Pacific Northwest National Laboratory

Operated by Battelle for the
U.S. Department of Energy

Results of RCRA Groundwater Quality Assessment at the 216-B-3 Pond Facility

D. B. Barnett
S. S. Teel

June 1997

RECEIVED
JUL 10 1997
OSTI

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

PNNL-11604

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

MASTER

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor Battelle Memorial Institute, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or Battelle Memorial Institute. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

PACIFIC NORTHWEST NATIONAL LABORATORY

operated by

BATTELLE

for the

UNITED STATES DEPARTMENT OF ENERGY

under Contract DE-AC06-76RLO 1830

Printed in the United States of America

Available to DOE and DOE contractors from the
Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831;
prices available from (615) 576-8401.

Available to the public from the National Technical Information Service,
U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161

This document was printed on recycled paper.

Results of RCRA Groundwater Quality Assessment at the 216-B-3 Pond Facility

D. B. Barnett
S. S. Teel

June 1997

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

Pacific Northwest National Laboratory
Richland, Washington 99352

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, make any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

Summary

This document describes a groundwater quality assessment of the 216-B-3 pond system, a *Resource Conservation and Recovery Act of 1976* (RCRA) waste facility. In 1990, sampling and chemical analysis of groundwater underlying the facility indicated that the contamination indicator parameters, total organic halogens (TOX), and total organic carbon (TOC) had exceeded established limits in two wells. This discovery placed the facility into RCRA groundwater-assessment status and subsequently led to a more detailed hydrochemical analysis of groundwater underlying the facility.

Comprehensive chemical analyses of groundwater samples from 1994 through 1996 revealed one compound, tris (2-chloroethyl) phosphate (TRIS2CH), that may have contributed to elevated TOX concentrations. No compound was identified as a contributor to TOC. Detailed evaluations of TOX, TOC, and TRIS2CH and comparison of occurrences of these parameters led to the conclusions that 1) with few exceptions, these constituents occur at low concentrations below or near limits of quantitation; 2) it is problematic whether the low concentrations of TRIS2CH represent a contaminant originating from the facility or if it is a product of well construction; and 3) given the low and diminishing concentrations of TOX, TOC, and TRIS2CH, no further investigation into the occurrence of these constituents is justified.

Continued groundwater monitoring should include an immediate recalculation of background critical means for upgradient/downgradient comparisons and a return to semiannual groundwater monitoring under a RCRA indicator-parameter-evaluation program.

Contents

Summary	iii
1.0 Introduction	1.1
2.0 Background	2.1
2.1 Facility Description and History of Operation	2.1
2.2 Regulatory Status and History	2.2
2.3 Groundwater Monitoring	2.4
2.4 Previous Reports	2.7
3.0 Hydrogeologic Framework	3.1
3.1 Site Geology	3.1
3.2 Groundwater Hydrology	3.3
3.2.1 Water-Table Elevation	3.3
3.2.2 Groundwater-Flow Direction and Gradient	3.3
3.2.3 Rate of Groundwater Flow	3.6
4.0 Groundwater Chemistry Summary	4.1
4.1 Constituents Detected	4.1
4.2 Elevated TOX and TOC	4.5
5.0 Groundwater Quality Assessment Investigation	5.1
5.1 Approach and Observations	5.1
5.2 Results of Comparisons	5.2
6.0 Discussion and Conclusions	6.1
6.1 Rate and Extent of Contaminant Migration	6.2
6.2 Conclusions	6.2
7.0 Recommendations	7.1
8.0 References	8.1
Appendix A--Known Releases to the Plutonium-Uranium Extraction Facility Chemical Sewer	A.1
Appendix B--Groundwater Analytical Data	B.1

Figures

1.1	Location of Hanford Site and 216-B-3 Pond System	1.2
2.1	216-B-3 Pond System and Associated Structures.....	2.2
2.2	Discharge Volumes to 216-B-3 Pond System, 1976 to 1996	2.3
2.3	Locations of Groundwater Monitoring Wells for 216-B-3 Pond System.....	2.6
3.1	Generalized Stratigraphy of 216-B-3 Pond Area.....	3.2
3.2	Water-Table Map for Area Surrounding 216-B-3 Pond System, January 1997.....	3.5
4.1	Wells in 216-B-3 Pond System Network with at Least One Total Organic Halogen Result Greater than the Limit of Quantitation.....	4.6
4.2	Wells in 216-B-3 Pond System Network with at Least One Total Organic Carbon Result Greater than the Critical Mean.....	4.7
5.1	Wells in 216-B-3 Pond System Network with at Least One TRIS2CH Result Above Method Detection Limit.....	5.3
5.2	Plots of Replicate Averages of Total Organic Carbon and Total Organic Halogens Plotted with Corresponding Sample Results of TRIS2CH	5.4
5.3	Total Organic Halogen Replicate Averages Plotted as a Function of Corresponding TRIS2CH Results.....	5.5
5.4	Total Organic Carbon Replicate Averages for all Wells in 216-B-3 Pond System, 1990 to 1997	5.7
5.5	Total Organic Halogens Replicate Averages for all Wells in 216-B-3 Pond System Network, 1987 to 1997.....	5.8
5.6	Plot of Corresponding Total Organic Halogens, Phosphate, and TRIS2CH Results in Well 699-43-41E, 1989 to 1997.....	5.9

Tables

2.1	216-B-3 Pond System Monitoring Wells and Date of Construction	2.5
2.2	Summary of Previous Reports Related to the 216-B-3 Pond System.....	2.8
3.1	Summary of Aquifer Parameters for the 216-B-3 Pond Area.....	3.4
4.1	216-B-3 Pond System Comprehensive Constituent List	4.2
4.2	Organic and Chlorinated Organic Compounds Detected in Groundwater Analyses for the 216-B-3 Pond System	4.4

1.0 Introduction

The 216-B-3 pond system is a regulated wastewater disposal facility for operations in the 200 East Area of the Hanford Site (Figure 1.1). This pond system has been a *Resource Conservation and Recovery Act of 1976* (RCRA) hazardous waste facility since 1986, when a RCRA (Part A) permit application was submitted to the State of Washington Department of Ecology (DOE 1994a). This document describes the hydrochemical evaluation of groundwater beneath the B Pond system to satisfy requirements for groundwater quality assessment as required by 40 CFR 265.93. This evaluation was performed by Pacific Northwest National Laboratory⁽¹⁾ for the U.S. Department of Energy (DOE).

Groundwater monitoring at the B Pond system began in 1988 under a RCRA indicator-parameter-evaluation program. In 1990, semiannual sampling and analyses indicated that critical means had been exceeded for contamination-indicator parameters total organic halogens (TOX) and total organic carbon (TOC), thus placing the B Pond system into a groundwater quality assessment status.

This document is organized as follows. Section 2.0 gives background information about the B Pond system, including a description of the facility and a history of its operation, regulatory status, groundwater monitoring, and a list of reports. Section 3.0 briefly discusses the hydrogeologic framework underlying the facility. Section 4.0 details the groundwater chemistry determined from sampling performed in the well monitoring network, including the prominent constituents detected. Section 5.0 outlines the quality assessment investigation, its approach and observations, and the results of constituent comparisons. Section 6.0 discusses the results and gives the conclusions drawn therefrom, followed by recommendations in Section 7.0. The references cited in the text are listed in Section 8.0. Additional supporting information is given in the two appendixes.

⁽¹⁾ Pacific Northwest National Laboratory is operated by Battelle for the DOE.

SG97050294.1

Figure 1.1. Location of Hanford Site and 216-B-3 Pond System

2.0 Background

2.1 Facility Description and History of Operation

The B Pond system is located east of the 200 East Area and consists of a main pond, feeder ditches, and three expansion ponds, all constructed for wastewater disposal (Figure 2.1). The B Pond system began receiving effluent in 1945 at the site of the main pond. The main pond was located in a natural topographic depression, was diked on the eastern margin, covered ~14.2 ha, and was ~6.1 m at maximum depth. Three expansion ponds (216-B-3A [3A], 216-B-3B [3B], and 216-B-3C [3C]) were placed into service in 1983, 1984, and 1985, respectively. The 3A and 3B expansion ponds are ~4.5 ha in size; the 3C expansion pond is ~16.6 ha. Water discharged to these ponds infiltrated into the ground and artificially recharged the underlying aquifer. The 216-B-3-1, 216-B-3-2, and 216-B-3-3 ditches were used to convey effluent from the producing facilities in the 200 East Area to the main pond. The three ditches have been backfilled with clean soil and are no longer in use (see Figure 2.1). Details of the operation of these ponds and ditches are presented in DOE (1994a).

In 1994, the main pond and the 216-B-3-3 ditch were filled with clean soil, and all vegetation was removed from the perimeter as part of interim stabilization activities. 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.

The 3C expansion pond currently receives wastewater primarily from B Plant. These streams consist of B Plant cooling water and chemical sewage. Additional sources of effluent to the 3C expansion pond are the 242-A Evaporator (cooling water and steam condensate), 244-AR Vault (liquid effluent), 241-A-702 vessel ventilation system (cooling water), 283-E Water Treatment Facility (filter backwash), and 284-E Powerhouse (liquid effluent). In June 1995, the Plutonium-Uranium Extraction (PUREX) Plant chemical sewer, B Plant chemical sewer, and effluent from the 242-A-81 Water Services Building were rerouted from the 3C expansion pond to the 200 Areas Treated Effluent Disposal Facility (TEDF; Project W-049H). The remaining streams will continue to discharge to the 3C expansion pond until October 1997. At that time, these streams also will be rerouted to the TEDF. These effluent feeds are described in greater detail in DOE (1994a) and Johnson et al. (1995).

In the past, the B Plant steam condensate and chemical sewer were discharged to the B Pond system (primarily the main pond). Potential contaminants contained within past waste streams, which may have entered the groundwater, are discussed in DOE (1994a). An inventory of compounds known to have been sent to the B Pond system and the corresponding volumes of these chemicals are given in Appendix A. A comprehensive discussion of these streams and other chemicals used at the generating facilities is provided in DOE (1994a). During calendar year 1996, the volume of effluent discharged to the 3C expansion pond averaged ~8,400 L/min or 12,000,000 L/day. Discharges to the nearby TEDF

SG97040179.2

Figure 2.1. 216-B-3 Pond System and Associated Structures

averaged ~1,400 L/min or 2,000,000 L/day during 1996. A historical perspective of discharges to the B Pond system is presented in Figure 2.2.

2.2 Regulatory Status and History

During 1994, the original RCRA Part A permit application (DOE 1989) was modified to distinguish the three expansion ponds (3A, 3B, and 3C) from the main pond and the 216-B-3-3 ditch (DOE 1994a). This change allowed clean closure of the expansion ponds to meet Milestone M-17-10 of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989). The expansion ponds were also included in a RCRA facility investigation/corrective measures study for the 200-BP-11 Operable Unit (DOE 1994b).

Figure 2.2. Discharge Volumes (by year) to 216-B-3 Pond System, 1976 to 1996
(after Johnson et al. 1995)

Activities conducted as part of the closure process for the expansion ponds include: 1) soil and sediment sampling, 2) interim stabilization of the 3A expansion pond, and 3) decontamination and removal of structures and associated fixed equipment (DOE 1994a). The soil- and sediment-sampling activities are briefly summarized below.

Soil- and sediment-sampling activities in support of closure were conducted in three phases. Phase I (completed in 1989) consisted of surface soil and sediment sampling in the expansion ponds, the main pond, and the 216-B-3-3 ditch. Phase 2 sampling (completed in 1992) consisted of confirmation sampling within the expansion ponds. Phase 3 sampling (completed in 1991 prior to Phase 2 sampling) consisted of soil and sediment sampling from the vadose zone beneath the expansion ponds. Results of all three phases showed no evidence of contamination (DOE 1994a).

The potential of the B Pond system to be a source of future groundwater contamination is summarized in Johnson et al. (1995). That assessment report was required as part of Milestones

M-17-00A and M-17-00B in Ecology et al. (1989). The report addressed the impact of continued discharge of uncontaminated water to the 3C expansion pond until 1997 and concluded the following:

- Based on groundwater modeling, only minor changes will occur in the existing flow regime beneath the pond and in the vicinity of the 200 East Area through the modeled period (ending June 1997).
- The groundwater mound resulting from effluent discharge will not remobilize any potential soil column contaminants to the groundwater.
- The effects on existing groundwater contamination plumes by effluent discharges will be negligible through the modeled period (ending June 1997).

The B Pond system also falls within the 200-BP-11 Source Operable Unit and the 200-BP-5 and 200-PO-1 Groundwater Operable Units, which are regulated under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) program (DOE 1994b).

2.3 Groundwater Monitoring

RCRA groundwater monitoring of the B Pond system began in 1988 with an indicator-parameter-evaluation program. The initial program was described by Luttrell et al. (1989). Groundwater monitoring was elevated from a RCRA detection-level program to an assessment program in 1990 because of elevated TOX and TOC levels in two downgradient wells. A groundwater quality assessment plan (Harris 1990) was submitted to the State of Washington Department of Ecology in May 1990. Activities to be performed under the assessment plan were divided into two phases: Phase I consisted of confirming the elevated TOX values and developing a time profile of TOX concentration changes, and Phase II consisted of 1) continued TOX monitoring, 2) identification of the chemical constituents causing the elevated TOX values, 3) identification of source(s) of these constituents, and 4) data verification to ensure against false positives. The results of assessment activities to date are presented in Sections 4.0 and 5.0.

A list of the wells in the current RCRA groundwater monitoring network and their dates of construction is shown in Table 2.1; well locations are shown in Figure 2.3. The maximum number of wells (25) was monitored from 1993 until late 1995. Three of these wells are part of the TEDF groundwater monitoring network. These three wells were monitored for informational purposes only and are not officially part of the RCRA-regulated B Pond system network. In 1995, the number of wells in the network was reduced to eliminate redundancy and to focus resources on additional hydrochemical analyses in the remaining wells. Ten of the network wells monitor groundwater near the water table; the remaining 15 wells are screened at deeper levels in the aquifer. Four well clusters, involving nine wells, are situated to provide vertical definition of aquifer conditions.

Table 2.1. 216-B-3 Pond System Monitoring Wells and Date of Construction

Well	Date of Construction	Comments
299-E18-1	1988	Upgradient monitoring well
299-E32-4	1987	Upgradient monitoring well
699-40-36	1992	TEDF monitoring well ^(a)
699-40-39	1989	Dropped from monitoring network in 1995
699-40-40A	1991	Cluster location with well 699-40-40B
699-40-40B	1991	Cluster location with well 699-40-40A Dropped from monitoring network in 1995
699-41-35	1992	TEDF monitoring well ^(a)
699-41-40	1989	Downgradient well
699-41-42	1992	Downgradient well
699-42-37	1992	TEDF monitoring well ^(a)
699-42-39A	1991	Cluster location with well 699-42-39B Dropped from monitoring network in 1995
699-42-39B	1991	Cluster location with well 699-42-39A
699-42-40A	1981	Dropped from monitoring network in 1995
699-42-41	1991	Downgradient well
699-42-42B	1988	Cluster location with well 699-43-42J
699-43-40	1991	Downgradient well
699-43-41E	1989	Cluster location with wells 699-43-41F, -41G
699-43-41F	1989	Cluster location with wells 699-43-41E, -41G Dropped from monitoring network in 1995
699-43-41G	1991	Cluster location with wells 699-43-41E, -41F
699-43-42J	1988	Cluster location with well 699-42-42B Dropped from monitoring network in 1995
699-43-43	1988	Dropped from monitoring network in 1995
699-43-45	1989	Downgradient well
699-44-39B	1992	Downgradient well
699-44-42	1988	Dropped from network in 1995
699-44-43B	1989	Downgradient well

(a) Included in B Pond system data sets for informational purposes only.

TEDF = 200 Areas Treated Effluent Disposal Facility.

SG97040179.4

Figure 2.3. Locations of Groundwater Monitoring Wells for 216-B-3 Pond System

Additional RCRA monitoring and characterization activities are described in the revised interim-status groundwater monitoring plan (Sweeney 1995), and closure activities are described in DOE (1994a, 1994b).

2.4 Previous Reports

A list of the major previous reports related to the B Pond system is presented in Table 2.2. Included in this table are the following:

- RCRA planning documents (e.g., groundwater monitoring plan)
- RCRA quarterly and annual reports
- other topical reports (e.g., hydrogeologic characterization)
- CERCLA reports.

RCRA planning documents provide guidance and documentation for RCRA groundwater monitoring and closure activities. RCRA groundwater monitoring quarterly reports publish analytical data and provide updates on monitoring activities. RCRA groundwater monitoring annual reports provide interpretation of analytical data, an evaluation of the adequacy of the monitoring network, and a summary of monitoring activities and results for the period. Other reports provide additional sources of data (e.g., borehole completion data packages) and CERCLA-related activities.

Table 2.2. Summary of Previous Reports Related to the 216-B-3 Pond System

Type of Report	Reference(s)
RCRA Plans	
Interim-status groundwater monitoring plan	Luttrell et al. (1989), Sweeney (1995)
Groundwater quality assessment plan	Harris (1990)
Closure plan	DOE (1989, 1994a)
RCRA Quarterly Reports (Fiscal Year)	
1988	PNL (1988a, b, c), Fruland et al. (1989a)
1989	Fruland et al. (1989b), Smith et al. (1989a, b, c)
1990	Smith et al. (1990), DOE (1990a, b)
1991	DOE (1991a, b, c, d)
1992	DOE (1992a, b, c, d)
1993	DOE (1993a, b, c; 1994c)
1994	DOE (1994d, e, f; 1995a)
1995	DOE (1995b, c, d, e)
RCRA Annual Reports (Fiscal Year)	
1988	Fruland and Lundgren (1989)
1989	Smith and Gorst (1990)
1990	DOE (1991e)
1991	DOE (1992e)
1992	DOE (1993d)
1993	DOE (1994g)
1994	DOE (1995f)
1995	DOE (1996)
1996	Hartman and Dresel (1997)
Other Reports	
Interim hydrogeologic characterization report	WHC (1990)
Borehole completion data packages	Delaney (1992a, b, c); Delaney 1993
Groundwater impact assessment report	Johnson et al. (1995)
CERCLA Report	
200-BP-11 OU and 216-B-3 work/closure plan	DOE (1994b)

3.0 Hydrogeologic Framework

This section discusses the hydrogeologic framework of the B Pond system area, including site geology and groundwater hydrology. The hydrogeology of the B Pond system and vicinity is discussed in more detail in WHC (1990), Davis et al. (1993), DOE (1994a), and Johnson et al. (1995).

3.1 Site Geology

The major geologic units beneath the B Pond system include (in ascending stratigraphic order) the Columbia River Basalt Group, the Ringold Formation, and the Hanford formation. A generalized stratigraphic diagram of the B Pond area is shown in Figure 3.1. The Hanford and Ringold Formations will be discussed in this section because these formations comprise the uppermost unconfined aquifer and vadose zone in the area of B Pond system. The uppermost aquifer beneath the B Pond system occurs primarily within sediments of the Ringold Formation, with the Hanford formation comprising the vadose zone. The Columbia River Basalt Group acts as the regional lower boundary for the uppermost unconfined aquifer. Davis et al. (1993) and DOE (1994a) provide a general description of the Columbia River Basalt Group in the vicinity of the B Pond system, and reference other reports that discuss this unit in more detail.

Ringold Formation sediments consist of (in ascending stratigraphic order): 1) unit A gravel and 2) lower mud sequence. The Ringold unit A gravel ranges in thickness from ~12 m in the area northwest of the main pond to ~30 m in the southern portion. This unit is mainly composed of a silty sandy gravel with secondary lenses and interbeds of gravely sand, sand, and muddy sands to clay/silt (DOE 1994a). The Ringold lower mud sequence is not present in the northwestern portion of the B Pond system but is ~24 m thick near the southern extreme of the 3C expansion pond. The lower mud unit consists of brown clay, silt, and various mixtures of silt and clay (DOE 1994a).

The Hanford formation ranges in thickness from 40 m beneath the 3C expansion pond to ~50 m at the northwestern corner of the main pond (Davis et al. 1993). The Hanford formation is represented by three facies in ascending stratigraphic order: 1) lower gravel sequence, 2) sandy sequence, and 3) upper gravel sequence (subdivisions after Lindsey et al. 1992). The upper and lower gravel sequences are not differentiated in those areas where the intervening sandy sequence is absent. These gravel units consist of coarse-grained, basalt-rich, sandy gravels with varying amounts of silt/clay. These gravel units may also contain interbedded sand and or silt/clay lenses. The sandy sequence is dominated by sand to gravely sand with minor sandy gravel or silt/clay interbeds. The sandy sequence is present mainly in the vicinity of the main pond.

SG97040179.5

Figure 3.1. Generalized Stratigraphy of 216-B-3 Pond Area

3.2 Groundwater Hydrology

The thickness of the uppermost aquifer at B Pond ranges from ~10 m at well 699-44-43B to > 30 m at the southern end of the 3C expansion pond. The water-table/potentiometric surface occurs near the Hanford-Ringold contact, with the Ringold Formation comprising the bulk of the uppermost aquifer. This aquifer has characteristically been referred to as unconfined. However, more recent hydrogeologic data suggest that portions of the aquifer may be semiconfined to confined (DOE 1994a). These data suggest that the aquifer is unconfined to the west and north of the main pond and becomes semiconfined to confined beneath the 3C expansion pond. The change from unconfined to confined is apparently gradational, and no marked transition is evident from the hydraulic head values measured in the confined and unconfined portions of the aquifer (DOE 1994a).

A summary of aquifer parameters, including horizontal head gradient, hydraulic conductivity, vertical gradient, effective porosity, groundwater-flow rate, and transmissivity, is given in Table 3.1. A summary of aquifer test results can be found in DOE (1994a).

3.2.1 Water-Table Elevation

Potentiometric-surface elevations are currently measured in all wells in the monitoring network at the time of quarterly groundwater sampling. Water levels are also measured in select wells in conjunction with the sitewide monitoring program. The configuration of the potentiometric surface in the vicinity of the B Pond system for January 1997 is shown in Figure 3.2.

3.2.2 Groundwater-Flow Direction and Gradient

Groundwater flows radially outward from the groundwater mound, the apex of which is approximately located in the vicinity of the 3B expansion pond. Based on June 1996 water-level measurements, the horizontal component of hydraulic gradient near B Pond varies from ~0.003 east of the mound apex to 0.006 west-southwest of the former location of the main pond. The mound was created by large volumes of wastewater recharging the uppermost unconfined aquifer and significantly altered the original groundwater-flow pattern of the area.

The vertical hydraulic gradient was calculated for four well pairs in the network, representing deep and shallow completions. All four pairs indicate a definitively downward hydraulic gradient. Because the screens in each of these wells are open to several meters of aquifer thickness, potentiometric measurements used for the calculations should be considered approximations. The well pairs and the calculated hydraulic gradients for June 1996 are shown in Table 3.1.

Table 3.1. Summary of Aquifer Parameters for the 216-B-3 Pond Area

Value	Location	Comments
Horizontal Head Gradient		
0.003	Beneath 216-B-3B expansion pond	Hartman and Dresel (1997)
0.006	West-southwest of main pond	Hartman and Dresel (1997)
Vertical Gradient		
0.13	699-43-42J/699-42-42B	Downward gradient (Hartman and Dresel 1997)
0.06	699-40-40A/40B	Downward gradient (Hartman and Dresel 1997)
0.01	699-42-39A/39B	Downward gradient (Hartman and Dresel 1997)
0.07	699-43-41E/41G	Downward gradient (Hartman and Dresel 1997)
Hydraulic Conductivity		
640 m/d	Hanford formation	WHC (1990)
1 m/d	Hanford formation	Thorne et al. (1993, 1994)
1.5 m/d	Ringold Formation	WHC (1990)
Effective Porosity		
0.1 to 0.3	Value for both Hanford and Ringold Formations at B Pond area	WHC (1990)
Groundwater-Flow Rate		
0.2 to 2.7 m/d	Numerical modeling of B Pond area, tritium concentration tracking	Freshley and Graham (1988), Freshley and Thorne (1992)
0.07 to 0.57 m/d	TEDF site, Ringold Formation unit A, wells 699-40-36 and 699-42-37	Barnett et al. (1994). Downhole flow-meter measurement
0.002 to 0.2 m/d	TEDF site, Ringold Formation unit A	Davis et al. (1993). Calculated from hydraulic conductivity values from pumping tests, hydraulic gradient, and effective porosity from borehole samples
0.009 to 0.03 m/d	Ringold Formation	Calculated value based on WHC (1990) hydraulic conductivity and effective porosity values and May 1989 head gradients (DOE 1996)
0.02 to 0.09 m/d	Ringold Formation	Calculated value based on WHC (1990) hydraulic conductivity and effective porosity values and June 1994 head gradients (DOE 1996)
15 to 46 m/d	Hanford formation	Calculated value based on WHC (1990) hydraulic conductivity and effective porosity values and May 1989 head gradients (DOE 1996)
0.01 to 38.4 m/d	Hanford formation	Calculated value based on available hydraulic conductivity and effective porosity values and June 1994 head gradients (DOE 1996)
Transmissivity		
0.2 to 28.8 m ² /d	Ringold (confined)	DOE (1994a)
0.03 to 6.6 m ² /d	Ringold (unconfined)	DOE (1994a)
3,437 to 7,060 m ² /d	Hanford/Ringold	DOE (1994a)
27 to 32 m ² /d	Hanford formation	Thorne et al. (1993)

TEDF = 200 Areas Treated Effluent Disposal Facility.

97jpm150 May 29, 1997 4:21 PM

Figure 3.2. Water-Table Map for Area Surrounding 216-B-3 Pond System, January 1997

3.2.3 Rate of Groundwater Flow

Estimates of groundwater-flow rates in the vicinity of the 200 East Area have been performed based on numerical modeling and simple tracking of tritium migration from the 200 East Area operations to the Columbia River (Freshley and Graham 1988, Freshley and Thorne 1992). The average horizontal groundwater-flow rate determined by these methods is estimated at 0.2 to 2.7 m/d. However, these estimates incorporate a large area around the B Pond system and, thus, may involve a large range of aquifer properties.

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

$$\bar{v} = KI/n_e \quad (3.1)$$

where

- $\bar{v}$ = average linear groundwater velocity (rate)
- K = hydraulic conductivity
- I = head gradient (horizontal)
- n_e = effective porosity.

For the B Pond system, hydraulic conductivity has been approximated at 640 m/d for the Hanford formation and 1.5 m/d for the Ringold Formation. Estimated effective porosity ranges were from 0.1 to 0.3 for both the Hanford and Ringold Formations (WHC 1990). However, Thorne et al. (1993, 1994) estimated horizontal hydraulic conductivity of the Hanford formation near the B Pond system at no more than 1 m/d. This is because of the higher mud content in some of the Hanford formation sediments at this location. Figure 3.2 indicates an area immediately west of the main pond with higher hydraulic gradient, which may be a manifestation of the lower hydraulic conductivity in that area.

Estimates of average linear flow velocity ($\bar{v}$) based on head gradients in May 1989 and aquifer properties (K and n) yielded rates from 0.009 to 0.03 m/d for the Ringold Formation and 15 to 46 m/d for the Hanford formation (WHC 1990). Performing this same calculation with head gradients observed for June 1994 and using the extreme values known for hydraulic conductivity, gradient, and effective porosity, groundwater-flow velocities are estimated to range between 0.02 to 0.09 m/d for the Ringold Formation and 0.01 to 38.4 m/d for the Hanford formation (DOE 1996). Virtually all groundwater flow beneath the B Pond system occurs within the Ringold Formation.

Groundwater-flow velocities estimated at the TEDF site ranged from 0.002 to 0.2 m/d within 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 TEDF site using a heat-pulse flow meter. The details of this investigation are presented in Barnett et al. (1994, 1995). Groundwater-flow velocities determined by this method ranged from an estimated average of 0.07 m/d in well 699-40-36 to 0.57 m/d in well 699-42-37. These wells are screened within the Ringold Formation unit A gravel.

4.0 Groundwater Chemistry Summary

Groundwater sampling from the B Pond system well network began in 1988 for background determination. Indicator-parameter evaluation continued until 1990, when elevated levels of TOX and TOC in two wells (699-43-41E and 699-43-41F) placed the facility into assessment-monitoring status. Assessment monitoring has remained in effect since 1990, primarily because of the continued occurrence of TOX in network wells, nonresolution of sources of TOX, interruption of analytical services during 1990 and 1991, and uncertainty over validity of TOX analyses during 1993 and 1994 (discussed in Section 4.2).

The list of constituents sought in groundwater analyses from the B Pond system has been repeatedly modified since groundwater monitoring first began at the facility. The modifications were the result of an evolving understanding of groundwater chemistry peculiar to the B Pond system and surrounding areas. Table 4.1 is a comprehensive list of the constituents sought in B Pond system groundwater analyses. Actual constituent lists are subsets of the list in Table 4.1. Groundwater from each of 25 wells used for the B Pond system monitoring network (see Table 2.1) was also analyzed at least once for the list of constituents in 40 CFR 264 (Appendix IX) during a well's first year of service.

Over the life of the network thus far (April 1997), 60,590 results have been produced from groundwater samples from all 25 wells. Of this number, 40,979 were below the method detection limits (MDLs). An additional 408 were flagged as suspect ("Y") or rejected ("R"), and 1,973 were below the contractually required quantitation limits. Only results that were above the MDL and not flagged Y or R were used for purposes of study and interpretation in this document.

4.1 Constituents Detected

Tritium and nitrate are the only contaminants consistently identified in the B Pond system groundwater monitoring network that can be readily attributed to facility operations. Of these two constituents, only tritium has occurred above the federal interim drinking water standard (DWS). TOX and TOC have occurred above the MDL in all wells in the network at low levels but have not been definitively linked to a specific compound. Numerous other compounds have been observed above the MDL, and some metals have exceeded the DWS. Most of these occurrences can be attributed to well construction, natural groundwater conditions, or sample contamination. The constituents in groundwater beneath the B Pond system are discussed below.

Tritium is a radiological groundwater quality parameter with a DWS of 20,000 pCi/L. Tritium was monitored for quarterly in each well in the B Pond system network from the beginning of groundwater monitoring in 1988 until mid-1995 (several wells were added to the network during this time). Records for pre-RCRA tritium monitoring in some wells date back to 1984. At the beginning of RCRA

Table 4.1. 216-B-3 Pond System Comprehensive Constituent List

Contamination-Indicator Parameters		
pH	Total organic carbon	
Specific conductance	Total organic halogens	
Groundwater Quality Parameters		
Chloride	Manganese	Sodium
Iron	Phenols	Sulfate
Drinking Water Parameters		
2,4-D	Fluoride	Nitrate
2,4,5-TP	Gross alpha	Radium
Arsenic	Gross beta	Selenium
Barium	Lead	Silver
Cadmium	Lindane	Silvex
Chromium	Mercury	Toxaphene
Coliform bacteria	Methoxychlor	Turbidity
Endrin		
Site-Specific Parameters		
Alkalinity	Anions	Inductively coupled-plasma metals
Ammonium	Hydrazine	Tritium
Assessment-Monitoring Parameters		
Herbicides	Polychlorinated biphenyls	
Pesticides	Volatile, semivolatile organic compounds	

groundwater monitoring in 1988, 13 wells produced results for tritium above the maximum contaminant level. The highest result, 232,000 pCi/L, was recorded from well 699-41-40 in December 1989. In June 1996, sampling of this well for the sitewide environmental monitoring program produced a tritium result of 111,120 pCi/L. By mid-1995, just before tritium was dropped from the RCRA constituent list at the B Pond system, only 8 wells produced results above the DWS, and trends in all wells in the network were definitively downward. Tritium is currently monitored on an annual basis in some wells in the B Pond system by the sitewide monitoring program.

Nitrate concentrations have been above Hanford Site background, $5,170 \pm 3,576$ $\mu\text{g/L}$ (Johnson 1993), in several wells in the monitoring network, but no result has exceeded the primary 45,000- $\mu\text{g/L}$ DWS. The highest result produced thus far is 22,500 $\mu\text{g/L}$ in well 699-41-40 in January 1990. Since 1990, nitrate concentrations have continued to decline in all wells in the network.

Out of 432 analyses for phosphate, only 19 were above the MDL, with 14 of these taken from well 699-43-41E. This well also produced the highest phosphate result, 3,200 µg/L, in the B Pond system network. The remaining five results are from wells 699-43-41F (4) and 699-40-40B (1). The relationship of this anion to potential contamination by a chlorinated organic compound is discussed in Sections 5.0 and 6.0.

Iron and chromium in unfiltered samples routinely exceeded the DWS in most wells in the B Pond system network. Manganese concentrations frequently exceeded the DWS in filtered samples from 10 of the 25 wells in the network. The occurrence of particulate chromium and iron in Hanford Site wells has been attributed to residues of well construction (Dresel et al. 1995). Dissolved manganese may occur naturally as a function of the oxygen content of groundwater (Johnson et al. 1995).

Ammonium and hydrazine were, for several years, included in the site-specific analytical list because of the reported abundance of these compounds in the facility's waste stream (DOE 1994a). However, ammonium was detected only intermittently at low concentrations (highest was 200 µg/L in upgradient well 299-E32-4). Hydrazine analyses produced only three low-level results, the highest of which was 5 µg/L in well 699-40-36.

Several organic and chlorinated organic compounds have been detected sporadically at very low concentrations in the B Pond system network and are listed in Table 4.2. Many of these compounds, such as acetone, methylene chloride, methanol, and phthalates, are typically ascribed to laboratory contamination (EPA 1986a, 1994). The occurrence of gasoline, oil and grease, and related compounds in July 1995 in the wells shared with the TEDF is enigmatic. Contamination from aquifer-testing activities at the TEDF (DOE 1994g) is suspected but no source was confirmed nor were these compounds detected in subsequent quarterly analyses. In addition to the compounds listed in Table 4.2, several tentatively identified compounds were reported in 10 of the network wells in 15 instances. Most of these results are reported as "unknown oxyhydrocarbons" or "unknown phthalates." All are estimated quantities from 4 to 13 µg/L, and most are associated with blank contamination.

Three compounds, bis (2-ethylhexyl) phthalate (BIS2EPH), methylene chloride, and tris (2-chloroethyl) phosphate (TRIS2CH), have been detected in samples from several wells on an intermittent basis. One of these wells, 699-43-41E, produced most of the results for TRIS2CH and the highest TOX results. TRIS2CH and BIS2EPH are components of plastics manufacturing, and may have been present in discharges to the main pond and/or products of pipeline and well construction (Section 6.0). These compounds are discussed further in Section 5.0 in relation to TOC and TOX occurrences.

TOX and TOC are contamination-indicator parameters and are used for comparison of analytical results in the upgradient well(s) to results in the downgradient wells. These are the parameters responsible for the assessment-monitoring status at the B Pond system. Averaged results of four replicate samples from each downgradient well are compared with established critical means in the upgradient well. Historical data for these two parameters are discussed in Section 4.2.

Table 4.2. Organic and Chlorinated Organic Compounds Detected in Groundwater Analyses for the 216-B-3 Pond System

Analyte	Total Number of Detections/Total Number of Wells	Highest Result (µg/L) ^(a)	Well with Highest Result	Date
Organic Compounds				
Bis (2-ethylhexyl) phthalate	23/14 ^(b)	100 (J)	699-41-35	Jan-94
2,4-Dimethylphenol	5/5	8	699-43-42J	Jan-92
2,4-Dinitrophenol	2/2	120	699-42-41	Jan-92
2-Nitrophenol	2/2	28	699-42-41	Jan-92
Acetone	3/3	12	699-43-42J	Aug-89
Benzene	1/1	1.7	699-42-39B	Apr-93
Benzothiazole	1/1	0.49	699-43-45	Jul-96
Butylbenzylphthalate	2/2	2	699-43-43	Apr-95
Di-n-butylphthalate	1/1	1	699-42-39A	Apr-95
Diethyl ether	1/1	5,000	699-40-36	Jul-95
Diethylphthalate	1/1	24	699-40-40B	Oct-94
Ethanol	1/1	5,000	699-40-36	Jul-95
Ethyl acetate	1/1	5,000	699-40-36	Jul-95
Ethylbenzene	1/1	2	699-44-39B	Apr-93
Ethylene glycol	3/3	5,000	699-40-36	Jul-95
Gasoline	4/3	118,000	699-41-35	Jul-95
Methanol	1/1	5,000	699-40-36	Jul-95
Oil and grease	7/3	63,300	699-41-35	Jul-95
Phorate	2/2	11	699-43-42J	Jan-92
Phenol	2/2	10	699-42-41	Jan-92
Toluene	6/6	54	699-43-41F	Jan-91
Chlorinated Organic Compounds				
4,4'-DDD	6/4	0.02	699-42-37	Jul-95
4,4'-DDT	3/3	0.06	699-41-35	Jul-95
Aldrin	3/1	0.01	699-42-37	Oct-95
cis-1,2-Dichloroethylene	3/1	1	699-42-37	Feb-93
Endosulfan I	1/1	0.01	699-41-35	Oct-95
Gamma-BHC (Lindane)	3/3	0.01	699-41-35	Oct-95
Heptachlor	7/3	0.04	699-44-39B	Apr-94
Heptachlor epoxide	1/1	0.01	699-40-36	May-93
Methylene chloride	15/11 ^(b)	6	699-42-42B	Jan-90
Tetrachlorophenol	1/1	10	699-40-40B	Jan-92
Tris (2-chloroethyl) phosphate	22/8	178(J)	699-43-41E	Sep-91

(a) Some results associated with blank contamination.

(b) Includes upgradient well.

J = Estimated value.

4.2 Elevated TOX and TOC

When a statistical background was established for B Pond system upgradient wells 299-E18-1 and 299-E32-4 in 1990, critical means calculated for TOX in these wells were below the limit of quantitation (LOQ) (Harris 1990). For this reason, the LOQ for TOX was substituted for the critical mean, as recommended in the *RCRA Ground Water Monitoring Technical Enforcement Guidance Document* (EPA 1986b). A critical mean was derived for TOC from samples taken during the same time period. The LOQ for TOX (15.4 µg/L) and critical mean for TOC (843.6 µg/L) were used for upgradient-downgradient well comparison. Six months after these background values were established in 1990, two wells, 699-43-41E and 699-43-41F, exceeded the LOQ for TOX and critical mean for TOC. This occurrence, and subsequent verification-sampling results, placed the B Pond system groundwater monitoring program into assessment-monitoring status. For purposes of regulatory and statistical evaluation, only the averages of four replicates taken at each sampling event for TOX, TOC, specific conductance, and pH are used for upgradient-downgradient comparison. Results of replicate averages for TOX and TOC are listed in Appendix B. For purposes of this study, these averages are calculated using only individual results above the MDL that have no Y or R flags.

Laboratory audits and surveillances conducted during 1993 and 1994 indicated serious deficiencies in TOX analytical procedures, and hence, in the reliability of results (DOE 1994g, 1995f). Audit and surveillance findings stated that most TOX results supplied by the primary hazardous chemistry laboratory from January 1992 through November 1993 be treated as suspect or rejected. Similar problems were discovered for some TOX results from samples taken during 1995. As a result of the findings, all results that were rejected or suspect have been flagged R or Y, respectively, and are not used for interpretation in this document. The main ramification of these problems is that the available database for TOX interpretation and study is materially reduced. Out of 1,859 individual analyses for TOX, 377 were above the MDL and do not have R or Y flags.

A total of nine wells, including both upgradient wells, have historically produced at least one replicate average for TOX above the LOQ (15.4-µg/L) (Figure 4.1). Well 699-43-41E produced the greatest number of replicate averages (four) that exceeded the LOQ during the period December 1989 to June 1991. This well also produced the highest replicate average (1,205 µg/L in May 1990). During April 1990, well 699-43-41F also produced an extreme TOX replicate average (1,184 µg/L). All subsequent replicate averages for these two and other network wells were 10 to 100 times lower than the two extreme averages. The overall mean of TOX replicate averages for the entire network (see Appendix A) is 13.1 ± 19.3 µg/L, excluding the two extreme values noted above.

The TOC analyses have not been affected by the problems associated with TOX; hence, a greater number of valid results are available for interpretation. TOC analyses total 1,985, of which 897 have results above the MDL with no Y or R flags. The critical mean for TOC, 843.6 µg/L, was exceeded by replicate averages at least once each in 10 wells in the B Pond system network. The highest replicate average, 2,000 µg/L, occurred in well 699-42-39B in April 1992. Wells in the B Pond system network that have produced at least one replicate average result above the 1990 critical mean for TOC are shown in Figure 4.2.

Figure 4.1. Wells in 216-B-3 Pond System Network with at Least One Total Organic Halogen Result Greater than the Limit of Quantitation

Figure 4.2. Wells in 216-B-3 Pond System Network with at Least One Total Organic Carbon Result Greater than the Critical Mean

5.0 Groundwater Quality Assessment Investigation

The *Groundwater Quality Assessment Plan for the 216-B-3 Pond System* (Harris 1990) outlines the basic strategy and fundamental criteria for evaluating assessment-monitoring results. The plan suggested a two-phase approach to assessing groundwater contamination. Because of analytical laboratory problems and evolution of the understanding of the groundwater chemistry at the B Pond system, the phases were combined for efficacy. The basic elements of the strategy presented by Harris (1990) are the following:

- develop a time profile of TOX (and TOC) occurrences
- evaluate laboratory occurrences for circumstances that may lead to false positives or errors in TOX and TOC results
- determine if elevated TOX and TOC are contamination from operation of the B Pond system
- select analyses that will allow identification of specific constituents contributing to elevated TOX and TOC (these include herbicides, pesticides, polychlorinated biphenyls, volatile organic compounds, and semivolatile organic compounds)
- determine the lateral and vertical distribution of contaminants, if contamination is present.

These elements formed the basis for a fundamental approach to investigation into causal factors of TOX and TOC occurrence in the B Pond system well network. To aid in the investigation, data were collected and evaluated from the three TEDF wells, 699-40-36, 699-41-35, and 699-42-37, even though these wells are not within the RCRA regulatory structure of the B Pond system. The actual details of the approach to and execution of this investigation are presented in Section 5.1. The results of the investigation and implications of the results are discussed in Sections 5.2 and 6.0.

5.1 Approach and Observations

Comprehensive assessment-monitoring sampling and analysis from 1991 through 1993 revealed a recurrence of the semivolatile organic compound TRIS2CH in some wells in the monitoring network (see Section 4.1). The compound was identified in early 1994, and thereafter, analyses were performed quarterly during a 2-year period from July 1994 to July 1996 to establish a database for possible correlation of TRIS2CH and other similar compounds with TOX and TOC. This schedule continued through the July 1996 sampling event, at which time analyses for semivolatile organic compounds were discontinued. Concurrent problems with laboratory procedures for TOX analysis introduced uncertainty in reliability; thus, the analyses were performed for a 2-year period to ensure a sufficient quantity of acceptable data for comparison (see Section 4.2).

Compilation of data for organic and halogenated (i.e., chlorinated) organic compounds detected from 1990 to 1996 (see Table 4.2) indicate that three compounds occurred with sufficient regularity and in such quantities as to be potential contributors to TOX and/or TOC concentrations: BIS2EPH, methylene chloride, and TRIS2CH. All other constituents in Table 4.2 were detected so infrequently and in such minute quantities that they cannot justifiably be considered significant contributors to elevated TOX and TOC results. Results of comparisons between TOX, TOC, and these three organic compounds are discussed in Section 5.2.

5.2 Results of Comparisons

The most frequently identified organic compound in B Pond system groundwater analyses is BIS2EPH ($C_{24}H_{38}O_4$), detected 23 times in 14 wells. Five of the 23 results are associated with blank contamination. The 100- $\mu\text{g/L}$ result, occurring in TEDF well 699-41-35, is far higher than the remaining 22 results. The second highest result is 35 $\mu\text{g/L}$, and the remaining results are from 0.4 to 20.0 $\mu\text{g/L}$. Results for TOC (see Appendix B) are typically in the range of several hundred micrograms per liter and have a large standard deviation (see Section 4.2). Hence, significant contribution by BIS2EPH to TOC levels cannot be demonstrated. Because this compound contains no halogens, it does not contribute to TOX concentrations. Additionally, phthalates are common laboratory contaminants and artifacts (EPA 1994). For these reasons, BIS2EPH is not given further consideration as a potential source of groundwater contamination.

As noted in Section 4.1, methylene chloride (CH_2Cl_2) is a halogenated compound occurring with relative frequency and has been detected in samples from 11 wells from 1991 to 1996. Out of 145 analyses, however, only 14 were above the MDL. Of these 14 results, 13 were associated with blank contamination, thus rendering most of the data invalid for comparison to other groundwater parameters. Additionally, only one reliable TOX result (above MDL and no Y or R flags) corresponds to a methylene chloride result. Methylene chloride is also a well-known laboratory contaminant. These circumstances disqualify methylene chloride as a source of TOX or TOC anomalies.

Since 1991, 200 analytical results for TRIS2CH ($[\text{ClC}_2\text{H}_4\text{O}]_3\text{PO}$) have been produced from the B Pond system, including results from the three wells in the TEDF network. Of the 200 results, only 22 were above the MDL, and 14 were above the contractually required quantitation limits. TRIS2CH has been detected in groundwater analyses from eight of the B Pond system wells (Figure 5.1). The highest result occurred in a sample from well 699-43-41E in September 1991 (qualified as an "estimated value"). Unfortunately, no TOX results were available for this well on the same date. However, that same well subsequently produced 9 of the 22 TRIS2CH results above the MDL at the B Pond system.

Figure 5.2 is a plot of all detected, nonqualified (no R or Y flags) TRIS2CH results with corresponding replicate average results of TOX and TOC from the same sampling events in B Pond system wells. The general distribution of these parameters shows a decline in concentrations of all three analytes beginning in early 1993. However, when TOX is plotted as a function of TRIS2CH results (Figure 5.3), no discernible relationship is evident. If total TOX concentration were a simple function of

Figure 5.1. Wells in 216-B-3 Pond System Network with at Least One TRIS2CH Result Above Method Detection Limit

Figure 5.2. Plots of Replicate Averages of Total Organic Carbon and Total Organic Halogens Plotted with Corresponding Sample Results of TRIS2CH

Figure 5.3. Total Organic Halogen Replicate Averages Plotted as a Function of Corresponding TRIS2CH Results

the chlorine content of TRIS2CH, all TOX f(TRIS2CH) points would nominally lie along the chlorine line for TRIS2CH in Figure 5.3. Only one point is nearly coincident with this line. The remaining data lie above the line, evincing possible halogen sources other than TRIS2CH.

Replicate average plots of TOC and TOX for the B Pond system network are shown in Figures 5.4 and 5.5, respectively. These are averages of results above the MDL that have no Y or R flags. Both plots indicate a period with generally higher concentrations of these two constituents, prior to 1991 for TOX and prior to 1993 for TOC. A hiatus in sampling and analysis from mid-1990 to mid-1991 produced the gap in data for that period.

As noted in Sections 4.1 and 5.2, well 699-43-41E produced 41% of all detected TRIS2CH data, the highest results for TOX, and anomalous levels of phosphate. Because phosphate is a component of the TRIS2CH molecule, these two species, along with TOX, were plotted for comparison for this well. Figure 5.6 suggests general concordance in trends between these three analytes, though maxima for each do not coincide. The two highest results for TRIS2CH were collected on the same day in 1991, and are qualified as "estimated" values.

Figure 5.4. Total Organic Carbon Replicate Averages for all Wells in 216-B-3 Pond System, 1990 to 1997

Figure 5.5. Total Organic Halogens Replicate Averages for all Wells in 216-B-3 Pond System Network, 1987 to 1997

Figure 5.6. Plot of Corresponding Total Organic Halogens, Phosphate, and TRIS2CH Results in Well 699-43-41E, 1989 to 1997

6.0 Discussion and Conclusions

Results of comparison of TOX concentrations with occurrences of the chlorinated compound TRIS2CH indicate that this compound alone cannot be a cause of the observed TOX results. Figures 5.2 and 5.6 show a coincidence in trends between TOX, TOC, and TRIS2CH. Figure 5.3 indicates that TRIS2CH may be a significant contributor to TOX concentrations, in instances where valid results for both parameters are available, but also suggests the presence of an additional, unknown, or undetected contributing compound(s). Furthermore, numerous elevated results occur for TOX that have no corresponding detected result for TRIS2CH, such as for well 699-43-41F (see Appendix B). This circumstance also argues for an unidentified contributor to TOX concentrations. No other halogenated compound has been identified that would explain elevated TOX concentrations.

The sum of concentrations of all identified organic compounds (see Table 4.2) is far below replicate averages for TOC in all wells in the network in corresponding samples. Furthermore, published background data on TOC for the Hanford Site for 1992 (Johnson 1993) indicated a background of 519 ± 367 $\mu\text{g/L}$ for TOC. Subsequent calculations of the LOQ for TOC in 1995 and 1996 were 976 and 1,113 $\mu\text{g/L}$, respectively. Hence, no compound is identifiable in sufficient quantity to be a cause of elevated TOC in B Pond system wells. Moreover, the original critical mean for TOC, established in 1990 (846.3 $\mu\text{g/L}$) is well below the more recent LOQs, and since 1993, all but four replicate averages have been below the 1995 and 1996 LOQs.

Both TOX and TOC occurred at the highest observed concentrations for these parameters in wells 699-43-41E and 699-43-41F during a brief period in 1990, then at much lower concentrations. This observation and the evident decline in concentration from 1990 onward (see Figures 5.2, 5.4, and 5.5) suggest that an organic compound has moved away from the affected sites or has dispersed or degraded in situ.

TRIS2CH and its related phosphite compound are described as flame-retardant plasticizers and components of greases (Lewis 1994). Both of these products are commonly used at well sites during well construction activities in the form of flame-resistant plastic tarps used as ground cover during casing-welding operations and in protective plastic containers for well parts. Greases are used as lubricants during well drilling and construction. TRIS2CH data are too few at the B Pond system to correlate this compound to well construction.

TRIS2CH has been detected in a total of 51 analyses in 26 Hanford Site wells. The samples were taken from 100-D Area, 200 West Area, 200 East Area, B Pond system, and 3000 Area. The Hanford Environmental Information System (HEIS) database indicates that 518 analyses for TRIS2CH have been performed in these areas since records began in 1990. Of that number, 200 analyses, 39%, are from the B Pond system. It is possible that, with further sampling of wells across the Hanford Site for TRIS2CH, it may be discovered to be more commonly occurring.

6.1 Rate and Extent of Contaminant Migration

Because early, pre-1994, analyses specifically for TRIS2CH were scant and discontinuous, it is possible that the highest levels of the compound went undetected in the B Pond system wells. Wells at the TEDF are directly downgradient hydraulically (see Figure 3.2) from the well having the highest results in the B Pond system network, 699-43-41E. Detectable levels of TRIS2CH have appeared in analyses from the three wells at the TEDF. The highest result at the TEDF was 30 µg/L in well 699-41-35 in January 1994. The highest replicate average for TOX at the TEDF, 11.93 µg/L, was recorded for the same well on the same date. This information suggests that contamination could have moved southeastward beneath the TEDF, assuming that contamination did not originate in the wells. The TEDF began operation in June 1995.

Comparison of results for TOX, TOC, and TRIS2CH in four deep/shallow well clusters (see Section 2.3) indicate no definitive trends in vertical distribution of these constituents. The four well clusters do reveal vertical differences in concentrations of tritium, nitrate, and metals.

Significant groundwater monitoring and hydrochemical analyses did not begin at the B Pond system until 1988, though the facility began operating in 1945. Hence, calculation of a rate of migration by tracking potential contamination would not be feasible, assuming that contamination were a result of discharges. Based on the most robust groundwater velocities derived by other means (see Section 3.2.3), contaminants entering the facility, or entering the wells, could have migrated as much as 1.3 km downgradient, mostly eastward and southeastward, since the beginning of operations. This calculation assumes that groundwater movement in this area occurs primarily within the Ringold Formation sediments. Travel times in the Hanford formation would be significantly less, with average linear velocities of up to 46 m/d, allowing a travel distance of 873 km since beginning of operations. Judging by observed travel times for tritium originating from the 200 East Area (Freshley and Graham 1988, Freshley and Thorne 1992), it is likely that a value for travel time intermediate between the stated Ringold and Hanford values is appropriate. The potentiometric surface lies at, to slightly below, the Ringold-Hanford contact.

6.2 Conclusions

From the foregoing observations and discussion, the following salient points emerge concerning the occurrence of TOX and TOC at the B Pond system:

- Analytical results indicate a general decline in TOX and TOC from 1990 to 1993, then a leveling off, with a few recent results above the 1990 LOQ (TOX) and critical mean (TOC).
- With the exception of a limited period during 1990 in wells 699-43-41E and 699-43-41F, TOX results have been slightly above to below the LOQ.
- No compound is identified in quantities that can account for the observed concentrations of TOC.

- Most detected results for TOC have been below sitewide background or LOQ.
- TRIS2CH is the only identified compound that may be related to elevated TOX concentrations.
- Judging from the distribution of data in Figures 5.2, 5.4, and 5.5, the highest levels of TRIS2CH, TOX, and TOC in groundwater most likely occurred at or before the beginning of systematic RCRA groundwater monitoring.
- TRIS2CH is identified as a possible component of materials routinely used during well construction and has been detected at other widely separated locations on the Hanford Site.
- Elevated levels of TOX with no corresponding TRIS2CH detections, and a lack of correlation between TOX and TRIS2CH, suggest that other compound(s) contributed to TOX concentrations or that undetected errors occurred in TOX analyses.
- Phosphate, a component of TRIS2CH, occurs with conspicuous frequency in well 699-43-41E. This well also has the most and highest results for TRIS2CH and the highest results for TOX.
- TRIS2CH, TOX, and TOC have been detected in samples from the TEDF-monitoring wells.

Compounds responsible for elevated TOX and TOC have either degraded, dispersed in situ, or, in large part, migrated out of the B Pond system network since 1990. TRIS2CH has most likely contributed to the TOX concentration, particularly during the early years of monitoring. However, elevated levels of TOX occur at the B Pond system for which no corresponding compound was identified. The problematic compound may be an unidentified parent product of TRIS2CH. Alternatively, the elevated TOX may be an artifact of unrecognized errors in TOX analyses. The low concentrations of TOX reported at the B Pond system (with the exception of the two 1990 samples) and the sporadic detection of low concentrations of TRIS2CH obviate any further reasonable attempts to establish correlations. The elevated TOC levels have been within sitewide background range, except on a few occasions. The data for TOX, TOC, and TRIS2CH clearly indicate that concentrations of all three constituents have generally declined since assessment monitoring began in 1990.

The pattern of TRIS2CH occurrence at the B Pond system logically eliminates the possibility that TRIS2CH is a laboratory contaminant because of repeated occurrence of TRIS2CH in samples from a few wells over a period of years. Also, TRIS2CH is not identified as a common laboratory contaminant. The conspicuous occurrence of phosphate, a component of TRIS2CH, in well 699-43-41E (also the well with the most TRIS2CH detections) reinforces this inference.

The two most likely candidates for sources of TRIS2CH in the B Pond system are 1) contamination from well construction that dispersed or degraded with time, or 2) contamination from the disposed effluent. At this time, no processes or effluents are identified that may be common to the widely separated areas (100-D Area, 200 West Area, 200 East Area, B Pond system, and 3000 Area) that would

account for the appearance of TRIS2CH in groundwater at these sites. Also unassessed is the distribution of historic sampling for this compound across the site. If sitewide sampling for this compound is focused on only a relatively few wells, it is possible that sampling a wider array of wells may reveal a ubiquitous occurrence of TRIS2CH. If it is found that TRIS2CH is more widespread, it would then be necessary to determine if it is a contaminant from operations or an artifact of well construction. An evaluation of well locations sampled for TRIS2CH and a careful inventory of processes at the widely separated sites may be necessary to resolve these uncertainties.

7.0 Recommendations

Based on the conclusions in Section 6.0, the following recommendations are made.

- The critical means for B Pond system contamination-indicator parameters should be recalculated using the most recent data from the upgradient well.
- The B Pond system groundwater monitoring program should be returned to a detection-level (indicator-parameter-evaluation) monitoring status.

Changes in the network and laboratory services since 1990 require that critical means for TOX and TOC be recalculated. Both upgradient wells have produced replicate averages above the 1990 LOQ. The critical means for TOX and TOC will be recalculated to obtain more representative background values for these parameters.

To resolve the origin(s) of the TRIS2CH would require additional research into facility operations and effluents, as well as past well installation practices and materials. Additional sampling and analysis across the Hanford Site might also be necessary to establish a larger sample population for TRIS2CH and TOX. In view of the low concentrations of TOX, TOC, and TRIS2CH in the B Pond system for the last few years, such research would be inefficacious and unjustified. Furthermore, TRIS2CH is not listed in WAC 173-303 as a dangerous waste; thus, TOX and TOC have not been correlated to a dangerous waste at the B Pond system. Should the recalculated critical means for the contamination-indicator parameters be exceeded, and concentrations of TOX and TOC are observed to systematically rise, the facility may again be placed into assessment monitoring. At that point, further consideration may be given to additional investigation of contamination sources.

8.0 References

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

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

WAC 173-303, Washington Administrative Code. *Dangerous Waste Regulations.* Olympia, Washington.

Barnett, D. B., J. A. Coates, and B. F. Strode. 1994. *Application of the K-V Associates Flowmeter at the Site of Project W-049H Treated Effluent Disposal Basin.* WHC-SD-EN-ER-006, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Barnett, D. B., J. D. Davis, L. C. Collard, and P. B. Freeman. 1995. *Groundwater Monitoring Plan -- 200 Areas Treated Effluent Disposal Facility.* WHC-SD-EN-WP-012, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended. Public Law 96-510, 94 Stat. 2767, 42 USC 9601 et seq.

Davis, J. D., D. B. Barnett, L. C. Swanson, W. J. McMahon, and D. D. Palomares. 1993. *Site Characterization Report: Results of Detailed Evaluation of the Suitability of the Site Proposed for Disposal of 200 Areas Treated Effluent.* WHC-SD-EN-ES-004, Westinghouse Hanford Company, Richland, Washington.

Delaney, C.D. 1992a. *Completion Report for the 216-B-3 Pond Drilling and Characterization Activities, FY 1988, Separations Area Groundwater Monitoring Project.* WHC-SD-EN-TI-029, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Delaney, C.D. 1992b. *Completion Report for the 216-B-3 Pond Drilling and Characterization Activities, FY 1989, Separations Area Groundwater Monitoring Project.* WHC-SD-EN-TI-030, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Delaney, C.D. 1992c. *Borehole Completion Data Package for the CY 1991 216-B-3 Pond Drilling Project.* WHC-SD-EN-DP-046, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Delaney, C. D. 1993. *Borehole Completion Data Package for the CY 1992 216-B-3 Pond Drilling Project*. WHC-SD-EN-DP-053, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

DOE - see U.S. Department of Energy

Dresel, P. E., P. D. Thorne, S. P. Luttrell, B. M. Gillespie, W. D. Webber, J. K. Merz, J. T. Rieger, M. A. Chamness, S. K. Wurstner, and B. E. Opitz. 1995. *Hanford Site Groundwater Monitoring for 1994*. PNL-10698, Pacific Northwest Laboratory, Richland, Washington.

Ecology - see State of Washington Department of Ecology

EPA - see U.S. Environmental Protection Agency

Freshley, M. D., and M. J. Graham. 1988. *Estimation of Ground-Water Travel Time at the Hanford Site: Description, Past Work, and Future Needs*. PNL-6328, Pacific Northwest Laboratory, Richland, Washington.

Freshley, M. D., and P. D. Thorne. 1992. *Ground-Water Contribution of Dose from Past Hanford Operations*. PNWD-1974 HEDR, Pacific Northwest Laboratory, Richland, Washington.

Fruland, R. M., and R. E. Lundgren (eds). 1989. *RCRA Ground-Water Monitoring Projects for Hanford Facilities: Annual Progress Report for 1988*. PNL-6852, Pacific Northwest Laboratory, Richland, Washington.

Fruland, R. M., D. J. Bates, and R. E. Lundgren. 1989a. *Resource Conservation and Recovery Act Ground-Water Monitoring Projects for Hanford Facilities: Progress Report for the Period July 1 to September 30, 1988*. PNL-6789, Pacific Northwest Laboratory, Richland, Washington.

Fruland, R. M., D. J. Bates, and R. E. Lundgren. 1989b. *Resource Conservation and Recovery Act Ground-Water Monitoring Projects for Hanford Facilities: Progress Report for the Period October 1 to December 31, 1988*. PNL-6844, Pacific Northwest Laboratory, Richland, Washington.

Harris, S. F. 1990. *Ground Water Quality Assessment Plan for the 216-B-3 Pond System*. WHC-SD-EN-AP-030, Westinghouse Hanford Company, Richland, Washington.

Hartman, M. J., and P. E. Dresel (eds). 1997. *Hanford Site Groundwater Monitoring for Fiscal Year 1996*. PNNL-11470, Pacific Northwest National Laboratory, Richland, Washington.

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

Johnson, V. G., A. G. Law, S. P. Reidel, S. D. Evelo, D. B. Barnett, and M. D. Sweeney. 1995. *Ground Water Impact Assessment Report for the 216-B-3 Pond System*. WHC-EP-0813, Westinghouse Hanford Company, Richland, Washington.

Lewis, R. J., Sr. 1994. *Hawley's Condensed Chemical Dictionary, Twelfth Edition*. Van Nostrand Reinhold, New York.

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

Luttrell, S. P., M. A. Chamness, and S. Dudziak. 1989. *Interim-Status Ground-Water Monitoring Plan for the 216-B-3 Pond*. WHC-SD-EN-AP-013, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Pacific Northwest Laboratory (PNL). 1988a. *Ground-Water Monitoring Compliance Projects for Hanford Site Facilities: Progress Report for the Period October 1 to December 31, 1987*. PNL-6536, Richland, Washington.

Pacific Northwest Laboratory (PNL). 1988b. *Ground-Water Monitoring Compliance Projects for Hanford Site Facilities: Progress Report for the Period January 1 to March 31, 1988*. PNL-6581, Richland, Washington.

Pacific Northwest Laboratory (PNL). 1988c. *Ground-Water Monitoring Compliance Projects for Hanford Site Facilities: Progress Report for the Period April 1 to June 30, 1988*. PNL-6675, Richland, Washington.

Resource Conservation and Recovery Act of 1976, as amended, Public Law 94-580, 90 Stat. 2795, 42 USC 6901 et seq.

Smith, R. M., and W. R. Gorst (eds). 1990. *RCRA Ground-Water Monitoring Projects for Hanford Facilities: Annual Progress Report for 1989*. PNL-6852, Pacific Northwest Laboratory, Richland, Washington.

Smith, R. M., D. J. Bates, and R. E. Lundgren. 1990. *Resource Conservation and Recovery Act Ground-Water Monitoring Projects for Hanford Facilities: Progress Report for the Period October 1 to December 31, 1989*. PNL-7306, Pacific Northwest Laboratory, Richland, Washington.

Smith, R. M., D. J. Bates, and R. E. Lundgren. 1989a. *Resource Conservation and Recovery Act Ground-Water Monitoring Projects for Hanford Facilities: Progress Report for the Period January 1 to March 31, 1989*. PNL-6957, Pacific Northwest Laboratory, Richland, Washington.

Smith, R. M., D. J. Bates, and R. E. Lundgren. 1989b. *Resource Conservation and Recovery Act Ground-Water Monitoring Projects for Hanford Facilities: Progress Report for the Period April 1 to June 30, 1989*. PNL-7134, Pacific Northwest Laboratory, Richland, Washington.

Smith, R. M., D. J. Bates, and R. E. Lundgren. 1989c. *Resource Conservation and Recovery Act Ground-Water Monitoring Projects for Hanford Facilities: Progress Report for the Period July 1 to September 30, 1989*. PNL-7222, Pacific Northwest Laboratory, Richland, Washington.

State of Washington Department of Ecology, (Ecology), U.S. Environmental Protection Agency (EPA), and U.S. Department of Energy (DOE). 1989. *Hanford Federal Facility Agreement and Consent Order Between the U.S. Environmental Protection Agency, the U.S. Department of Energy, and the State of Washington Department of Ecology, May 15, 1989, as amended*. Olympia, Seattle and Richland, Washington.

Sweeney, M. D. 1995. *Interim-Status Groundwater Monitoring Plan for the 216-B-3 Pond System*. WHC-SD-EN-AP-013, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

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

Thorne, P. D., M. A. Chamness, V. R. Vermeul, Q. C. MacDonald, and S. E. Schubert. 1994. *Three-Dimensional Conceptual Model for the Hanford Site Unconfined Aquifer System, FY 94 Status Report*. PNL-10195, Pacific Northwest Laboratory, Richland, Washington.

U.S. Department of Energy (DOE). 1989. *216-B-3 Pond System Closure/Postclosure Plan*. DOE/RL 89-28, Richland Operations Office, Richland, Washington.

U.S. Department of Energy (DOE). 1990a. *Quarterly Report of RCRA Groundwater Monitoring Data for Period April 1, 1990 through June 30, 1990*. DOE/RL-90-36, Richland Operations Office, Richland, Washington.

U.S. Department of Energy (DOE). 1990b. *Quarterly Report of RCRA Groundwater Monitoring Data for Period July 1, 1990 through September 30, 1990*. DOE/RL-90-46, Richland Operations Office, Richland, Washington.

U.S. Department of Energy (DOE). 1991a. *Quarterly Report of RCRA Groundwater Monitoring Data for Period October 1, 1990 through December 31, 1990*. DOE/RL-91-04, Richland Operations Office, Richland, Washington.

U.S. Department of Energy (DOE). 1991b. *Quarterly Report of RCRA Groundwater Monitoring Data for Period January 1, 1991 through March 31, 1991*. DOE/RL-91-26, Richland Operations Office, Richland, Washington.

U.S. Department of Energy (DOE). 1991c. *Quarterly Report of RCRA Groundwater Monitoring Data for Period April 1, 1991 through June 30, 1991*. DOE/RL-91-47, Richland Operations Office, Richland, Washington.

U.S. Department of Energy (DOE). 1991d. *Quarterly Report of RCRA Groundwater Monitoring Data for Period July 1, 1991 through September 30, 1991*. DOE/RL-91-57, Richland Operations Office, Richland, Washington.

U.S. Department of Energy (DOE). 1991e. *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1990*. DOE/RL-91-03, prepared by Geosciences Group, Westinghouse Hanford Company, Environmental Division for Richland Operations Office, Richland, Washington.

U.S. Department of Energy (DOE). 1992a. *Quarterly Report of RCRA Groundwater Monitoring Data for Period October 1, 1991 through December 31, 1991*. DOE/RL-92-26, Richland Operations Office, Richland, Washington.

U.S. Department of Energy (DOE). 1992b. *Quarterly Report of RCRA Groundwater Monitoring Data for Period January 1, 1992 through March 31, 1992*. DOE/RL-92-26-1, Richland Operations Office, Richland, Washington.

U.S. Department of Energy (DOE). 1992c. *Quarterly Report of RCRA Groundwater Monitoring Data for Period April 1, 1992 through June 30, 1992*. DOE/RL-92-26-2, Richland Operations Office, Richland, Washington.

U.S. Department of Energy (DOE). 1992d. *Quarterly Report of RCRA Groundwater Monitoring Data for Period July 1, 1992 through September 30, 1992*. DOE/RL-92-26-3, Richland Operations Office, Richland, Washington.

U.S. Department of Energy (DOE). 1992e. *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1991*. DOE/RL-92-03, prepared by Geosciences Group, Westinghouse Hanford Company, Environmental Division for Richland Operations Office, Richland, Washington.

U.S. Department of Energy (DOE). 1993a. *Quarterly Report of RCRA Groundwater Monitoring Data for Period October 1, 1992 through December 31, 1992*. DOE/RL-92-26-4, Richland Operations Office, Richland, Washington.

U.S. Department of Energy (DOE). 1993b. *Quarterly Report of RCRA Groundwater Monitoring Data for Period January 1, 1993 through March 31, 1993*. DOE/RL-93-56-1, Richland Operations Office, Richland, Washington.

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

U.S. Department of Energy (DOE). 1993d. *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1992*. DOE/RL-93-09, Rev. 0, prepared by Geosciences Group, Westinghouse Hanford Company, Environmental Division for Richland Operations Office, Richland, Washington.

U.S. Department of Energy (DOE). 1994a. *216-B-3 Expansion Ponds Closure Plan*. DOE/RL-89-28, Rev. 2, Richland Operations Office, Richland, Washington.

U.S. Department of Energy (DOE). 1994b. *200-BP-11 Operable Unit and 216-B-3 Main Pond Work/Closure Plan, Hanford Site, Richland, Washington, Volume 1: Field Investigation and Sampling Strategy*. DOE/RL-93-74 Draft A, Richland Operations Office, Richland, Washington.

U.S. Department of Energy (DOE). 1994c. *Quarterly Report of RCRA Groundwater Monitoring Data for Period July 1, 1993 through September 30, 1993*. DOE/RL-93-56-3, Richland Operations Office, Richland, Washington.

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

U.S. Department of Energy (DOE). 1994e. *Quarterly Report of RCRA Groundwater Monitoring Data for Period January 1, 1994 through March 31, 1994*. DOE/RL-94-36-1, Richland Operations Office, Richland, Washington.

U.S. Department of Energy (DOE). 1994f. *Quarterly Report of RCRA Groundwater Monitoring Data for Period April 1, 1994 through June 30, 1994*. DOE/RL-94-36-2, Richland Operations Office, Richland, Washington.

U.S. Department of Energy (DOE). 1994g. *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1993*. DOE/RL-93-88, Rev. 0, prepared by Geosciences Group, Westinghouse Hanford Company, Environmental Division for Richland Operations Office, Richland, Washington.

U.S. Department of Energy (DOE). 1995a. *Quarterly Report of RCRA Groundwater Monitoring Data for Period July 1, 1994 through September 30, 1994*. DOE/RL-94-36-3, Richland Operations Office, Richland, Washington.

U.S. Department of Energy (DOE). 1995b. *Quarterly Report of RCRA Groundwater Monitoring Data for Period October 1, 1994 through December 31, 1994*. DOE/RL-94-36-4, Richland Operations Office, Richland, Washington.

U.S. Department of Energy (DOE). 1995c. *Quarterly Report of RCRA Groundwater Monitoring Data for Period January 1, 1995 through March 31, 1995*. DOE/RL-94-69-1, Richland Operations Office, Richland, Washington.

U.S. Department of Energy (DOE). 1995d. *Quarterly Report of RCRA Groundwater Monitoring Data for Period April 1, 1995 through June 30, 1995*. DOE/RL-94-69-2, Richland Operations Office, Richland, Washington.

U.S. Department of Energy (DOE). 1995e. *Quarterly Report of RCRA Groundwater Monitoring Data for Period July 1, 1995 through September 30, 1995*. DOE/RL-94-69-3, Richland Operations Office, Richland, Washington.

U.S. Department of Energy (DOE). 1995f. *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1994*. DOE/RL-94-136, Rev. 0, prepared by Earth and Environmental Technical Services, Westinghouse Hanford Company for Richland Operations Office, Richland, Washington.

U.S. Department of Energy (DOE). 1996. *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1995*. DOE/RL-96-01, Rev. 0, prepared by Earth and Environmental Technical Services, Westinghouse Hanford Company for Richland Operations Office, Richland, Washington.

U.S. Environmental Protection Agency (EPA). 1986a. *Test Methods for Evaluating Solid Waste, Volume 1A*. SW-846, Office of Solid Waste and Emergency Response, Washington, D.C.

U.S. Environmental Protection Agency (EPA). 1986b. *RCRA Ground Water Monitoring Technical Enforcement Guidance Document (TEGD)*. OSWER-9950.1, Washington, D.C.

U.S. Environmental Protection Agency (EPA). 1994. *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*. Publication 9240.1-05, EPA-540/R-94/012, Office of Emergency and Remedial Response, Washington, D.C.

Westinghouse Hanford Company (WHC). 1990. *Interim Hydrogeologic Characterization Report for the 216-B-3 Pond*. WHC-SD-EV-002, Rev. 0, Richland, Washington.

Appendix A

Known Releases to the Plutonium-Uranium Extraction Facility Chemical Sewer

Appendix A

Known Releases to the Plutonium-Uranium Extraction Facility Chemical Sewer

The following list includes all inventoried discharges of chemical wastes to the 216-B-3 pond system waste streams. These chemicals originated in the Plutonium-Uranium Extraction (PUREX) facility and were discharged via the PUREX chemical sewer line. Details of these operations and lists of other chemicals used at 200 East Area facilities are given in U.S. Department of Energy (1994).

Table A.1. Releases into the Plutonium-Uranium Extraction Facility Chemical Sewer Line

Date	Chemical	Pounds	Designation ^(a)
05/20/83	Aluminum nitrate nonahydrate	17,725	None
10/17/83	Potassium permanganate Sodium carbonate	10,700 1,412	None
02/09/84	Potassium hydroxide	83,000	D002
02/26/84	Sodium hydroxide	3,700	D002, WT02
05/16/84	Cadmium nitrate	25 to 50	D006, WT01
06/06/84	Hydrazine Hydroxylamine nitrate	332 90	U133
08/22/84	Nitric acid	9,000	D002
10/02/84	Hydrazine Hydroxylamine nitrate	280 407	U133, WT02
11/01/84	Sulfuric acid	3,482	None
11/27/84	Nitric acid Ferrous sulfamate Sulfamic acid	349 43 68	None
12/02/84	Potassium hydroxide	150	D002
12/02/84	Potassium hydroxide	62,683	D002, WT02
01/10/85	Hydroxylamine nitrate Hydrazine Nitric acid	100 21 66	U133
01/18/85	Nitric acid	6,236	D002, WT02

Table A.1. (contd)

Date	Chemical	Pounds	Designation ^(a)
02/08/85	Sodium nitrate	160	None
04/04/85	Ferrous sulfamate	52	None
	Nitric acid	269	
	Sulfamic acid	132	
05/14/85	Nitric acid	190	U133
	Hydroxylamine nitrate	98	
	Hydrazine	0.4	
05/27/85	Nitric acid	223	None
06/25/85	Nitric acid	24,189	D002, WT02
07/01/85	Ammonium fluoride	5,368	WT01
	Ammonium nitrate	1,016	
08/06/85	Sodium hydroxide	42,440	D002, WT02
10/28/85	Nitric acid	1,181	D002
12/18/85	Cadmium nitrate	35	D006, WT01
12/28/85	Aluminum nitrate nonahydrate	650 to 730	None
02/12/86	Nitric acid	42	D002
	Sulfuric acid	276	
02/13/86	Sulfuric acid	77	D002
02/19/86	Sodium hydroxide	<100	D002, WT02
02/21/86	Sulfuric acid	<100	D002
03/24/86	Sulfuric acid	<100	D002
06/28/86	Sulfuric acid	121	D002
07/07/86	Hydrazine	6	U133
04/25/87	Sodium nitrite	1,275	None

(a) Waste designation in WAC 173-303.

References

U.S. Department of Energy (DOE). 1994. *216-B-3 Expansion Ponds Closure Plan*. DOE/RL-89-28, Rev. 2, Richland Operations Office, Richland, Washington.

WAC 173-303, Washington Administrative Code. *Dangerous Waste Regulations*. Olympia, Washington.

Appendix B

Groundwater Analytical Data

Appendix B

Groundwater Analytical Data

This appendix contains groundwater analytical results for the 216-B-3 pond groundwater monitoring wells for the following constituents: total organic halogens (TOX; replicate average results), total organic carbon (TOC; replicate average results), and individual results for tris (2-chloroethyl) phosphate. Replicate averages are calculated using all results above the method detection limit (MDL) with no "Y" or "R" flags.

Table B.1. Total Organic Halogen (TOX) Replicate Average Analytical Data (µg/L)

Well Name	Replicate Average	Sample Date
299-E18-1	32.3	10-Mar-94
299-E18-1	5.1	1-Dec-94
299-E32-4	47	27-Sep-88
299-E32-4	28	5-Aug-91
299-E32-4	7.3	11-Apr-94
299-E32-4	5.8	11-Oct-94
299-E32-4	7.01	11-Apr-95
299-E32-4	10.93	10-Jun-96
299-E32-4	13	9-Jan-97
699-40-36	9.6	14-Apr-92
699-40-36	11.4	14-Apr-94
699-40-36	8.47	1-Aug-94
699-40-36	11.28	27-Oct-94
699-40-39	9.1	19-Jan-94
699-40-39	9.73	21-Apr-94
699-40-39	7.6	12-Aug-94
699-40-39	8.58	12-Apr-95
699-40-40A	7.7	13-Apr-94
699-40-40A	7.53	28-Jul-94
699-40-40A	5.73	12-Oct-94

Table B.1. (contd)

Well Name	Replicate Average	Sample Date
699-40-40A	9	10-Oct-95
699-40-40A	7.26	8-Apr-96
699-40-40A	14.8	25-Jul-96
699-40-40B	6.85	21-Apr-94
699-40-40B	6.3	27-Jul-94
699-40-40B	23.33	14-Oct-94
699-40-40B	43.5	5-Jan-95
699-40-40B	11.75	12-Apr-95
699-40-40B	6.9	28-Nov-95
699-41-35	11.93	19-Jan-94
699-41-35	11.55	14-Apr-94
699-41-35	10.68	3-Aug-94
699-41-35	13.2	27-Oct-94
699-41-35	7.35	9-Jan-95
699-41-40	10	5-Dec-89
699-41-40	7.6	19-Apr-94
699-41-40	8.93	11-Aug-94
699-41-40	5.57	24-Oct-94
699-41-40	5.8	10-Jan-95
699-41-40	13.3	12-Apr-95
699-41-40	13.8	13-Jan-97
699-41-42	6.3	12-Apr-94
699-41-42	6.5	1-Aug-94
699-41-42	8.01	13-Apr-95
699-41-42	9.17	9-Apr-96
699-41-42	7.85	13-Jan-97
699-42-37	8.4	11-Apr-94
699-42-37	6.68	29-Jul-94
699-42-37	7.4	27-Oct-94
699-42-37	7.6	9-Jan-95
699-42-39A	10.35	11-Apr-94
699-42-39A	5.93	25-Jul-94
699-42-39A	6.05	9-Jan-95
699-42-39B	7.77	12-Apr-94
699-42-39B	7.27	25-Jul-94
699-42-39B	10.1	9-Jan-95

Table B.1. (contd)

Well Name	Replicate Average	Sample Date
699-42-40A	54.1	8-Jan-88
699-42-40A	13.33	31-May-89
699-42-40A	6.33	14-Feb-94
699-42-40A	8.3	12-Apr-94
699-42-40A	10.37	28-Jul-94
699-42-40A	5.7	24-Oct-94
699-42-40A	6.25	5-Jan-95
699-42-41	6.8	12-Apr-94
699-42-41	10.13	25-Jul-94
699-42-41	7.23	19-Oct-94
699-42-41	8.4	5-Jan-95
699-42-41	8.87	11-Apr-95
699-42-41	7.93	31-Jan-96
699-42-41	7.54	8-Apr-96
699-42-41	10.82	18-Jul-96
699-42-41	12.84	9-Jan-97
699-42-42B	66.5	9-Aug-89
699-42-42B	9.75	18-Jan-94
699-42-42B	7.67	13-Apr-94
699-42-42B	6.75	29-Jul-94
699-42-42B	10.7	10-Jan-95
699-42-42B	6.32	13-Apr-95
699-42-42B	7	20-Jul-95
699-42-42B	9.23	9-Apr-96
699-43-40	7.5	14-Apr-94
699-43-40	8.32	29-Jul-94
699-43-40	8.67	19-Oct-94
699-43-40	11.61	10-Jan-95
699-43-40	5.4	13-Jan-97
699-43-41E	26	5-Dec-89
699-43-41E	23	25-Jan-90
699-43-41E	184	19-Mar-90
699-43-41E	1205	15-May-90
699-43-41E	130	28-Jun-91
699-43-41E	12.03	13-Apr-94
699-43-41E	14.05	29-Jul-94

Table B.1. (contd)

Well Name	Replicate Average	Sample Date
699-43-41E	8.13	19-Oct-94
699-43-41E	11.3	9-Jan-95
699-43-41E	11.53	12-Apr-95
699-43-41E	8	20-Jul-95
699-43-41E	9	10-Oct-95
699-43-41E	7.35	23-Jan-96
699-43-41E	11.93	9-Apr-96
699-43-41E	8.98	24-Jul-96
699-43-41E	5.15	14-Jan-97
699-43-41F	19	5-Dec-89
699-43-41F	11	25-Jan-90
699-43-41F	1187	18-Apr-90
699-43-41F	23	2-Jul-91
699-43-41F	7	13-Apr-94
699-43-41F	6.2	28-Jul-94
699-43-41F	5.7	20-Oct-94
699-43-41F	7.02	12-Apr-95
699-43-41G	7.85	15-Apr-94
699-43-41G	8.63	28-Jul-94
699-43-41G	8.73	17-Jan-95
699-43-41G	7.69	12-Apr-95
699-43-41G	7.5	10-Oct-95
699-43-41G	10.14	9-Apr-96
699-43-42J	12	31-Jan-90
699-43-42J	5.4	13-Apr-94
699-43-42J	6.6	28-Jul-94
699-43-42J	5.2	20-Oct-94
699-43-42J	6.65	12-Apr-95
699-43-43	11.5	9-Aug-89
699-43-43	14	26-Jan-90
699-43-43	12.07	20-Apr-94
699-43-43	8.47	19-Jul-94
699-43-43	9.55	10-Jan-95
699-43-43	7.98	10-Apr-96
699-43-45	10	26-Jan-90
699-43-45	8.73	20-Apr-94

Table B.1. (contd)

Well Name	Replicate Average	Sample Date
699-43-45	6.27	19-Jul-94
699-43-45	7.33	11-Jan-95
699-43-45	11.4	9-Apr-96
699-43-45	8.4	13-Jan-97
699-44-39B	7.23	14-Apr-94
699-44-39B	6.4	28-Jul-94
699-44-39B	7.63	20-Oct-94
699-44-39B	26.15	10-Apr-96
699-44-42	23	15-Jun-89
699-44-42	7.7	26-Jan-94
699-44-42	15.73	18-Apr-94
699-44-42	7.23	28-Jul-94
699-44-42	20.43	9-Sep-94
699-44-42	6.38	20-Oct-94
699-44-42	11	12-Apr-95
699-44-43B	15	26-Jan-90
699-44-43B	6.95	29-Jul-94
699-44-43B	6.7	9-Jan-95
699-44-43B	9.05	14-Jan-97

Table B.2. Total Organic Carbon (TOC) Replicate Average Analytical Data (µg/L)

Well Name	Replicate Average	Sample Date
299-E18-1	200	11-Jun-93
299-E18-1	425	10-Mar-94
299-E18-1	500	14-Jun-94
299-E18-1	200	1-Dec-94
299-E18-1	200	16-Mar-95
299-E18-1	183.33	5-Jun-95
299-E18-1	212.5	5-Sep-95
299-E18-1	180	18-Jan-96
299-E18-1	176.5	8-Apr-96
299-E32-4	233.33	30-Apr-93
299-E32-4	300	2-Sep-93
299-E32-4	135	13-Dec-94
299-E32-4	133.33	6-Jan-95
299-E32-4	185	7-Jun-95
299-E32-4	170	18-Jul-95
299-E32-4	161	7-Dec-95
299-E32-4	740	9-Jan-97
699-40-36	437.5	13-May-93
699-40-36	400	9-Aug-93
699-40-36	350	8-Oct-93
699-40-36	400	1-Aug-94
699-40-36	200	27-Oct-94
699-40-36	250	9-Jan-95
699-40-39	200	26-Apr-93
699-40-39	325	5-Aug-93
699-40-39	400	12-Aug-94
699-40-39	220	25-Oct-94
699-40-39	250	5-Jan-95
699-40-39	200	21-Jul-95
699-40-40A	1000	24-Jan-92
699-40-40A	1750	27-Apr-93
699-40-40A	266.67	27-Jul-93
699-40-40A	300	12-Jan-94
699-40-40A	210	12-Oct-94
699-40-40A	162.5	6-Jan-95

Table B.2. (contd)

Well Name	Replicate Average	Sample Date
699-40-40A	225	10-Oct-95
699-40-40A	172.5	18-Jan-96
699-40-40A	318	8-Apr-96
699-40-40A	560	8-Oct-96
699-40-40A	537	9-Jan-97
699-40-40B	800	24-Jan-92
699-40-40B	300	27-Jul-93
699-40-40B	300	7-Oct-93
699-40-40B	300	12-Jan-94
699-40-40B	300	14-Oct-94
699-41-35	275	13-May-93
699-41-35	200	8-Oct-93
699-41-35	300	19-Jan-94
699-41-35	203.33	27-Oct-94
699-41-35	225	9-Jan-95
699-41-35	1120	10-Jul-95
699-41-40	1400	19-Apr-90
699-41-40	400	5-Aug-93
699-41-40	300	11-Oct-93
699-41-40	225	24-Oct-94
699-41-40	225	10-Jan-95
699-41-40	225	24-Jul-95
699-41-40	170	9-Oct-95
699-41-40	220	18-Jan-96
699-41-40	225.75	8-Apr-96
699-41-40	308	22-Jul-96
699-41-42	450	28-Jul-93
699-41-42	300	11-Oct-93
699-41-42	412.5	12-Apr-94
699-41-42	400	1-Aug-94
699-41-42	300	20-Oct-94
699-41-42	325	24-Jul-95
699-41-42	200	9-Oct-95
699-41-42	263.5	22-Jan-96
699-41-42	209.5	9-Apr-96
699-41-42	329.5	17-Jul-96

Table B.2. (contd)

Well Name	Replicate Average	Sample Date
699-41-42	555.5	13-Jan-97
699-42-37	266.67	13-May-93
699-42-37	266.67	30-Aug-93
699-42-37	800	7-Jan-94
699-42-37	120	27-Oct-94
699-42-37	225	9-Jan-95
699-42-39A	266.67	29-Jul-93
699-42-39A	300	7-Oct-93
699-42-39A	400	11-Apr-94
699-42-39A	400	25-Jul-94
699-42-39A	200	12-Oct-94
699-42-39A	275	9-Jan-95
699-42-39B	600	23-Jan-92
699-42-39B	2000	17-Apr-92
699-42-39B	325	29-Jul-93
699-42-39B	325	7-Oct-93
699-42-39B	400	12-Apr-94
699-42-39B	360	25-Jul-94
699-42-39B	250	12-Oct-94
699-42-39B	250	21-Jul-95
699-42-39B	200	10-Oct-95
699-42-39B	284.75	22-Jan-96
699-42-39B	419.5	8-Apr-96
699-42-39B	350	18-Jul-96
699-42-40A	1080	22-Aug-85
699-42-40A	1235	12-May-86
699-42-40A	1400	8-Jul-91
699-42-40A	1100	23-Jan-92
699-42-40A	1000	23-Apr-93
699-42-40A	875	11-Oct-93
699-42-40A	750	14-Feb-94
699-42-40A	850	12-Apr-94
699-42-40A	937.5	28-Jul-94
699-42-40A	625	24-Oct-94
699-42-41	1100	24-Jan-92
699-42-41	1666.67	17-Apr-92

Table B.2. (contd)

Well Name	Replicate Average	Sample Date
699-42-41	800	28-Jul-93
699-42-41	875	11-Oct-93
699-42-41	825	13-Jan-94
699-42-41	800	12-Apr-94
699-42-41	925	25-Jul-94
699-42-41	750	19-Oct-94
699-42-41	1000	21-Jul-95
699-42-41	700	9-Oct-95
699-42-41	705.5	31-Jan-96
699-42-41	882.75	8-Apr-96
699-42-41	974.25	18-Jul-96
699-42-41	821.25	9-Oct-96
699-42-41	757.75	9-Jan-97
699-42-42B	325	28-Jul-93
699-42-42B	300	13-Oct-93
699-42-42B	200	18-Jan-94
699-42-42B	320	13-Apr-94
699-42-42B	330	29-Jul-94
699-42-42B	250	20-Oct-94
699-42-42B	300	10-Jan-95
699-42-42B	250	20-Jul-95
699-42-42B	300	9-Oct-95
699-42-42B	272	22-Jan-96
699-42-42B	217.25	9-Apr-96
699-42-42B	326	23-Jul-96
699-42-42B	533	13-Jan-97
699-43-40	437.5	30-Jul-93
699-43-40	425	11-Oct-93
699-43-40	550	13-Jan-94
699-43-40	400	14-Apr-94
699-43-40	425	29-Jul-94
699-43-40	475	19-Oct-94
699-43-40	437.5	10-Jan-95
699-43-40	350	19-Jul-95
699-43-40	325	9-Oct-95
699-43-40	312.5	23-Jan-96

Table B.2. (contd)

Well Name	Replicate Average	Sample Date
699-43-40	231	9-Apr-96
699-43-40	344.33	24-Jul-96
699-43-40	645.5	13-Jan-97
699-43-41E	1125	15-May-90
699-43-41E	450	30-Jul-93
699-43-41E	425	11-Oct-93
699-43-41E	355	13-Apr-94
699-43-41E	400	29-Jul-94
699-43-41E	325	19-Oct-94
699-43-41E	225	20-Jul-95
699-43-41E	300	10-Oct-95
699-43-41E	300.75	23-Jan-96
699-43-41E	282	9-Apr-96
699-43-41E	336.25	24-Jul-96
699-43-41E	615	9-Oct-96
699-43-41E	580	14-Jan-97
699-43-41F	1125	18-Apr-90
699-43-41F	300	28-Jul-93
699-43-41F	325	11-Oct-93
699-43-41F	300	19-Jan-94
699-43-41F	200	20-Oct-94
699-43-41F	275	6-Jan-95
699-43-41G	600	23-Jan-92
699-43-41G	350	27-Apr-93
699-43-41G	375	30-Jul-93
699-43-41G	320	15-Apr-94
699-43-41G	340	28-Jul-94
699-43-41G	225	19-Oct-94
699-43-41G	275	17-Jan-95
699-43-41G	225	20-Jul-95
699-43-41G	300	10-Oct-95
699-43-41G	298.25	23-Jan-96
699-43-41G	265	9-Apr-96
699-43-41G	347	18-Jul-96
699-43-42J	1100	2-Jul-91
699-43-42J	350	5-Aug-93

Table B.2. (contd)

Well Name	Replicate Average	Sample Date
699-43-42J	375	13-Oct-93
699-43-42J	250	18-Jan-94
699-43-42J	400	13-Apr-94
699-43-42J	320	28-Jul-94
699-43-43	525	28-Jul-93
699-43-43	550	13-Oct-93
699-43-43	500	4-Jan-94
699-43-43	550	20-Apr-94
699-43-43	625	19-Jul-94
699-43-43	625	6-Oct-94
699-43-43	550	10-Jan-95
699-43-43	900	6-Jul-95
699-43-43	575	17-Oct-95
699-43-43	638.75	10-Apr-96
699-43-45	700	24-Jan-92
699-43-45	450	26-Apr-93
699-43-45	425	27-Jul-93
699-43-45	400	13-Oct-93
699-43-45	375	4-Jan-94
699-43-45	400	20-Apr-94
699-43-45	420	19-Jul-94
699-43-45	425	6-Oct-94
699-43-45	400	11-Jan-95
699-43-45	375	6-Jul-95
699-43-45	500	6-Oct-95
699-43-45	429.75	25-Jan-96
699-43-45	347	9-Apr-96
699-43-45	424.5	25-Jul-96
699-43-45	681	13-Jan-97
699-44-39B	575	26-Apr-93
699-44-39B	525	29-Jul-93
699-44-39B	525	17-Jan-94
699-44-39B	500	14-Apr-94
699-44-39B	575	28-Jul-94
699-44-39B	475	6-Jan-95
699-44-39B	750	20-Jul-95

Table B.2. (contd)

Well Name	Replicate Average	Sample Date
699-44-39B	725	10-Oct-95
699-44-39B	497.5	30-Jan-96
699-44-39B	574	10-Apr-96
699-44-39B	691.75	23-Jul-96
699-44-39B	578	14-Jan-97
699-44-42	450	26-Apr-93
699-44-42	500	28-Jul-93
699-44-42	400	13-Oct-93
699-44-42	425	26-Jan-94
699-44-42	575	18-Apr-94
699-44-42	475	28-Jul-94
699-44-42	387.5	6-Jan-95
699-44-43B	325	26-Apr-93
699-44-43B	375	30-Jul-93
699-44-43B	300	12-Oct-93
699-44-43B	325	21-Oct-94
699-44-43B	250	20-Jul-95
699-44-43B	300	10-Oct-95
699-44-43B	262.63	25-Jan-96
699-44-43B	246.88	10-Apr-96

Table B.3. Tris (2-chloroethyl) Phosphate Analytical Data (µg/L)

Well Name	Value	Sample Date	Qualifier	Review Flag
699-40-36	18	09-Aug-93		F
699-40-40A	7.2	12-Oct-94	L	
699-40-40A	44	27-Apr-93		F
699-40-40A	21	27-Jul-93		F
699-40-40A	5	11-Apr-95	J	
699-40-40A	2.5	25-Jul-96	L	
699-40-40A	1.9	25-Jul-96	L	
699-40-40B	14	27-Jul-93		F
699-40-40B	2	12-Apr-95	J	
699-41-35	25	09-Aug-93		F
699-41-35	30	19-Jan-94		
699-42-37	18	13-May-93		F
699-43-40	3	11-Apr-95	J	
699-43-41E	6.4	09-Apr-96	L	
699-43-41E	9	20-Jul-95	L	
699-43-41E	5.8	24-Jul-96	L	
699-43-41E	13	29-Jul-94		
699-43-41E	24	11-Sep-91	J	
699-43-41E	8.8	23-Jan-96	L	
699-43-41E	178	11-Sep-91	J	
699-43-41E	11	10-Oct-95		
699-43-41G	0.96	18-Jul-96	L	
Qualifier Codes: L = Analytical result below the contract-required quantitation limit but is at or above the method detection limit. J = Estimated value. Review Flags: F = Result is undergoing further review.				

Distribution

No. of Copies

No. of Copies

OFFSITE

2 CH2M Hill Hanford

S. Leja
State of Washington Department
of Ecology
1315 4th Avenue
Kennewick, WA 99336

R. L. Jackson H9-02
L. C. Swanson H9-11

2 Rust Federal Services of Hanford, Inc.

R. C. Bowman H6-24
A. L. Prignano H6-24

ONSITE

4 DOE Richland Operations Office

U.S. Environmental Protection Agency

M. J. Furman HO-12
R. D. Hildebrand HO-12
K. M. Thompson HO-12
Public Reading Room H2-53

L. E. Gadbois B5-01

17 Pacific Northwest National Laboratory

4 Bechtel Hanford, Inc.

K. R. Fecht HO-02
B. N. Ford HO-02
A. J. Knepp HO-19
G. B. Mitchem HO-17
J. J. McGuire X5-53

D. B. Barnett (3) K6-81
P. E. Dresel K6-96
G. R. Holdren K6-81
S. P. Luttrell K6-96
R. M. Smith K6-81
S. S. Teel (2) K6-81
B. A. Williams K6-81
Information Release Office (7) K1-06