cis-1,2-dichloroethylene (DCE) remain elevated in only one well (399-1-16B). Three wells near and upgradient of the 300 APT have higher concentrations of TOX. The three wells are 399-1-16B and 1-17A (downgradient) and 399-1-14A (upgradient throughout most of the year except when the river level is elevated during May and June).

6.1.5 Groundwater Flow

6.1.5.1 Groundwater Flow Direction. The groundwater flow direction in the unconfined aquifer near the 300 Area Process Trenches is predominantly to the southeast with changes caused by fluctuations in the Columbia River stage. Figure 6.1-6 shows the elevation of the water table June 26, 1995, when the river stage was very near the high for the year. Typically, during these high water stages, a localized flow reversal occurs when the river stage is higher than the water level in the unconfined aquifer. The area involved in these flow reversals depends on the elevation of the high river stage and its duration. In June 1995 the river stage was high enough for a long enough period of time that the reversed gradient on the water table extended beyond well 399-6-1 to the southeast. This produced a reversed flow direction in the vicinity of the process trenches. Figure 6.1-7 shows the elevation of the water table September 5, 1995, during the low stage for the Columbia River. Flow direction in the vicinity of the process trenches had returned to its direction before the high water stage.

Because wastewater is no longer discharged to the process trenches, the groundwater mound clearly observable on earlier water table maps of the 300 Area is no long present. As long as no sudden and prolonged rises in river stage occur, the water table gradient in the vicinity of the process trenches slopes downward to the southeast in a relatively uniform manner (Figure 6.1-7).

There is a vertical head difference, with the gradient in an upward direction, between the unconfined aquifer above the Ringold lower mud unit and the gravels beneath the mud. At wells 399-1-17A (103.88 m) and -17C (113.78 m) the head difference is about 10 m (33 ft).

6.1.5.2 Rate of Flow. The flow rate in the top of the unconfined aquifer has been reported as about 10.6 m/d (35 ft/d) near the process trenches (Schalla et al. 1988) based on data from a perchloroethene spill. The rate of flow can also be estimated roughly by using the Darcy equation.

$$v = \frac{Ki}{n_e} \qquad (1)$$

where:

v = Average linear groundwater velocity
K = Hydraulic conductivity
i = Hydraulic gradient
n_e = Effective porosity.

Schalla et al. (1988) reported values of hydraulic conductivity for the unconfined aquifer ranging from 150 to 15,240 m/d (500 to 50,000 ft/d). These values were determined from pumping tests. The hydraulic gradient near the process trenches, estimated from the September 1995 water table map (Figure 6.1-6), averages approximately 0.0007. This gradient is about average for the year. Estimates of effective porosity for the unconfined aquifer range from 0.10 to 0.30. Using these values as input parameters to the Darcy equation, the range of groundwater flow velocity is approximately 0.35 to 106.7 m/d (1.15 to 350 ft/d). The large range in flow velocity values is a result of the large range in values of hydraulic conductivity reported for the aquifer. The range in hydraulic conductivity may be attributed to facies variations within and between the Hanford and Ringold formations.

6.1.5.3 Evaluation of Monitoring Network. Groundwater flow has not changed significantly since the 300 Area Process Trenches monitoring network was designed. The network is still adequate to assess contamination from the trenches.

6.1.6 References

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Figure 6.1-1. Facility and Well Location Map.

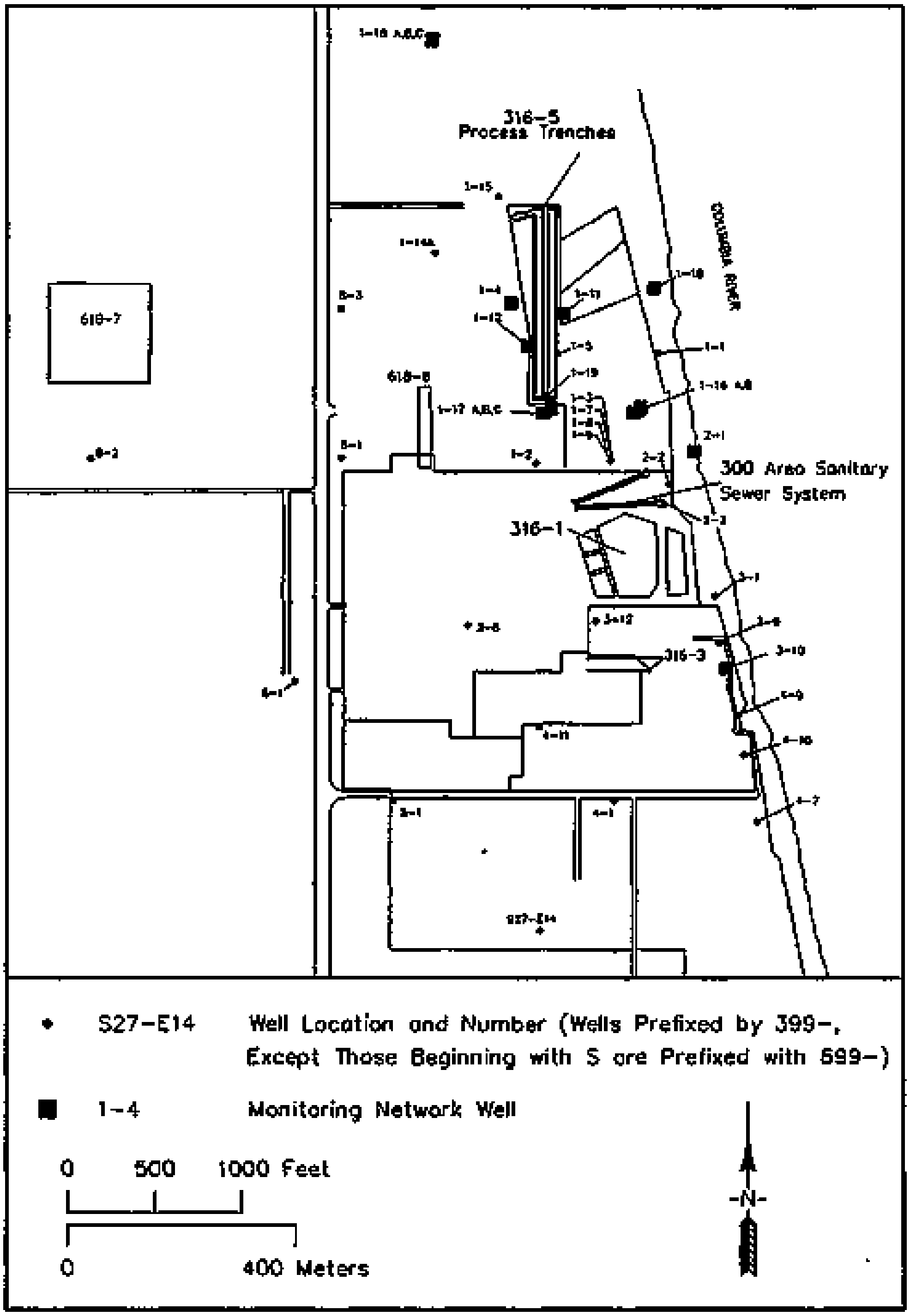

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Figure 6.1-2. TCE in Well 399-1-16B, 300 Area Process Trenches.

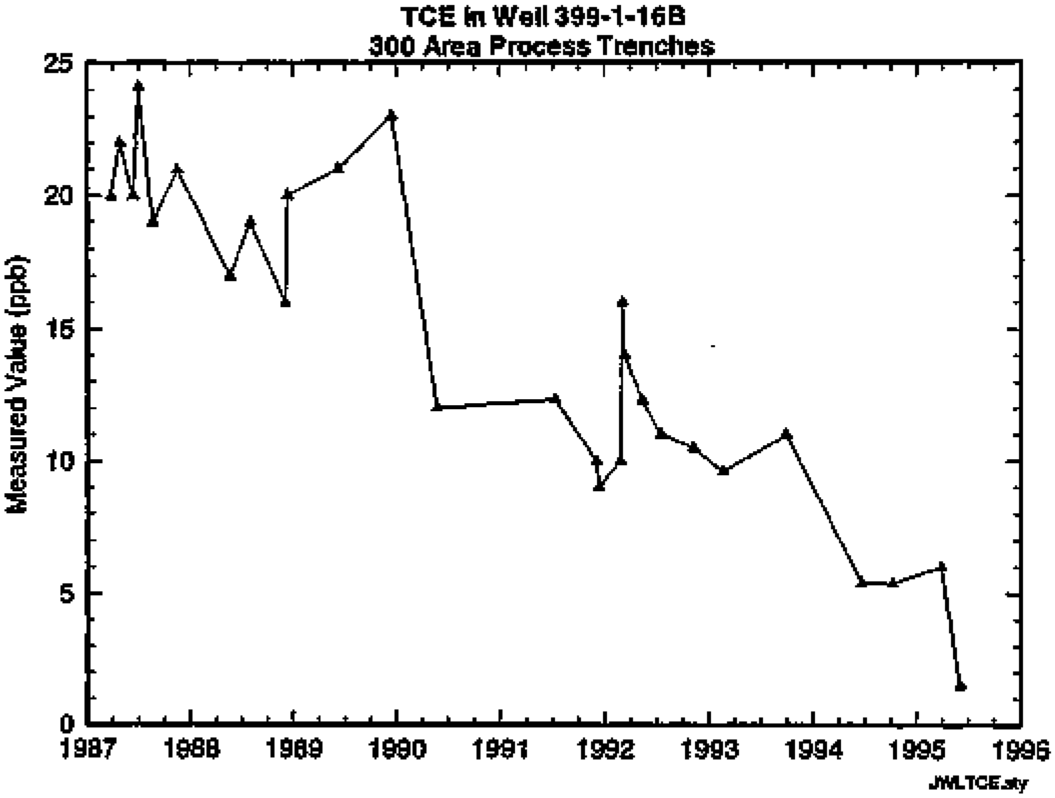

Figure 6.1-3. CIS-DCE in Well 399-1-16B, 300 Area Process Trenches.

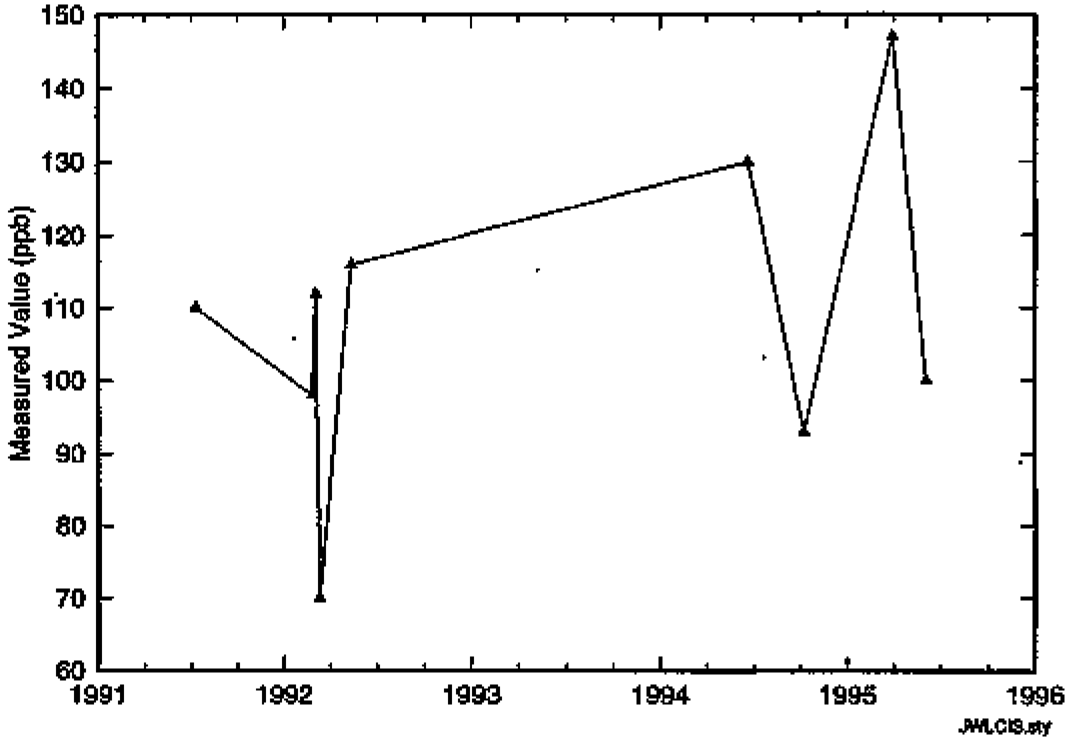

Figure 6.1-4. Uranium in Well 399-1-17A, 300 Area Process Trenches.

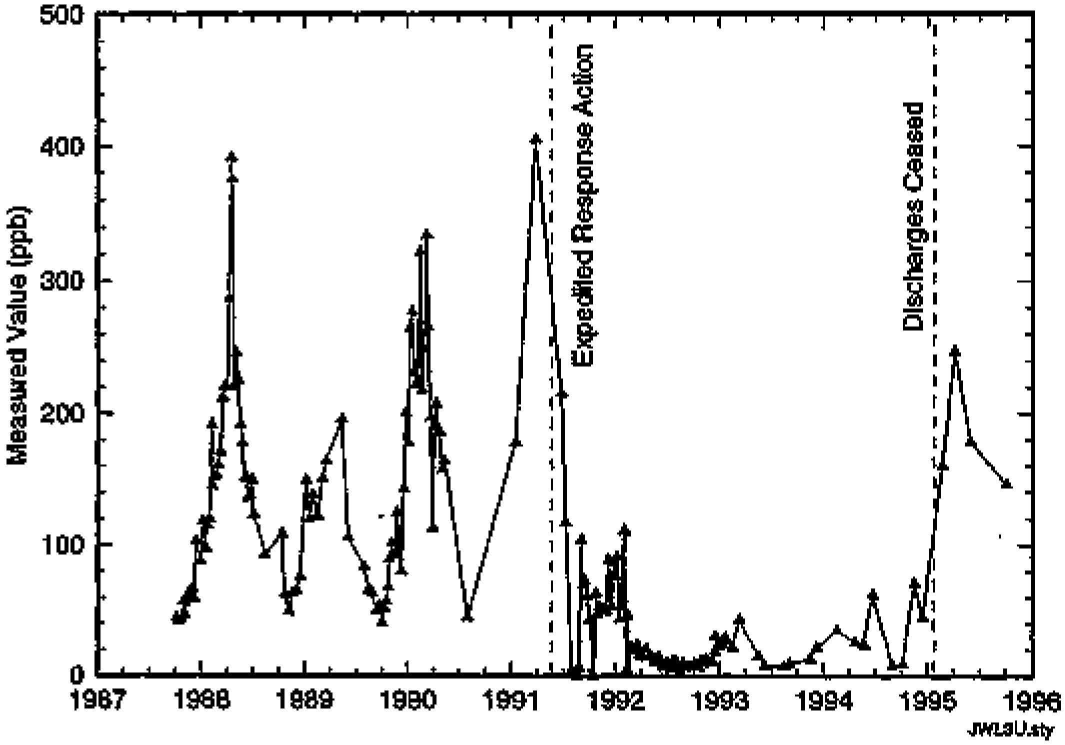

Figure 6.1-5. Uranium Plume, 300 ATP, June 1995.

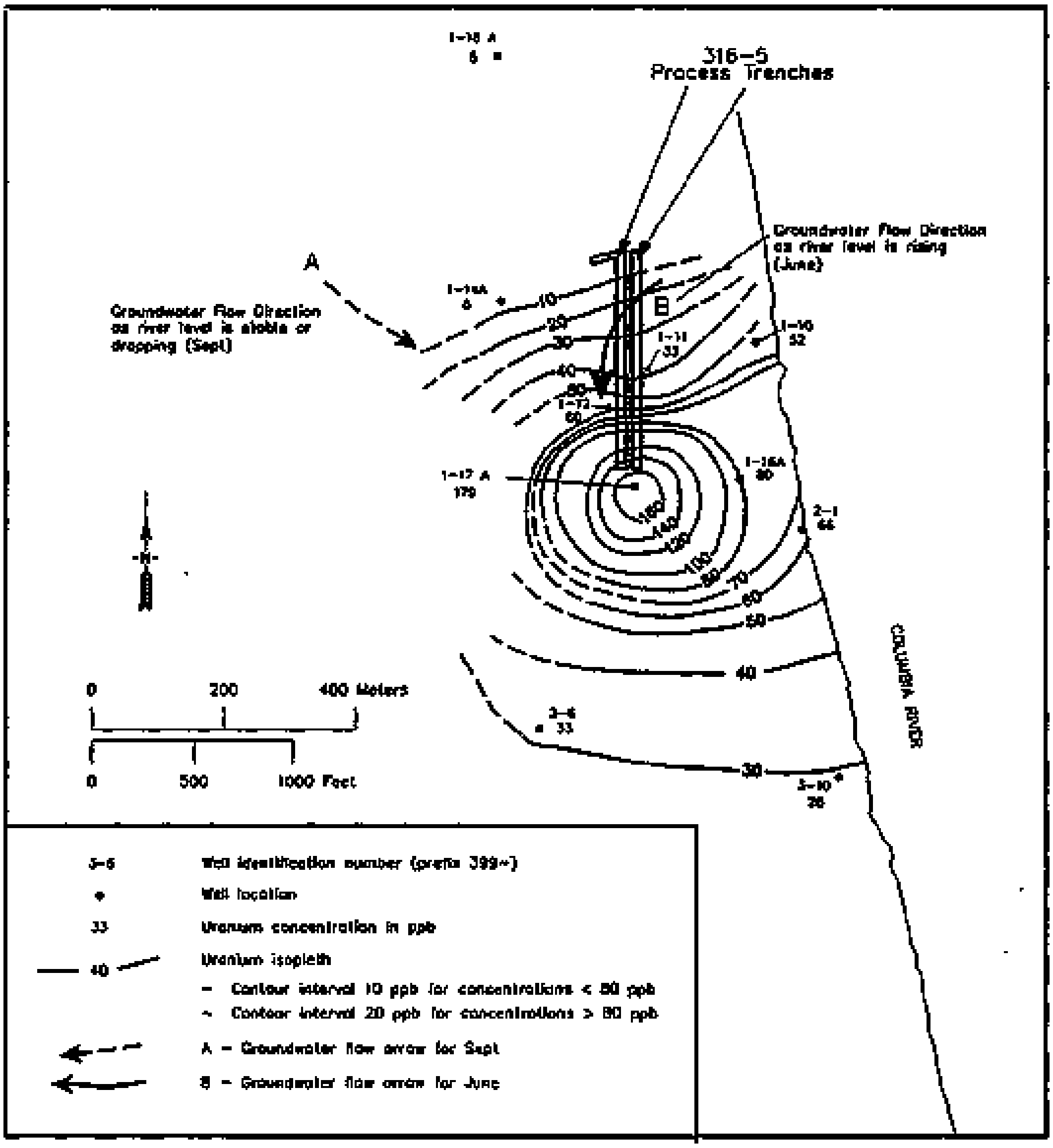

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Figure 6.1-6. Water Table Elevation Map, June 26, 1995.

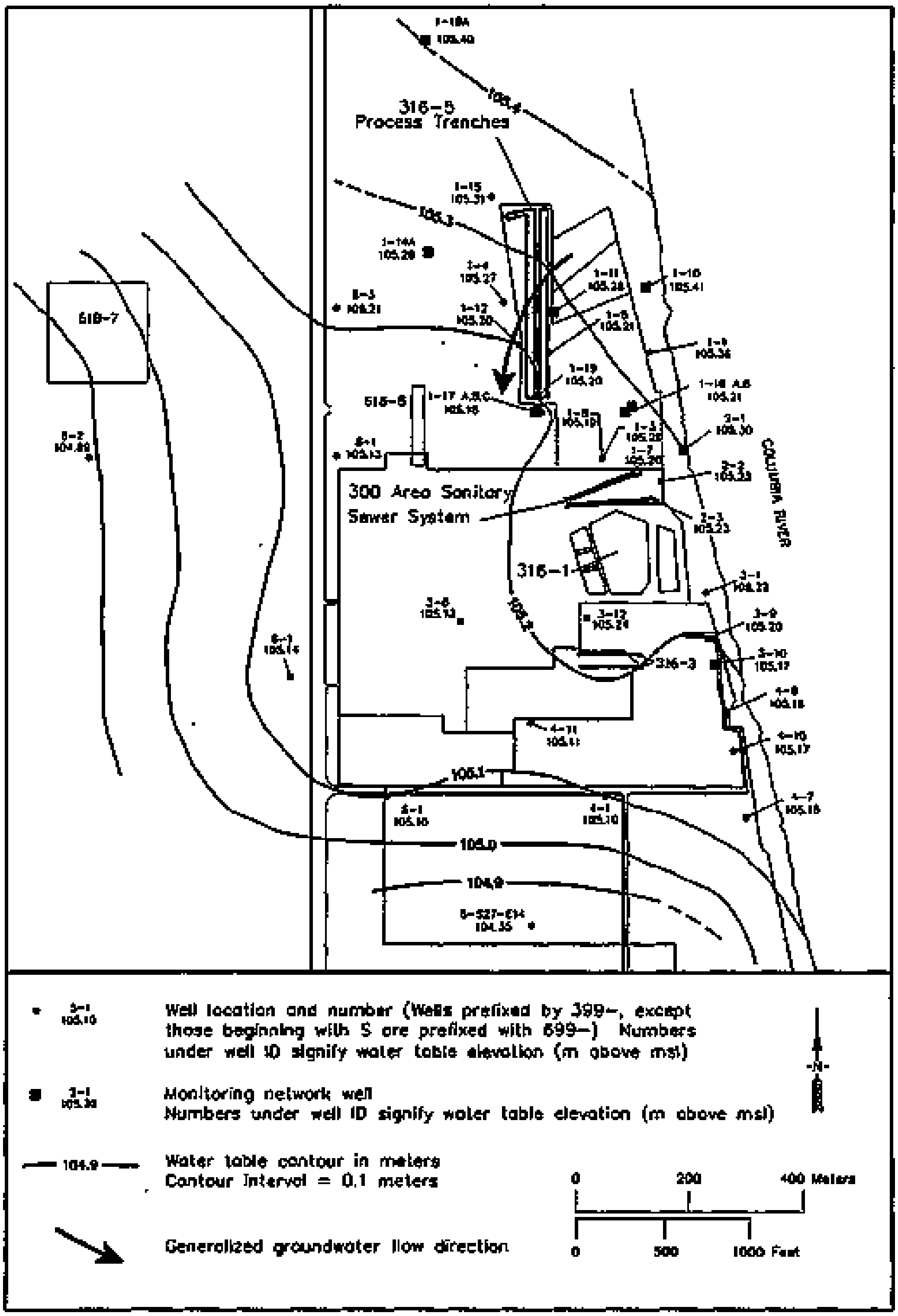

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Figure 6.1-7. Water Table Elevation Map, September 5, 1995.

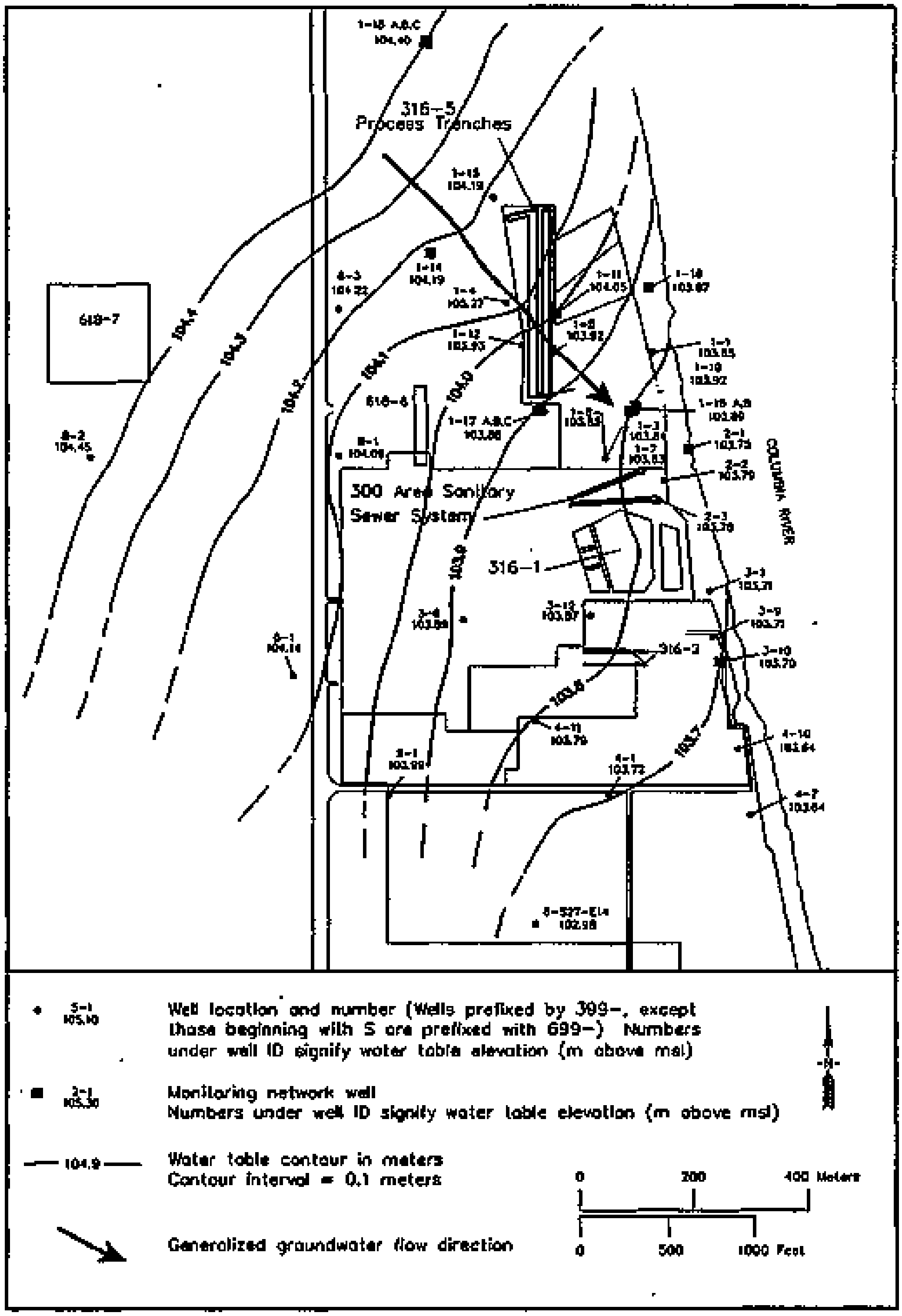

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Table 6.1-1. Monitoring Wells Used for the 300 Area Process Trenches.

Well	Aquifer	Sampling frequency	Water levels	Well standards
399-1-10A^{86}	Top of unconfined	SA	Q	RCRA
399-1-11^{86}	Top of unconfined	SA	Q	RCRA
399-1-12^{86}	Top of unconfined	SA	Q	RCRA
399-1-14A^{86}	Top of unconfined	SA	Q	RCRA
399-1-16A^{86}	Top of unconfined	SA	Q	RCRA
399-1-16B^{87}	Bottom unconfined	SA	Q	RCRA
399-1-17A^{86}	Top of unconfined	Q	Q	RCRA
399-1-17B^{86}	Bottom unconfined	SA	Q	RCRA
399-1-18A^{86}	Top of unconfined	SA	Q	RCRA
399-2-1^{48}	Top of unconfined	SA^{a}	Q	PRE
399-3-10^{76}	Top of unconfined	SA^{a}	Q	PRE

Notes: Shading denotes upgradient wells. Superscript following well number denotes the year of installation.

^{a} = Well is sampled for supporting data.
PRE = well was constructed before RCRA-specified standards.
Q = frequency on a quarterly basis.
RCRA = well is in compliance with RCRA standards.
SA = frequency on a semiannual basis.

Table 6.1-2. Constituents Analyzed in the 300 Area Process Trenches.

Contamination indicator parameters		
pH	Total organic carbon	
Specific conductance	Total organic halogen	
Groundwater quality parameters		
Chloride	Manganese	Sulfate
Iron	Sodium	
Drinking water parameters		
Arsenic	Coliform bacteria	Mercury
Barium	Fluoride	Nitrate
Beta-BHC	Gross alpha	Radium
Cadmium	Gross beta	Selenium
Chromium	Lead	Silver
Site-specific and other parameters		
Alkalinity	Gamma scan	Strontium 90
Aluminum	Isotopic Uranium	Tin
Antimony	Magnesium	Tritium
Beryllium	Nickel	Uranium
Bromide	Nitrite	Vanadium
Calcium	Phosphate	Volatile organics
Cobalt	Potassium	Zinc
Copper	Strontium	

APPENDIX A

QUALITY CONTROL PROGRAM

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A.0 QUALITY CONTROL PROGRAM

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A.1 INTRODUCTION

The *Resource Conservation and Recovery Act of 1976* (RCRA) Quality Control (QC) program is based on guidance from the U.S. Environmental Protection Agency (EPA), the *Resource Conservation and Recovery Act (RCRA) Groundwater Monitoring Technical Enforcement Guidance Document* (EPA 1986a), and Chapter I, "Quality Control," from *Test Methods for Evaluating Solid Waste* (EPA 1986b).

A.1.1 Data Quality Objectives

The QC program uses the five measures of data quality: precision, accuracy, representativeness, completeness, and comparability, along with applicable program-specific quality parameters to evaluate the quality of the data and the analytical laboratories analyzing the samples (WHC 1992a). Target values for precision and accuracy are specified in the *Quality Assurance Project Plan for RCRA Groundwater Monitoring Activities* (WHC 1992b).

1. Precision is evaluated using data results from laboratory duplicates, matrix spike duplicates (see Section A.3), field duplicates, and blind samples (see Section A.2).

2. Accuracy is evaluated using data results from laboratory matrix spikes; laboratory control samples; EPA Water Pollution (WP), Water Supply (WS), and intercomparison studies (see Section A.3); and by blind samples (see Section A.2).

3. Representativeness expresses the degree to which RCRA facility groundwater samples represent the actual composition of the groundwater in the aquifer. Goals for data representativeness for groundwater monitoring programs are addressed qualitatively by the specification of well construction, sampling locations, sampling intervals, and sampling and analysis techniques in the groundwater monitoring plan for each RCRA facility.

4. Completeness is defined as the percentage of measurements that are judged to be valid. Completeness is determined by the number of data unflagged during the validation process, divided by the total number of data evaluated, and multiplied by 100. The calculated percentages used in reporting completeness are conservative because all values flagged with F, H, P, Q, R, and Y are used in calculating the percent complete. These flags point out potential problems related to data quality, but do not necessarily invalidate the data.

5. Comparability is the confidence with which one data set can be compared to another. Ideally, it should be evaluated using

replicates to ensure that samples analyzed by different laboratories or by the same laboratory over different time periods are comparable. The primary hazardous chemistry laboratory was requested to analyze samples and submit data for most of 1995; however, between March 15, 1995, and April 30, 1995, another hazardous chemistry laboratory analyzed samples and submitted data. Before using the second laboratory, laboratory procedures from both laboratories were compared to determine if the procedures were based on the same reference methods. The procedures for constituents of concern were examined individually to ensure comparability. A comparison of the method detection limits (MDL) was also conducted. Contractual administrative controls were put in place with the second laboratory to make the contracts as similar as possible. No split samples were sent to the two laboratories.

For 1995, two different laboratories were used for total organic halogen (TOX) measurements. The methodology used by the two laboratories was similar; however, some differences have been noticed in the data (Section A.2).

Only the primary radiochemistry laboratory was used for radiochemical analysis in 1995.

Samples were analyzed in accordance with *Test Methods for Evaluating Solid Waste* (EPA 1986b) and other applicable approved methods. Comparability of field measurements is determined by following approved sampling procedures that ensure consistency among sampling events.

A.2 EXTERNAL QUALITY CONTROL PROGRAM

The external QC program uses three kinds of QC samples to evaluate quality in the field and laboratory. These are field duplicates, field blanks, and blind samples.

The analytical results of QC samples are judged to be acceptable if the following evaluation criteria are met.

- Field duplicates--Results of field duplicate pairs must have precision within 25%, as measured by relative percent difference (RPD). Beginning with the April to June 1995 quarter, the criterion for RPD has been changed to 20% and only results that are quantifiable will be evaluated (WHC 1995).

- Blanks--Four kinds of blanks are used to check for contamination resulting from field activities and/or bottle preparation. These are full trip, daily trip, field transfer, and bottle blanks. Beginning with the July to September 1995 quarter, daily trip and transfer blanks were combined (WHC 1992d). The RCRA Groundwater Monitoring program's primary regulatory and guidance documents provide no requirement for daily trip blanks as they were previously collected. The new field trip blanks serve as trip blanks, but because they are collected at the well rather than in the lab, more meaningful information is provided.

Except for common laboratory contaminants, results above the limit of two times the MDL are identified as suspected contamination. For common laboratory contaminants, such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, sample results greater than five times the MDL are identified as suspected contamination.

- Blind samples--Blind samples are periodically forwarded to the laboratories to evaluate the laboratory performance (WHC 1992b).

Table A-1 provides a summary of the field duplicate and field blank results evaluated for 1995.

Tables A-2 and A-3 summarize the total number of field blanks and field duplicates outside of the QC limit per method for 1995. The numbers listed in Tables A-2 and A-3 were calculated from the tables used to prepare the first-, second-, and third-quarter-1995 quarterly reports and regenerated QC tables from the fourth quarter 1994. The regenerated QC tables are not identical to those used for the fourth-quarter-1994 quarterly report. Methods not listed in Tables A-2 or A-3 were 100% acceptable for field blanks or field duplicates.

Throughout the year almost all the field blank constituents had low percentages of results exceeding QC limits. One exception was turbidity. Ninety-five percent of the turbidity results exceeded the QC limits. Problems with turbidity have existed for several years. Midway through 1995, laboratory analysis of turbidity ceased. Turbidity measurements are now taken in the field. Measures have been taken to ensure reliability of data. For example, at certain problem wells, pumping rates have been slowed in order to acheive lower turbidity readings. In general, samplers now contact project scientists for guidance when field turbidity measurements are outside the expected range.

Many field duplicate results for total organic carbon (TOC), turbidity, gross alpha, gross uranium, and lead exceeded the QC limit. For TOC, turbidity, and lead, all of the exceedences were from the fourth quarter of 1994 and the first quarter of 1995 when nonquantifiable data were still used in the evaluation of QC results. For gross alpha, the percentage of flagged duplicates dropped from 35.7 to 11.8 between the first and second halves of the year. The percentage of flags for uranium remained high. Expecting duplicate results near the detection limit to fall within the former ±25% RPD criterion was unrealistic and led to misleading data flags. Results close to the MDL or MDC are not quantifiable and precision in the region is poor. During the first half of the year, before the change in the evaluation criteria, 8.7% of duplicate data were flagged. For the last two quarters of this year, 0.1% of duplicates have been flagged.

Performance evaluation (PE) samples were sent out each quarter during the annual reporting period. Standards for TOX, TOC, inductively coupled plasma metals (ICP), anions, and volatile organic analytes (VOA) were sent out during the reporting period. The ICP standards were spiked with iron, zinc, manganese, and chromium. The VOA standards were spiked with carbon tetrachloride, carbon disulfide, benzene, and toluene. The anion standard contained nitrate. Fifteen of the 16 samples were sent to the primary hazardous chemistry laboratory. Only nine of the results received from the primary hazardous chemistry laboratory were acceptable. The laboratory had unacceptable results twice for TOX and once each for TOC, iron, zinc, and chromium. The TOX PE results were biased low. Results that seem to be biased low were reported for the NRDWL and SWL projects. The impact of this bias is discussed in the sections for NRDWL and SWL in this report. WHC is evaluating whether a new laboratory for TOX should be selected.

A.3 INTERNAL QUALITY CONTROL PROGRAM

The internal QC program uses five types of QC data to establish and monitor performance in the laboratory. These data are laboratory blanks, matrix spikes, matrix duplicates, matrix spike duplicates, and EPA studies (WP, WS, and intercomparisons).

Every quarter the contracted laboratories supply their own QC reports, in the form of precision and accuracy, which include data quality information on matrix spikes, matrix duplicates, matrix spike duplicates, and blanks. The contracted laboratories also report their results for the EPA's WP, WS, and radiochemical intercomparison studies quarterly. The results of EPA studies independently verify the level of laboratory performance and are expressed as the percentage of EPA-accepted results. Each half-year the contracted laboratories also supply an MDL/minimum detectable concentration (MDC) report. In the future the hazardous chemistry laboratory will only provide one MDL report per year. The MDLs and MDCs are required to be below the contractually required quantitation limit (CRQL). The CRQL is not associated with a quantitation limit as the name suggests; it is intended to be the lowest analyte concentration in a given matrix that a laboratory can be expected to detect consistently. The CRQL is agreed on under the contractual statement of work. A laboratory nonconformance report (NCR) is issued when the MDL is greater than the CRQL. Westinghouse Hanford Company (WHC) QC team reviews each of these reports and summarizes the results in this section.

Results from the EPA water pollution, water supply, and intercomparison studies are summarized in Table A-4. The EPA studies do not necessarily include an evaluation of laboratory performance for all constituents of concern to the RCRA program, but the EPA studies do give an idea of whether or not the laboratory is in control for those constituents that are included in the studies.

Radiochemistry precision and accuracy figures are provided in the radiochemistry laboratory's quarterly report, with percent acceptability calculated from duplicates and spikes, respectively. These results are summarized in Table A-4. The precision and accuracy results indicate the performance of all customers submitting water matrix samples. WHC samples represent only a part of the performance summary.

A.4 NONCONFORMANCE/INCIDENT REPORTS

NCR and incident reports are methods of documentation by which contract laboratories can inform laboratory contractors and their customers of any problems encountered with the analysis, data, and/or data deliverable. This method of documentation is intended to identify occurrences, deficiencies, and/or issues that may potentially have an adverse effect on the data integrity. These may include, but are not limited to the following:

- Lost sample
- Broken bottles
- Instrument malfunctions
- Calibration standards out of acceptable range
- Laboratory control standards out of acceptable range
- Matrix spike recovery out of acceptable range
- Blank contamination
- Procedural noncompliance
- Chain-of-custody discrepancies
- Shipping temperatures out of acceptable range
- Misreported data.

During the 1995 reporting year 43 NCR and incident reports were transmitted, affecting 246 data points. There were 40 reports transmitted by the hazardous chemistry laboratory and 3 reports transmitted by the radiochemistry laboratory. The reports represent a 50% decrease in the number of incident reports transmitted during fiscal year 1995 as compared to fiscal year 1994. The reports describe incidents that affect either groundwater samples or external QC samples (e.g., trip blanks).

The reports transmitted by the hazardous chemistry laboratories affect 241 data points, 68 of which were rejected. The rejected data were primarily attributed to broken sample containers received at the laboratories. Additionally, 173 analytical results were evaluated as being suspect. These data points should be used for trending purposes only. The suspect data are primarily attributed to the development of air in the TOX sample bottles. Per SW-846 the TOX should have no head space at the time of collection, to prevent the potential loss of volatiles. The samples were noted as not having air at the time of collection, but the samples had developed air bubbles by the time they arrived at the laboratory. The reason for this phenomenon is under investigation, however each sample that developed air was noted and flagged as being suspect.

The reports transmitted by the radiochemistry laboratory affect five data points, four of which were rejected. Three of the rejected radiochemistry data points were attributed to sample bottles being broken, the fourth data point was caused by laboratory contamination. The suspect data point is attributed to sample matrix effect that prevented the laboratory from achieving contractual detection limit. The incident reports received from the laboratories during this reporting year have been instrumental in identifying potential issues for laboratory surveillances.

A.5 QUALITY ASSURANCE OCCURRENCES

Quality assurance (QA) occurrences are situations that potentially affect the quality of the data. These situations are discussed through summaries of inspections of laboratory services and/or system and performance audits/surveillances. Inspection of laboratory services and/or system and performance audits/surveillances for the RCRA groundwater monitoring program are performed throughout the year by the laboratory contractor, WHC, and/or the U.S. Department of Energy on various aspects of this program. QA requirements and data quality objectives are defined in the *Quality Assurance Project Plan for RCRA Groundwater Monitoring Activities* (WHC 1992b). Results of these oversight activities are documented with the audit/surveillance and/or inspecting organization(s).

During the 1994 reporting period, WHC performed three inspections in conjunction with the contract administrator (i.e. PNNL). Results of the inspections were classified as findings and observations and were discussed in the 1994 RCRA Annual Report. In February 1995 the contract administrator evaluated the hazardous chemistry laboratories responses with respect to each of the findings and observations. As a result of this evaluation, three of the findings were reclassified as observations (see discussion for observations #3, #4, and #5 below); two of the findings were withdrawn; and one of the findings was addressed by corrective action taken by the laboratories. The details of the report are provided below.

FINDING # F1May94.121 **The Contractor failed to track and verify implementation of corrective actions, as required by the contract**

This Finding is withdrawn and changed to an Observation.

Please refer to "Observation 3" for discussion.

FINDING # F2May94.121 **Noncompliances were found with the hazardous chemistry laboratories procedures governing document control. Multiple instances were found of effective dates for procedures preceding approval dates**

This Finding is withdrawn and changed to an Observation.

Please refer to "Observation 4" for discussion.

FINDING # F3May94.121 **Noncompliances were found with the implementation of the contractual requirement for annual review of procedures**

This Finding is withdrawn.

Corrective actions were in process for 1994 procedure reviews; it appears that the hazardous chemistry laboratory is adequately addressing this issue and understands the need to continue its annual review of procedures.

FINDING # F4May94.121 Deficiencies exist in the traceability to specific procedures and standards used for the analysis of samples

This Finding is withdrawn.

The contract administrator will require that all data be traceable to specific analytical procedures (including revision dates) in the forthcoming Operations Year Statement of Work.

FINDING # F5May94.121 Noncompliances were found to procedural and contractual requirements of training

The corrective action provided for this finding is acceptable. Future inspections will evaluate implementation of the laboratory's corrective action in this area.

FINDING # F6May94.121 Deficiencies and inconsistencies exist in the control charting and tracking for both analysis and reporting purposes

This Finding is withdrawn and changed to an Observation.

Please refer to "Observation 5" below for discussion.

OBSERVATIONS

The Laboratory is reminded that, in inspection, Observation is a conclusion that presents the results of a generally subjective evaluation of implementation practices or management systems related to the area under review. An Observation may or may not relate to specific noncompliance(s) with contractual requirements but is based on the inspector's evaluation of factual evidence.

OBSERVATION NO. 1 The contract laboratory was unable to clearly explain the responsibilities of its QA organization as applicable to WHC samples.

This Observation is withdrawn.

The contract administrator will reevaluate this issue during the next Inspection of Services. The evaluation will be based on the laboratory's internal procedures and Appendix B, Section I of the contract that required the organizational structure, functional responsibilities, level of authority, and lines of communication for the activities affecting quality that are to be documented. Such documentation must be consistent with the current practices within the laboratory.

OBSERVATION NO. 2 It was unclear whether the laboratory has an effective program in place to control contamination

This Observation is withdrawn.

The contract administrator will make a contract change in forthcoming documentation that is expected to resolve the issues involved. The "Contractual Required Quantitation Limit" (CRQL) will be changed to a "Contractual Required Detection Limit" (CRDL) and blank acceptance criteria will be tied to the CRDL.

<u>NOTE</u>: The following observations did not appear in the original report and are the result of reclassifying three of the original findings as observations.

OBSERVATION NO. 3 The Contractor failed to track and verify implementation of corrective actions, as required by the contract

The laboratory acknowledges that the specific corrective action to the August 1993 Finding and Observations taken was different from that committed to in its correspondence to the contract administrator dated March 24, 1994. The contract administrator recognized that corrective actions cannot always be implemented as committed. However, the laboratory's changes to corrective action commitments could result in additional conditions that could adversely affect quality.

The contract administrator expects the hazardous chemistry laboratory to work toward improving its system for follow-up of corrective action commitments and notify the contract administrator in a more timely manner when changes to commitments are made (e.g., when it is determined the original/committed corrective action is not appropriate). The laboratory must recognize that such changes are made at its own risk and the possibility exists that, on occasion, a change may be questioned and justification of the validity of the data may be requested.

A good example of how this could work is provided in the laboratory's May 12, 1994, correspondence to the contract administrator. If the changes addressed in this letter had been communicated to the contract administrator before the May 2-6 Inspection of Services, the inspection team would have had confidence in the laboratory's corrective action/follow-up system. Most of these changes were known by the laboratory before the inspection.

OBSERVATION NO. 4 Noncompliances were found with the hazardous chemistry laboratories procedures governing document control. Multiple instances were found of effective dates for procedures preceding approval dates

In several instances, approval signatures' dates were later than the effective date of the procedure. These instances included administrative procedures, analytical procedures, and the laboratory's *Environmental Chemistry Quality Assurance Program Plan*, QA-2/83 revised 6/92. The discrepancy did not appear to affect the quality of the deliverable and implementation of the subject procedures was within a short time after the effective date. However, the laboratory should ensure in the future that indicated effective dates do not precede approval dates.

OBSERVATION NO. 5 Inconsistencies were noted in the control charting and tracking for both analysis and reporting purposes of the laboratory's QC Program.

Significant background information has already been addressed in the contract administrator's September 6, 1994, Inspection of Services Report and in the laboratory's October 17, 1994, Response (Ref. 94P900) that addresses the complex and varied issues involved in this observation. The laboratory acknowledged that opportunity for improvements existed in their QC Program. Therefore, it is recommended that the technical parties involved communicate directly on these issues to finalize the laboratory's control charting and tracking QC program. Any changes must be authorized through a formal contract modification.

The laboratory's committed corrective action to this issue is deemed acceptable as a response to this observation and is repeated below for follow up and verification.

> "The laboratory will continue to develop and refine the existing computerized QC System (with accompanying guidelines and documentation) such that specifications of the contract administrator are satisfied. Significant improvements have been effected at the lab in the last few weeks. As the program is finalized, the lab will provide the contract administrator with documentation and details in an effort to provide a product that is considered acceptable."

The second inspection of services was performed July 6-8, 1994, at the radiochemistry laboratory. The third surveillance was performed August 8-10, 1994, at the subcontracted laboratory responsible for analyses such as coliform, anions and biological oxygen demand. The official audit report has not been transmitted by the contract administrator. WHC has requested an official statement from the contract administrator to provide the status of these two surveillances.

Sampling and Analysis

During the 1995 reporting period (October 1, 1994 to September 30, 1995), WHC retained the sampling activities and analytical services. RCRA sampling activities had previously been subcontracted to Pacific Northwest National Laboratory (PNNL) by WHC. The analytical services were also procured by WHC through PNNL analytical contracts.

In January, 1995, WHC began performing all RCRA sampling activities. An internal surveillance was performed in June to evaluate the WHC samplers on the preparation for a sampling event at RCRA wells. The surveillance covered operator calibration of instruments for monitoring field parameters, well purging, acquisition of field parameters, sample collection, chain of custody and well security.

Initially there was a concern about the calibration (standardization) status of the E-tape used to determine the elevation of the groundwater. Note, there is a regulatory requirement to determine the elevation of groundwater each time samples are collected. The E-tape was later determined to be in calibration. There were no findings or observations from the surveillance.

The analytical services were transitioned to WHC contracted laboratories in April, 1995. Per DOE direction the analytical services were transitioned back to PNNL contracted laboratories in May 1995.

A.6 LIMIT OF DETECTION, LIMIT OF QUANTITATION, AND METHOD DETECTION LIMIT--C. J. Chou

The concentration at which an analyte can be detected depends on the variability of the blank response. For purpose of this discussion, the 'blank' is taken to be a method blank. The limit of detection (LOD) is defined as the lowest concentration level that is statistically different from a blank (Currie 1988). In general, it is calculated as the mean concentration in the blank plus three standard deviations of that concentration (EPA 1987). The blank corrected LOD is simply three times the blank standard deviation. At three standard deviations from the blank mean, the false positive error rate and the false negative error rate are each about 7% (Miller and Miller 1988). A false positive error is an instance when an analyte is declared to be present but is, in fact, absent. A false negative error is an instance when an analyte is declared to be absent but is, in fact, present.

The limit of quantitation (LOQ) is defined as the level above which quantitative results may be obtained with a specified degree of confidence (Keith 1991). It is calculated as the blank mean plus 10 standard deviations of the blank (EPA 1987). The blank corrected LOQ is 10 times the blank standard deviation. The LOQ is most useful for defining the lower limit of the useful range of concentration measurement technology. When the analyte signal is 10 times larger than the standard deviation of the blank measurements, there is a 95% probability that the true concentration of the analyte is +25% of the measured concentration. The LOD and LOQ are shown graphically in Figure A-1. For purpose of illustration, the numbers appearing in this figure are the respective blank mean, LOD, and LOQ for TOC and TOX (see Tables A-5 and A-6).

The MDL is defined as the minimum concentration of a substance that can be measured and reported with a 99% confidence that the analyte concentration is greater than 0. The MDL is determined from analysis of a sample in a given matrix containing the analyte (Currie 1988). The MDL is 3.14 times the standard deviation of the results of 7 replicates of a low-level standard. Note that the MDL as defined here is based on the variability of the response of low-level standards rather than on the variability of the blank response.

For this RCRA annual report, TOC, TOX, and radionuclide field blank data are available for LOD and LOQ determinations. The field blanks are quality control samples that are introduced into a process to monitor the performance of the system. The use of field blanks to calculate LOD and LOQ is preferred over the use of laboratory blanks because field blanks provide a measure of the errors in the entire sampling and analysis system. Methods to calculate LOD and LOQ are described in detail in DOE-RL (1991, Appendix A). TOX samples have been analyzed by DataChem Laboratories (DCL) of Salt Lake City, Utah since June 1995. Only TOX blanks analyzed by DCL were used in the LOD/LOQ determination. The results of the LOD and LOQ determinations for 1995 RCRA sampling at the Hanford Site are shown in Tables A-5 through A-17.

Because blanks data are lacking for other constituents of concern, WHC deemed it necessary to calculate approximated LOD and LOQ values using variability information obtained from low-level standards. As shown in Figure A-1, the values along the horizontal axis are measured in units of 'standard deviation' of the measurement process (i.e., based on well-known blank). If low-level standards are used, the variability of the difference between the sample and blank response is increased by a factor of $\sqrt{2}$ (Currie 1988, p. 84). The formulas are summarized below:

$$\text{MDL} = 3.14 * s$$

$$\begin{aligned}\text{LOD} &= 3 * (\sqrt{2} * s) \\ &= 4.24 * s\end{aligned}$$

$$\begin{aligned}\text{LOQ} &= 10 * (\sqrt{2} * s) \\ &= 14.14 * s\end{aligned}$$

where s denotes standard deviation from the seven replicates of the low-level standard.

The results of MDL, LOD, and LOQ calculations, for other constituents of concern, are shown in Table A-18.

A.7 QUALITY CONTROL DEFINITIONS

Accuracy--The closeness of agreement between an observed value and a true value. Accuracy is assessed by means of reference samples and percent recoveries.

Blind sample--A sample that contains a concentration of analyte that is known to the supplier but unknown to the analyzing laboratory. The analyzing laboratory is informed that the sample is a QC sample and not a field sample. The blind, the double blind, and the matrix-matched double blind samples are used to assess accuracy and monitor the performance of the analytical laboratory(ies) with prepared or purchased materials from EPA QC samples/ concentrates or primary materials.

Bottle blank--A sample that contains only Type II reagent water. The bottle blank contains one sample for each bottle size, with at least enough bottles to include all constituents analyzed by a specific project, except radionuclides. Bottle blanks shall be submitted to the primary laboratory per lot of bottles. Bottle blanks are filled in the analytical laboratory under the sample preparation procedures. Bottle blanks do <u>not</u> go into the field.

Contractually required quantitation limit--A value intended to be the lowest analyte concentration in a given matrix that the laboratory can be expected to achieve consistently; agreed on under the contract statement of work.

Daily trip blank--A sample that contains only Type II reagent water. The daily trip blank is used to check for sample contamination by volatile organic compounds arising from conditions encountered during the collection of samples. The daily trip blank is not opened in the field. One daily trip blank is collected for each day sampling occurs.

Double blind sample--A sample that contains a concentration of analyte that is known to the supplier but is unknown to the analyzing laboratory. The analyzing laboratory is not informed that the sample is a QC sample. All attempts are made to make this sample appear like a field sample. For example, the double blind sample should be submitted to the laboratory within the same time period and with a sample identification number similar to that of the field samples. The double blind sample does not include matrix matching.

External quality control sample--Any QC sample prepared without the knowledge of the analytical laboratory.

Field duplicate sample--A sample used to determine repeatability of an analytical measurement on identical samples collected as close as possible to the same time at the same location. These samples are stored in separate containers and are analyzed independently by the same laboratory.

Field transfer blank--A sample that contains only Type II reagent water. The blank field transfer blank is used to check for sample contamination by volatile organic compounds arising from conditions encountered during the collection of samples. The field transfer blank is taken during the collection of samples. The field transfer blank is filled at the sampling site by pouring Type II reagent water from a cleaned container into a volatile organic analysis vial. At least 1 field transfer blank is collected for each 20 samples, or 1 per sampling batch.

Field trip blank--A sample that contains only Type II reagent water. At the time of sample collection, the field blank is filled at the sampling site by pouring Type II reagent water from a cleaned container into volatile organic analysis (VOA) vials. After collection, the field trip blank is treated in the same manner as the other samples collected during the sampling event. Field trip blanks are collected only on days when samples are collected for VOA.

Full trip blank--A sample that contains only Type II reagent water and preservative, as required. A full trip blank is used to check for contamination in sample bottles and sample preparation. The full trip blank is analyzed for all constituents of interest on all types of sample bottles used during that sampling period. The frequency of collection for a full trip blank is 1 per 20 samples, or 1 per sampling batch. A full trip blank is filled in the analytical laboratory under the sample preparation procedures. The full trip blank is not opened in the field.

Internal quality control sample--Any QC sample prepared by the analytical laboratory and used to establish and monitor the quality of the analytical laboratory.

Limit of detection--The lowest concentration level that is statistically different from a blank. This is calculated by the average blank signal plus three standard deviations for the blank analyses (see Appendix B for more detail).

Matrix-matched double blind sample--A matrix-matched double blind sample contains a concentration of analyte that is known to the supplier but unknown to the analyzing laboratory. The sample matrix has been altered to closely match that of the field samples.

Method detection limit--The minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero, and is determined from analysis of a sample in a given matrix type containing the analyte.

Minimum detectable concentration--Required level of analytical detection for radiochemical samples.

Precision--The agreement among a set of individual measurements of the same property, usually under prescribed similar conditions. Precision is calculated by using relative percent difference of the duplicate/replicate analyses. These samples should contain concentrations of analyte above the MDL and may involve the use of matrix spikes.

Reliable detection level--A detection limit set at two times the concentration of the MDL, so the risk of both false positives and false negatives falls below 1%.

Type II reagent water--Distilled or deionized water that is free of contaminants that may interfere with the analytical test in question.

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Figure A-1. Levels of Detection and Quantitation.

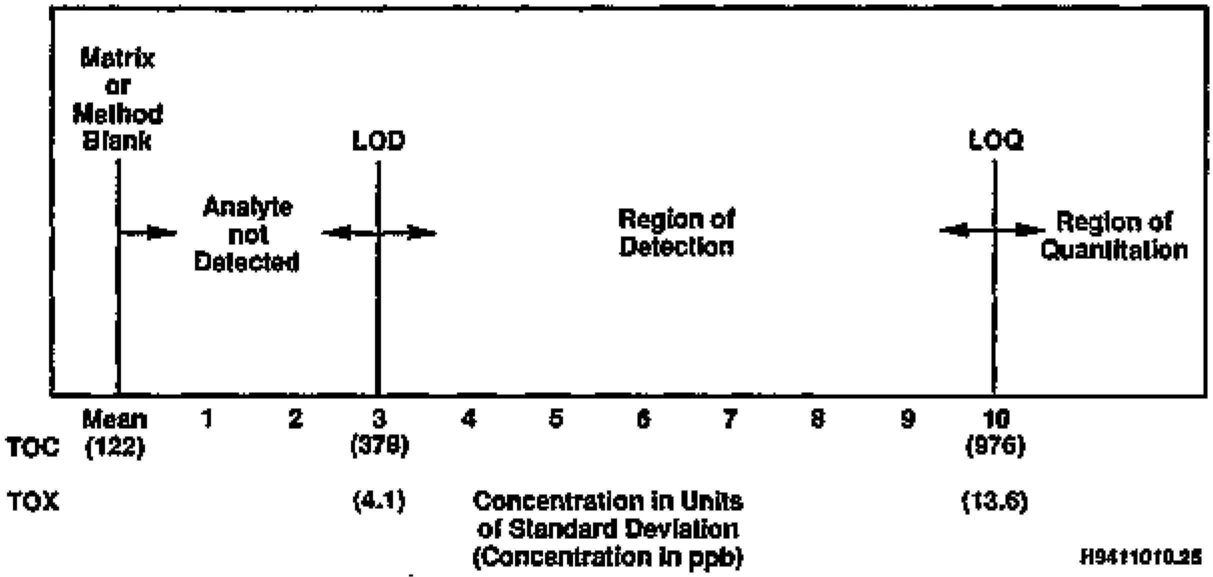

Table A-1. Summary of 1995 Quality Control Quarterly Reports.

Quarterly reports	Field duplicates (% acceptable)	Field blanks (% acceptable)
October-December 1994	94.1	95.1
January-March 1995	93.2	95.5
April-June 1995	98.1	98.2
July-September 1995	99.0	96.7

Table A-2. 1995 Field Blanks Exceeding Quality Control Limits.

Method	Method name	Group	Total analyses	Q Flags	%Out of limits
122/1230	SW-846 9060	TOC	86	8	9.3
124/1083	ASTM D-4327-88/EPA 300.0	Anions	294	31	10.5
126/1044	Std Meth #214A/EPA 180.1	Turbidity	17	16	94.1
127/113	ASTM D-2579-A/EPA 415.1	Total Carbon	2	2	100.0
140/1249	ITAS Gamma Scan	Gamma	21	2	9.5
142/1255	ITAS H-3	Tritium	35	1	2.9
182/1300	SW-846 8260	VOA GC/MS	528	39	7.4
16	SW-846 8240	VOA GC/MS	2,903	70	2.4
25	SW-846 8010/8020	VOA GC	187	10	5.3
30/1197	SW-846 8040	Phenols	160	1	0.6
34/1139	SW-846 6010	ICP Metals	956	80	8.4
40/1170	SW-846 7421	Lead	14	2	14.3
41/1174	SW-846 7470	Mercury	15	5	33.3
65/1039	Std Meth #209B/EPA 160.1	TDS	9	3	33.3
67	SW-846 9020	TOX	103	14	13.6

Table A-3. 1995 Field Duplicates Exceeding Quality Control Limits. (2 sheets)

Method	Method name		Total analyses	Q Flags	%Out of limits
122/1230	SW-846 9060	TOC	53	12	22.6
124/1083	ASTM D-4327-88/EPA 300.0	Anions	280	9	3.2
126/1044	Std Meth #214A/EPA 180.1	Turbidity	16	6	37.5
129	ASTM D-1426-C	Ammonium ion	3	2	66.7
135/1247	SW-846 9310, Alpha	Gross alpha	35	7	20.0
136/1252	SW-846 9310, Beta	Gross beta	27	2	7.4
137	SW-846 9315, Radium	Radium	4	1	25.0
143/1283	ITAS Tc-99	Technetium-99	11	1	9.1

Table A-3. 1995 Field Duplicates Exceeding Quality Control Limits. (2 sheets)

Method	Method name		Total analyses	Q Flags	%Out of limits
145/1288	ITAS Gross U	Uranium	17	5	29.4
25	SW-846 8010/8020	VOA GC	204	7	3.4
34/1139	SW-846 6010	ICP Metals	855	57	6.7
65/1039	Std Meth #2098/EPA 160.1	TDS	14	2	14.3
67	SW-846 9020	TOX	58	11	11.2

Table A-4. Summary of 1995 Quality Control Semiannual and Quarterly Reports (in percent acceptable).

1995 Quarterly reports	Precision[a]	Accuracy[a]	EPA water pollution	EPA water supply	Radiochemical interlab comparison
Oct-Dec 1994	98.1	99.2	Samples not sent this quarter	94.8	100
Jan-Mar 1995	97.7	98.5	97.2	Samples not sent this quarter	100
Apr-Jun 1995	100	99.2	Samples not sent this quarter	97.6	100
Jul-Sept 1995	Not reported by lab	Not reported by lab	96.5	Samples not sent this quarter	Not reported by lab

[a] These figures represent radiochemistry data.
EPA = U.S. Environmental Protection Agency.

Table A-5. Groundwater Field Blanks Data from DataChem Laboratories. Constituent: Total Organic Carbon. (2 sheets)

Period from	Period to	Number of samples	Mean (ppb)	Standard deviation (ppb)	LOD[a] (ppb)	LOQ[a] (ppb)
10/18/94	12/30/94	34[b]	119	88.0	383	999
01/06/95	03/24/95	23	145	91.1	419	1,056
06/09/95	06/21/95	6	94	65.4	290	748
07/07/95	08/14/95	6	75	53.7	236	612

Table A-5. Groundwater Field Blanks Data from DataChem Laboratories.
Constituent: Total Organic Carbon. (2 sheets)

Period from	Period to	Number of samples	Mean (ppb)	Standard deviation (ppb)	LOD[a] (ppb)	LOQ[a] (ppb)
Summary		69	122	85.4	378	976

[a] LOD equals the mean blank concentration plus 3 standard deviation and LOQ equals the mean blank concentration plus 10 standard deviation.
[b] excluding contaminated blanks that were analyzed on 11/29/94.
LOD = limit of detection.
LOQ = limit of quantitation.

Table A-6. Groundwater Field Blanks Data from DataChem Laboratories.
Constituent: Total Organic Halogen.

Period from	Period to	Number of samples	Mean (ppb)	Standard deviation (ppb)	LOD[a] (ppb)	LOQ[a] (ppb)
06/07/95	09/12/95	25	0.191	1.356	4.1	13.6

[a] LOD (blank corrected) equals 3 times the blank standard deviation and LOQ (blank corrected) equals 10 times the blank standard deviation.
LOD = limit of detection.
LOQ = limit of quantitation.

Table A-7. Groundwater Field Blanks Data from IT Analytical Services.
Constituent: Antimony-125.

Period from	Period to	Number of samples	Mean (pCi/L)	Standard deviation (pCi/L)	LOD[a] (pCi/L)	LOQ[a] (pCi/L)
10/28/94	12/29/94	3	2.733	10.478	31.43	104.78

[a] LOD (blank corrected) equals 3 times the blank standard deviation and LOQ (blank corrected) equals 10 times the blank standard deviation.
LOD = limit of detection.
LOQ = limit of quantitation.

Table A-8. Groundwater Field Blanks Data from IT Analytical Services.
Constituent: Cesium-137.

Period from	Period to	Number of samples	Mean (pCi/L)	Standard deviation (pCi/L)	LOD[a] (pCi/L)	LOQ[a] (pCi/L)
10/28/94	12/29/94	3	-0.400	4.623	13.87	46.23

[a]LOD (blank corrected) equals 3 times the blank standard deviation and LOQ (blank corrected) equals 10 times the blank standard deviation.
LOD = limit of detection.
LOQ = limit of quantitation.

Table A-9. Groundwater Field Blanks Data from IT Analytical Services.
Constituent: Cobalt-60.

Period from	Period to	Number of samples	Mean (pCi/L)	Standard deviation (pCi/L)	LOD[a] (pCi/L)	LOQ[a] (pCi/L)
10/28/94	12/29/94	3	1.357	2.149	6.45	21.49

[a]LOD (blank corrected) equals 3 times the blank standard deviation and LOQ (blank corrected) equals 10 times the blank standard deviation.
LOD = limit of detection.
LOQ = limit of quantitation.

Table A-10. Groundwater Field Blanks Data from IT Analytical Services.
Constituent: Gross Alpha.

Period from	Period to	Number of samples	Mean (pCi/L)	Standard deviation (pCi/L)	LOD[a] (pCi/L)	LOQ[a] (pCi/L)
10/14/94	12/26/94	11	0.048	0.306	0.92	3.06
01/10/95	03/24/95	8	-0.041	0.150	0.45	1.50
04/14/95	06/29/95	13	0.139	0.299	0.90	2.99
08/07/95	09/29/95	8	-0.045	0.133	0.40	1.33
Summary		40	0.041	0.252	0.76	2.52

[a] LOD (blank corrected) equals 3 times the blank standard deviation and LOQ (blank corrected) equals 10 times the blank standard deviation.
LOD = limit of detection.
LOQ = limit of quantitation.

Table A-11. Groundwater Field Blanks Data from IT Analytical Services.
Constituent: Gross Beta.

Period from	Period to	Number of samples	Mean (pCi/L)	Standard deviation (pCi/L)	LOD[a] (pCi/L)	LOQ[a] (pCi/L)
10/18/94	12/23/94	10	0.644	1.216	3.65	12.16
01/10/95	03/22/95	8	-0.796	1.695	5.08	16.95
04/17/95	06/27/95	12	-0.089	1.427	4.28	14.27
07/04/95	09/30/95	9	-0.438	1.291	3.87	12.91
Summary		39	-0.126	1.406	4.22	14.06

[a] LOD (blank corrected) equals 3 times the blank standard deviation and LOQ (blank corrected) equals 10 times the blank standard deviation.
LOD = limit of detection.
LOQ = limit of quantitation.

Table A-12. Groundwater Field Blanks Data from IT Analytical Services. Constituent: Iodine-129.

Period from	Period to	Number of samples	Mean (pCi/L)	Standard deviation (pCi/L)	LOD[a] (pCi/L)	LOQ[a] (pCi/L)
11/21/94	09/08/95	9	-0.079	0.315	0.94	3.15

[a] LOD (blank corrected) equals 3 times the blank standard deviation and LOQ (blank corrected) equals 10 times the blank standard deviation.
LOD = limit of detection.
LOQ = limit of quantitation.

Table A-13. Groundwater Field Blanks Data from IT Analytical Services. Constituent: Radium.

Period from	Period to	Number of samples	Mean (pCi/L)	Standard deviation (pCi/L)	LOD[a] (pCi/L)	LOQ[a] (pCi/L)
10/31/94	06/22/95	4	0.011	0.075	0.225	0.750

[a] LOD (blank corrected) equals 3 times the blank standard deviation and LOQ (blank corrected) equals 10 times the blank standard deviation.
LOD = limit of detection.
LOQ = limit of quantitation.

Table A-14. Groundwater Field Blanks Data from IT Analytical Services. Constituent: Strontium-90.

Period from	Period to	Number of samples	Mean (pCi/L)	Standard deviation (pCi/L)	LOD[a] (pCi/L)	LOQ[a] (pCi/L)
12/21/94	01/25/95	2	0.027	0.155	0.464	1.548

[a] LOD (blank corrected) equals 3 times the blank standard deviation and LOQ (blank corrected) equals 10 times the blank standard deviation.
LOD = limit of detection.
LOQ = limit of quantitation.

Table A-15. Groundwater Field Blanks Data from IT Analytical Services. Constituent: Technetium-99[b].

Period from	Period to	Number of samples	Mean (pCi/L)	Standard deviation (pCi/L)	LOD[a] (pCi/L)	LOQ[a] (pCi/L)
12/23/94	03/09/95	4	-0.465	0.460	1.381	4.603
04/21/95	06/30/95	3	-0.442	0.914	2.741	9.137
07/16/95	09/30/95	4	-0.517	0.629	2.741	6.288
Summary		11	-0.478	0.706	2.119	7.063

[a] LOD (blank corrected) equals 3 times the blank standard deviation and LOQ (blank corrected) equals 10 times the blank standard deviation.
[b] excluding contaminated blank that was analyzed on 12/19/94.
LOD = limit of detection.
LOQ = limit of quantitation.

Table A-16. Groundwater Field Blanks Data from IT Analytical Services. Constituent: Tritium.

Period from	Period to	Number of samples	Mean (pCi/L)	Standard deviation (pCi/L)	LOD[a] (pCi/L)	LOQ[a] (pCi/L)
10/20/94	12/31/94	11	95.20	148.361	445.08	1,483.6
02/23/95	03/28/95	5	138.88	109.422	328.27	1,094.2
04/21/95	06/30/95	12	68.69	73.866	221.60	738.7
08/11/95	09/30/95	7	194.47	97.265	291.80	972.6
Summary		35	112.20	111.411	334.23	1,114.1

[a] LOD (blank corrected) equals 3 times the blank standard deviation and LOQ (blank corrected) equals 10 times the blank standard deviation.
LOD = limit of detection.
LOQ = limit of quantitation.

Table A-17. Groundwater Field Blanks Data from IT Analytical Services. Constituent: Uranium.

Period from	Period to	Number of samples	Mean (ppb)	Standard deviation (ppb)	LOD[a] (ppb)	LOQ[a] (ppb)
10/21/94	12/22/94	4	0.029	0.0547	0.164	0.547
01/12/95	03/02/95	2	0.047	0.1112	0.334	1.112
04/23/95	06/27/95	4	-0.010	0.0427	0.128	0.427
07/14/95	09/30/95	3	0.012	0.0437	0.131	0.437
Summary		13	0.016	0.0584	0.175	0.584

[a] LOD (blank corrected) equals 3 times the blank standard deviation and LOQ (blank corrected) equals 10 times the blank standard deviation.
LOD = limit of detection.
LOQ = limit of quantitation.

Table A-18. LOD and LOQ Calculations for Selected Constituents Based on MDL Report[a,b] for Low Level Standards. (11 sheets)

Method Name	Constituent Name	MDL	STD. DEV.	LOD	LOQ
ASTM D-1385	Hydrazine	2.8	0.892	3.78	12.61
ASTM D-1426-C	Ammonium ion	27	8.599	36.48	121.60
ASTM D-1426-D	Ammonium ion	27	8.599	36.48	121.60
ASTM D-4327-88	Bromide	72	22.930	97.28	324.28
ASTM D-4327-88	Chloride	110	35.032	148.63	495.42
ASTM D-4327-88	Fluoride	52	16.561	70.26	234.20
ASTM D-4327-88	Nitrate	120	38.217	162.14	540.46
ASTM D-4327-88	Nitrite	140	44.586	189.16	630.54
ASTM D-4327-88	Phosphate	340	108.280	459.39	1531.31
ASTM D-4327-88	Sulfate	130	41.401	175.65	585.50
EPA 410.4	Chemical oxygen demand	2900	923.567	3918.35	13061.18
EPA 600, 310.2	Alkalinity	3500	1114.650	4729.05	15763.49
Inhouse Ion Chrom.	Perchlorate	54	17.197	72.96	243.21
SW-846 6010	Aluminum	31	9.873	41.89	139.62
SW-846 6010	Antimony	24	7.643	32.43	108.09
SW-846 6010	Barium	1.4	0.446	1.89	6.31
SW-846 6010	Beryllium	0.63	0.201	0.85	2.84
SW-846 6010	Cadmium	0.98	0.312	1.32	4.41
SW-846 6010	Calcium	41	13.057	55.40	184.66
SW-846 6010	Chromium	3.7	1.178	5.00	16.66
SW-846 6010	Cobalt	5.3	1.688	7.16	23.87
SW-846 6010	Copper	2.1	0.669	2.84	9.46
SW-846 6010	Iron	8.9	2.834	12.03	40.08
SW-846 6010	Magnesium	26	8.280	35.13	117.10
SW-846 6010	Manganese	0.55	0.175	0.74	2.48
SW-846 6010	Nickel	11	3.503	14.86	49.54
SW-846 6010	Potassium	390	124.204	526.95	1756.50
SW-846 6010	Silver	5.5	1.752	7.43	24.77
SW-846 6010	Sodium	44	14.013	59.45	198.17
SW-846 6010	Tin	30	9.554	40.53	135.12
SW-846 6010	Vanadium	1.9	0.605	2.57	8.56
SW-846 6010	Zinc	3.7	1.178	5.00	16.66
SW-846 6010, ICP Metals	Strontium	0.31	0.099	0.42	1.40
SW-846 7060	Arsenic	2	0.637	2.70	9.01

Table A-18. LOD and LOQ Calculations for Selected Constituents Based on MDL Report[a,b] for Low Level Standards. (11 sheets)

Method Name	Constituent Name	MDL	STD. DEV.	LOD	LOQ
SW-846 7421	Lead	0.88	0.280	1.19	3.96
SW-846 7421	Lead	1.4	0.446	1.89	6.31
SW-846 7470	Mercury	0.019	0.006	0.03	0.09
SW-846 7740	Selenium	1.2	0.382	1.62	5.40
SW-846 7740	Selenium	1.6	0.510	2.16	7.21
SW-846 7841	Thallium	1.2	0.382	1.62	5.40
SW-846 7841	Thallium	2.44	0.777	3.30	10.99
SW-846 8010/8020	1,1,1-Trichloroethane	0.061	0.019	0.08	0.27
SW-846 8010/8020	1,1,2-Trichloroethane	0.068	0.022	0.09	0.31
SW-846 8010/8020	1,1-Dichloroethane	0.047	0.015	0.06	0.21
SW-846 8010/8020	1,2-Dichloroethane	0.049	0.016	0.07	0.22
SW-846 8010/8020	1,4-Dichlorobenzene	0.056	0.018	0.08	0.25
SW-846 8010/8020	Benzene	0.059	0.019	0.08	0.27
SW-846 8010/8020	Carbon tetrachloride	0.042	0.013	0.06	0.19
SW-846 8010/8020	Chloroform	0.029	0.009	0.04	0.13
SW-846 8010/8020	Ethylbenzene	0.034	0.011	0.05	0.15
SW-846 8010/8020	Methylene chloride	0.084	0.027	0.11	0.38
SW-846 8010/8020	Tetrachloroethene	0.035	0.011	0.05	0.16
SW-846 8010/8020	Toluene	0.048	0.015	0.06	0.22
SW-846 8010/8020	Trichloroethene	0.075	0.024	0.10	0.34
SW-846 8010/8020	Vinyl chloride	0.25	0.080	0.34	1.13
SW-846 8010/8020	Xylenes (total)	0.085	0.027	0.11	0.38
SW-846 8010/8020	cis-1,2-Dichloroethylene	0.049	0.016	0.07	0.22
SW-846 8010/8020	trans-1,2-Dichloroethylene	0.045	0.014	0.06	0.20
SW-846 8021	1,1,1-Trichloroethane	0.061	0.019	0.08	0.27
SW-846 8021	1,1,2-Trichloroethane	0.068	0.022	0.09	0.31
SW-846 8021	1,1-Dichloroethane	0.047	0.015	0.06	0.21

Table A-18. LOD and LOQ Calculations for Selected Constituents Based on MDL Report[a,b] for Low Level Standards. (11 sheets)

Method Name	Constituent Name	MDL	STD. DEV.	LOD	LOQ
SW-846 8021	1,2-Dichloroethane	0.049	0.016	0.07	0.22
SW-846 8021	1,4-Dichlorobenzene	0.056	0.018	0.08	0.25
SW-846 8021	Benzene	0.059	0.019	0.08	0.27
SW-846 8021	Carbon tetrachloride	0.042	0.013	0.06	0.19
SW-846 8021	Chloroform	0.029	0.009	0.04	0.13
SW-846 8021	Ethylbenzene	0.034	0.011	0.05	0.15
SW-846 8021	Methylene chloride	0.084	0.027	0.11	0.38
SW-846 8021	Tetrachloroethene	0.035	0.011	0.05	0.16
SW-846 8021	Toluene	0.048	0.015	0.06	0.22
SW-846 8021	Trichloroethene	0.075	0.024	0.10	0.34
SW-846 8021	Vinyl chloride	0.25	0.080	0.34	1.13
SW-846 8021	Xylenes (total)	0.085	0.027	0.11	0.38
SW-846 8021	cis-1,2-Dichloroethylene	0.049	0.016	0.07	0.22
SW-846 8021	trans-1,2-Dichloroethylene	0.045	0.014	0.06	0.20
SW-846 8040	2,4,6-Trichlorophenol	0.8	0.255	1.08	3.60
SW-846 8040	2,4-Dichlorophenol	0.43	0.137	0.58	1.94
SW-846 8040	2,4-Dimethylphenol	0.62	0.197	0.84	2.79
SW-846 8040	2,4-Dinitrophenol	6.8	2.166	9.19	30.63
SW-846 8040	2,6-Dichlorophenol	0.52	0.166	0.70	2.34
SW-846 8040	2-Chlorophenol	0.6	0.191	0.81	2.70
SW-846 8040	2-Nitrophenol	0.6	0.191	0.81	2.70
SW-846 8040	2-sec-Butyl-4,6-dinitrophenol(DNBP)	0.41	0.131	0.55	1.85
SW-846 8040	4,6-Dinitro-2-methylphenol	0.84	0.268	1.13	3.78
SW-846 8040	4-Chloro-3-methylphenol	0.52	0.166	0.70	2.34
SW-846 8040	4-Nitrophenol	0.49	0.156	0.66	2.21
SW-846 8040	Cresols (methylphenols)	1.7	0.541	2.30	7.66
SW-846 8040	Pentachlorophenol	0.48	0.153	0.65	2.16
SW-846 8040	Phenol	0.58	0.185	0.78	2.61
SW-846 8040	Tetrachlorophenols	0.52	0.166	0.70	2.34
SW-846 8040	Trichlorophenols	0.56	0.178	0.76	2.52
SW-846 8080	4,4'-DDD	0.0043	0.001	0.006	0.019
SW-846 8080	4,4'-DDE	0.0012	0.000	0.002	0.005
SW-846 8080	4,4'-DDT	0.00038	0.000	0.001	0.002
SW-846 8080	Aldrin	0.00062	0.000	0.001	0.003

Table A-18. LOD and LOQ Calculations for Selected Constituents Based on MDL Report[a,b] for Low Level Standards. (11 sheets)

Method Name	Constituent Name	MDL	STD. DEV.	LOD	LOQ
SW-846 8080	Alpha-BHC	0.0018	0.001	0.002	0.008
SW-846 8080	Aroclor-1016	0.026	0.008	0.035	0.117
SW-846 8080	Aroclor-1221	0.029	0.009	0.039	0.131
SW-846 8080	Aroclor-1232	0.071	0.023	0.096	0.320
SW-846 8080	Aroclor-1242	0.018	0.006	0.024	0.081
SW-846 8080	Aroclor-1248	0.019	0.006	0.026	0.086
SW-846 8080	Aroclor-1254	0.0035	0.001	0.005	0.016
SW-846 8080	Aroclor-1260	0.011	0.004	0.015	0.050
SW-846 8080	Beta-BHC	0.00086	0.000	0.001	0.004
SW-846 8080	Chlordane	0.017	0.005	0.023	0.077
SW-846 8080	Delta-BHC	0.0012	0.000	0.002	0.005
SW-846 8080	Dieldrin	0.00053	0.000	0.001	0.002
SW-846 8080	Endosulfan I	0.00028	0.000	0.000	0.001
SW-846 8080	Endosulfan II	0.0031	0.001	0.004	0.014
SW-846 8080	Endosulfan sulfate	0.0037	0.001	0.005	0.017
SW-846 8080	Endrin	0.0035	0.001	0.005	0.016
SW-846 8080	Endrin Aldehyde	0.00085	0.000	0.001	0.004
SW-846 8080	Heptachlor	0.0012	0.000	0.002	0.005
SW-846 8080	Heptachlor epoxide	0.0012	0.000	0.002	0.005
SW-846 8080	Methoxychlor	0.0046	0.001	0.006	0.021
SW-846 8080	Toxaphene	0.18	0.057	0.243	0.811
SW-846 8080	gamma-BHC (Lindane)	0.0013	0.000	0.002	0.006
SW-846 8140	Disulfoton	0.097	0.031	0.131	0.437
SW-846 8140	Methyl parathion	0.26	0.083	0.35	1.17
SW-846 8140	Phorate	0.12	0.038	0.16	0.54
SW-846 8150	2,4,5-T	0.029	0.009	0.04	0.13
SW-846 8150	2,4,5-TP	0.048	0.015	0.06	0.22
SW-846 8150	2,4-D	0.12	0.038	0.16	0.54
SW-846 8150	2-sec-Butyl-4,6-dinitrophenol(DNBP)	0	0.000	0.00	0.00
SW-846 8240	1,1,1,2-Tetrachloroethane	0.27	0.086	0.36	1.22
SW-846 8240	1,1,1-Trichloroethane	0.4	0.127	0.54	1.80
SW-846 8240	1,1,2,2-Tetrachloroethane	0.67	0.213	0.91	3.02
SW-846 8240	1,1,2-Trichloroethane	0.65	0.207	0.88	2.93

Table A-18. LOD and LOQ Calculations for Selected Constituents Based on MDL Report[a,b] for Low Level Standards. (11 sheets)

Method Name	Constituent Name	MDL	STD. DEV.	LOD	LOQ
SW-846 8240	1,1-Dichloroethane	0.19	0.061	0.26	0.86
SW-846 8240	1,1-Dichloroethene	0.14	0.045	0.19	0.63
SW-846 8240	1,2,3-Trichloropropane	0.78	0.248	1.05	3.51
SW-846 8240	1,2-Dibromo-3-chloropropane	0.24	0.076	0.32	1.08
SW-846 8240	1,2-Dibromoethane	0.63	0.201	0.85	2.84
SW-846 8240	1,2-Dichloroethane	0.12	0.038	0.16	0.54
SW-846 8240	1,2-Dichloroethene	0.35	0.111	0.47	1.58
SW-846 8240	1,2-Dichloropropane	0.27	0.086	0.36	1.22
SW-846 8240	1,4-Dichlorobenzene	0.38	0.121	0.51	1.71
SW-846 8240	1,4-Dioxane	79	25.159	106.74	355.80
SW-846 8240	1-Butanol	170	54.140	229.70	765.66
SW-846 8240	2-Hexanone	0.7	0.223	0.95	3.15
SW-846 8240	4-Methyl-2-pentanone	8.3	2.643	11.21	37.38
SW-846 8240	Acetone	3.1	0.987	4.19	13.96
SW-846 8240	Acetonitrile	78	24.841	105.39	351.30
SW-846 8240	Acrolein	8.4	2.675	11.35	37.83
SW-846 8240	Acrylonitrile	3	0.955	4.05	13.51
SW-846 8240	Benzene	0.11	0.035	0.15	0.50
SW-846 8240	Bromodichloromethane	0.33	0.105	0.45	1.49
SW-846 8240	Bromoform	0.13	0.041	0.18	0.59
SW-846 8240	Carbon disulfide	0.73	0.232	0.99	3.29
SW-846 8240	Carbon tetrachloride	0.094	0.030	0.13	0.42
SW-846 8240	Chlorobenzene	0.18	0.057	0.24	0.81
SW-846 8240	Chloroethane	0.98	0.312	1.32	4.41
SW-846 8240	Chloroform	0.18	0.057	0.24	0.81
SW-846 8240	Chloroprene	0.21	0.067	0.28	0.95
SW-846 8240	Dibromochloromethane	0.51	0.162	0.69	2.30
SW-846 8240	Dibromomethane	0.65	0.207	0.88	2.93
SW-846 8240	Dichlorodifluoromethane	1.7	0.541	2.30	7.66
SW-846 8240	Ethyl cyanide	3.5	1.115	4.73	15.76
SW-846 8240	Ethyl methacrylate	0.76	0.242	1.03	3.42
SW-846 8240	Ethylbenzene	0.23	0.073	0.31	1.04
SW-846 8240	Isobutyl alcohol	52	16.561	70.26	234.20
SW-846 8240	Methacrylonitrile	0.35	0.111	0.47	1.58
SW-846 8240	Methyl iodide	0.76	0.242	1.03	3.42

Table A-18. LOD and LOQ Calculations for Selected Constituents Based on MDL Report[a,b] for Low Level Standards. (11 sheets)

Method Name	Constituent Name	MDL	STD. DEV.	LOD	LOQ
SW-846 8240	Methyl bromide	0.83	0.264	1.12	3.74
SW-846 8240	Methyl chloride	0.32	0.102	0.43	1.44
SW-846 8240	Methyl ethyl ketone	2.5	0.796	3.38	11.26
SW-846 8240	Methyl methacrylate	0.83	0.264	1.12	3.74
SW-846 8240	Methylene chloride	0.11	0.035	0.15	0.50
SW-846 8240	Pentachloroethane	3.8	1.210	5.13	17.11
SW-846 8240	Styrene	0.23	0.073	0.31	1.04
SW-846 8240	Tetrachloroethene	0.64	0.204	0.86	2.88
SW-846 8240	Tetrahydrofuran	3.7	1.178	5.00	16.66
SW-846 8240	Toluene	0.16	0.051	0.22	0.72
SW-846 8240	Trichloroethane	0.29	0.092	0.39	1.31
SW-846 8240	Trichloromonofluoromethane	0.55	0.175	0.74	2.48
SW-846 8240	Vinyl acetate	1.8	0.573	2.43	8.11
SW-846 8240	Vinyl chloride	0.79	0.252	1.07	3.56
SW-846 8240	Xylenes (total)	0.68	0.217	0.92	3.06
SW-846 8240	allylchloride	0.41	0.131	0.55	1.85
SW-846 8240	cis-1,3-Dichloropropene	0.41	0.131	0.55	1.85
SW-846 8240	trans-1,3-Dichloropropene	0.47	0.150	0.64	2.12
SW-846 8240	trans-1,4-dichloro-2-butene	0.26	0.083	0.35	1.17
SW-846 8260	1,1,1,2-Tetrachloroethane	0.11	0.035	0.15	0.50
SW-846 8260	1,1,1-Trichloroethane	0.28	0.089	0.38	1.26
SW-846 8260	1,1,2,2-Tetrachloroethane	0.54	0.172	0.73	2.43
SW-846 8260	1,1,2-Trichloroethane	0.19	0.061	0.26	0.86
SW-846 8260	1,1-Dichloroethane	0.22	0.070	0.30	0.99
SW-846 8260	1,1-Dichloroethene	0.26	0.083	0.35	1.17
SW-846 8260	1,2,3-Trichloropropane	0.59	0.188	0.80	2.66
SW-846 8260	1,2-Dibromo-3-chloropropane	0.64	0.204	0.86	2.88
SW-846 8260	1,2-Dibromoethane	0.44	0.140	0.59	1.98
SW-846 8260	1,2-Dichloroethane	0.24	0.076	0.32	1.08
SW-846 8260	1,2-Dichloroethene	0.26	0.083	0.35	1.17
SW-846 8260	1,2-Dichloropropane	0.051	0.016	0.07	0.23
SW-846 8260	1,4-Dichlorobenzene	0.2	0.064	0.27	0.90
SW-846 8260	1,4-Dioxane	62	19.745	83.77	279.24
SW-846 8260	1-Butanol	84	26.752	113.50	378.32
SW-846 8260	2-Hexanone	0.51	0.162	0.69	2.30

Table A-18. LOD and LOQ Calculations for Selected Constituents Based on MDL Report^{a,b} for Low Level Standards. (11 sheets)

Method Name	Constituent Name	MDL	STD. DEV.	LOD	LOQ
SW-846 8260	4-Methyl-2-pentanone	0.65	0.207	0.88	2.93
SW-846 8260	Acetone	4.7	1.497	6.35	21.17
SW-846 8260	Acetonitrile	69	21.975	93.23	310.77
SW-846 8260	Acrolein	4.7	1.497	6.35	21.17
SW-846 8260	Acrylonitrile	4.6	1.465	6.22	20.72
SW-846 8260	Benzene	0.14	0.045	0.19	0.63
SW-846 8260	Bromodichloromethane	0.033	0.011	0.04	0.15
SW-846 8260	Bromoform	0.41	0.131	0.55	1.85
SW-846 8260	Carbon disulfide	0.65	0.207	0.88	2.93
SW-846 8260	Carbon tetrachloride	0.22	0.070	0.30	0.99
SW-846 8260	Chlorobenzene	0.15	0.048	0.20	0.68
SW-846 8260	Chloroethane	0.32	0.102	0.43	1.44
SW-846 8260	Chloroform	0.21	0.067	0.28	0.95
SW-846 8260	Chloroprene	0.23	0.073	0.31	1.04
SW-846 8260	Dibromochloromethane	0.28	0.089	0.38	1.26
SW-846 8260	Dibromomethane	0.36	0.115	0.49	1.62
SW-846 8260	Dichlorodifluoromethane	0.85	0.271	1.15	3.83
SW-846 8260	Ethyl cyanide	2.7	0.860	3.65	12.16
SW-846 8260	Ethyl methacrylate	0.56	0.178	0.76	2.52
SW-846 8260	Ethylbenzene	0.19	0.061	0.26	0.86
SW-846 8260	Isobutyl alcohol	94	29.936	127.01	423.36
SW-846 8260	Methacrylonitrile	0.46	0.146	0.62	2.07
SW-846 8260	Methyl iodide	0.23	0.073	0.31	1.04
SW-846 8260	Methyl bromide	0.59	0.188	0.80	2.66
SW-846 8260	Methyl chloride	0.44	0.140	0.59	1.98
SW-846 8260	Methyl ethyl ketone	3.9	1.242	5.27	17.57
SW-846 8260	Methyl methacrylate	0.41	0.131	0.55	1.85
SW-846 8260	Methylene chloride	0.62	0.197	0.84	2.79
SW-846 8260	Pentachloroethane	0.1	0.032	0.14	0.45
SW-846 8260	Styrene	0.14	0.045	0.19	0.63
SW-846 8260	Tetrachloroethene	0.24	0.076	0.32	1.08
SW-846 8260	Tetrahydrofuran	0.45	0.143	0.61	2.03
SW-846 8260	Toluene	0.13	0.041	0.18	0.59
SW-846 8260	Trichloroethene	0.24	0.076	0.32	1.08
SW-846 8260	Trichloromonofluoromethane	0.37	0.118	0.50	1.67

Table A-18. LOD and LOQ Calculations for Selected Constituents Based on MDL Report[a,b] for Low Level Standards. (11 sheets)

Method Name	Constituent Name	MDL	STD. DEV.	LOD	LOQ
SW-846 8260	Vinyl acetate	0.76	0.242	1.03	3.42
SW-846 8260	Vinyl chloride	0.33	0.105	0.45	1.49
SW-846 8260	Xylenes (total)	0.57	0.182	0.77	2.57
SW-846 8260	allylchloride	0.74	0.236	1.00	3.33
SW-846 8260	cis-1,3-Dichloropropene	0.43	0.137	0.58	1.94
SW-846 8260	trans-1,3-Dichloropropene	0.25	0.080	0.34	1.13
SW-846 8260	trans-1,4-dichloro-2-butene	0.64	0.204	0.86	2.88
SW-846 8270	1,2,4,5-Tetrachlorobenzene	0.42	0.134	0.57	1.89
SW-846 8270	1,2,4-Trichlorobenzene	1.1	0.350	1.49	4.95
SW-846 8270	1,2-Dichlorobenzene	1.2	0.382	1.62	5.40
SW-846 8270	1,3-Dichlorobenzene	1.4	0.446	1.89	6.31
SW-846 8270	1,4-Dichlorobenzene	0.58	0.185	0.78	2.61
SW-846 8270	1,4-Naphtoquinone	7.3	2.325	9.86	32.88
SW-846 8270	1-Naphthylamine	1.7	0.541	2.30	7.66
SW-846 8270	2,3,4,6-Tetrachlorophenol	1.3	0.414	1.76	5.86
SW-846 8270	2,4,5-Trichlorophenol	0.48	0.153	0.65	2.16
SW-846 8270	2,4,6-Trichlorophenol	4.2	1.338	5.67	18.92
SW-846 8270	2,4-Dichlorophenol	2.8	0.892	3.78	12.61
SW-846 8270	2,4-Dimethylphenol	1.5	0.478	2.03	6.76
SW-846 8270	2,4-Dinitrophenol	4.7	1.497	6.35	21.17
SW-846 8270	2,4-Dinitrotoluene	0.88	0.280	1.19	3.96
SW-846 8270	2,6-Dichlorophenol	2.5	0.796	3.38	11.26
SW-846 8270	2,6-Dinitrotoluene	0.73	0.232	0.99	3.29
SW-846 8270	2-Acetylaminofluorene	3.2	1.019	4.32	14.41
SW-846 8270	2-Chloronaphthalene	2.3	0.732	3.11	10.36
SW-846 8270	2-Chlorophenol	0.56	0.178	0.76	2.52
SW-846 8270	2-Methylnaphthalene	0.19	0.061	0.26	0.86
SW-846 8270	2-Methylphenol	0.29	0.092	0.39	1.31
SW-846 8270	2-Naphthylamine	2.1	0.669	2.84	9.46
SW-846 8270	2-Nitroaniline	2.4	0.764	3.24	10.81
SW-846 8270	2-Nitrophenol	4.2	1.338	5.67	18.92
SW-846 8270	2-Picoline	2.1	0.669	2.84	9.46
SW-846 8270	3,3'-Dichlorobenzidine	2.5	0.796	3.38	11.26
SW-846 8270	3,3'-Dimethylbenzidine	3.3	1.051	4.46	14.86
SW-846 8270	3-Methylcholanthrene	1.1	0.350	1.49	4.95

Table A-18. LOD and LOQ Calculations for Selected Constituents Based on MDL Report[a,b] for Low Level Standards. (11 sheets)

Method Name	Constituent Name	MDL	STD. DEV.	LOD	LOQ
SW-846 8270	3-Nitroaniline	4.3	1.369	5.81	19.37
SW-846 8270	4,6-Dinitro-2-methylphenol	0.98	0.312	1.32	4.41
SW-846 8270	4-Aminobiphenyl	5	1.592	6.76	22.52
SW-846 8270	4-Bromophenylphenyl ether	0.59	0.188	0.80	2.66
SW-846 8270	4-Chloro-3-methylphenol	0.5	0.159	0.68	2.25
SW-846 8270	4-Chloroaniline	3.3	1.051	4.46	14.86
SW-846 8270	4-Chlorophenylphenyl ether	0.28	0.089	0.38	1.26
SW-846 8270	4-Methylphenol	0.52	0.166	0.70	2.34
SW-846 8270	4-Nitroaniline	2.8	0.892	3.78	12.61
SW-846 8270	4-Nitrophenol	2.7	0.860	3.65	12.16
SW-846 8270	4-Nitroquinoline-1-oxide	19	6.051	25.67	85.57
SW-846 8270	5-Nitro-o-toluidine	0.28	0.089	0.38	1.26
SW-846 8270	7,12-Dimethylbenz[a]anthracene	1.1	0.350	1.49	4.95
SW-846 8270	Acenaphthene	0.49	0.156	0.66	2.21
SW-846 8270	Acenaphthylene	0.19	0.061	0.26	0.86
SW-846 8270	Acetophenone	0.54	0.172	0.73	2.43
SW-846 8270	Aniline	9.3	2.962	12.57	41.89
SW-846 8270	Anthracene	0.16	0.051	0.22	0.72
SW-846 8270	Aramite	1.3	0.414	1.76	5.86
SW-846 8270	Benzo(a)anthracene	0.18	0.057	0.24	0.81
SW-846 8270	Benzo(a)pyrene	0.24	0.076	0.32	1.08
SW-846 8270	Benzo(b)fluoranthene	0.18	0.057	0.24	0.81
SW-846 8270	Benzo(ghi)perylene	2.6	0.828	3.51	11.71
SW-846 8270	Benzo(k)fluoranthene	0.24	0.076	0.32	1.08
SW-846 8270	Benzothiazole	2.1	0.669	2.84	9.46
SW-846 8270	Benzyl alcohol	4	1.274	5.40	18.02
SW-846 8270	Bis(2-Choroethoxy)methane	2.5	0.796	3.38	11.26
SW-846 8270	Bis(2-chloroethyl) ether	0.21	0.067	0.28	0.95
SW-846 8270	Bis(2-chloroisopropyl) ether	0.24	0.076	0.32	1.08
SW-846 8270	Bis(2-ethylhexyl) phthalate	0.37	0.118	0.50	1.67
SW-846 8270	Butylbenzylphthalate	7.1	2.261	9.59	31.98
SW-846 8270	Chlorobenzilate	1.3	0.414	1.76	5.86
SW-846 8270	Chrysene	0.17	0.054	0.23	0.77
SW-846 8270	Decane	0.38	0.121	0.51	1.71
SW-846 8270	Di-n-butylphthalate	2.5	0.796	3.38	11.26

Table A-18. LOD and LOQ Calculations for Selected Constituents Based on MDL Report[a,b] for Low Level Standards. (11 sheets)

Method Name	Constituent Name	MDL	STD. DEV.	LOD	LOQ
SW-846 8270	Di-n-octylphthalate	0.055	0.018	0.07	0.25
SW-846 8270	Diallate	0.21	0.067	0.28	0.95
SW-846 8270	Dibenz[a,h]anthracene	0.53	0.169	0.72	2.39
SW-846 8270	Dibenzofuran	0.15	0.048	0.20	0.68
SW-846 8270	Diethyl phthalate	0.12	0.038	0.16	0.54
SW-846 8270	Dimethoate	1.4	0.446	1.89	6.31
SW-846 8270	Dimethyl phthalate	0.13	0.041	0.18	0.59
SW-846 8270	Diphenylamine	0.44	0.140	0.59	1.98
SW-846 8270	Dodecane	0.26	0.083	0.35	1.17
SW-846 8270	Ethyl methanesulfonate	3	0.955	4.05	13.51
SW-846 8270	Famphur	5.4	1.720	7.30	24.32
SW-846 8270	Fluoranthene	0.12	0.038	0.16	0.54
SW-846 8270	Fluorene	0.093	0.030	0.13	0.42
SW-846 8270	Hexachlorobenzene	0.41	0.131	0.55	1.85
SW-846 8270	Hexachlorobutadiene	0.55	0.175	0.74	2.48
SW-846 8270	Hexachlorocyclopentadiene	0.43	0.137	0.58	1.94
SW-846 8270	Hexachloroethane	0.55	0.175	0.74	2.48
SW-846 8270	Hexachlorophene	12	3.822	16.21	54.05
SW-846 8270	Hexachloropropene	0.29	0.092	0.39	1.31
SW-846 8270	Indeno(1,2,3-cd)pyrene	0.58	0.185	0.78	2.61
SW-846 8270	Isodrin	1	0.318	1.35	4.50
SW-846 8270	Isophorone	0.092	0.029	0.12	0.41
SW-846 8270	Isosafrole	0.31	0.099	0.42	1.40
SW-846 8270	Kepone	2	0.637	2.70	9.01
SW-846 8270	Kerosene	2.6	0.828	3.51	11.71
SW-846 8270	Methapyrilene	5	1.592	6.76	22.52
SW-846 8270	Methyl methanesulfonate	0.35	0.111	0.47	1.58
SW-846 8270	N-Nitroso-di-n-dipropylamine	0.48	0.153	0.65	2.16
SW-846 8270	N-Nitrosodi-n-butylamine	2.6	0.828	3.51	11.71
SW-846 8270	N-Nitrosodiethylamine	1.4	0.446	1.89	6.31
SW-846 8270	N-Nitrosodimethylamine	4	1.274	5.40	18.02
SW-846 8270	N-Nitrosodiphenylamine	0.27	0.086	0.36	1.22
SW-846 8270	N-Nitrosomethylethylamine	1.2	0.382	1.62	5.40
SW-846 8270	N-Nitrosomorpholine	0.24	0.076	0.32	1.08
SW-846 8270	N-Nitrosopiperidine	1.3	0.414	1.76	5.86

Table A-18. LOD and LOQ Calculations for Selected Constituents Based on MDL Report[a,b] for Low Level Standards. (11 sheets)

Method Name	Constituent Name	MDL	STD. DEV.	LOD	LOQ
SW-846 8270	Naphthalene	0.16	0.051	0.22	0.72
SW-846 8270	Nitrobenzene	0.61	0.194	0.82	2.75
SW-846 8270	Nitrosopyrrolidine	1.6	0.510	2.16	7.21
SW-846 8270	O,O,O-Triethyl phosphorothioate	0.63	0.201	0.85	2.84
SW-846 8270	O,O-diethylO-2-pyrazinyl phosphorothioa	3.5	1.115	4.73	15.76
SW-846 8270	Parathion	0.54	0.172	0.73	2.43
SW-846 8270	Pentachlorobenzene	0.31	0.099	0.42	1.40
SW-846 8270	Pentachloronitrobenzene (PCNB)	4.2	1.338	5.67	18.92
SW-846 8270	Pentachlorophenol	0.87	0.277	1.18	3.92
SW-846 8270	Phenacetin	1.3	0.414	1.76	5.86
SW-846 8270	Phenanthrene	0.073	0.023	0.10	0.33
SW-846 8270	Phenol	0.21	0.067	0.28	0.95
SW-846 8270	Pronamide	8.4	2.675	11.35	37.83
SW-846 8270	Pyrene	0.16	0.051	0.22	0.72
SW-846 8270	Pyridine	2.8	0.892	3.78	12.61
SW-846 8270	Safrol	0.27	0.086	0.36	1.22
SW-846 8270	Tetradecane	0.28	0.089	0.38	1.26
SW-846 8270	Tetraethyldithiopyrophosphate	0.52	0.166	0.70	2.34
SW-846 8270	Tributyl Phosphate	0.14	0.045	0.19	0.63
SW-846 8270	Tris-2-chloroethyl phosphate	6.4	2.038	8.65	28.82
SW-846 8270	alpha,alpha-Dimethylphenethylamine	19	6.051	25.67	85.57
SW-846 8270	m-Cresol	0.77	0.245	1.04	3.47
SW-846 8270	m-dinitrobenzene	0.41	0.131	0.55	1.85
SW-846 8270	o-Toluidine	2.1	0.669	2.84	9.46
SW-846 8270	p-Dimethylaminoazobenzene	0.29	0.092	0.39	1.31
SW-846 8270	p-Phenylenediamine	8.5	2.707	11.48	38.28
SW-846 8270	sym-Trinitrobenzene	0.87	0.277	1.18	3.92
SW-846 9012	Cyanide	1.7	0.541	2.30	7.66
SW-846 9020	Total organic halogen	6.9	2.197	9.32	31.08
SW-846 9030	Sulfide	190	60.510	256.72	855.73
SW-846 9060	Total organic carbon	140	44.586	189.16	630.54

[a] based on MDL report for February through December 1995. MDLs are based on seven replicates of low-level standards by the same analyst on the same day.

[b] units are in parts per billion (ppb).

LOD = limit of detection.
LOQ = limit of quantitation.
MDL = method detection limit.

APPENDIX B

DATA EVALUATION

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B.0 DATA EVALUATION

R. V. Gray
Westinghouse Hanford Company

Data evaluation is a process through which suspect data are identified and investigated. At present, the data evaluation process consists of the investigation of requests for data evaluation (RADE) and the statistical evaluation of contamination indicator parameter data.

The evaluation of RADEs is discussed in the following section. The statistical evaluation of contamination indicator parameters is discussed in the site-specific chapters and Appendix C.

B.1 REQUEST FOR ANALYTICAL DATA EVALUATION PROCEDURE

Suspect data called out in RADEs are evaluated in terms of the following (WHC-CM-7-8):

- A review of trends in historical data for the well in question
- An examination of contaminant distributions (e.g., plumes) that may affect concentrations in the well in question
- Results of quality control samples that may affect the data in question
- Laboratory data (e.g., chemist sheets) for the data in question
- Internal consistencies between replicate analyses.

As a result of the RADEs, the data in question may be:

- Determined to be in error and corrected
- Viewed as acceptable, resulting in a G flag
- Viewed as suspect data, resulting in a Y flag
- Viewed as rejected data, resulting in an R flag.

B.2 REQUESTS FOR ANALYTICAL DATA EVALUATION

A total of 178 RADEs were submitted from October 1994 through September 1995. The RADEs submitted involved most of the major analytical groups; however, approximately 80% of the total was accounted for by the following five constituent groups: (1) pH and conductivity measurements performed in the field, (2) inductively coupled plasma metals, (3) radionuclides, (4) total organic halogen, and (5) anions (Figure B-1).

B.2.1 Field Measurements

Forty-one RADEs involve measurements of pH and conductivity made by field samplers. These RADEs reflect values that are unusually higher or lower than historical trends and/or critical means/ranges for a particular well. This represents a long-term recurrent problem with field calibration and/or measurement. The values are usually flagged as suspect data unless hard evidence is available to flag the data as rejected, such as when laboratory measurements made during the same sampling event or subsequent verification sampling confirm that field measurements were in error.

B.2.2 Inductively Coupled Plasma Metals

Forty-two RADEs were submitted for inductively coupled plasma metals. There does not appear to be a systematic error, so evaluation for many of them will depend on laboratory records and trending.

B.2.3 Radionuclides

Twenty-six RADEs were submitted concerning radionuclide analysis. These RADEs seem to represent a random collection of out-of-range data and do not indicate systematic problems with the analyses.

B.2.4 Total Organic Halogen

This constituent group received seventeen RADEs. The RADEs for total organic halogen appear for the most part to be the result of laboratory problems. Many involve quadruplicate samples that do not agree. The others usually exceed historical trends. The fliers are usually flagged as suspect.

B.2.5 Anions

Seventeen RADEs were submitted for anions. There does not appear to be a systematic error, so evaluation for many of them will depend on laboratory records and trending.

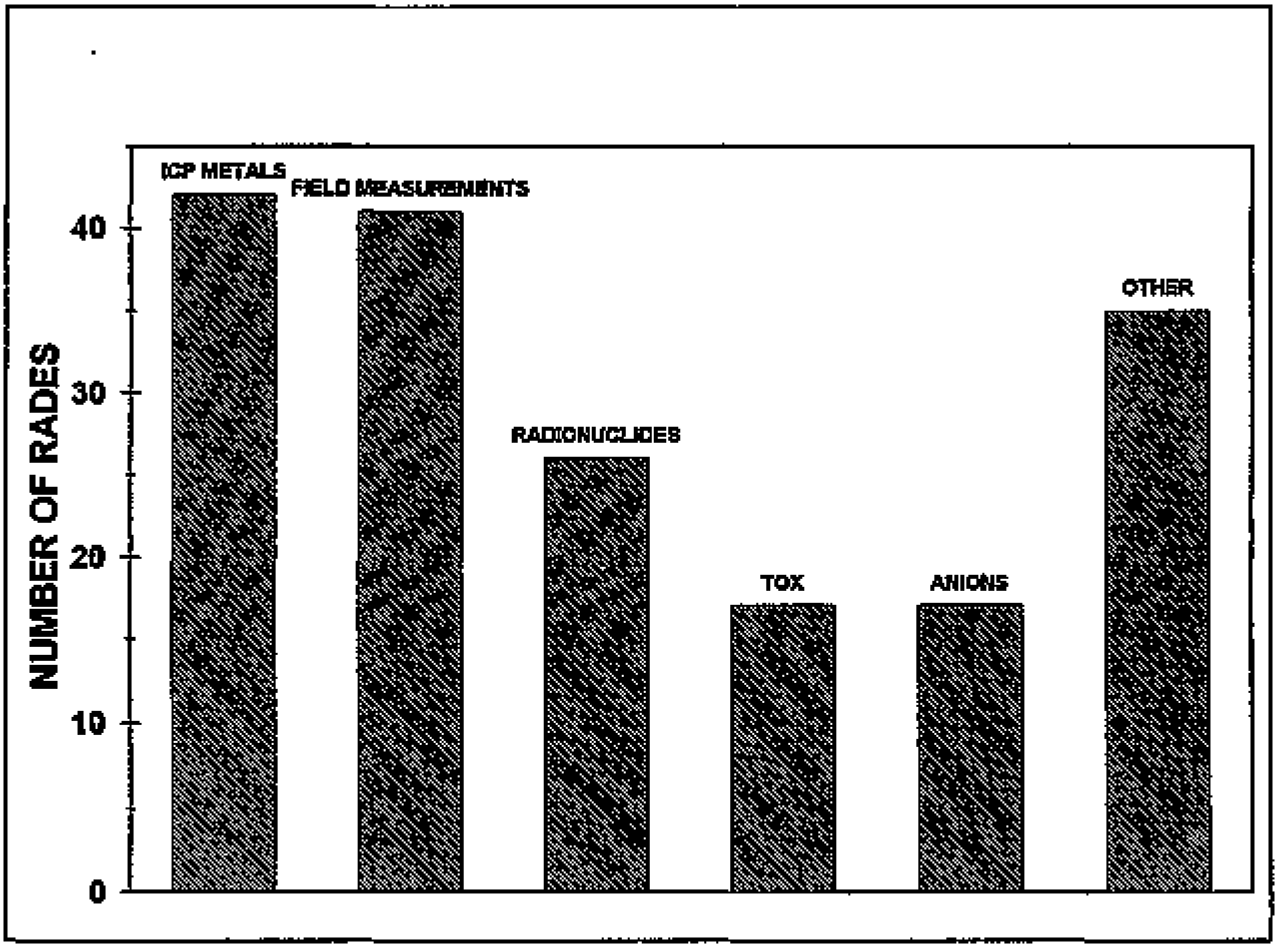
B.2.6 Others

The remainder of the categories reflect a variety of random problems, of which none could be contrived as significant enough to warrant review of established sampling and analysis practices. Examples in this category include total organic carbon, volatile and semi-volatile organics, turbidity, ammonium, alkalinity, and water level measurements.

B.3 REFERENCES

WHC-CM-7-8, "Evaluation of Requests for Analytical Data Review," Section 4.2, *Environmental Engineering and Geotechnology Function Procedures*, Westinghouse Hanford Company, Richland, Washington.

Figure B-1. Histogram Showing Number of RADEs
Submitted in Different Analytical Categories.



APPENDIX C

STATISTICS

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C.0 INTRODUCTION

C. J. Chou
Westinghouse Hanford Company

The *Resource Conservation and Recovery Act of 1976* (RCRA) facilities include both liquid and solid waste treatment, storage, and/or disposal (TSD) units. Those units with potential for contaminating groundwater require groundwater monitoring as prescribed in 40 *Code of Federal Regulation* (CFR) 265 and *Washington Administrative Code* (WAC) 173-303-400 (interim status) and 40 CFR 264 and WAC 173-303-645 (final status). The primary objectives of RCRA groundwater monitoring are to: comply with the intent of applicable interim- and final-status state and federal RCRA regulations and assess potential impact on groundwater quality. Statistical evaluation at a TSD facility is required to detect changes in downgradient groundwater quality from conditions upgradient of the facility.

The final Hanford Facility RCRA Permit (RCRA Permit) was issued by the Washington State Department of Ecology (Ecology) and the U.S. Environmental Protection Agency (EPA) on August 29, 1994. The RCRA Permit became effective on September 28, 1994. The permit has two parts. The first part contains the requirements for operating the RCRA facility and standards for managing it under the base RCRA program (Ecology 1994). The second part contains the requirements for corrective action conditions for the cleanup of hazardous waste under the *Hazardous and Solid Waste Amendments to RCRA* (EPA 1994). Groundwater monitoring activities at most of the TSD units will continue to be governed under interim-status regulations except for the 183-H Solar Evaporation Basins (183-H Basins) and the 300 Area Process Trenches (300 APT), which are subject to final-status regulations. Statistical evaluations under interim- and final-status regulations are discussed separately in the following sections.

C.1 STATISTICAL EVALUATIONS--INTERIM STATUS

In accordance with interim-status regulations, RCRA projects are conducted under one of three levels of monitoring efforts: background monitoring, indicator parameter evaluation, and groundwater quality assessment. All of the RCRA facilities at the Hanford Site have completed their initial background monitoring programs.

Statistical evaluations for interim-status facilities during the past year consisted of reestablishing background levels for several RCRA facilities to reflect changes in the monitoring network, evaluating RCRA facilities' impact on the quality of groundwater, and performing required statistical evaluations for the Solid Waste Landfill (SWL). The SWL is a solid waste disposal facility. It is not a RCRA hazardous waste site. The current operations of the SWL fall under the regulations of WAC 173-304, and a permit application for the facility under this regulation has been prepared (DOE-RL 1993). Statistical method employed and results of statistical evaluations for the SWL are described in the SWL chapter of this report. The following sections provide a general description of the statistical methods and results of statistical evaluations for the interim-status RCRA facilities.

C.1.1 Statistical Method

The statistical method used to summarize background data is the averaged replicate t-test method as described in Appendix B of the *Resource Conservation and Recovery Act (RCRA) Groundwater Monitoring Technical Enforcement Guidance Document (TEGD)* (EPA 1986) and Chou (1991). The averaged replicate t-test method, for each contamination indicator parameter, is calculated as:

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

where:

t = Test statistic
$\bar{x}_i$ = Average of replicates from the i^{th} monitoring well
$\bar{x}_b$ = Background average
S_b = Background standard deviation
n_b = Number of background replicate averages.

The Technical Enforcement Guidance Document states that a test statistic larger than the Bonferroni critical value (t_c), i.e., $t > t_c$, indicates a statistically significant probability of contamination. These Bonferroni critical values depend on the overall false-positive rate required for each sampling period (i.e., 1% for interim status), the total number of wells in the monitoring network, and the number of degrees of freedom ($n_b - 1$) associated with the background standard deviation. Because of the nature of the test statistic in Equation 2, results to be compared to background do not contribute to the estimate of the variance. The test can be reformulated, without prior knowledge of the results of the sample to be compared to background (i.e., $\bar{x}_i$), in such a way that a critical mean (CM) can be obtained:

$$CM = \bar{x}_b + t_c * S_b * \sqrt{(1+1/n_b)} \quad \text{(one-tailed).} \qquad (2)$$

$$CM = \bar{x}_b \pm t_c * S_b * \sqrt{(1+1/n_b)} \quad \text{(two-tailed).} \qquad (3)$$

For pH, a two-tailed CM (or critical range) is calculated and a one-tailed CM is calculated for specific conductance, total organic carbon (TOC), and total organic halogen (TOX). The CM (or range, for pH) is the value above which (or above/below in the case of pH) a compared value is determined to be statistically different from background.

Most of the measured values for TOC from upgradient (background) wells, were less than the contractually required quantitation limit (CRQL) of 1,000 ppb for DataChem Laboratories. Estimates of the background standard deviations cannot be obtained because of laboratory reporting practices. Also, a new hazardous chemical laboratory contract became effective during 1993. In the old contract (before April 26, 1993), these values were reported with the CRQL value followed by a 'U' qualifier. In the new contract (after April 26, 1993) results below CRQL but above the method detection limit (MDL) are reported with the measured value followed by an 'L' qualifier. Results below the MDL are reported with the MDL value followed by a 'U' qualifier. The lack of estimates of background variability precludes the determination of TOC critical means for various RCRA facilities. In this case, a limit of quantitation (LOQ) will be used as the upgradient/downgradient comparison value. The LOQ for TOC was calculated to be 976 ppb using 1995 field blanks data (see Appendix A).

Because of concerns over DataChem Laboratories' procedure for TOX, samples were analyzed by Roy F. Weston Laboratories from November 1993 to May 1995. The change of laboratories does not provide the needed background values from which critical means are derived. However, the TOX data are evaluated using the following steps: (1) screening TOX values from upgradient wells; (2) if results from upgradient wells indicate a history of non-detects, a LOQ will be used as the upgradient/downgradient comparison value; and (3) if TOX is historically detected, a LOQ cannot be used as a surrogate background value. In this case, the background value must be derived based on four quarters of monitoring data (e.g., 100-D Pond) and used in the statistical evaluation. If four quarters of background data are not available, comparisons of upgradient/downgradient TOX values will not be performed (e.g., Single-Shell Tanks Waste Management Area U).

Finally, if the calculated critical range (for pH) was outside the chemically possible range [0, 14] or too large to be meaningful because of the requirement to use four quarters of data to establish background (e.g., 2101-M Pond, Liquid Effluent Retention Facility), the upgradient/downgradient comparison value shall be the revised critical range using all available data. The expansion of the background data set to include more than 1 year's data provides a better estimate of background mean and background standard deviation. More importantly, it increases the number of degrees of freedom associated with the background standard deviation. Other things being equal, a smaller t_c value and a narrower critical range for pH would result. This approach is preferred because it complies with both the requirements and the spirit of the regulations.

C.1.2 Results of Statistical Evaluations

During the past year, no exceedances of critical means occurred for TOC, TOX, and specific conductance. However, several incidents of pH exceedance were noted. The wells (downgradient) were resampled. Verification sampling results indicated that these exceedances were caused by erroneous pH measurements in the field. Detailed information can be obtained from each individual chapter of this report.

C.2 STATISTICAL EVALUATIONS--FINAL STATUS

Three levels of groundwater monitoring programs are required under final status regulations (40 CFR 264, Subpart F and WAC 173-303-645): detection monitoring, compliance monitoring, and corrective action (Figure C-1). During most of the past year, however, groundwater monitoring activities conducted at RCRA projects were monitored under interim-status requirements. Groundwater monitoring plans reflecting requirements of final-status regulations were prepared for the 183-H Basins and 300 APT.

C.2.1 Detection-Level Groundwater Monitoring Program

In a <u>detection-level</u> groundwater monitoring program, groundwater parameter data (pH, specific conductance, TOC, TOX, or heavy metals, waste constituents, or reaction products) from downgradient compliance-point wells will be compared with data on area background wells semiannually to determine whether there is a statistically significant increase (or decrease for pH) over background concentrations. Statistical methods appropriate for a final status detection monitoring program will include analysis of variance, tolerance intervals, prediction intervals, control charts, test of proportions, or other statistical methods approved by Ecology. The distribution(s) of monitoring parameters, the nature of the data, the proportions of nondetects, seasonal, temporal, and spatial variations are important factors to consider when selecting appropriate statistical methods. The statistical evaluation procedures chosen will be based on these EPA guidance documents: *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities - Interim Final Guidance* (EPA 1989) and *Addendum to Interim Final Guidance* (EPA 1992). Specifics will be addressed in the unit-specific permit applications and/or in the groundwater plans.

C.2.2 Compliance-Level Monitoring Program

A compliance groundwater monitoring program will be established for a TSD unit if groundwater sampling during the detection-level monitoring program reveals a statistically significant increase (or pH decrease) over area background concentrations for groundwater. In a <u>compliance-level</u> monitoring program, the monitoring objective is to determine whether groundwater protection standards have been exceeded. This is accomplished by comparing the concentration of a constituent of concern to groundwater protection standards such as a risk-based maximum concentration limit; alternative concentration limit; area or natural background; or applicable, relevant, and appropriate requirements.

Maximum concentration limits will be identified for each groundwater monitoring parameter listed in Table 1 of WAC 173-303-645. Alternative concentration limits will be proposed after considering the observed concentrations of chemical constituents in the groundwater that might have originated from the regulated unit in question. The area background, natural background, and other standards that are applicable, relevant, and appropriate requirements will be evaluated when proposing an alternative concentration limit.

C.2.3 Corrective-Action Program

If, during compliance-level monitoring at the point of compliance, dangerous constituents are measured in the groundwater at concentrations that exceed acceptable groundwater protection standards, sufficient data, supporting information, and analyses will be provided to establish a corrective-action program. Details for the corrective action program will be specified in the unit-specific permit applications. In addition, a groundwater monitoring plan that will be used to assess the effectiveness of the corrective-action measures will be submitted. This monitoring plan will be similar in scope to the compliance-level groundwater monitoring program and will include all relevant information pertaining to the location and description of monitoring wells, monitoring network, well construction and development, sampling and analysis plans, statistical methods, and quality assurance and quality control procedures.

C.2.4 183-H Solar Evaporation Basins (183-H Basins)

As described earlier, the Hanford Facility RCRA Permit became effective on 9/28/94. The 183-H Solar Evaporation Basins (183-H Basins) are one of five TSD units included in the RCRA Permit and are subject to final-status groundwater monitoring regulations. This unit will be closed under final-status requirements (WAC 173-303-610).

Groundwater monitoring at 183-H Basins was mandated by a *Consent Agreement and Compliance Order* (Ecology and EPA 1986). It went directly into an interim-status assessment-level monitoring program in response to the 1986 *Consent Agreement and Compliance Order*. The initial groundwater monitoring plan was prepared by Pacific Northwest National Laboratory based on interim-status regulations using limited data from then-existing 100-H Area wells (PNL 1986). In 1990 a closure plan was prepared (DOE-RL 1991). However, groundwater monitoring described in these documents does not address whether 183-H Basins should be under compliance monitoring (equivalent to the interim-status assessment monitoring) or corrective action (because some concentration limits have been exceeded). During 1995 a groundwater monitoring plan was prepared to reflect final-status compliance-level requirements, and to describe the updated well list, constituent list, and sampling frequency. Detailed statistical methods can be found in Hartman and Chou (1995).

C.2.5 300 Area Process Trenches (300 APT)

An extensive groundwater monitoring program was carried out during the operational life (1975 to 1994) of the 300 APT. RCRA groundwater monitoring at the 300 APT was mandated by a *Consent Agreement and Compliance Order* (Ecology and EPA 1986). It went directly into an interim-status assessment-level monitoring program in response to the 1986 *Consent Agreement and Compliance Order*. The initial groundwater monitoring plan was prepared by Pacific Northwest National Laboratory based on interim-status regulations (Schalla et al. 1986). In 1988 a revised groundwater monitoring compliance plan was implemented (Schalla et al. 1988).

The 300 APT are scheduled to be included in the Permit as a TSD unit undergoing closure through the permit modification process. A groundwater monitoring plan was prepared for the 300 APT in 1995 (Lindberg et al. 1995). This plan will be used to meet final-status compliance-level groundwater monitoring requirements from the time the 300 APT becomes part of the Permit and through the postclosure care period until certification of final closure. This plan describes the updated monitoring network, constituent list, sampling schedule, statistical methods, and sampling and analysis protocols to be employed for the 300 APT in detail.

C.3 BACKGROUND TABLES

This section contains revised background information for several RCRA facilities (e.g., 1301-N Liquid Waste Disposal Facility, 216-A-36B Crib, etc.) because the change in the groundwater monitoring network warrants the reestablishment of background conditions. In addition, background levels have been revised for Low-Level Waste Management Area 3 to account for an upgradient source of contamination.

A set of three tables is provided for each facility (Table C-1 through C-9.b). Each set includes the table listing input data for background well(s), the table containing background replicate averages, and the table presenting the background summary statistics.

C.4 REFERENCES

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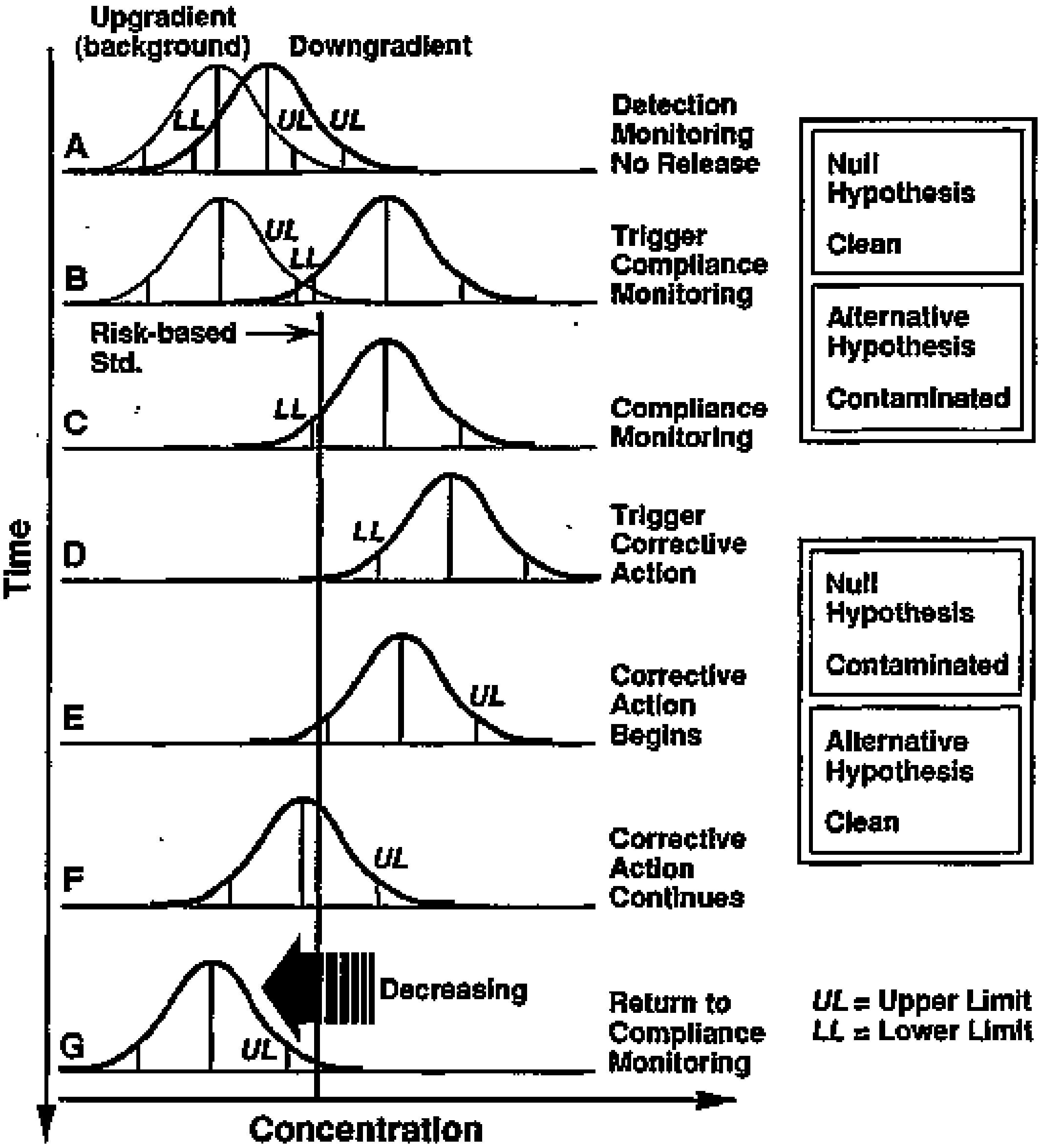
Schalla, R., R. L. Aaberg, D. J. Bates, J. V. M. Carlile, M. D. Freshley, T. L. Liikala, P. J. Mitchell, K. B. Olsen, and J. T. Rieger, 1988, *Revised Ground-Water Monitoring Compliance Plan for the 300 Area Process Trenches*, PNL-6671, Pacific Northwest Laboratory, Richland, Washington.

Resource Conservation and Recovery Act of 1976, 42 USC 6901 et seq.

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

WAC 173-304, "Minimum Functional Standards for Solid Waste Handling," *Washington Administrative Code*, as amended.

Figure C-1. A Statistical Perspective of the Sequence of Groundwater Monitoring Requirements Under RCRA.



(Notice that until contamination above a risk standard is documented (D) the null hypothesis is that the facility is clean. Once the facility has been proven to be in exceedance of a health criteria then the null hypothesis is that the facility is contaminated until proven otherwise (G).

H9401016.1

Table C-I. Background Contamination Indicator Parameter Data for the 1301-N Liquid Waste Disposal Facility. (page 1 of 3)

Well name	Sample date	Dupl. sample number	Specific conductance µmho/cm 1/700w	Field pH 0.01/[6.5, 8.5s]	TOC ppb 1000/.	TOX ppb 10/.
1-N-34	02/01/94	1	317	8.36	200^{L}	10.3
		2	317	8.34	200^{U}	5.0^{U}
		3	318	8.37	200^{U}	7.6
		4	314	8.36	200^{U}	6.0
1-N-34	05/24/94	1	333	7.87	320^{U}	6.9
		2	333	7.87	320^{L}	5.3
		3	333	7.89	320^{U}	6.2
		4	333	7.89	320^{U}	5.0^{U}
1-N-34	09/06/94	1	338	7.75	400^{L}	24.9^{F*}
		2	367	7.75	320^{U}	5.8^{F}
		3	366	7.75	320^{U}	5.4^{F}
		4	367	7.74	320^{U}	9.4^{F}
1-N-34	11/04/94	1	340	7.89	200^{LB}	6.9
		2	340	7.88	300^{LB}	7.3
		3	340	7.89	200^{LB}	6.8
		4	340	7.89	200^{LB}	9.9

The column headers consist of: Constituent Name; Analysis Units; and Contractually Required Quantitation Limit/Drinking Water Standard (suffix).

Suffix s = based on Secondary Maximum Contaminant Levels in 40 CFR Part 143, National Secondary Drinking Water Regulations
w = based on additional Secondary Maximum Contaminant Levels in WAC 248-54, Public Water Supplies

Data flag:

^{L}denotes that concentration is below Contract Required Quantitation Limit (CRQL) but above the Method Detection Limit (MDL).
^{U}denotes that analyte concentration is not detected (<MDL).
^{B}denotes blank associated with analyte is contaminated.
^{F}denotes suspect data currently under review.
^{R}denotes reviewed data that have been rejected.
*denotes data value is inconsistent with the rest of analytical results and is not used in the subsequent calculations.

Table C-1. Background Contamination Indicator Parameter Data for the 1301-N Liquid Waste Disposal Facility. (page 2 of 3)

Well name	Sample date	Dupl. sample number	Specific conductance µmho/cm 1/700w	Field pH 0.01/[6.5, 8.5s]	TOC ppb 1000/.	TOX ppb 10/.
1-N-34	02/24/95	1	327	8.03	200^{L}	10.1
		2	328	8.05	200^{L}	9.5
		3	329	8.07	200^{L}	7.6
		4	329	8.06	200^{L}	5.0^{U}
1-N-57	02/01/94	1	892	7.58	500^{L}	13.4
		2	---	---	500^{L}	9.6
		3	---	---	500^{L}	7.4
		4	---	---	500^{L}	8.7
1-N-57	06/14/94	1	832	7.49	400^{L}	14.6
		2	832	7.52	500^{L}	8.9
		3	833	7.53	500^{L}	9.4
		4	828	7.54	400^{L}	11.2
1-N-57	09/06/94	1	795	6.80^{R}	600^{L}	27.5^{F}
		2	792	6.80^{R}	500^{L}	13.7^{F}
		3	790	6.81^{R}	500^{L}	16.0^{F}
		4	798	6.83^{R}	600^{L}	14.5^{F}

The column headers consist of: Constituent Name; Analysis Units; and Contractually Required Quantitation Limit/Drinking Water Standard (suffix).

Suffix		
s	=	based on Secondary Maximum Contaminant Levels in 40 CFR Part 143, National Secondary Drinking Water Regulations
w	=	based on additional Secondary Maximum Contaminant Levels in WAC 248-54, Public Water Supplies

Data flag:

[L] denotes that concentration is below Contract Required Quantitation Limit (CRQL) but above the Method Detection Limit (MDL).
[U] denotes that analyte concentration is not detected (<MDL).
[B] denotes blank associated with analyte is contaminated.
[F] denotes suspect data currently under review.
[R] denotes reviewed data that have been rejected and were not used.

"---" = no data.

Table C-1. Background Contamination Indicator Parameter Data for the 1301-N Liquid Waste Disposal Facility. (page 3 of 3)

Well name	Sample date	Dupl. sample number	Specific conductance µmho/cm 1/700w	Field pH 0.01/[6.5, 8.5s]	TOC ppb 1000/.	TOX^{P} ppb 10/.
1-N-57	01/05/95	1	923	7.83	700^{L}	19.4
		2	923	7.83	700^{L}	12.8
		3	923	7.83	700^{L}	13.7
		4	924	7.84	700^{L}	15.7
1-N-57	02/24/95	1	803	7.84	600^{L}	17.3
		2	802	7.84	600^{L}	14.6
		3	802	7.84	600^{L}	14.9
		4	801	7.84	600^{L}	31.0^{F}

The column headers consist of: Constituent Name; Analysis Units; and Contractually Required Quantitation Limit/Drinking Water Standard (suffix).

Suffix	
s =	based on Secondary Maximum Contaminant Levels in 40 CFR Part 143, National Secondary Drinking Water Regulations
w =	based on additional Secondary Maximum Contaminant Levels in WAC 248-54, Public Water Supplies

Data flag:

^{L}denotes that concentration is below Contract Required Quantitation Limit (CRQL) but above the Method Detection Limit (MDL).
^{U}denotes that analyte concentration is not detected (<MDL).
^{B}denotes blank associated with analyte is contaminated.
^{F}denotes suspect data currently under review.
^{R}denotes reviewed data that have been rejected.

Table C-2. Average Replicate Statistics—Background Indicator Parameter Data for the 1301-N Liquid Waste Disposal Facility. (page 1 of 2)

Constituent (unit)	Well name	Sample date	n	Average	Standard deviation	C.V. (%)
Specific conductance (µmho/cm)	1-N-34	02/01/94	4	316.50	1.732	0.55
	1-N-34	05/24/94	4	333.00	0	0
	1-N-34	09/06/94	4	367.00	0.816	0.22
	1-N-34	11/04/94	4	340.00	0	0
	1-N-34	02/24/95	4	328.25	0.957	0.29
Field pH	1-N-34	02/01/94	4	8.358	0.012	0.15
	1-N-34	05/24/94	4	7.880	0.012	0.15
	1-N-34	09/06/94	4	7.748	0.005	0.06
	1-N-34	11/04/94	4	7.888	0.005	0.06
	1-N-34	02/24/95	4	8.052	0.017	0.21
TOC[a] (ppb)	1-N-34	02/01/94	4	125[U]	50	40
	1-N-34	05/24/94	4	200[L]	80	40
	1-N-34	09/06/94	4	220[L]	120	54.55
	1-N-34	11/04/94	4	225[LB]	50	22.22
	1-N-34	02/24/95	4	200[L]	0	0
TOX[a] (ppb)	1-N-34	02/01/94	4	6.600	3.259	49.38
	1-N-34	05/24/94	4	5.225	1.931	36.96
	1-N-34	09/06/94	3	6.867	2.203	32.08
	1-N-34	11/04/94	4	7.725	1.466	18.98
	1-N-34	02/24/95	4	7.425	3.452	46.49

[a] statistics were calculated by replacing not detected values with half of the method detection limit.

[L] denotes that concentration is below Contract Required Quantitation Limit (CRQL) but above the Method Detection Limit (MDL).

[U] denotes that analyte concentration is not detected (<MDL).

[B] denotes blank associated with analyte is contaminated.

[?] denotes suspect data currently under review.

[R] denotes reviewed data that have been rejected and are not used in the subsequent calculations.

N.A. = not available. C.V. = coefficient of variation.
N.C. = not calculated.

Table C-2. Average Replicate Statistics--Background Indicator Parameter Data for the 1301-N Liquid Waste Disposal Facility. (page 2 of 2)

Constituent (unit)	Well name	Sample date	n	Average	Standard deviation	C.V. (%)
Specific conductance (μmho/cm)	1-N-57	02/01/94	1	892.00	N.C.	N.C.
	1-N-57	06/14/94	4	831.25	2.217	0.27
	1-N-57	09/06/94	4	793.75	3.500	0.44
	1-N-57	01/05/95	4	923.25	0.500	0.05
	1-N-57	02/24/95	4	802.00	0.816	0.10
Field pH	1-N-57	02/01/94	1	7.580	N.C.	N.C.
	1-N-57	06/14/94	4	7.520	0.022	0.29
	1-N-57	09/06/94	4	6.81[R]	0.014[R]	0.21[R]
	1-N-57	01/05/95	4	7.832	0.005	0.06
	1-N-57	02/04/95	4	7.840	0	0
TOC[a] (ppb)	1-N-57	02/01/94	4	500[L]	0	0
	1-N-57	06/14/94	4	450[L]	57.735	12.83
	1-N-57	09/06/94	4	550[L]	57.735	10.50
	1-N-57	01/05/95	4	700[L]	0	0
	1-N-57	02/04/95	4	600[L]	0	0
TOX (ppb)	1-N-57	02/01/94	4	9.775	2.580	26.39
	1-N-57	06/14/94	4	11.025	2.580	23.40
	1-N-57	09/06/94	4	17.925	6.454	36.01
	1-N-57	01/05/95	4	15.400	2.929	19.02
	1-N-57	02/04/95	4	19.450	7.794	40.07

[a] statistics were calculated by replacing not detected values with half of the method detection limit.

[L] denotes that concentration is below Contract Required Quantitation Limit (CRQL) but above the Method Detection Limit (MDL).

[U] denotes that analyte concentration is not detected (<MDL).

[B] denotes blank associated with analyte is contaminated.

[F] denotes suspect data currently under review.

[R] denotes reviewed data that have been rejected and are not used in the subsequent calculations.

N.A. = not available. C.V. = coefficient of variation.
N.C. = not calculated.

Table C-3. Background Statistics[a]--Contamination Indicator Parameter Data for the 1301-N Liquid Waste Disposal Facility.

Constituent	Units	n	Background average	Background standard deviation	Background C.V. (%)
Specific conductance	µmho/cm	10	592.700	272.527	45.98
Field pH		9[*]	7.855	0.248	3.16
TOC	ppb	10	377.000	205.037	54.39
TOX	ppb	10	10.742	5.087	47.35

[a] background summary statistics for TOC and/or TOX were calculated using values below the method detection limits.

[*] Excluding pH results from samples collected on 9/6/94 from well 1-N-57.

Table C-4. Background Contamination Indicator Parameter Data for the 216-A-36B Crib. (page 1 of 3)

Well name	Sample date	Dupl. sample number	Specific conductance µmho/cm 1/700w	Field pH 0.01/[6.5, 8.5s]	TOC ppb a/.	TOX ppb b/.
2-E17-17	09/13/88	1	295	7.60	844[#]	10.5[#]
		2	296	7.60	747[#]	4.8[#]
		3	294	7.70	672[#]	8.9[#]
		4	294	7.50	775[#]	5.3[#]
2-E17-17	12/21/88	1	351	7.90	400[#]	-1.0[#]
		2	350	7.90	400[#]	-1.0[#]
		3	353	7.90	400[#]	0[#]
		4	354	7.90	400[#]	2.0[#]
2-E17-17	05/12/89	1	230	7.90	600[#]	5.0[#]
		2	230	8.05	500[#]	2.1[#]
		3	230	8.04	500[#]	4.0[#]
		4	230	8.00	500[#]	6.0[#]
2-E17-17	06/23/89	1	316	7.71	500[#]	1.0[#]
		2	317	7.76	500[#]	1.0[#]
		3	317	7.75	500[#]	2.0[#]
		4	316	7.76	500[#]	2.0[#]

The column headers consist of: Constituent Name; Analysis Units; and Contractually Required Quantitation Limit/Drinking Water Standard (suffix).

Suffix s = based on Secondary Maximum Contaminant Levels in 40 CFR Part 143, National Secondary Drinking Water Regulations
w = based on additional Secondary Maximum Contaminant Levels in WAC 248-54, Public Water Supplies

Data flag:

[a] denotes data analyzed by US Testing Inc. of Richland, Washington. Contractual detection limit before January 1989 = 1,000 ppb; after January 1989 = 2,000 ppb.

[b] denotes data analyzed by US Testing Inc. of Richland, Washington. Contractual detection limit before January 1989 = 20 ppb; after January 1989 = 10 ppb.

[#] less than contractual detection limit value.

Table C-4. Background Contamination Indicator Parameter Data for the 216-A-36B Crib. (page 2 of 3)

Well name	Sample date	Dupl. sample number	Specific conductance µmho/cm 1/700w	Field pH 0.01/[6.5, 8.5s]	TOC ppb a/.	TOX ppb b/.
2-E24-18	11/02/88	1	407	8.00	400[#]	3.0[#]
		2	408	8.20	500[#]	6.0[#]
		3	408	8.10	500[#]	7.0[#]
		4	408	8.20	500[#]	3.0[#]
2-E24-18	02/14/89	1	323	8.50	500[#]	8.0[#]
		2	322	8.50	500[#]	9.0[#]
		3	323	8.50	600[#]	3.0[#]
		4	323	8.50	500[#]	1.0[#]
2-E24-18	06/19/89	1	274	7.63	400[#]	1.0[#]
		2	274	7.63	1,100[#]	1.0[#]
		3	274	7.63	1,100[#]	1.0[#]
		4	274	7.63	600[#]	5.0[#]
2-E24-18	08/11/89	1	338	7.96	500[#]	3.0[#]
		2	335	7.95	500[#]	10.0
		3	334	7.95	700[#]	4.0[#]
		4	335	7.95	700[#]	8.0[#]

The column headers consist of: Constituent Name; Analysis Units; and Contractually Required Quantitation Limit/Drinking Water Standard (suffix).

Suffix s = based on Secondary Maximum Contaminant Levels in 40 CFR Part 143, National Secondary Drinking Water Regulations

w = based on additional Secondary Maximum Contaminant Levels in WAC 248-54, Public Water Supplies

Data flag:

[a] denotes data analyzed by US Testing Inc. of Richland, Washington. Contractual detection limit before January 1989 = 1,000 ppb; after January 1989 = 2,000 ppb.

[b] denotes data analyzed by US Testing Inc. of Richland, Washington. Contractual detection limit before January 1989 = 20 ppb; after January 1989 = 10 ppb.

[#] less than contractual detection limit value.

Table C-4. Background Contamination Indicator Parameter Data for the 216-A-36B Crib. (page 3 of 3)

Well name	Sample date	Dupl. sample number	Specific conductance µmho/cm 1/700w	Field pH 0.01/[6.5, 8.5s]	TOC ppb a/.	TOX ppb b/.
2-E25-36	11/04/88	1	179	7.70	600#	10.0#
		2	180	8.00	600#	5.0#
		3	180	7.90	600#	7.0#
		4	179	8.00	700#	4.0#
2-E25-36	02/14/89	1	194	8.40	600#	4.0#
		2	194	8.40	700#	1.0#
		3	194	8.40	800#	4.0#
		4	194	8.40	600#	3.0#
2-E25-36	06/19/89	1	232	8.01	500#	5.0#
		2	236	8.06	500#	8.0#
		3	235	8.05	500#	.01#
		4	233	8.11	500#	3.0#
2-E25-36	10/24/89	1	239	7.63	600#	5.0#
		2	---	---	900#	4.0#
		3	---	---	600#	5.0#
		4	---	---	900#	2.0#

The column headers consist of: Constituent Name; Analysis Units; and Contractually Required Quantitation Limit/Drinking Water Standard (suffix).

Suffix s = based on Secondary Maximum Contaminant Levels in 40 CFR Part 143, National Secondary Drinking Water Regulations
w = based on additional Secondary Maximum Contaminant Levels in WAC 248-54, Public Water Supplies

Data flag:

[a] denotes data analyzed by US Testing Inc. of Richland, Washington. Contractual detection limit before January 1989 = 1,000 ppb; after January 1989 = 2,000 ppb.

[b] denotes data analyzed by US Testing Inc. of Richland, Washington. Contractual detection limit before January 1989 = 20 ppb; after January 1989 = 10 ppb.

[#] less than contractual detection limit value.

"___" = no data.

Table C-5. Average Replicate Statistics--Background Indicator Parameter Data for the 216-A-36B Crib. (page 1 of 3)

Constituent (unit)	Well name	Sample date	n	Average	Standard deviation	C.V. (%)
Specific conductance (μmho/cm)	2-E17-17	09/13/88	4	294.75	0.957	0.32
	2-E17-17	12/21/88	4	352.00	1.826	0.52
	2-E17-17	05/12/89	4	230.00	0	0
	2-E17-17	06/23/89	4	316.50	0.577	0.18
Field pH	2-E17-17	09/13/88	4	7.600	0.082	1.07
	2-E17-17	12/21/88	4	7.900	0	0
	2-E17-17	05/12/89	4	7.998	0.068	0.86
	2-E17-17	06/23/89	4	7.745	0.024	0.31
TOC (ppb)	2-E17-17	09/13/88	4	759.5#	71.164	9.37
	2-E17-17	12/21/88	4	400.0#	0	0
	2-E17-17	05/12/89	4	525.0#	50	9.52
	2-E17-17	06/23/89	4	550.0#	100	18.18
TOX (ppb)	2-E17-17	09/13/88	4	7.375#	2.770	37.57
	2-E17-17	12/21/88	4	0#	1.414	N.C.
	2-E17-17	05/12/89	4	4.275#	1.664	38.93
	2-E17-17	06/23/89	4	1.500#	3.452	46.49

#less than contractual detection limit value.

N.C. = not calculated. C.V. = coefficient of variation.

Table C-5. Average Replicate Statistics--Background Indicator Parameter Data for the 216-A-36B Crib. (page 2 of 3)

Constituent (unit)	Well name	Sample date	n	Average	Standard deviation	C.V. (%)
Specific conductance (µmho/cm)	2-E24-18	11/02/88	4	407.75	0.500	0.12
	2-E24-18	02/14/89	4	322.75	0.500	0.15
	2-E24-18	06/19/89	4	274.00	0	0
	2-E24-18	08/11/89	4	335.50	1.732	0.52
Field pH	2-E24-18	11/02/88	4	8.125	0.096	1.18
	2-E24-18	02/14/89	4	8.500	0	0
	2-E24-18	06/19/89	4	7.630	0	0
	2-E24-18	08/11/89	4	7.952	0.005	0.06
TOC (ppb)	2-E24-18	11/02/88	4	475.0#	50.000	10.53
	2-E24-18	02/14/89	4	525.0#	50.000	9.52
	2-E24-18	06/19/89	4	800.0#	355.903	44.49
	2-E24-18	08/11/89	4	600.0#	115.470	19.24
TOX (ppb)	2-E24-18	11/02/88	4	4.750#	2.062	43.40
	2-E24-18	02/14/89	4	5.250#	3.862	73.57
	2-E24-18	06/19/89	4	2.000#	2.000	100.0
	2-E24-18	08/11/89	4	6.250#	3.304	52.86

#less than contractual detection limit value.

N.C. = not calculated. C.V. = coefficient of variation.

Table C-5. Average Replicate Statistics--Background Indicator Parameter Data for the 216-A-36B Crib. (page 3 of 3)

Constituent (unit)	Well name	Sample date	n	Average	Standard deviation	C.V. (%)
Specific conductance (µmho/cm)	2-E25-36	11/04/88	4	179.50	0.577	0.32
	2-E25-36	02/14/89	4	194.00	0	0
	2-E25-36	06/19/89	4	234.00	1.826	0.78
	2-E25-36	10/24/89	1	239.00	N.C.	N.C.
Field pH	2-E25-36	11/04/88	4	7.900	0.141	1.79
	2-E25-36	02/14/89	4	8.400	0	0
	2-E25-36	06/19/89	4	8.058	0.041	0.51
	2-E25-36	10/24/89	1	7.630	N.C.	N.C.
TOC (ppb)	2-E25-36	11/04/88	4	625.0[#]	50.000	8.00
	2-E25-36	02/14/89	4	675.0[#]	95.743	14.18
	2-E25-36	06/19/89	4	500.0[#]	0	0
	2-E25-36	10/24/89	4	750.0[#]	173.210	23.09
TOX (ppb)	2-E25-36	11/04/88	4	6.500[#]	2.646	40.70
	2-E25-36	02/14/89	4	3.000[#]	1.414	47.14
	2-E25-36	06/19/89	4	4.002[#]	3.362	84.01
	2-E25-36	10/24/89	4	4.000[#]	1.414	35.36

[#] less than contractual detection limit value.

N.C. = not calculated. C.V. = coefficient of variation.

Table C-6. Background Statistics[a]--Contamination Indicator Parameter Data for the 216-A-36B Crib.

Constituent	Units	n	Background average	Background standard deviation	Background C.V. (%)
Specific conductance	μmho/cm	12	281.646	68.595	24.36
Field pH		12	7.953	0.290	3.64
TOC	ppb	12	598.708	125.606	20.98
TOX	ppb	12	4.075	2.176	53.40

[a] background summary statistics for TOC and/or TOX were calculated using values below the contractual detection limits.

Table C-7.a. Background Contamination Indicator Parameter Data for the Low-Level Waste Management Area 3[a]. (page 1 of 3)

Well name	Sample date	Dupl. sample number	Specific conductance µmho/cm 1/700w	Field pH 0.01/[6.5, 8.5s]	TOC ppb 1000/.	TOX ppb 10/.
2-W10-13	02/18/94	1	385	8.21	300^{L}	---
		2	390	8.20	300^{L}	---
		3	387	8.19	200^{L}	---
		4	387	8.18	200^{L}	---
2-W10-13	05/25/94	1	480	8.01	320^{U}	---
		2	481	8.01	350^{L}	---
		3	479	8.01	320^{U}	---
		4	477	8.02	330^{L}	---
2-W10-13	07/14/94	1	446	7.99	---	13.3 14.5
		2	445	7.99	---	13.3 14.1
		3	447	7.99	---	14.5 12.1
		4	447	7.99	---	14.6 14.3
2-W10-13	08/31/94	1	459	8.06	320^{U}	5.0^{U}
		2	458	8.06	320^{U}	5.5
		3	455	8.05	320^{U}	5.0^{U}
		4	455	8.05	320^{U}	5.0^{U}

The column headers consist of: Constituent Name; Analysis Units; and Contractually Required Quantitation Limit/Drinking Water Standard (suffix).

Suffix s = based on Secondary Maximum Contaminant Levels in 40 CFR Part 143, National Secondary Drinking Water Regulations

w = based on additional Secondary Maximum Contaminant Levels in WAC 248-54, Public Water Supplies

Notes and data flag:

[a] area not impacted by upgradient source of contamination.

^{L}denotes that concentration is below Contract Required Quantitation Limit (CRQL) but above the Method Detection Limit (MDL).

^{U}denotes that analyte concentration is not detected (<MDL).

"---" = no data.

Table C-7.a. Background Contamination Indicator Parameter Data for the Low-Level Waste Management Area 3[a]. (page 2 of 3)

Well name	Sample date	Dupl. sample number	Specific conductance µmho/cm 1/700w	Field pH 0.01/[6.5, 8.5s]	TOC ppb 1000/.	TOX ppb 10/.
2-W10-13	12/14/94	1	452	8.51	110[L]	14.0
		2	453	8.58	200[L]	14.4
		3	450	8.61	140[L]	11.1
		4	451	8.61	120[L]	11.1
2-W10-13	03/10/95	1	407	8.17	200[L]	26.7
		2	405	8.17	300[L]	23.3
		3	404	8.16	200[L]	22.6
		4	402	8.16	200[L]	22.1
2-W9-1	02/18/94	1	418	8.05	300[L]	5.0[U]
		2	413	8.03	200[U]	5.0[U]
		3	417	8.02	200[U]	---
		4	415	8.00	200[U]	---
2-W9-1	05/25/94	1	441	7.66	320[U]	---
		2	445	7.67	320[U]	---
		3	442	7.68	320[U]	---
		4	444	7.68	320[U]	---

The column headers consist of: Constituent Name; Analysis Units; and Contractually Required Quantitation Limit/Drinking Water Standard (suffix).

Suffix s =	based on Secondary Maximum Contaminant Levels in 40 CFR Part 143, National Secondary Drinking Water Regulations
w =	based on additional Secondary Maximum Contaminant Levels in WAC 248-54, Public Water Supplies

Notes and data flag:

[a] area not impacted by upgradient source of contamination.
[L] denotes that concentration is below Contract Required Quantitation Limit (CRQL) but above the Method Detection Limit (MDL).
[U] denotes that analyte concentration is not detected (<MDL).

"---" = no data.

Table C-7.a. Background Contamination Indicator Parameter Data for the Low-Level Waste Management Area 3[a]. (page 3 of 3)

Well name	Sample date	Dupl. sample number	Specific conductance µmho/cm 1/700w	Field pH 0.01/[6.5, 8.5s]	TOC ppb 1000/.	TOX ppb 10/.
2-W9-1	07/14/94	1	317	7.91	---	5.0^U
		2	317	7.90	---	5.0^U
		3	318	7.89	---	5.0^U
		4	314	7.90	---	5.0^U
2-W9-1	08/12/94	1	333	7.93	320^U	12.6
		2	333	7.91	320^U	13.4
		3	333	7.91	320^U	9.6
		4	333	7.90	400^L	6.1
2-W9-1	12/14/94	1	338	8.76	110^U 110^U	5.0^U 5.0^U
		2	367	8.75	140^L 300^L	5.0^U 5.0^U
		3	366	8.74	150^L 300^L	5.0^U 5.0^U
		4	367	8.74	200^L 200^L	5.3 5.0^U
2-W9-1	03/10/95	1	340	8.26	300^L	10.5
		2	340	8.25	200^L	5.0^U
		3	340	8.14	200^L	9.6
		4	340	8.12	200^L	5.1

The column headers consist of: Constituent Name; Analysis Units; and Contractually Required Quantitation Limit/Drinking Water Standard (suffix).

Suffix s = based on Secondary Maximum Contaminant Levels in 40 CFR Part 143, National Secondary Drinking Water Regulations

w = based on additional Secondary Maximum Contaminant Levels in WAC 248-54, Public Water Supplies

Notes and data flag:

[a] area not impacted by upgradient source of contamination.

^{L}denotes that concentration is below Contract Required Quantitation Limit (CRQL) but above the Method Detection Limit (MDL).

^{U}denotes that analyte concentration is not detected.

"---" = no data.

Table C-7.b. Background Contamination Indicator Parameter Data for the Low-Level Waste Management Area 3[a]. (page 1 of 5)

Well name	Sample date	Dupl. sample number	Specific conductance µmho/cm 1/700w	Field pH 0.01/[6.5, 8.5s]	TOC ppb 1000/.	TOX ppb 10/.
2-W10-19	02/18/94	1	567	7.97	300^L	---
		2	562	7.93	300^L	---
		3	559	7.91	300^L	---
		4	560	7.90	300^L	---
2-W10-19	05/25/94	1	570	8.19	340^L	---
		2	568	8.18	320^U	---
		3	571	8.15	320^U	---
		4	571	8.14	340^L	---
2-W10-19	08/03/94	1	518	7.99	---	994
		2	515	7.99	---	729
		3	513	7.99	---	939
		4	516	7.98	---	1,030
2-W10-19	08/15/94	1	561	7.64	320^U	833
		2	562	7.66	600^L	870
		3	560	7.61	400^L	955
		4	559	7.66	320^U	685

The column headers consist of: Constituent Name; Analysis Units; and Contractually Required Quantitation Limit/Drinking Water Standard (suffix).

Suffix s = based on Secondary Maximum Contaminant Levels in 40 CFR Part 143, National Secondary Drinking Water Regulations
w = based on additional Secondary Maximum Contaminant Levels in WAC 248-54, Public Water Supplies

Notes and data flag:

[a] area impacted by upgradient source of contamination.
[L] denotes that concentration is below Contract Required Quantitation Limit (CRQL) but above the Method Detection Limit (MDL).
[U] denotes that analyte concentration is not detected (<MDL).

"---" = no data.

Table C-7.b. Background Contamination Indicator Parameter Data for the Low-Level Waste Management Area 3^a. (page 2 of 5)

Well name	Sample date	Dupl. sample number	Specific conductance µmho/cm 1/700w	Field pH 0.01/[6.5, 8.5s]	TOC ppb 1000/.	TOX ppb 10/.
2-W10-19	12/14/94	1	558	8.77	300^L	1,000
		2	---	---	---	---
		3	---	---	---	---
		4	---	---	---	---
2-W10-19	03/09/95	1	560	8.30	200^L	1,060
		2	561	8.28	300^L	1,060
		3	563	8.24	200^L	1,050
		4	565	8.21	200^L	1,050
2-W10-20	02/18/94	1	593	7.76	600^L	717
		2	585	7.71	600^U	609
		3	587	7.71	700^L	832
		4	587	7.69	600^L	957
2-W10-20	05/25/94	1	613	7.70	500^L	---
		2	612	7.69	600^L	---
		3	612	7.69	500^L	---
		4	615	7.69	600^L	---

The column headers consist of: Constituent Name; Analysis Units; and Contractually Required Quantitation Limit/Drinking Water Standard (suffix).

Suffix s = based on Secondary Maximum Contaminant Levels in 40 CFR Part 143, National Secondary Drinking Water Regulations
w = based on additional Secondary Maximum Contaminant Levels in WAC 248-54, Public Water Supplies

Notes and data flag:

^{a}area impacted by upgradient source of contamination.
^{L}denotes that concentration is below Contract Required Quantitation Limit (CRQL) but above the Method Detection Limit (MDL).
^{U}denotes that analyte concentration is not detected (<MDL).

"---" = no data.

Table C-7.b. Background Contamination Indicator Parameter Data for the Low-Level Waste Management Area 3[a]. (page 3 of 5)

Well name	Sample date	Dupl. sample number	Specific conductance µmho/cm 1/700w	Field pH 0.01/[6.5, 8.5s]	TOC ppb 1000/.	TOX ppb 10/.
2-W10-20	07/14/94	1	618	7.60	---	875
		2	618	7.59	---	884
		3	618	7.59	---	766
		4	616	7.59	---	---
2-W10-20	08/12/94	1	628	7.67	400^L	1,360
		2	629	7.65	400^L	930
		3	629	7.63	400^L	848
		4	628	7.63	500^L	1,400
2-W10-20	12/15/94	1	623	6.87	400^L	1,280
		2	623	6.91	---	---
		3	625	6.95	---	---
		4	623	7.01	---	---
2-W10-20	03/09/95	1	612	7.80	300^L	1,190
		2	611	7.81	300^L	1,310
		3	609	7.81	300^L	1,180
		4	608	7.80	300^L	1,110

The column headers consist of: Constituent Name; Analysis Units; and Contractually Required Quantitation Limit/Drinking Water Standard (suffix).

Suffix s = based on Secondary Maximum Contaminant Levels in 40 CFR Part 143, National Secondary Drinking Water Regulations
w = based on additional Secondary Maximum Contaminant Levels in WAC 248-54, Public Water Supplies

Notes and data flag:

[a] area impacted by upgradient source of contamination.
[L] denotes that concentration is below Contract Required Quantitation Limit (CRQL) but above the Method Detection Limit (MDL).
[U] denotes that analyte concentration is not detected (<MDL).

"---" = no data.

Table C-7.b. Background Contamination Indicator Parameter Data for the Low-Level Waste Management Area 3[*]. (page 4 of 5)

Well name	Sample date	Dupl. sample number	Specific conductance µmho/cm 1/700w	Field pH 0.01/[6.5, 8.5s]	TOC ppb 1000/.	TOX ppb 10/.
2-W10-21	02/22/94	1	529	7.59	400[L]	462
		2	525	7.59	400[L]	393
		3	530	7.61	400[L]	358
		4	530	7.62	400[L]	389
2-W10-21	05/26/94	1	569	7.66	400[L]	446
		2	570	7.65	400[L]	427
		3	571	7.65	320[U]	466
		4	570	7.74	350[L]	461
2-W10-21	08/12/94	1	583	7.84	400[L]	300
		2	584	7.81	400[L]	385
		3	579	7.80	400[L]	371
		4	579	7.77	340[L]	408
2-W10-21	12/14/94	1	598	8.20	400[L]	444
		2	---	---	---	---
		3	---	---	---	---
		4	---	---	---	---

The column headers consist of: Constituent Name; Analysis Units; and Contractually Required Quantitation Limit/Drinking Water Standard (suffix).

Suffix s = based on Secondary Maximum Contaminant Levels in 40 CFR Part 143, National Secondary Drinking Water Regulations

w = based on additional Secondary Maximum Contaminant Levels in WAC 248-54, Public Water Supplies

Notes and data flag:

[*] area impacted by upgradient source of contamination.

[L] denotes that concentration is below Contract Required Quantitation Limit (CRQL) but above the Method Detection Limit (MDL).

[U] denotes that analyte concentration is not detected (<MDL).

"---" = no data.

Table C-7.b. Background Contamination Indicator Parameter Data for the Low-Level Waste Management Area 3[a]. (page 5 of 5)

Well name	Sample date	Dupl. sample number	Specific conductance µmho/cm 1/700w	Field pH 0.01/[6.5, 8.5s]	TOC ppb 1000/.	TOX ppb 10/.
2-W10-21	03/09/95	1	589	7.35	300[L]	479
		2	589	7.85	300[L]	470
		3	590	7.85	300[L]	476
		4	590	7.85	300[L]	452

The column headers consist of: Constituent Name; Analysis Units; and Contractually Required Quantitation Limit/Drinking Water Standard (suffix).

Suffix s =	based on Secondary Maximum Contaminant Levels in 40 CFR Part 143, National Secondary Drinking Water Regulations
w =	based on additional Secondary Maximum Contaminant Levels in WAC 248-54, Public Water Supplies

Notes and data flag:

[a] area impacted by upgradient source of contamination.

[L] denotes that concentration is below Contract Required Quantitation Limit (CRQL) but above the Method Detection Limit (MDL).

[U] denotes that analyte concentration is not detected (<MDL).

Table C-8.a. Average Replicate Statistics--Background Indicator Parameter Data for the Low-Level Waste Management Area 3[a]. (page 1 of 2)

Constituent (unit)	Well name	Sample date	n	Average	Standard deviation	C.V. (%)
Specific conductance (μmho/cm)	2-W10-13	02/18/94	4	387.25	2.062	0.53
	2-W10-13	05/25/94	4	479.25	1.708	0.36
	2-W10-13	07/14/94	4	446.25	0.957	0.21
	2-W10-13	08/31/94	4	456.75	2.062	0.45
	2-W10-13	12/14/94	4	451.50	1.291	0.29
	2-W10-13	03/10/95	4	404.50	2.082	0.51
Field pH	2-W10-13	02/18/94	4	8.195	0.013	0.16
	2-W10-13	05/25/94	4	8.012	0.005	0.06
	2-W10-13	07/14/94	4	7.990	0	0
	2-W10-13	08/31/94	4	8.055	0.006	0.07
	2-W10-13	12/14/94	4	8.578	0.047	0.55
	2-W10-13	03/10/95	4	8.165	0.006	0.07
TOC[b] (ppb)	2-W10-13	02/18/94	4	250[L]	57.735	23.09
	2-W10-13	05/25/94	4	250[L]	104.243	41.70
	2-W10-13	08/31/94	4	160[U]	0	0
	2-W10-13	12/14/94	4	142.5[L]	40.311	28.29
	2-W10-13	03/10/95	4	225[L]	50	22.22
TOX[b] (ppb)	2-W10-13	07/14/94	8	13.80	0.906	6.56
	2-W10-13	08/31/94	4	3.25	1.500	46.15
	2-W10-13	12/14/94	4	12.65	1.797	14.21
	2-W10-13	03/10/95	4	23.675	2.076	8.77

[a] area not impacted by upgradient source of contamination.

[b] statistics were calculated by replacing not detected values with half of the Method Detection Limit (MDL).

[L] denotes that concentration is below Contract Required Quantitation Limit (CRQL) but above the MDL.

[U] denotes that analyte concentration is not detected (<MDL).

N.C. = not calculated. C.V. = coefficient of variation.

Table C-8.a. Average Replicate Statistics--Background Indicator Parameter Data for the Low-Level Waste Management Area 3[a]. (page 2 of 2)

Constituent (unit)	Well name	Sample date	n	Average	Standard deviation	C.V. (%)
Specific conductance (μmho/cm)	2-W9-1	02/18/94	4	415.75	2.217	0.53
	2-W9-1	05/25/94	4	443.00	1.826	0.41
	2-W9-1	07/14/94	4	421.00	2.160	0.51
	2-W9-1	08/31/94	4	459.75	2.062	0.45
	2-W9-1	12/14/94	4	453.25	2.217	0.49
	2-W9-1	03/10/95	4	459.50	1.291	0.28
Field pH	2-W9-1	02/18/94	4	8.025	0.021	0.26
	2-W9-1	05/25/94	4	7.673	0.010	0.12
	2-W9-1	07/14/94	4	7.900	0.008	0.10
	2-W9-1	08/31/94	4	7.913	0.013	0.16
	2-W9-1	12/14/94	4	8.748	0.010	0.11
	2-W9-1	03/10/95	4	8.192	0.073	0.89
TOC[b] (ppb)	2-W9-1	02/18/94	4	150[L]	100	66.67
	2-W9-1	05/25/94	4	160[L]	0	0
	2-W9-1	08/12/94	4	220[U]	120	54.55
	2-W9-1	12/14/94	8	175[L]	94.981	54.27
	2-W9-1	03/10/95	4	225[L]	50	22.22
TOX[b] (ppb)	2-W9-1	02/18/94	2	2.5[U]	0	0
	2-W9-1	07/14/94	4	2.5[U]	0	0
	2-W9-1	08/12/94	4	10.425	3.315	31.80
	2-W9-1	12/14/94	8	2.85	1.000	34.74
	2-W9-1	03/10/95	4	6.925	3.779	54.57

[a] area not impacted by upgradient source of contamination.

[b] statistics were calculated by replacing not detected values with half of the Method Detection Limit (MDL).

[L] denotes that concentration is below Contract Required Quantitation Limit (CRQL) but above the MDL.

[U] denotes that analyte concentration is not detected (<MDL).

N.C. = not calculated. C.V. = coefficient of variation.

Table C-8.b. Average Replicate Statistics--Background Indicator Parameter Data for the Low-Level Waste Management Area 3[a]. (page 1 of 3)

Constituent (unit)	Well name	Sample date	n	Average	Standard deviation	C.V. (%)
Specific conductance (μmho/cm)	2-W10-19	02/18/94	4	562.00	3.559	0.63
	2-W10-19	05/25/94	4	570.00	1.414	0.25
	2-W10-19	08/03/94	4	515.50	2.082	0.40
	2-W10-19	08/15/94	4	560.50	1.291	0.23
	2-W10-19	12/14/94	1	558.00	N.C.	N.C.
	2-W10-19	03/09/95	4	562.25	2.217	0.39
Field pH	2-W10-19	02/18/94	4	7.928	0.031	0.39
	2-W10-19	05/25/94	4	8.165	0.024	0.29
	2-W10-19	08/03/94	4	7.988	0.005	0.06
	2-W10-19	08/15/94	4	7.642	0.024	0.31
	2-W10-19	12/14/94	1	8.770	N.C.	N.C.
	2-W10-19	03/09/95	4	8.258	0.040	0.49
TOC[b] (ppb)	2-W10-19	02/18/94	4	300[L]	0	0
	2-W10-19	05/25/94	4	250[L]	103.923	41.57
	2-W10-19	08/15/94	4	330[L]	212.603	64.43
	2-W10-19	12/14/94	1	300[L]	N.C.	N.C.
	2-W10-19	03/09/95	4	225[L]	50	22.22
TOX (ppb)	2-W10-19	08/03/94	4	923.00	134.638	14.59
	2-W10-19	08/15/94	4	835.75	112.734	13.49
	2-W10-19	12/14/94	1	1,000	N.C.	N.C.
	2-W10-19	03/09/95	4	1,050	14.142	1.35

[a] area impacted by upgradient source of contamination.

[b] statistics were calculated by replacing not detected values with half of the Method Detection Limit (MDL).

[L] denotes that concentration is below Contract Required Quantitation Limit (CRQL) but above the MDL.

[U] denotes that analyte concentration is not detected (<MDL).

N.C. = not calculated. C.V. = coefficient of variation.

Table C-8.b. Average Replicate Statistics--Background Indicator Parameter Data for the Low-Level Waste Management Area 3[a]. (page 2 of 3)

Constituent (unit)	Well name	Sample date	n	Average	Standard deviation	C.V. (%)
Specific conductance (μmho/cm)	2-W10-20	02/18/94	4	588.00	3.464	0.59
	2-W10-20	05/25/94	4	613.00	1.414	0.23
	2-W10-20	07/14/94	4	617.50	1.000	0.16
	2-W10-20	08/12/94	4	628.50	0.577	0.09
	2-W10-20	12/15/94	4	623.50	1.000	0.16
	2-W10-20	03/09/95	4	610.00	1.826	0.30
Field pH	2-W10-20	02/18/94	4	7.718	0.030	0.39
	2-W10-20	05/25/94	4	7.692	0.005	0.06
	2-W10-20	07/14/94	4	7.592	0.005	0.07
	2-W10-20	08/12/94	4	7.645	0.019	0.25
	2-W10-20	12/15/94	4	6.935	0.060	0.86
	2-W10-20	03/09/95	4	7.805	0.006	0.07
TOC[b] (ppb)	2-W10-20	02/18/94	4	625[L]	50.000	8.00
	2-W10-20	05/25/94	4	550[L]	57.735	10.50
	2-W10-20	08/12/94	4	425[L]	50.000	11.76
	2-W10-20	12/15/94	1	400[L]	N.C.	N.C.
	2-W10-20	03/09/95	4	300[L]	0	0
TOX (ppb)	2-W10-20	02/18/94	4	778.75	149.707	19.22
	2-W10-20	07/14/94	3	841.667	65.684	7.80
	2-W10-20	08/12/94	4	1,134.5	285.916	25.20
	2-W10-20	12/15/94	1	1,280.0	N.C.	N.C.

[a] area impacted by upgradient source of contamination.

[b] statistics were calculated by replacing not detected values with half of the Method Detection Limit (MDL).

[L] denotes that concentration is below Contract Required Quantitation Limit (CRQL) but above the MDL.

[U] denotes that analyte concentration is not detected (<MDL).

N.C. = not calculated. C.V. = coefficient of variation.

Table C-8.b. Average Replicate Statistics--Background Indicator Parameter Data for the Low-Level Waste Management Area 3[a]. (page 3 of 3)

Constituent (unit)	Well name	Sample date	n	Average	Standard deviation	C.V. (%)
Specific conductance (µmho/cm)	2-W10-21	02/22/94	4	528.50	2.380	0.45
	2-W10-21	05/26/94	4	570.00	0.816	0.14
	2-W10-21	08/12/94	4	581.25	2.630	0.45
	2-W10-21	12/14/94	1	598.00	N.C.	N.C.
	2-W10-21	03/09/95	4	589.50	0.577	0.10
Field pH	2-W10-21	02/22/94	4	7.602	0.015	0.20
	2-W10-21	05/26/94	4	7.650	0.008	0.11
	2-W10-21	08/12/94	4	7.805	0.029	0.37
	2-W10-21	12/14/94	1	8.200	N.C.	N.C.
	2-W10-21	03/09/95	4	7.850	0	0
TOC[b] (ppb)	2-W10-21	02/22/94	4	400[L]	0	0
	2-W10-21	05/26/94	4	327.5[L]	114.127	34.85
	2-W10-21	08/12/94	4	385[L]	30.000	7.79
	2-W10-21	12/14/94	1	400[L]	N.C.	N.C.
	2-W10-21	03/09/95	4	300[L]	0	0
TOX (ppb)	2-W10-21	02/22/94	4	400.50	43.882	10.96
	2-W10-21	05/26/94	4	450.00	17.531	3.90
	2-W10-21	08/12/94	4	366.00	46.569	12.72
	2-W10-21	12/14/94	1	444.00	N.C.	N.C.
	2-W10-21	03/09/95	4	469.25	12.093	2.58

[a] area impacted by upgradient source of contamination.

[b] statistics were calculated by replacing not detected values with half of the Method Detection Limit (MDL).

[L] denotes that concentration is below Contract Required Quantitation Limit (CRQL) but above the MDL.

[U] denotes that analyte concentration is not detected (<MDL).

N.C. = not calculated. C.V. = coefficient of variation.

Table C-9.a. Background Statistics[a]--Contamination Indicator Parameter Data for the Low-Level Waste Management Area 3[b].

Constituent	Units	n	Background average	Background standard deviation	Background C.V. (%)
Specific conductance	μmho/cm	12	439.812	26.865	6.11
Field pH		12	8.120	0.294	3.62
TOC	ppb	10	195.75	42.296	21.61
TOX	ppb	9	8.731	7.183	82.28

[a] background summary statistics for TOC and/or TOX were calculated using values below the method detection limits.

[b] area not impacted by upgradient source of contamination.

Table C-9.b. Background Statistics[a]--Contamination Indicator Parameter Data for the Low-Level Waste Management Area 3[b].

Constituent	Units	n	Background average	Background standard deviation	Background C.V. (%)
Specific conductance	µmho/cm	17	580.941	32.230	5.55
Field pH		17	7.838	0.3867	4.93
TOC	ppb	15	367.833	107.483	29.22
TOX	ppb	14	797.923	319.605	40.05

[a] background summary statistics for TOC were calculated using values below the method detection limits.

[b] area impacted by upgradient source of contamination.

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