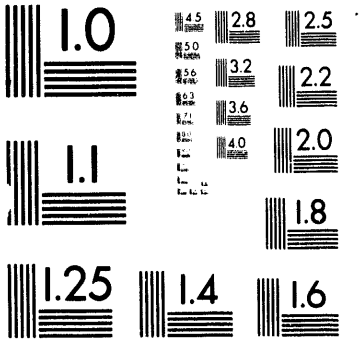
1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6.3
7.1

1 of 1

WSRC-TR-93-393

SECOND QUARTER 1993

P-AREA ACID/CAUSTIC BASIN GROUNDWATER MONITORING REPORT (U)

PUBLICATION DATE: SEPTEMBER 1993

Authorized Derivative Classifier:

Michele Bullington

WESTINGHOUSE SAVANNAH RIVER COMPANY
SAVANNAH RIVER SITE
AIKEN, SC 29808

MASTER

Prepared for the U.S. Department of Energy under Contract No. DE-AC09-89SR18035

Abstract

During second quarter 1993, samples from the six PAC monitoring wells at the P-Area Acid/Caustic Basin were collected and analyzed for indicator parameters, groundwater quality parameters, parameters characterizing suitability as a drinking water supply, and other constituents. Monitoring results that exceeded the final Primary Drinking Water Standards (PDWS) or the Savannah River Site (SRS) flagging criteria or turbidity standard during the quarter are discussed in this report.

During second quarter 1993, no constituents exceeded the final PDWS. Aluminum exceeded the SRS Flag 2 criterion in five of the wells. Iron and manganese each exceeded its Flag 2 criterion in four wells, and lead exceeded its Flag 2 criterion in one well. Radium-228 results were above its Flag 2 criterion in two wells; in each case, the radium-228 activity was much higher than the well's nonvolatile beta activity.

Contents

List of Figures

List of Tables

Executive Summary

The six monitoring wells at the P-Area Acid/Caustic Basin are sampled quarterly as part of the Savannah River Site (SRS) Groundwater Monitoring Program and to comply with the terms of a consent decree signed May 26, 1988, by the U.S. District Court (District of South Carolina, Aiken Division). During second quarter 1993, samples from the monitoring wells were analyzed for indicator parameters, groundwater quality parameters, parameters characterizing suitability as a drinking water supply, and other constituents. Monitoring results that exceeded the final Primary Drinking Water Standards (PDWS) or the SRS flagging criteria or turbidity standard are discussed in this report.

During second quarter 1993, no constituents exceeded the final PDWS in wells at the P-Area Acid/Caustic Basin. Aluminum exceeded the SRS Flag 2 criterion in wells PAC 1, 3, 4, 5, and 6. Iron and manganese each exceeded the Flag 2 criterion in wells PAC 2, 3, 5, and 6. Lead was elevated above its Flag 2 criterion in well PAC 5, and radium-228 was above its proposed DWS (Flag 2) in wells PAC 3 and 6. Radium-228 results that exceeded nonvolatile beta activities were reported in these and other wells.

Introduction

The P-Area Acid/Caustic Basin is located east of P Area and Road F at the Savannah River Site (SRS) on a slope that leads to a tributary of Par Pond. The basin, constructed in the early 1950s, is an unlined earthen pit that received dilute sulfuric acid and sodium hydroxide solutions and other wastes from several areas within SRS. The basin provided an area for the mixing and neutralization of the dilute solutions before their discharge to nearby streams. The P-Area Acid/Caustic Basin remained in service until new neutralization facilities became operational in 1982 (Heffner and Exploration Resources, 1991).

Four groundwater monitoring wells were installed at the P-Area Acid/Caustic Basin between November 1983 and July 1984. Under the terms of a consent decree signed May 26, 1988, by the U.S. District Court (District of South Carolina, Aiken Division), the basin became subject on June 1, 1988, to requirements of Subtitle C of the Resource Conservation and Recovery Act (RCRA), the South Carolina Hazardous Waste Management Regulations (SCHWMR), and associated regulations. The basin monitoring wells were reevaluated during the summer of 1988 to ensure compliance with SCHWMR. As part of this compliance effort, two additional wells were installed at the P-Area Acid/Caustic Basin during fall 1988.

The monitoring wells at the P-Area Acid/Caustic Basin are sampled quarterly as part of the SRS Groundwater Monitoring Program and to comply with the consent decree. The revised Groundwater Quality Assessment Plan (WSRC, 1991), submitted to the South Carolina Department of Health and Environmental Control on April 30, 1991, indicates that the monitoring well network at the P-Area Acid/Caustic Basin is sufficient to detect effects of the basin on the groundwater.

Discussion

Groundwater Monitoring Data

The groundwater sampling procedure was modified beginning fourth quarter 1992 in response to regulatory guidance and advances in sampling equipr nt design (WSRC, 1992). The modified procedure requires evacuation of a minimum of two well volumes and stabilization of pH, specific conductance, and turbidity prior to sample collection. Stability is established when a minimum of three successive measurements, taken within a given time period, are within a specified tolerance range. If a well pumps dry before two well volumes are purged or before stabilization is achieved, it must be revisited within 24 hours for the data to be considered the result of a single sampling event. On the second visit within 24 hours, samples are taken without purging or stabilizing; thus, these samples may not be representative of the groundwater quality.

A further modification in the procedure is that samples collected for metals analyses are not filtered. Thus, the analyses are for total metals rather than dissolved metals. Roy F. Weston, Inc., performs a digestion on the metals samples prior to analysis, yielding results for total recoverable metals.

During second quarter 1993, samples from the six monitoring wells at the P-Area Acid/ Caustic Basin were analyzed for indicator parameters, groundwater quality parameters, parameters characterizing suitabiiity as a drinking water supply, and turbidity. This report describes monitoring results that exceeded the Safe Drinking Water Act final Primary Drinking Water Standards (PDWS) established by the U.S. Environmental Protection Agency (EPA) (Appendix A), the South Carolina final PDWS for lead (Appendix A), other SRS flagging criteria (Appendix B), or the SRS turbidity standard.

The SRS flagging criteria are based on final and proposed PDWS, Secondary Drinking Water Standards, and method detection limits. Constituent levels that equal or exceed the final PDWS, screening levels, or Flag 2 criteria are described as *elevated.*

The final PDWS for individual analytes provided in Appendix A may not always match the SRS flagging criteria provided in Appendix B. The final PDWS are used as guidelines in this compliance report to meet regulatory requirements; the flagging criteria are used by the Environmental Protection Department/Environmental Monitoring Section to identify relative levels of constituents in the groundwater and as guides for scheduling groundwater sampling.

Illustrations of the monitored waste management unit at SRS (Figure 1), the individual monitoring wells (Figure 2), and the flow direction of the groundwater beneath the basin (Figure 3) are in Appendix C. All figures are aligned to true north. Figure 1 includes SRS grid coordinates and latitude/longitude. Figure 2 includes latitude/longitude and Universal

Transverse Mercator (UTM) coordinates. Monitoring results are presented in Appendix D, and a discussion of data quality and useability is in Appendix E.

Analytical Results Exceeding Standards

No analytes exceeded the final PDWS (Appendix A) during second quarter 1993; see Table 1 (Appendix D).

Constituents that exceeded other Flag 1 or Flag 2 criteria (Appendix B) during second quarter 1993 are summarized in Table 2 (Appendix D). Aluminum exceeded the Flag 2 criterion in wells PAC 1, 3, 4, 5, and 6, with a maximum concentration of 842 μg/L in well PAC 5. Iron exceeded the Flag 2 criterion in wells PAC 2, 3, 5, and 6, with concentrations up to 9,240 μg/L in well PAC 2. Manganese also exceeded the Flag 2 criterion in wells PAC 2, 3, 5, and 6, with concentrations up to 196 μg/L in well PAC 3. Lead was detected at its Flag 2 criterion in well PAC 5.

Radium-228 was reported above its proposed DWS (Flag 2) in wells PAC 3 and 6; it also exceeded the nonvolatile beta activities in those and other wells. After being queried, the laboratory verified these Ra-228 results. During second quarter, some laboratory blanks were identified as having false positive results for Ra-228; however, particular laboratory blanks have not been associated with specific samples at this time.

Table 3 (Appendix D) presents all of the results for individual wells, indicates those analyses that exceeded holding times or the final PDWS, and lists the number of well volumes purged from each PAC well during second quarter 1993. Wells PAC 5 and 6 each yielded less than two well volumes prior to purging dry.

Constituent results are compared with the PDWS in the database of values reported by the laboratory. Many constituents are reported to more significant digits in the database than in these reports. Thus, there may be some constituent results in Table 3 that appear to equal the PDWS but are not marked in the *D* column. Those results are below the PDWS in the database.

Some of the values for earlier quarters presented in Table 1 of this report may differ from the values for those same quarters presented in previous reports, and reported values may not match reported sample dates. These differences result from the following: (1) a new computer program, which rounds numbers differently from the former computer program, was first used during third quarter 1992; and (2) some reanalyses may have been performed by the laboratories after the quarterly reports had gone to press.

Turbidity Results Exceeding Standards

Turbidity results, in nephelometric turbidity units (NTU), of less than 5 NTU meet the EPA's general standard for acceptability of groundwater samples (EPA, 1986). That standard, however, is considered unrealistic for monitoring wells at SRS. Gass (1989) has documented turbidity measurements ranging up to 5,000 NTU from properly designed wells

screened in poorly productive formations. During the 1989 RCRA Compliance Evaluation Inspection, officials from EPA Region IV indicated that the SRS turbidity standard of 50 NTU is conservative. These officials also agreed that water-table wells in this area often correspond to nonaquifer formations, rendering development of these wells more difficult due to the low yield and high proportion of mobile fines typical of these formations (Bergren and Bennett, 1989).

During second quarter 1993, turbidity results for samples from wells PAC 2, 3, 4, and 6 were between 5 and 50 NTU (Table 3, Appendix D). None of the samples exceeded the SRS turbidity standard.

Water Elevations, Flow Directions, and Flow Rates

Water-table elevations and the groundwater flow direction beneath the P-Area Acid/Caustic Basin are shown in Figure 3 (Appendix C). Water-table elevations indicate that the groundwater flow direction is northwest.

The groundwater flow rate in the water table (Aquifer Zone IIB_2) beneath the P-Area Acid/Caustic Basin is estimated using the following equation:

$$\text{Flow (ft/day)} = \frac{\text{Hydraulic Conductivity (ft/day)}}{\text{Porosity (unitless)}} \times \frac{dh\ \text{(ft)}}{dl\ \text{(ft)}}$$

A hydraulic conductivity constant of 10 ft/day (Geraghty & Miller, Inc., 1990) is a conservative estimate (i.e., the actual hydraulic conductivity should be somewhat less than 10 ft/day).

The effective porosity is estimated at 20% (Killian et al., 1987), *dh* is the difference in head, and *dl* is the length of the flow path to the nearest ft. Flow rate estimations vary depending on the vertical gradient between wells, the size of the area under consideration, and the number of data points. The flow path is measured along the map; as much as possible, the path is drawn the same each quarter. Because of these variables, the estimation of flow rate must be considered accurate to an order of magnitude only.

Flow rate estimates are calculated as follows: flow rate per day is calculated to two significant figures using the above equation. This value is then multiplied by 365 and rounded to two significant figures for the flow rate per year.

Using the above equation with dh = 8 ft and dl = 50 ft (Figure 3, Appendix C), the flow rate estimate for groundwater in the water table beneath the P-Area Acid/Caustic Basin is as follows:

$$\frac{10}{0.20} \times \frac{8}{50} = 8.0 \text{ ft/day}$$

$$8.0 \text{ ft/day} \times 365 \text{ days} \approx 2{,}900 \text{ ft/yr}$$

This result varies considerably from the rate calculated for fourth quarter 1992 but is fairly consistent with those from other recent quarters, as shown below.

	3Q92	4Q92	1Q93	2Q93
Groundwater flow rate (ft/yr)	3,000	2,000	3,000	2,900

Results for Upgradient vs. Downgradient Wells

Well PAC 4 is the upgradient well at the P-Area Acid/Caustic Basin. During second quarter 1993, no constituents exceeded the final PDWS or the SRS turbidity standard in well PAC 4. Aluminum exceeded its SRS flagging criteria in the upgradient well. Aluminum, iron, lead, manganese and radium-228 each exceeded the Flag 2 criteria in one or more downgradient wells.

Conclusions

During second quarter 1993, no analytes exceeded the final PDWS in any wells at the P-Area Acid/Caustic Basin. Aluminum was the only constituent to exceed its SRS Flag 2 criterion in upgradient well PAC 4. Aluminum, iron, lead, and manganese each exceeded the Flag 2 criterion in downgradient wells. Radium-228 activities reported above Flag 2 are inconsistent with historical results and with the nonvolatile beta activities reported for the same wells. Generally, constituents found in downgradient wells but not upgradient wells at a waste management unit are considered products of the waste management unit.

Water-table elevations at the P-Area Acid/Caustic Basin indicate that groundwater flow direction was northwest at a rate of approximately 2,900 ft/yr. Groundwater flow direction in this area can be accurately defined because the groundwater gradient is large and follows the surface topography. The revised Groundwater Quality Assessment Plan (WSRC, 1991) for the basin indicates that the monitoring well network at the P-Area Acid/Caustic Basin is sufficient to detect effects on groundwater quality of past operations at the basin.

Errata

Second Quarter 1992:

- No errata have been reported.

Third Quarter 1992:

- Prior to third quarter 1992, the results of certain analyses for *nitrate-nitrite as nitrogen* were reported incorrectly by the General Engineering laboratory as *nitrate as nitrogen* results. The analyses in the results tables of this report beginning this quarter are reported correctly (*nitrate-nitrite* results have been separated from true *nitrate* results).

First Quarter 1993:

- No errata have been reported.

Second Quarter 1993:

- No errata have been reported.

References Cited

Bergren, C. L., and C. B. Bennett, 1989. **Assessment of SRS Groundwater Monitoring Wells Impacted by Turbidity**, WSRC-RP-89-891. Westinghouse Savannah River Company, Aiken, SC.

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

Gass, T. E., 1989. *Monitoring Wells in Non-Aquifer Formations*. **Water Well Journal** 43(2):27–29.

Geraghty & Miller, Inc., 1990. **Evaluation of Integrated Waste Facility Closure Capping on Ground-Water Flow and Solute Transport in General Separations Area, Savannah River Site: Flow Model and Particle-Tracking Analysis, Final Report**. Prepared by Geraghty & Miller Modeling Group for Westinghouse Savannah River Company, Waste Management Technology, Savannah River Site, Aiken, SC.

Heffner, J. D., and Exploration Resources, Inc., 1991. **Technical Summary of Groundwater Quality Protection Program at the Savannah River Site (1952–1986), Volume I – Site Geohydrology and Waste Sites**, DPSP-88-1002. Westinghouse Savannah River Company, Aiken, SC.

Killian, T. H., N. L. Kolb, P. Corbo, and I. W. Marine, 1987. **F-Area Seepage Basins**, DPST-85-704. Savannah River Laboratory, E. I. du Pont de Nemours & Company, Aiken, SC.

WSRC (Westinghouse Savannah River Company), 1991. **F-, H-, K-, and P-Area Acid Caustic Basins Groundwater Quality Assessment Plan**, WSRC-TR-91-178, Revision 1.0. Westinghouse Savannah River Company, Aiken, SC.

WSRC, 1992. **Hydrogeologic Data Collection Procedures and Specifications: Sampling Groundwater Monitoring Wells**, Manual 3Q5, Chapter 14, Revision 0. Environmental Protection Department, Environmental Monitoring Section, Savannah River Site, Aiken, SC.

Appendix A – Final Primary Drinking Water Standards

Final Primary Drinking Water Standards

Analyte	Unit	Level	Status	Source
Antimony	µg/L	6	Final	EPA, 1992b
Arsenic	µg/L	50	Final	EPA, 1992a
Asbestos	fibers/L	7,000,000	Final	EPA, 1992a
Barium	µg/L	2,000	Final	EPA, 1992a
Benzene	µg/L	5	Final	EPA, 1992a
Benzo[a]pyrene	µg/L	0.2	Final	EPA, 1992b
Beryllium	µg/L	4	Final	EPA, 1992b
Bis(2-ethylhexyl) phthalate	µg/L	6	Final	EPA, 1992b
Bromodichloromethane	µg/L	100[a]	Final	EPA, 1992a
Bromoform	µg/L	100[a]	Final	EPA, 1992a
2-sec-Butyl-4,6-dinitrophenol	µg/L	7	Final	EPA, 1992b
Cadmium	µg/L	5	Final	EPA, 1992a
Carbon tetrachloride	µg/L	5	Final	EPA, 1992a
Chlordane	µg/L	2	Final	EPA, 1992a
Chlorobenzene	µg/L	100	Final	EPA, 1992a
Chloroethene (Vinyl chloride)	µg/L	2	Final	EPA, 1992a
Chloroform	µg/L	100[a]	Final	EPA, 1992a
Chromium	µg/L	100	Final	EPA, 1992a
Copper	µg/L	1,300	Final	EPA, 1992a
Cyanide	µg/L	200	Final	EPA, 1992b
Dibromochloromethane	µg/L	100[a]	Final	EPA, 1992a
Dibromochloropropane	µg/L	0.2	Final	EPA, 1992a
1,2-Dibromoethane (Ethylene dibromide)	µg/L	0.05	Final	EPA, 1992a
1,2-Dichlorobenzene	µg/L	600	Final	EPA, 1992a
1,4-Dichlorobenzene	µg/L	75	Final	EPA, 1992a
1,2-Dichloroethane	µg/L	5	Final	EPA, 1992a
1,1-Dichloroethene	µg/L	7	Final	EPA, 1992a
1,2-Dichloroethene	µg/L	50	Final	EPA, 1992b
cis-1,2-Dichloroethene	µg/L	70	Final	EPA, 1992a
trans-1,2-Dichloroethene	µg/L	100	Final	EPA, 1992a
Dichloromethane (Methylene chloride)	µg/L	5	Final	EPA, 1992b
2,4-Dichlorophenoxyacetic acid	µg/L	70	Final	EPA, 1992a
1,2-Dichloropropane	µg/L	5	Final	EPA, 1992a
Endrin	µg/L	2	Final	EPA, 1992b
Ethylbenzene	µg/L	700	Final	EPA, 1992a
Fluoride	µg/L	4,000	Final	EPA, 1992a
Gross alpha[b]	pCi/L	1.5E+01	Final	EPA, 1992a
Heptachlor	µg/L	0.4	Final	EPA, 1992a
Heptachlor epoxide	µg/L	0.2	Final	EPA, 1992a
Hexachlorobenzene	µg/L	1	Final	EPA, 1992b
Hexachlorocyclopentadiene	µg/L	50	Final	EPA, 1992b
Lead	µg/L	50	Final	SCDHEC, 1981
Lindane	µg/L	0.2	Final	EPA, 1992a
Mercury	µg/L	2	Final	EPA, 1992a
Methoxychlor	µg/L	40	Final	EPA, 1992a
Nickel	µg/L	100	Final	EPA, 1992b
Nitrate as nitrogen	µg/L	10,000	Final	EPA, 1992a
Nitrate-nitrite as nitrogen	µg/L	10,000	Final	EPA, 1992a
Nitrite as nitrogen	µg/L	1,000	Final	EPA, 1992a
Nonvolatile beta[c]	pCi/L	5E+01	Final	EPA, 1977
PCBs[d]	µg/L	0.5	Final	EPA, 1992a
Pentachlorophenol	µg/L	1	Final	EPA, 1992a
Radium, total (Radium-226 and -228)	pCi/L	5E+00	Final	EPA, 1992a

Analyte	Unit	Level	Status	Source
Selenium	µg/L	50	Final	EPA, 1992a
Strontium-89/90[e]	pCi/L	8E+00	Final	EPA, 1992a
Strontium-90	pCi/L	8E+00	Final	EPA, 1992a
Styrene	µg/L	100	Final	EPA, 1992a
2,3,7,8-TCDD	µg/L	0.00003	Final	EPA, 1992b
Tetrachloroethylene	µg/L	5	Final	EPA, 1992a
Thallium	µg/L	2	Final	EPA, 1992b
Toluene	µg/L	1,000	Final	EPA, 1992a
Total trihalomethanes	µg/L	100	Final	EPA, 1992a
Toxaphene	µg/L	3	Final	EPA, 1992a
2,4,5-TP (Silvex)	µg/L	50	Final	EPA, 1992a
1,2,4-Trichlorobenzene	µg/L	70	Final	EPA, 1992b
1,1,1-Trichloroethane	µg/L	200	Final	EPA, 1992a
1,1,2-Trichloroethane	µg/L	5	Final	EPA, 1992b
Trichloroethylene	µg/L	5	Final	EPA, 1992a
Tritium	pCi/mL	2E+01	Final	EPA, 1992a
Xylenes	µg/L	10,000	Final	EPA, 1992a

[a] This value is the drinking water standard for total trihalomethanes (the sum of bromoform, bromodichloromethane, chloroform, and dibromochloromethane).

[b] The standard given is for gross alpha including radium-226 but excluding radon and uranium.

[c] This is the screening level above which providers of public drinking water should perform analyses for specific man-made radionuclides. The standard for the total dose equivalent from all such radionuclides is 4 mrem per year.

[d] Analyses were conducted in 1992 for the following: PCB 1016, PCB 1221, PCB 1232, PCB 1242, PCB 1248, PCB 1254, and PCB 1260.

[e] For double radionuclide analyses where each separate radionuclide has its own standard, the more stringent standard is used.

References

EPA (U.S. Environmental Protection Agency), 1977. **National Interim Primary Drinking Water Regulations**, EPA-570/9-76-003. Washington, DC.

EPA (U.S. Environmental Protection Agency), 1992a. *National Primary Drinking Water Regulations,* **Code of Federal Regulations**, Title 40, Part 141, pp. 589-729. Washington, DC.

EPA (U.S. Environmental Protection Agency), 1992b. *National Primary Drinking Water Regulations—Synthetic Organic Chemicals and Inorganic Chemicals; National Primary Drinking Water Regulations Implementation.* **Federal Register**, July 17, 1992, pp. 31776-31849. Washington, DC.

SCDHEC (South Carolina Department of Health and Environmental Control), 1981. **State Primary Drinking Water Regulations**, R.61-58.5. Columbia, SC.

Appendix B – Flagging Criteria

Flagging Criteria

The Savannah River Site Environmental Protection Department/Environmental Monitoring Section (EPD/EMS) flagging criteria are as follows:

- Flag 2 criteria for constituents equal the Safe Drinking Water Act (SDWA) final Primary Drinking Water Standard (PDWS), the SDWA proposed PDWS, or the SDWA Secondary Drinking Water Standard (SDWS). If a constituent does not have a drinking water standard, the Flag 2 criterion equals 10 times the method detection limit (MDL) calculated as the 90th percentile detection limit obtained recently by one of the primary analytical laboratories.

- Flag 1 criteria for constituents equal one-half of the final PDWS, one-half the proposed PDWS, or one-half the SDWS. If a constituent does not have a drinking water standard, the Flag 1 criterion equals 5 times the MDL calculated as the 90th percentile detection limit obtained recently by one of the primary analytical laboratories.

- Flag 0 criteria are assigned to constituent levels below Flag 1 criteria, constituent levels below the sample detection limits, or constituents having no flagging criteria.

The following parameters are not assigned flagging criteria: alkalinity, calcium, color, corrosivity, Eh, magnesium, odor, potassium, silica, sodium, total dissolved solids, total phosphates (as P), total phosphorus, and turbidity. In addition, common laboratory contaminants and cleaners including some phthalates, ketones, and toluene are not assigned flagging criteria.

Analyte	Unit	Flag 1	Flag 2	Source[a]
Acenaphthene	µg/L	50	100	EPA Method 8270
Acenaphthylene	µg/L	50	100	EPA Method 8270
Acetone	µg/L	500	1,000	EPA Method 8240
Acetonitrile (Methyl cyanide)	µg/L	500	1,000	EPA Method 8240
Acetophenone	µg/L	50	100	EPA Method 8270
2-Acetylaminofluorene	µg/L	50	100	EPA Method 8270
Acrolein	µg/L	100	200	EPA Method 8240
Acrylonitrile	µg/L	100	200	EPA Method 8240
Actinium-228	pCi/L	1.64E+03	3.27E+03	Proposed PDWS (EPA, 1991)
Aldrin	µg/L	0.25	0.5	EPA Method 8080
Alkalinity (as $CaCO_3$)		No flag	No flag	Set by EPD/EMS
Allyl chloride	µg/L	250	500	EPA Method 8240
Aluminum	µg/L	25	50	SDWS (EPA, 1992c)
Americium-241	pCi/L	3.17E+00	6.34E+00	Proposed PDWS (EPA, 1991)
Americium-243	pCi/L	3.19E+00	6.37E+00	Proposed PDWS (EPA, 1991)
4-Aminobiphenyl	µg/L	50	100	EPA Method 8270
Ammonia	µg/L	500	1,000	APHA Method 417B
Ammonia nitrogen	µg/L	500	1,000	EPA Method 350.1
Aniline	µg/L	50	100	EPA Method 8270
Anthracene	µg/L	50	100	EPA Method 8270
Antimony	µg/L	3	6	Final PDWS (EPA, 1992b)
Antimony-125	pCi/L	1.5E+02	3E+02	Final PDWS (EPA, 1977)
Aramite	µg/L	50	100	EPA Method 8270
Arsenic	µg/L	25	50	Final PDWS (EPA, 1992a)

Analyte	Unit	Flag 1	Flag 2	Source[a]
Asbestos	Fibers/L	3,500,000	7,000,000	Final PDWS (EPA, 1992a)
Azobenzene	µg/L	50	100	EPA Method 625
Barium	µg/L	1,000	2,000	Final PDWS (EPA, 1992a)
Barium-140	pCi/L	4.5E+01	9E+01	Final PDWS (EPA, 1977)
Benzene	µg/L	2.5	5	Final PDWS (EPA, 1992a)
alpha-Benzene hexachloride	µg/L	0.25	0.5	EPA Method 8080
beta-Benzene hexachloride	µg/L	0.25	0.5	EPA Method 8080
delta-Benzene hexachloride	µg/L	0.25	0.5	EPA Method 8080
Benzidine	µg/L	250	500	EPA Method 8270
Benzo[*a*]anthracene	µg/L	0.05	0.1	Proposed PDWS (EPA, 1990)
Benzo[*b*]fluoranthene	µg/L	0.1	0.2	Proposed PDWS (EPA, 1990)
Benzo[*k*]fluoranthene	µg/L	0.1	0.2	Proposed PDWS (EPA, 1990)
Benzoic acid	µg/L	250	500	EPA Method 8270
Benzo[*g,h,i*]perylene	µg/L	50	100	EPA Method 8270
Benzo[*a*]pyrene	µg/L	0.1	0.2	Final PDWS (EPA, 1992b)
1,4-Benzoquinone	µg/L	50	100	EPA Method 8270
Benzyl alcohol	µg/L	50	100	EPA Method 8270
Beryllium	µg/L	2	4	Final PDWS (EPA, 1992b)
Beryllium-7	pCi/L	3E+03	6E+03	Final PDWS (EPA, 1977)
Bis(2-chloroethoxy) methane	µg/L	50	100	EPA Method 8270
Bis(2-chloroethyl) ether	µg/L	50	100	EPA Method 8270
Bis(2-chloroisopropyl) ether	µg/L	50	100	EPA Method 8270
Bis(chloromethyl) ether	µg/L	50	100	EPA Method 8270
Bis(2-ethylhexyl) phthalate	µg/L	3	6	Final PDWS (EPA, 1992b)
Bromide	µg/L	5,000	10,000	EPA Method 300.0
Bromodichloromethane	µg/L	50	100	Final PDWS (EPA, 1992a)
Bromoform	µg/L	50	100	Final PDWS (EPA, 1992a)
Bromomethane (Methyl bromide)	µg/L	5	10	EPA Method 8240
4-Bromophenyl phenyl ether	µg/L	50	100	EPA Method 8270
2-sec-Butyl-4,6-dinitrophenol	µg/L	3.5	7	Final PDWS (EPA, 1992b)
Butylbenzyl phthalate		No flag	No flag	Set by EPD/EMS
Cadmium	µg/L	2.5	5	Final PDWS (EPA, 1992a)
Calcium		No flag	No flag	Set by EPD/EMS
Carbon disulfide	µg/L	5	10	EPA Method 8240
Carbon tetrachloride	µg/L	2.5	5	Final PDWS (EPA, 1992a)
Carbon-14	pCi/L	1E+03	2E+03	Final PDWS (EPA, 1977)
Carbonate		No flag	No flag	Set by EPD/EMS
Cerium-141	pCi/L	1.5E+02	3E+02	Final PDWS (EPA, 1977)
Cerium-144	pCi/L	1.31E+02	2.61E+02	Proposed PDWS (EPA, 1991)
Cesium-134[b]	pCi/L	4.07E+01	8.13E+01	Proposed PDWS (EPA, 1991)
Cesium-137	pCi/L	1E+02	2E+02	Final PDWS (EPA, 1977)
Chlordane	µg/L	1	2	Final PDWS (EPA, 1992a)
Chloride	µg/L	125,000	250,000	SDWS (EPA, 1992c)
4-Chloroaniline	µg/L	50	100	EPA Method 8270
Chlorobenzene	µg/L	50	100	Final PDWS (EPA, 1992a)
Chlorobenzilate	µg/L	50	100	EPA Method 8270
Chloroethane	µg/L	5	10	EPA Method 8240
Chloroethene (Vinyl chloride)	µg/L	1	2	Final PDWS (EPA, 1992a)
Chloroethyl vinyl ether	µg/L	5	10	EPA Method 8240
2-Chloroethyl vinyl ether	µg/L	5	10	EPA Method 8240
Chloroform	µg/L	50	100	Final PDWS (EPA, 1992a)
4-Chloro-m-cresol	µg/L	50	100	EPA Method 8270
Chloromethane (Methyl chloride)	µg/L	5	10	EPA Method 8240
2-Chloronaphthalene	µg/L	50	100	EPA Method 8240
2-Chlorophenol	µg/L	50	100	EPA Method 8270

Analyte	Unit	Flag 1	Flag 2	Source[a]
4-Chlorophenyl phenyl ether	µg/L	50	100	EPA Method 8270
Chloroprene	µg/L	1,000	2,000	EPA Method 8240
Chromium	µg/L	50	100	Final PDWS (EPA, 1992a)
Chromium-51	pCi/L	3E+03	6E+03	Final PDWS (EPA, 1977)
Chrysene	µg/L	0.1	0.2	Proposed PDWS (EPA, 1990)
Cobalt	µg/L	20	40	EPA Method 6010
Cobalt-57	pCi/L	5E+02	1E+03	Final PDWS (EPA, 1977)
Cobalt-58	pCi/L	4.5E+03	9E+03	Final PDWS (EPA, 1977)
Cobalt-60	pCi/L	5E+01	1E+02	Final PDWS (EPA, 1977)
Color		No flag	No flag	Set by EPD/EMS
Copper	µg/L	650	1,300	Final PDWS (EPA, 1992a)
Corrosivity		No flag	No flag	Set by EPD/EMS
m-Cresol (3-Methylphenol)	µg/L	50	100	EPA Method 8270
o-Cresol (2-Methylphenol)	µg/L	50	100	EPA Method 8270
p-Cresol (4-Methylphenol)	µg/L	50	100	EPA Method 8270
Curium-242	pCi/L	6.65E+01	1.33E+02	Proposed PDWS (EPA, 1991)
Curium-243	pCi/L	4.15E+00	8.3E+00	Proposed PDWS (EPA, 1991)
Curium-243/244[c]	pCi/L	4.15E+00	8.3E+00	Proposed PDWS (EPA, 1991)
Curium-244	pCi/L	4.92E+00	9.84E+00	Proposed PDWS (EPA, 1991)
Curium-245/246[c]	pCi/L	3.12E+00	6.23E+00	Proposed PDWS (EPA, 1991)
Curium-246	pCi/L	3.14E+00	6.27E+00	Proposed PDWS (EPA, 1991)
Cyanide	µg/L	100	200	Final PDWS (EPA, 1992b)
p,p'-DDD	µg/L	0.5	1	EPA Method 8080
p,p'-DDE	µg/L	0.5	1	EPA Method 8080
p,p'-DDT	µg/L	0.5	1	EPA Method 8080
Di-n-butyl phthalate		No flag	No flag	Set by EPD/EMS
Di-n-octyl phthalate		No flag	No flag	Set by EPD/EMS
Diallate	µg/L	50	100	EPA Method 8270
Dibenz[*a,h*]anthracene	µg/L	0.15	0.3	Proposed PDWS (EPA, 1990)
Dibenzofuran	µg/L	50	100	EPA Method 8270
Dibromochloromethane	µg/L	50	100	Final PDWS (EPA, 1992a)
1,2-Dibromo-3-chloropropane	µg/L	0.1	0.2	Final PDWS (EPA, 1992a)
1,2-Dibromoethane (Ethylene dibromide)	µg/L	0.025	0.05	Final PDWS (EPA, 1992a)
Dibromomethane (Methylene bromide)	µg/L	5	10	EPA Method 8240
1,2-Dichlorobenzene	µg/L	300	600	Final PDWS (EPA, 1992a)
1,3-Dichlorobenzene	µg/L	50	100	EPA Method 8270
1,4-Dichlorobenzene	µg/L	37.5	75	Final PDWS (EPA, 1992a)
3,3'-Dichlorobenzidine	µg/L	50	100	EPA Method 8270
trans-1,4-Dichloro-2-butene	µg/L	150	300	EPA Method 8240
Dichlorodifluoromethane	µg/L	5	10	EPA Method 8240
1,1-Dichloroethane	µg/L	5	10	EPA Method 8240
1,2-Dichloroethane	µg/L	2.5	5	Final PDWS (EPA, 1992a)
1,1-Dichloroethene	µg/L	3.5	7	Final PDWS (EPA, 1992a)
1,2-Dichloroethene	µg/L	25	50	Final PDWS (EPA, 1992b)
cis-1,2-Dichloroethene	µg/L	35	70	Final PDWS (EPA, 1992a)
trans-1,2-Dichloroethene	µg/L	50	100	Final PDWS (EPA, 1992a)
Dichloromethane (Methylene chloride)	µg/L	2.5	5	Final PDWS (EPA, 1992b)
2,4-Dichlorophenol	µg/L	50	100	EPA Method 8270
2,6-Dichlorophenol	µg/L	50	100	EPA Method 8270
2,4-Dichlorophenoxyacetic acid	µg/L	35	70	Final PDWS (EPA, 1992a)
1,2-Dichloropropane	µg/L	2.5	5	Final PDWS (EPA, 1992a)
cis-1,3-Dichloropropene	µg/L	5	10	EPA Method 8240

Analyte	Unit	Flag 1	Flag 2	Source[a]
trans-1,3-Dichloropropene	µg/L	5	10	EPA Method 8240
Dieldrin	µg/L	2.5	5	EPA Method 8080
Diethyl phthalate		No flag	No flag	Set by EPD/EMS
Dimethoate	µg/L	50	100	EPA Method 8270
p-Dimethylaminoazobenzene	µg/L	50	100	EPA Method 8270
p-(Dimethylamino)ethylbenzene	µg/L	50	100	EPA Method 8270
7,12-Dimethylbenz[*a*]anthracene	µg/L	50	100	EPA Method 8270
3,3'-Dimethylbenzidine	µg/L	50	100	EPA Method 8270
a,a-Dimethylphenethylamine	µg/L	50	100	EPA Method 8270
2,4-Dimethyl phenol	µg/L	50	100	EPA Method 8270
Dimethyl phthalate		No flag	No flag	Set by EPD/EMS
1,3-Dinitrobenzene	µg/L	50	100	EPA Method 8270
2,4-Dinitrophenol	µg/L	250	500	EPA Method 8270
2,4-Dinitrotoluene	µg/L	50	100	EPA Method 8270
2,6-Dinitrotoluene	µg/L	50	100	EPA Method 8270
1,4-Dioxane	µg/L	50	100	EPA Method 8270
Diphenylamine	µg/L	50	100	EPA Method 8270
1,2-Diphenylhydrazine	µg/L	50	100	EPA Method 8270
Dissolved organic carbon	µg/L	5,000	10,000	EPA Method 9060
Disulfoton	µg/L	50	100	EPA Method 8270
Eh		No flag	No flag	Set by EPD/EMS
alpha-Endosulfan	µg/L	50	100	EPA Method 8270
beta-Endosulfan	µg/L	50	100	EPA Method 8270
Endosulfan I	µg/L	0.5	1	EPA Method 8080
Endosulfan II	µg/L	0.5	1	EPA Method 8080
Endosulfan sulfate	µg/L	0.5	1	EPA Method 8080
Endrin	µg/L	1	2	Final PDWS (EPA, 1992b)
Endrin aldehyde	µg/L	0.5	1	EPA Method 8080
Endrin ketone		No flag	No flag	Set by EPD/EMS
Ethylbenzene	µg/L	350	700	Final PDWS (EPA, 1992a)
Ethyl methacrylate	µg/L	50	100	EPA Method 8270
Ethyl methanesulfonate	µg/L	50	100	EPA Method 8270
Europium-152	pCi/L	3E+01	6E+01	Final PDWS (EPA, 1977)
Europium-154	pCi/L	1E+02	2E+02	Final PDWS (EPA, 1977)
Europium-155	pCi/L	3E+02	6E+02	Final PDWS (EPA, 1977)
Famphur	µg/L	50	100	EPA Method 8270
Fluoranthene	µg/L	50	100	EPA Method 8270
Fluorene	µg/L	50	100	EPA Method 8270
Fluoride	µg/L	2,000	4,000	Final PDWS (EPA, 1992a)
Gross alpha	pCi/L	7.5E+00	1.5E+01	Final PDWS (EPA, 1992a)
Heptachlor	µg/L	0.2	0.4	Final PDWS (EPA, 1992a)
Heptachlor epoxide	µg/L	0.1	0.2	Final PDWS (EPA, 1992a)
Heptachlorodibenzo-p-dioxin isomers	µg/L	0.00325	0.0065	EPA Method 8280
1,2,3,4,6,7,8-HPCDD	µg/L	0.00325	0.0065	EPA Method 8280
Heptachlorodibenzo-p-furan isomers	µg/L	0.00225	0.0045	EPA Method 8280
1,2,3,4,6,7,8-HPCDF	µg/L	0.00225	0.0045	EPA Method 8280
Hexachlorobenzene	µg/L	0.5	1	Final PDWS (EPA, 1992b)
Hexachlorobutadiene	µg/L	50	100	EPA Method 8270
Hexachlorocyclopentadiene	µg/L	25	50	Final PDWS (EPA, 1992b)
Hexachlorodibenzo-p-dioxin isomers	µg/L	0.00225	0.0045	EPA Method 8280
1,2,3,4,7,8-HXCDD	µg/L	0.00225	0.0045	EPA Method 8280
Hexachlorodibenzo-p-furan isomers	µg/L	0.002	0.004	EPA Method 8280
1,2,3,4,7,8-HXCDF	µg/L	0.002	0.004	EPA Method 8280

Analyte	Unit	Flag 1	Flag 2	Source[a]
Hexachloroethane	µg/L	50	100	EPA Method 8270
Hexachlorophene	µg/L	250	500	EPA Method 8270
Hexachloropropene	µg/L	50	100	EPA Method 8270
2-Hexanone	µg/L	50	100	EPA Method 8240
Indeno[1,2,3-*c,d*]pyrene	µg/L	50	100	EPA Method 8270
Iodine	µg/L	250	500	APHA Method 415A
Iodine-129	pCi/L	5E-01	1E+00	Final PDWS (EPA, 1977)
Iodine-131	pCi/L	1.5E+00	3E+00	Final PDWS (EPA, 1977)
Iodomethane (Methyl iodide)	µg/L	75	150	EPA Method 8240
Iron	µg/L	150	300	SDWS (EPA, 1992c)
Iron-55	pCi/L	1E+03	2E+03	Final PDWS (EPA, 1977)
Iron-59	pCi/L	1E+02	2E+02	Final PDWS (EPA, 1977)
Isobutyl alcohol	µg/L	500	1,000	EPA Method 8240
Isodrin	µg/L	50	100	EPA Method 8270
Isophorone	µg/L	50	100	EPA Method 8270
Isosafrole	µg/L	50	100	EPA Method 8270
Kepone	µg/L	50	100	EPA Method 8270
Lanthanum-140	pCi/L	3E+01	6E+01	Final PDWS (EPA, 1977)
Lead	µg/L	7.5	15	Final PDWS (EPA, 1992a)
Lindane	µg/L	0.1	0.2	Final PDWS (EPA, 1992a)
Lithium	µg/L	25	50	EPA Method 6010
Magnesium		No flag	No flag	Set by EPD/EMS
Manganese	µg/L	25	50	SDWS (EPA, 1992c)
Manganese-54	pCi/L	1.5E+02	3E+02	Final PDWS (EPA, 1977)
Mercury	µg/L	1	2	Final PDWS (EPA, 1992a)
Methacrylonitrile	µg/L	250	500	EPA Method 8240
Methapyrilene	µg/L	50	100	EPA Method 8270
Methoxychlor	µg/L	20	40	Final PDWS (EPA, 1992a)
3-Methylcholanthrene	µg/L	50	100	EPA Method 8270
2-Methyl-4,6-dinitrophenol	µg/L	250	500	EPA Method 8270
Methyl ethyl ketone		No flag	No flag	Set by EPD/EMS
Methyl isobutyl ketone		No flag	No flag	Set by EPD/EMS
Methyl methacrylate	µg/L	50	100	EPA Method 8270
Methyl methanesulfonate	µg/L	50	100	EPA Method 8270
2-Methylnaphthalene	µg/L	50	100	EPA Method 8270
Molybdenum	µg/L	250	500	EPA Method 6010
Naphthalene	µg/L	50	100	EPA Method 8270
1,4-Naphthoquinone	µg/L	50	100	EPA Method 8270
1-Naphthylamine	µg/L	50	100	EPA Method 8270
2-Naphthylamine	µg/L	50	100	EPA Method 8270
Neptunium-237	pCi/L	3.53E+00	7.06E+00	Proposed PDWS (EPA, 1991)
Nickel	µg/L	50	100	Final PDWS (EPA, 1992b)
Nickel-59	pCi/L	1.5E+02	3E+02	Final PDWS (EPA, 1977)
Nickel-63	pCi/L	2.5E+01	5E+01	Final PDWS (EPA, 1977)
Niobium-95	pCi/L	1.5E+02	3.E+02	Final PDWS (EPA, 1977)
Nitrate as nitrogen	µg/L	5,000	10,000	Final PDWS (EPA, 1992a)
Nitrate-nitrite as nitrogen	µg/L	5,000	10,000	Final PDWS (EPA, 1992a)
Nitrite as nitrogen	µg/L	500	1,000	Final PDWS (EPA, 1992a)
2-Nitroaniline	µg/L	50	100	EPA Method 8270
3-Nitroaniline	µg/L	50	100	EPA Method 8270
4-Nitroaniline	µg/L	50	100	EPA Method 8270
Nitrobenzene	µg/L	50	100	EPA Method 8270
Nitrogen by Kjeldahl method	µg/L	500	1,000	EPA Method 351.2
2-Nitrophenol	µg/L	50	100	EPA Method 8270
4-Nitrophenol	µg/L	50	100	EPA Method 8270

Analyte	Unit	Flag 1	Flag 2	Source[a]
4-Nitroquinoline-1-oxide	µg/L	50	100	EPA Method 8270
N-Nitrosodi-n-butylamine	µg/L	50	100	EPA Method 8270
N-Nitrosodiethylamine	µg/L	50	100	EPA Method 8270
N-Nitrosodimethylamine	µg/L	50	100	EPA Method 8270
N-Nitrosodiphenylamine	µg/L	50	100	EPA Method 8270
N-Nitrosodipropylamine	µg/L	50	100	EPA Method 8270
N-Nitrosomethylethylamine	µg/L	50	100	EPA Method 8270
N-Nitrosomorpholine	µg/L	50	100	EPA Method 8270
N-Nitrosopiperidine	µg/L	50	100	EPA Method 8270
N-Nitrosopyrrolidine	µg/L	50	100	EPA Method 8270
5-Nitro-o-toluidine	µg/L	50	100	EPA Method 8270
Nonvolatile beta	pCi/L	2.5E+01	5E+01	Proposed PDWS (EPA, 1986)
Octachlorodibenzo-p-dioxin isomers	µg/L	0.005	0.01	EPA Method 8280
Octachlorodibenzo-p-furan isomers	µg/L	0.005	0.01	EPA Method 8280
Odor		No flag	No flag	Set by EPD/EMS
Oil & Grease	µg/L	5,000	10,000	EPA Method 413.1
Parathion	µg/L	0.25	0.5	EPA Method 8080
Parathion methyl	µg/L	0.25	0.5	EPA Method 8080
PCB 1016	µg/L	0.25	0.5	Final PDWS (EPA, 1992a)
PCB 1221	µg/L	0.25	0.5	Final PDWS (EPA, 1992a)
PCB 1232	µg/L	0.25	0.5	Final PDWS (EPA, 1992a)
PCB 1242	µg/L	0.25	0.5	Final PDWS (EPA, 1992a)
PCB 1248	µg/L	0.25	0.5	Final PDWS (EPA, 1992a)
PCB 1254	µg/L	0.25	0.5	Final PDWS (EPA, 1992a)
PCB 1260	µg/L	0.25	0.5	Final PDWS (EPA, 1992a)
PCB 1262	µg/L	0.25	0.5	Final PDWS (EPA, 1992a)
Pentachlorobenzene	µg/L	50	100	EPA Method 8270
Pentachlorodibenzo-p-dioxin isomers	µg/L	0.00275	0.0055	EPA Method 8280
1,2,3,7,8-PCDD	µg/L	0.00275	0.0055	EPA Method 8280
Pentachlorodibenzo-p-furan isomers	µg/L	0.00275	0.0055	EPA Method 8280
1,2,3,7,8-PCDF	µg/L	0.00275	0.0055	EPA Method 8280
Pentachloroethane	µg/L	50	100	EPA Method 8270
Pentachloronitrobenzene	µg/L	50	100	EPA Method 8270
Pentachlorophenol	µg/L	0.5	1	Final PDWS (EPA, 1992a)
pH	pH	8	10	Set by EPD/EMS
pH	pH	4	3	Set by EPD/EMS
Phenacetin	µg/L	50	100	EPA Method 8270
Phenanthrene	µg/L	50	100	EPA Method 8270
Phenol	µg/L	50	100	EPA Method 8270
Phenols	µg/L	25	50	EPA Method 420.1
p-Phenylenediamine	µg/L	50	100	EPA Method 8270
Phorate	µg/L	0.5	1	EPA Method 8080
2-Picoline	µg/L	50	100	EPA Method 8270
Plutonium-238	pCi/L	3.51E+00	7.02E+00	Proposed PDWS (EPA, 1991)
Plutonium-239	pCi/L	3.11E+01	6.21E+01	Proposed PDWS (EPA, 1991)
Plutonium-239/240[c]	pCi/L	3.11E+01	6.21E+01	Proposed PDWS (EPA, 1991)
Plutonium-240	pCi/L	3.11E+01	6.22E+01	Proposed PDWS (EPA, 1991)
Plutonium-241	pCi/L	3.13E+01	6.26E+01	Proposed PDWS (EPA, 1991)
Plutonium-242	pCi/L	3.27E+01	6.54E+01	Proposed PDWS (EPA, 1991)
Potassium		No flag	No flag	Set by EPD/EMS
Potassium-40	pCi/L	1.5E+02	3E+02	Proposed PDWS (EPA, 1986)
Pronamid	µg/L	50	100	EPA Method 8270
Propionitrile	µg/L	1,000	2,000	EPA Method 8240
Pyrene	µg/L	50	100	EPA Method 8270
Pyridine	µg/L	50	100	EPA Method 8270

Analyte	Unit	Flag 1	Flag 2	Source[a]
Radium (alpha-emitting)[d]	pCi/L	1E+01	2E+01	Proposed PDWS (EPA, 1991)
Radium-226	pCi/L	1E+01	2E+01	Proposed PDWS (EPA, 1991)
Radium-228	pCi/L	1E+01	2E+01	Proposed PDWS (EPA, 1991)
Radon-222	pCi/L	1.5E+02	3E+02	Proposed PDWS (EPA, 1991)
Ruthenium-103	pCi/L	1E+02	2E+02	Final PDWS (EPA, 1977)
Ruthenium-106	pCi/L	1.5E+01	3E+01	Final PDWS (EPA, 1977)
Safrole	µg/L	50	100	EPA Method 8270
Selenium	µg/L	25	50	Final PDWS (EPA, 1992a)
Silica		No flag	No flag	Set by EPD/EMS
Total silica	µg/L	500	1,000	EPA Method 6010
Silver	µg/L	50	100	SDWS (EPA, 1992c)
Sodium		No flag	No flag	Set by EPD/EMS
Sodium-22	pCi/L	2.33E+02	4.66E+02	Proposed PDWS (EPA, 1991)
Specific conductance	µS/cm	250	500	Set by EPD/EMS
Strontium-89	pCi/L	1E+01	2E+01	Final PDWS (EPA, 1977)
Strontium-89/90[c]	pCi/L	4E+00	8E+00	Final PDWS (EPA, 1992a)
Strontium-90	pCi/L	4E+00	8E+00	Final PDWS (EPA, 1992a)
Styrene	µg/L	50	100	Final PDWS (EPA, 1992a)
Sulfate	µg/L	200,000	400,000	Proposed PDWS (EPA, 1990)
Sulfide	µg/L	5,000	10,000	EPA Method 9030
Sulfotepp	µg/L	50	100	EPA Method 8270
Surfactants		No flag	No flag	Set by EPD/EMS
2,3,7,8-TCDD	µg/L	0.000015	0.00003	Final PDWS (EPA, 1992b)
2,3,7,8-TCDF	µg/L	0.002	0.004	EPA Method 8280
Technetium-99	pCi/L	4.5E+02	9E+02	Final PDWS (EPA, 1977)
1,2,4,5-Tetrachlorobenzene	µg/L	50	100	EPA Method 8270
Tetrachlorodibenzo-p-dioxin isomers	µg/L	0.00225	0.0045	EPA Method 8280
Tetrachlorodibenzo-p-furan isomers	µg/L	0.002	0.004	EPA Method 8280
1,1,1,2-Tetrachloroethane	µg/L	5	10	EPA Method 8240
1,1,2,2-Tetrachloroethane	µg/L	5	10	EPA Method 8240
Tetrachloroethylene	µg/L	2.5	5	Final PDWS (EPA, 1992a)
2,3,4,6-Tetrachlorophenol	µg/L	50	100	EPA Method 8270
Tetraethyl dithiopyrophosphate	µg/L	50	100	EPA Method 8270
Thallium	µg/L	1	2	Final PDWS (EPA, 1992b)
Thionazin	µg/L	50	100	EPA Method 8270
Thorium-228	pCi/L	6.25E+01	1.25E+02	Proposed PDWS (EPA, 1991)
Thorium-230	pCi/L	3.96E+01	7.92E+01	Proposed PDWS (EPA, 1991)
Thorium-232	pCi/L	4.4E+01	8.8E+01	Proposed PDWS (EPA, 1991)
Thorium-234	pCi/L	2E+02	4.01E+02	Proposed PDWS (EPA, 1991)
Tin	µg/L	10	20	EPA Method 282.2
Tin-113	pCi/L	1.5E+02	3E+02	Final PDWS (EPA, 1977)
Toluene	µg/L	500	1,000	Final PDWS (EPA, 1992a)
o-Toluidine	µg/L	50	100	EPA Method 8270
Total carbon	µg/L	5,000	10,000	EPA Method 9060
Total dissolved solids		No flag	No flag	Set by EPD/EMS
Total hydrocarbons	µg/L	5,000	10,000	EPA Method 418.1
Total inorganic carbon	µg/L	5,000	10,000	EPA Method 9060
Total organic carbon	µg/L	5,000	10,000	EPA Method 9060
Total organic halogens	µg/L	25	50	EPA Method 9020
Total organic nitrogen	µg/L	500	1,000	APHA Method 420
Total petroleum hydrocarbons	µg/L	5,000	10,000	EPA Method 418.1
Total phosphates (as P)		No flag	No flag	Set by EPD/EMS
Total phosphorus		No flag	No flag	Set by EPD/EMS

Analyte	Unit	Flag 1	Flag 2	Source[a]
Toxaphene	µg/L	1.5	3	Final PDWS (EPA, 1992a)
2,4,5-TP (Silvex)	µg/L	25	50	Final PDWS (EPA, 1992a)
Tributyl phosphate	µg/L	50	100	EPA Method 8270
1,2,4-Trichlorobenzene	µg/L	35	70	Final PDWS (EPA, 1992b)
1,1,1-Trichloroethane	µg/L	100	200	Final PDWS (EPA, 1992a)
1,1,2-Trichloroethane	µg/L	2.5	5	Final PDWS (EPA, 1992b)
Trichloroethylene	µg/L	2.5	5	Final PDWS (EPA, 1992a)
Trichlorofluoromethane	µg/L	5	10	EPA Method 8240
2,4,5-Trichlorophenol	µg/L	50	100	EPA Method 8270
2,4,6-Trichlorophenol	µg/L	50	100	EPA Method 8270
2,4,5-Trichlorophenoxyacetic acid	µg/L	2.5	5	EPA Method 8150
1,2,3-Trichloropropane	µg/L	5	10	EPA Method 8240
O,O,O-Triethyl phosphorothioate	µg/L	50	100	EPA Method 8270
1,3,5-Trinitrobenzene	µg/L	50	100	EPA Method 8270
Tritium	pCi/mL	1E+01	2E+01	Final PDWS (EPA, 1992a)
Turbidity		No flag	No flag	Set by EPD/EMS
Uranium	µg/L	10	20	Proposed PDWS (EPA, 1991)
Uranium alpha activity	pCi/L	1.5E+01	3E+01	Proposed PDWS (EPA, 1991)
Uranium-233/234[c]	pCi/L	6.9E+00	1.38E+01	Proposed PDWS (EPA, 1991)
Uranium-234	pCi/L	6.95E+00	1.39E+01	Proposed PDWS (EPA, 1991)
Uranium-235	pCi/L	7.25E+00	1.45E+01	Proposed PDWS (EPA, 1991)
Uranium-238	pCi/L	7.3E+00	1.46E+01	Proposed PDWS (EPA, 1991)
Vanadium	µg/L	40	80	EPA Method 6010
Vinyl acetate	µg/L	5	10	EPA Method 8240
Xylenes	µg/L	5,000	10,000	Final PDWS (EPA, 1992a)
Zinc	µg/L	2,500	5,000	SDWS (EPA, 1992c)
Zinc-65	pCi/L	1.5E+02	3E+02	Final PDWS (EPA, 1977)
Zirconium-95	pCi/L	1E+02	2E+02	Final PDWS (EPA, 1977)
Zirconium/Niobium-95[c]	pCi/L	1E+02	2E+02	Final PDWS (EPA, 1977)

[a] References for methods are found in Appendix E; references for dated sources are at the end of this appendix.
[b] EPD/EMS set this flagging criterion using the 1991 proposed PDWS because the final PDWS in 1977 may have been in error.
[c] When radionuclide analyses are combined, the lower PDWS of the two isotopes is used for flagging.
[d] The applied standard is for radium-226.

References

EPA (U.S. Environmental Protection Agency), 1977. **National Interim Primary Drinking Water Regulations**, EPA-570/9-76-003. Washington, DC.

EPA (U.S. Environmental Protection Agency), 1986. *Water Pollution Control; National Primary Drinking Water Regulations, Radionuclides (Proposed).* **Federal Register**, September 30, 1986, pp. 34836-34862. Washington, DC.

EPA (U.S. Environmental Protection Agency), 1990. *National Primary and Secondary Drinking Water Regulations; Synthetic Organic Chemicals and Inorganic Chemicals (Proposed Rule).* **Federal Register**, July 25, 1990, pp. 30369-30448. Washington, DC.

EPA (U.S. Environmental Protection Agency), 1991. *National Primary Drinking Water Regulations; Radionuclides; Proposed Rule.* **Federal Register**, July 18, 1991, pp. 33052-33127. Washington, DC.

EPA (U.S. Environmental Protection Agency), 1992a. *National Primary Drinking Water Regulations,* **Code of Federal Regulations**, Section 40, Part 141, pp. 589-729. Washington, DC.

EPA (U.S. Environmental Protection Agency), 1992b. *National Primary Drinking Water Regulations—Synthetic Organic Chemical and Inorganic Chemicals; National Primary Drinking Water Regulations Implementation.* **Federal Register**, July 17, 1992, pp. 31776-31849. Washington, DC.

EPA (U.S. Environmental Protection Agency), 1992c. *National Secondary Drinking Water Regulations,* **Code of Federal Regulations**, Section 40, Part 143, pp. 772-776. Washington, DC.

Appendix C – Figures

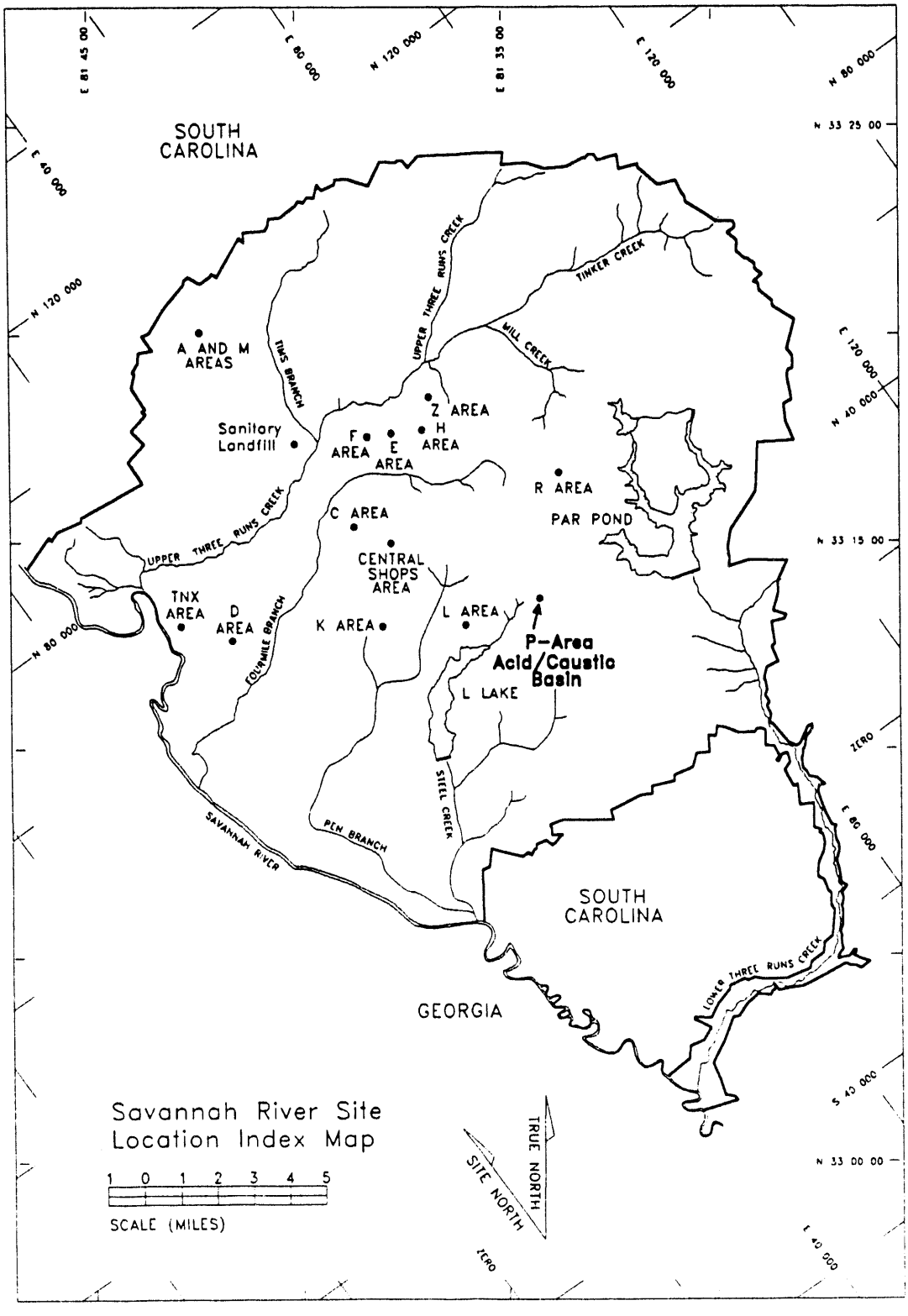

Figure 1. Location of the P-Area Acid/Caustic Basin at the Savannah River Site

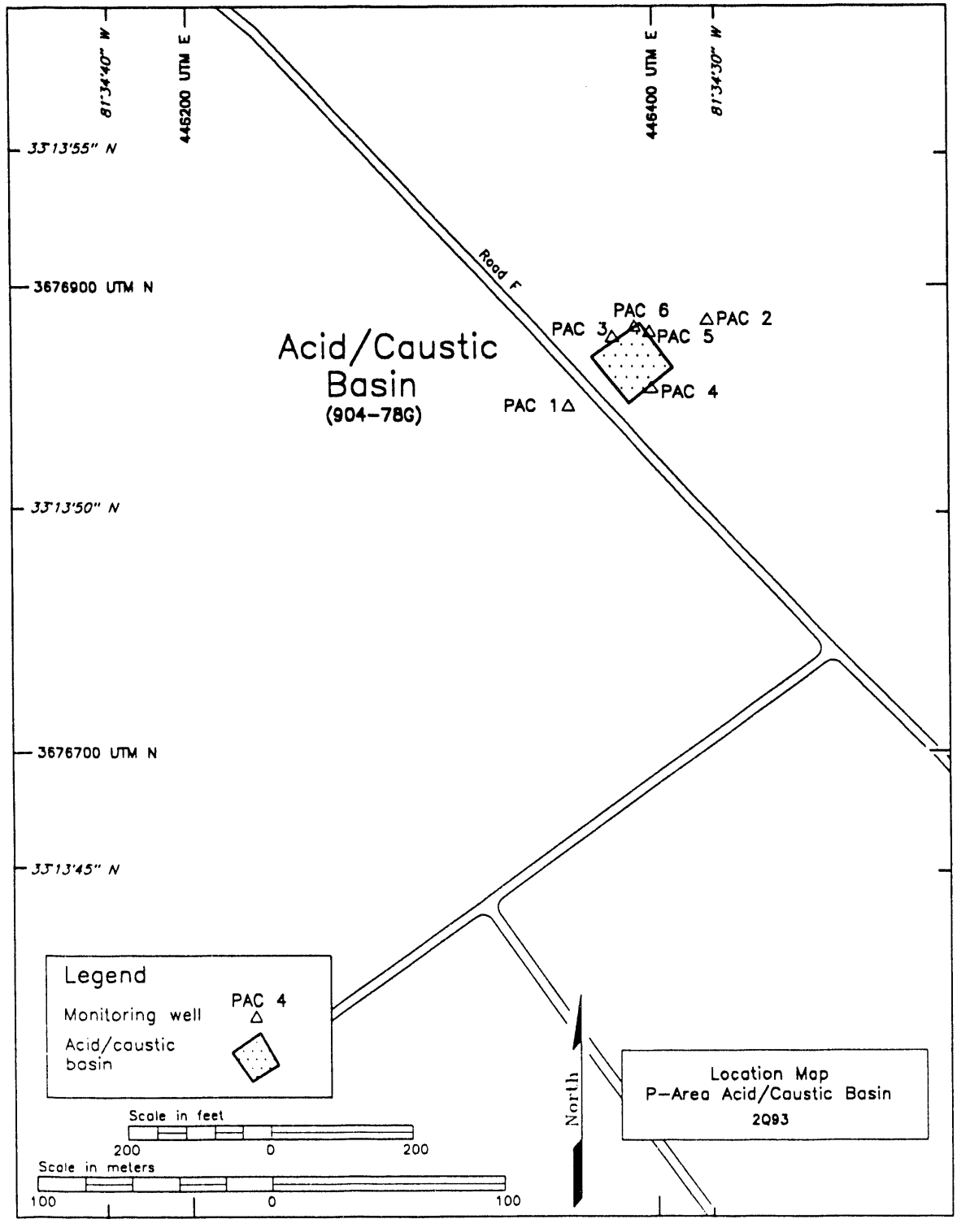

Figure 2. Location of Groundwater Monitoring Wells at the P-Area Acid/Caustic Basin

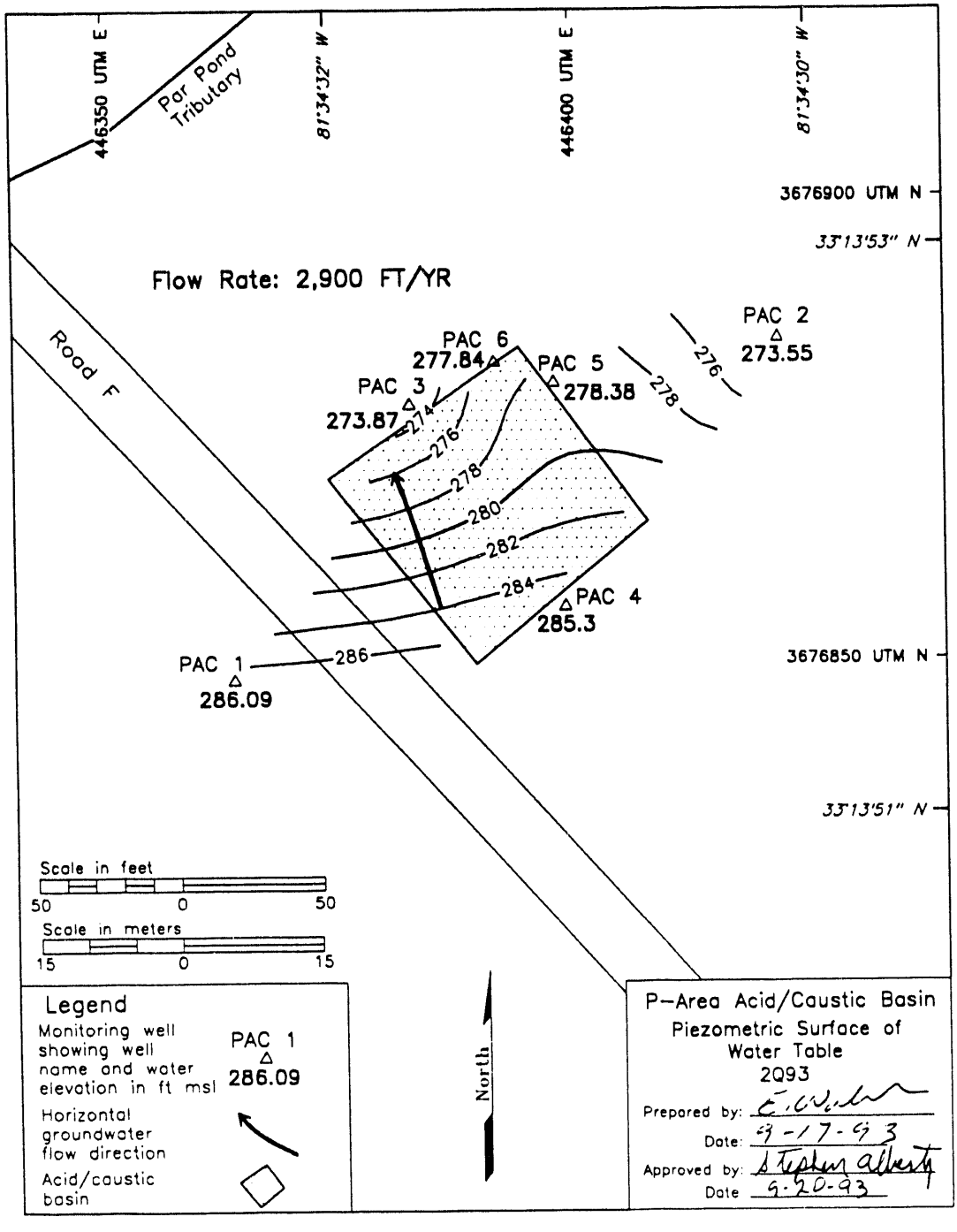

Figure 3. Water-Elevation Contour Map of the Water Table at the P-Area Acid/Caustic Basin

Appendix D – Groundwater Monitoring Results Tables

Key to Reading the Tables

The following abbreviations may appear in the tabular data:

B = sample collected from well using an open bucket bailer
BA = Barringer Laboratories, Inc.
CN = Clemson Technical Center, Inc.
CS = carbon steel
D = primary drinking water standard (PDWS)
E = exponential notation (e.g., 1.1E-09 = 1.1 × 10^{-9} = 0.0000000011)
EM = Environmental Protection Department/Environmental Monitoring Section (EPD/EMS) Laboratory
GE = General Engineering Laboratories
GP = Environmental Physics, Inc.
H = holding time
1,2,3,4,6,7,8-HPCDD = 1,2,3,4,6,7,8-heptachlorodibenzo-p-dioxin
1,2,3,4,6,7,8-HPCDF = 1,2,3,4,6,7,8-heptachlorodibenzo-p-furan
1,2,3,4,7,8-HXCDD = 1,2,3,4,7,8-hexachlorodibenzo-p-dioxin
1,2,3,4,7,8-HXCDF = 1,2,3,4,7,8-hexachlorodibenzo-p-furan
Lindane = gamma-benzene hexachloride
mg/L = milligrams per liter
Mod = modifier
msl = mean sea level
MSL = million structures per liter
NTU = turbidity unit
P = sample collected from well using a bladder pump
PCB = polychlorinated biphenyl
1,2,3,7,8-PCDD = 1,2,3,7,8-pentachlorodibenzo-p-dioxin
1,2,3,7,8-PCDF = 1,2,3,7,8-pentachlorodibenzo-p-furan
pCi/L = picocuries per liter
pCi/mL = picocuries per milliliter
PDWS = primary drinking water standard
pH = pH unit
PVC = polyvinyl chloride
S = sample collected from well using a single-speed centrifugal downhole pump
Sp. conductance = specific conductance
SP = Spencer Testing Services, Inc.
TCDD = tetrachlorodibenzo-p-dioxin
TCDF = tetrachlorodibenzo-p-furan
TM = TMA/Eberline
TOC = top of casing
V = sample collected from well using a variable-speed pump
WA = Roy F. Weston, Inc.
µg/L = micrograms per liter
µS/cm = microsiemens per centimeter

Holding Times

Standard analytical methods include a limit, called holding time, on the maximum elapsed time between sample collection and extraction or analysis by the laboratory. In the data tables, a large dot (●) in the H (holding time) column indicates that holding time was exceeded. Analyses performed beyond holding time may not yield valid results.

The South Carolina Department of Health and Environmental Control allows only 15 minutes to elapse between sampling and analysis for pH. Thus, only field pH measurements can meet the holding time criterion; laboratory pH analyses will always exceed it.

Laboratory-initiated procedures for reducing the number of other analyses performed out of holding time include subcontracting analyses when difficulties with equipment, personnel, or work load would prevent timely analyses. SRS reduces the compensation to laboratories for analyses performed out of holding time.

Data Qualification

The contract laboratories continually assess their own accuracy and precision according to U.S. Environmental Protection Agency (EPA) guidelines. They submit sample- or batch-specific quality assurance/quality control information either at the same time as analytical results or in a quarterly summary. Properly defined and used result modifiers (also referred to as qualifiers) can be a key component in assessing data useability. Result modifiers designed by Environmental Protection Department/Environmental Monitoring Section and provided to the primary laboratories are defined below. These modifiers appear in the data tables under the column "Mod." The lettered modifiers are based on EPA's STORET codes.

Result modifier	Definition
(Blank)	Data are not qualified. Number should be interpreted exactly as reported.
A	Value reported is the mean of two or more determinations.
J	Value is estimated because quantitation in the sample or in associated quality control samples did not meet specifications.
L	Value is off-scale high. The actual value is not known but is known to be greater than the value shown.
M	Presence of the analyte is verified but not quantified.
R	Result was rejected because performance requirements in the sample analysis or associated quality control analyses were not met.
T	Analyte was not detected; if present, it was below the criteria for detection.
V	Analyte was detected in an associated method blank.
Y	Result was obtained from an unpreserved or improperly preserved sample. Data may not be accurate.

Result modifier	Definition
1	Result may be an underestimation of the true value due to analytical bias.
2	Result may be an overestimation of the true value due to analytical bias.
3	The associated result may be of poor precision (high variability) due to analytical bias.
4	Result is associated with QA results indicating matrix interference.
6	The associated result is from a reanalysis performed out of holding time due to problems with an earlier analysis.

Table 1. Constituents Exceeding Final Primary Drinking Water Standards

Well	Constituent	Unit	3Q92	4Q92	1Q93	2Q93	Mod
N[a]	None	N	N	N	N	N	N

[a] N = not applicable.

Table 2. Maximum Results for Constituents Exceeding Half their Final Primary Drinking Water Standards, Other Flag 1 or Flag 2 Criteria, or the SRS Turbidity Standard

Well	Constituent	Unit	2Q93	Mod	Flag
PAC 1	Aluminum	µg/L	188		2
PAC 2	Iron	µg/L	9,240		2
	Manganese	µg/L	101		2
PAC 3	Aluminum	µg/L	384		2
	Iron	µg/L	2,150		2
	Manganese	µg/L	196		2
	Radium-228	pCi/L	1.6E+02		2
	Specific conductance	µS/cm	490	J	1
	Total organic carbon	µg/L	8,070		1
PAC 4	Aluminum	µg/L	246		2
PAC 5	Aluminum	µg/L	842		2
	Iron	µg/L	910		2
	Lead	µg/L	15		2
	Manganese	µg/L	81		2
PAC 6	Aluminum	µg/L	113		2
	Iron	µg/L	2,550		2
	Manganese	µg/L	152		2
	Radium-228	pCi/L	3.4E+01		2

Note: These results do not include field data results.

Table 3. Groundwater Monitoring Results for Individual Wells

WELL PAC 1

SRS Coord.	Lat/Longitude	Screen Zone Elevation	Top of Casing	Casing	Pump	Formation
N43543.3 E66753.4	33.230963 °N 81.575658 °W	283.9-253.9 ft msl	295.9 ft msl	4" PVC	S	Water table

FIELD MEASUREMENTS

Sample date: 05/17/93
Depth to water: 9.81 ft (2.99 m) below TOC
Water elevation: 286.09 ft (87.20 m) msl
Sp. conductance: 39 µS/cm
Water evacuated before sampling: 237 gal
Time: 14:57
pH: 5.0
Alkalinity: 5 mg/L
Water temperature: 17.1 °C
Volumes purged: 11.2 well volumes

LABORATORY ANALYSES

H	D	Analyte	Result	Mod	Unit	Flag	Lab
•		pH	5.4	J	pH	0	WA
•		Specific conductance	37	J	µS/cm	0	WA
•		Specific conductance	37	J	µS/cm	0	WA
		Turbidity	4.8		NTU	0	WA
		Aluminum	188		µg/L	2	WA
		Aluminum	157		µg/L	2	WA
		Arsenic	<2.0		µg/L	0	WA
		Arsenic	<2.0		µg/L	0	WA
		Barium	16		µg/L	0	WA
		Barium	15		µg/L	0	WA
		Cadmium	<2.0		µg/L	0	WA
		Cadmium	<2.0		µg/L	0	WA
		Calcium	373		µg/L	0	WA
		Calcium	374		µg/L	0	WA
		Carbon tetrachloride	<1.0		µg/L	0	WA
		Carbon tetrachloride	<1.0		µg/L	0	WA
		Carbon tetrachloride	<1.0		µg/L	0	WA
		Chloride	3,430	J1	µg/L	0	WA
		Chloride	3,440	J1	µg/L	0	WA
		Chloroform	<1.0		µg/L	0	WA
		Chloroform	<1.0		µg/L	0	WA
		Chloroform	<1.0		µg/L	0	WA
		Chromium	<4.0		µg/L	0	WA
		Chromium	<4.0		µg/L	0	WA
		2,4-Dichlorophenoxyacetic acid	<1.1		µg/L	0	WA
		Endrin	<0.11		µg/L	0	WA
		Endrin	<0.22		µg/L	0	WA
		Fluoride	<100		µg/L	0	WA
		Iron	123		µg/L	0	WA
		Iron	107		µg/L	0	WA
		Lead	3.2	J3	µg/L	0	WA
		Lead	3.4	J3	µg/L	0	WA
		Lindane	<0.053		µg/L	0	WA
		Lindane	<0.11		µg/L	0	WA
		Magnesium	192		µg/L	0	WA
		Magnesium	192		µg/L	0	WA
		Manganese	4.5	J3	µg/L	0	WA
		Manganese	3.6	J3	µg/L	0	WA
		Mercury	<0.20		µg/L	0	WA

• = exceeded holding time. ■ = exceeded screening level or final primary drinking water standard.

WELL PAC 1 collected on 05/17/93, laboratory analyses (cont.)

H	D	Analyte	Result	Mod	Unit	Flag	Lab
		Mercury	<0.20		µg/L	0	WA
		Methoxychlor	<0.53		µg/L	0	WA
		Methoxychlor	<1.1		µg/L	0	WA
		Methoxychlor	<1.1		µg/L	0	WA
		Nitrate as nitrogen	743		µg/L	0	WA
		Phenols	<5.0		µg/L	0	WA
		Phenols	<5.0		µg/L	0	WA
		Potassium	532	J3	µg/L	0	WA
		Potassium	516	J3	µg/L	0	WA
		Selenium	<2.0		µg/L	0	WA
		Selenium	<2.0		µg/L	0	WA
		Silica	4,800		µg/L	0	WA
		Silica	4,740		µg/L	0	WA
		Silver	<2.0		µg/L	0	WA
		Silver	<2.0		µg/L	0	WA
		Sodium	5,930	V	µg/L	0	WA
		Sodium	5,760	V	µg/L	0	WA
		Sulfate	1,290		µg/L	0	WA
		Tetrachloroethylene	<1.0		µg/L	0	WA
		Tetrachloroethylene	<1.0		µg/L	0	WA
		Tetrachloroethylene	<1.0		µg/L	0	WA
		Total dissolved solids	88,000		µg/L	0	WA
		Total organic carbon	<1,000		µg/L	0	WA
		Total organic halogens	7.6		µg/L	0	WA
		Total phosphates (as P)	<50		µg/L	0	WA
		Total phosphates (as P)	<50		µg/L	0	WA
		Toxaphene	<1.1		µg/L	0	WA
		Toxaphene	<2.2		µg/L	0	WA
		Toxaphene	<2.2		µg/L	0	WA
		2,4,5-TP (Silvex)	<0.54		µg/L	0	WA
		1,1,1-Trichloroethane	<1.0		µg/L	0	WA
		1,1,1-Trichloroethane	<1.0		µg/L	0	WA
		Trichloroethylene	<1.0		µg/L	0	WA
		Trichloroethylene	<1.0		µg/L	0	WA
		Trichloroethylene	<1.0		µg/L	0	WA
		Gross alpha	<7.0E-01		pCi/L	0	TM
		Gross alpha	<7.0E-01		pCi/L	0	TM
		Nonvolatile beta	<8.0E-01		pCi/L	0	TM
		Nonvolatile beta	9.0E-01 ± 1.7E+00		pCi/L	0	TM
		Radium-226	<1.9E-01		pCi/L	0	TM
		Radium-226	1.6E-01 ± 1.4E-01		pCi/L	0	TM
		Radium-228	2.9E+00 ± 1.4E+00		pCi/L	0	TM
		Radium-228	1.0E+00 ± 1.4E+00		pCi/L	0	TM
		Tritium	6.1E+00 ± 5.4E-01		pCi/mL	0	TM
		Tritium	6.0E+00 ± 5.4E-01		pCi/mL	0	TM

• = exceeded holding time. ■ = exceeded screening level or final primary drinking water standard.

WELL PAC 2

SRS Coord.	Lat/Longitude	Screen Zone Elevation	Top of Casing	Casing	Pump	Formation
N43527.7 E66980.9	33.231299 °N 81.575029 °W	277.9-247.9 ft msl	284.8 ft msl	4" PVC	S	Water table

FIELD MEASUREMENTS

Sample date: 05/17/93
Depth to water: 11.25 ft (3.43 m) below TOC
Water elevation: 273.55 ft (83.38 m) msl
Sp. conductance: 95 µS/cm
Water evacuated before sampling: 329 gal
Time: 13:12
pH: 6.3
Alkalinity: 31 mg/L
Water temperature: 18.4 °C
Volumes purged: 19.6 well volumes

LABORATORY ANALYSES

H	D	Analyte	Result	Mod	Unit	Flag	Lab
●		pH	6.3	J	pH	0	WA
●		pH	6.3	J	pH	0	WA
●		Specific conductance	75	J	µS/cm	0	WA
		Turbidity	8.2		NTU	0	WA
		Aluminum	<20		µg/L	0	WA
		Arsenic	2.0	J3	µg/L	0	WA
		Barium	28		µg/L	0	WA
		Cadmium	<2.0		µg/L	0	WA
		Calcium	5,170		µg/L	0	WA
		Carbon tetrachloride	<1.0		µg/L	0	WA
		Chloride	2,850		µg/L	0	WA
		Chloroform	<1.0		µg/L	0	WA
		Chromium	<4.0		µg/L	0	WA
		2,4-Dichlorophenoxyacetic acid	<1.1		µg/L	0	WA
		2,4-Dichlorophenoxyacetic acid	<2.2		µg/L	0	WA
		Endrin	<0.11		µg/L	0	WA
		Fluoride	<100		µg/L	0	WA
		Iron	9,240		µg/L	2	WA
		Lead	<3.0		µg/L	0	WA
		Lindane	<0.054		µg/L	0	WA
		Magnesium	879		µg/L	0	WA
		Manganese	101		µg/L	2	WA
		Mercury	<0.20		µg/L	0	WA
		Methoxychlor	<0.54		µg/L	0	WA
		Nitrate as nitrogen	<20	J1	µg/L	0	WA
		Nitrate as nitrogen	<20	J1	µg/L	0	WA
		Phenols	<5.0		µg/L	0	WA
		Potassium	1,070		µg/L	0	WA
		Selenium	<2.0		µg/L	0	WA
		Silica	7,590		µg/L	0	WA
		Silver	<2.0		µg/L	0	WA
		Sodium	4,970	V	µg/L	0	WA
		Sulfate	6,310		µg/L	0	WA
		Tetrachloroethylene	<1.0		µg/L	0	WA
		Total dissolved solids	36,000		µg/L	0	WA
		Total organic carbon	1,060		µg/L	0	WA
		Total organic halogens	7.5		µg/L	0	WA
		Total phosphates (as P)	<50		µg/L	0	WA
		Toxaphene	<1.1		µg/L	0	WA

● = exceeded holding time. ■ = exceeded screening level or final primary drinking water standard.

WELL PAC 2 collected on 05/17/93, laboratory analyses (cont.)

H	D	Analyte	Result	Mod	Unit	Flag	Lab
		2,4,5-TP (Silvex)	<0.54		µg/L	0	WA
		2,4,5-TP (Silvex)	<1.1		µg/L	0	WA
		1,1,1-Trichloroethane	<1.0		µg/L	0	WA
		Trichloroethylene	<1.0		µg/L	0	WA
		Gross alpha	1.1E+00 ± 1.1E+00		pCi/L	0	TM
		Nonvolatile beta	4.3E+00 ± 2.0E+00		pCi/L	0	TM
		Radium-226	<1.6E-01		pCi/L	0	TM
		Radium-228	2.1E+00 ± 1.5E+00		pCi/L	0	TM
		Tritium	6.7E-01 ± 2.8E-01		pCi/mL	0	TM

WELL PAC 3

SRS Coord.	Lat/Longitude	Screen Zone Elevation	Top of Casing	Casing	Pump	Formation
N43585.6 E66861.4	33.231232 °N 81.575456 °W	282.9-252.9 ft msl	289.9 ft msl	4" PVC	S	Water table

FIELD MEASUREMENTS

Sample date: 05/17/93
Depth to water: 16.03 ft (4.89 m) below TOC
Water elevation: 273.87 ft (83.48 m) msl
Sp. conductance: 515 µS/cm
Water evacuated before sampling: 301 gal
Time: 12:24
pH: 6.0
Alkalinity: 31 mg/L
Water temperature: 18.5 °C
Volumes purged: 21.9 well volumes

LABORATORY ANALYSES

H	D	Analyte	Result	Mod	Unit	Flag	Lab
•		pH	6.0	J	pH	0	WA
•		Specific conductance	490	J	µS/cm	1	WA
		Turbidity	20		NTU	0	WA
		Aluminum	384		µg/L	2	WA
		Arsenic	<2.0		µg/L	0	WA
		Barium	143		µg/L	0	WA
		Cadmium	<2.0		µg/L	0	WA
		Calcium	24,400		µg/L	0	WA
		Carbon tetrachloride	<1.0		µg/L	0	WA
		Chloride	13,300		µg/L	0	WA
		Chloroform	<1.0		µg/L	0	WA
		Chromium	<4.0		µg/L	0	WA
		2,4-Dichlorophenoxyacetic acid	<1.1		µg/L	0	WA
		Endrin	<0.11		µg/L	0	WA
		Fluoride	<100		µg/L	0	WA
		Iron	2,150		µg/L	2	WA
		Lead	3.6	J3	µg/L	0	WA
		Lindane	<0.053		µg/L	0	WA
		Magnesium	6,640		µg/L	0	WA
		Manganese	196		µg/L	2	WA
		Mercury	<0.20		µg/L	0	WA
		Methoxychlor	<0.53		µg/L	0	WA
		Nitrate as nitrogen	457		µg/L	0	WA
		Phenols	<5.0		µg/L	0	WA
		Potassium	1,260		µg/L	0	WA

• = exceeded holding time. ■ = exceeded screening level or final primary drinking water standard.

WELL PAC 3 collected on 05/17/93, laboratory analyses (cont.)

H	D	Analyte	Result	Mod	Unit	Flag	Lab
		Selenium	<2.0		µg/L	0	WA
		Silica	12,400		µg/L	0	WA
		Silver	<2.0		µg/L	0	WA
		Sodium	62,500	V	µg/L	0	WA
		Sulfate	175,000		µg/L	0	WA
		Tetrachloroethylene	<1.0		µg/L	0	WA
		Total dissolved solids	324,000		µg/L	0	WA
		Total organic carbon	8,070		µg/L	1	WA
		Total organic halogens	16		µg/L	0	WA
		Total organic halogens	16		µg/L	0	WA
		Total phosphates (as P)	<50		µg/L	0	WA
		Toxaphene	<1.1		µg/L	0	WA
		2,4,5-TP (Silvex)	<0.55		µg/L	0	WA
		1,1,1-Trichloroethane	<1.0		µg/L	0	WA
		Trichloroethylene	<1.0		µg/L	0	WA
		Gross alpha	<6.0E-01		pCi/L	0	TM
		Nonvolatile beta	9.5E+00 ± 2.4E+00		pCi/L	0	TM
		Radium-226	3.2E-01 ± 2.0E-01		pCi/L	0	TM
		Radium-228	1.6E+02 ± 7.1E+00		pCi/L	2	TM
		Tritium	6.3E+00 ± 5.8E-01		pCi/mL	0	TM

WELL PAC 4

SRS Coord.	Lat/Longitude	Screen Zone Elevation	Top of Casing	Casing	Pump	Formation
N43495.4 E66863.2	33.231036 °N 81.575276 °W	280.6-250.6 ft msl	291.6 ft msl	4" PVC	S	Water table

FIELD MEASUREMENTS

Sample date: 05/17/93
Depth to water: 6.30 ft (1.92 m) below TOC
Water elevation: 285.30 ft (86.96 m) msl
Sp. conductance: 104 µS/cm
Water evacuated before sampling: 261 gal
Time: 13:58
pH: 5.2
Alkalinity: 4 mg/L
Water temperature: 19.7 °C
Volumes purged: 11.5 well volumes

LABORATORY ANALYSES

H	D	Analyte	Result	Mod	Unit	Flag	Lab
•		pH	5.1	J	pH	0	GE
•		pH	4.9	J	pH	0	GE
•		pH	5.4	J	pH	0	WA
•		pH	5.5	JY	pH	0	WA
		Specific conductance	108		µS/cm	0	GE
		Specific conductance	106		µS/cm	0	GE
•		Specific conductance	93	J	µS/cm	0	WA
•		Specific conductance	95	JY	µS/cm	0	WA
		Turbidity	17		NTU	0	GE
		Turbidity	17		NTU	0	GE
		Turbidity	4.0		NTU	0	WA
		Turbidity	3.8	Y	NTU	0	WA
		Aluminum	246		µg/L	2	GE
		Aluminum	211		µg/L	2	GE

• = exceeded holding time. ■ = exceeded screening level or final primary drinking water standard.

WELL PAC 4 collected on 05/17/93, laboratory analyses (cont.)

H	D	Analyte	Result	Mod	Unit	Flag	Lab
		Aluminum	179		µg/L	2	WA
		Aluminum	175	Y	µg/L	2	WA
		Arsenic	<2.0		µg/L	0	GE
		Arsenic	<2.0		µg/L	0	GE
		Arsenic	<2.0		µg/L	0	WA
		Arsenic	<2.0	Y	µg/L	0	WA
		Barium	14		µg/L	0	GE
		Barium	13		µg/L	0	GE
		Barium	13		µg/L	0	WA
		Barium	12	Y	µg/L	0	WA
		Cadmium	<2.0		µg/L	0	GE
		Cadmium	<2.0		µg/L	0	GE
		Cadmium	<2.0		µg/L	0	WA
		Cadmium	<2.0	Y	µg/L	0	WA
		Calcium	133		µg/L	0	GE
		Calcium	132		µg/L	0	GE
		Calcium	144		µg/L	0	WA
		Calcium	144	Y	µg/L	0	WA
		Carbon tetrachloride	<1.0		µg/L	0	GE
		Carbon tetrachloride	<1.0		µg/L	0	GE
		Carbon tetrachloride	<1.0		µg/L	0	WA
		Carbon tetrachloride	<1.0	Y	µg/L	0	WA
		Chloride	2,530		µg/L	0	GE
		Chloride	2,450		µg/L	0	GE
		Chloride	2,670		µg/L	0	WA
		Chloride	2,570	Y	µg/L	0	WA
		Chloroform	<1.0		µg/L	0	GE
		Chloroform	<1.0		µg/L	0	GE
		Chloroform	<1.0		µg/L	0	WA
		Chloroform	<1.0	Y	µg/L	0	WA
		Chromium	<4.0		µg/L	0	GE
		Chromium	<4.0		µg/L	0	GE
		Chromium	<4.0		µg/L	0	WA
		Chromium	<4.0	Y	µg/L	0	WA
		2,4-Dichlorophenoxyacetic acid	<0.30		µg/L	0	GE
		2,4-Dichlorophenoxyacetic acid	<0.30		µg/L	0	GE
		2,4-Dichlorophenoxyacetic acid	<1.1		µg/L	0	WA
		2,4-Dichlorophenoxyacetic acid	<1.1	Y	µg/L	0	WA
		Endrin	<0.0060		µg/L	0	GE
		Endrin	<0.0060		µg/L	0	GE
		Endrin	<0.11		µg/L	0	WA
		Endrin	<0.11	Y	µg/L	0	WA
		Fluoride	<100		µg/L	0	GE
		Fluoride	<100		µg/L	0	GE
		Fluoride	<100		µg/L	0	WA
		Fluoride	<100	Y	µg/L	0	WA
		Iron	53		µg/L	0	GE
		Iron	46		µg/L	0	GE
		Iron	71		µg/L	0	WA
		Iron	69	Y	µg/L	0	WA
		Lead	<3.0		µg/L	0	GE
		Lead	<3.0		µg/L	0	GE
		Lead	<3.0		µg/L	0	WA
		Lead	<3.0	Y	µg/L	0	WA
		Lindane	<0.0050		µg/L	0	GE
		Lindane	<0.0050		µg/L	0	GE

● = exceeded holding time. ■ = exceeded screening level or final primary drinking water standard.

WELL PAC 4 collected on 05/17/93, laboratory analyses (cont.)

H	D	Analyte	Result	Mod	Unit	Flag	Lab
		Lindane	<0.054		µg/L	0	WA
		Lindane	<0.055	Y	µg/L	0	WA
		Magnesium	166		µg/L	0	GE
		Magnesium	163		µg/L	0	GE
		Magnesium	164	J3	µg/L	0	WA
		Magnesium	164	JY3	µg/L	0	WA
		Manganese	<2.0		µg/L	0	GE
		Manganese	<2.0		µg/L	0	GE
		Manganese	2.5		µg/L	0	WA
		Manganese	<2.0	Y	µg/L	0	WA
		Mercury	<0.20		µg/L	0	GE
		Mercury	<0.20		µg/L	0	GE
		Mercury	<0.20		µg/L	0	WA
		Mercury	<0.20	Y	µg/L	0	WA
		Methoxychlor	<0.50		µg/L	0	GE
		Methoxychlor	<0.50		µg/L	0	GE
		Methoxychlor	<0.54		µg/L	0	WA
		Methoxychlor	<0.55	Y	µg/L	0	WA
		Nitrate as nitrogen	786		µg/L	0	WA
		Nitrate as nitrogen	786	Y	µg/L	0	WA
		Nitrate-nitrite as nitrogen	926		µg/L	0	GE
		Nitrate-nitrite as nitrogen	895		µg/L	0	GE
		Phenols	<5.0		µg/L	0	GE
		Phenols	<5.0		µg/L	0	GE
		Phenols	<5.0		µg/L	0	WA
		Phenols	<5.0	Y	µg/L	0	WA
		Potassium	518		µg/L	0	GE
		Potassium	<500		µg/L	0	GE
		Potassium	<500		µg/L	0	WA
		Potassium	561	JY3	µg/L	0	WA
		Selenium	<2.0		µg/L	0	GE
		Selenium	<2.0		µg/L	0	GE
		Selenium	<2.0		µg/L	0	WA
		Selenium	<2.0	Y	µg/L	0	WA
		Silica	5,610		µg/L	0	GE
		Silica	5,510		µg/L	0	GE
		Silica	5,470		µg/L	0	WA
		Silica	5,330	Y	µg/L	0	WA
		Silver	<2.0		µg/L	0	GE
		Silver	<2.0		µg/L	0	GE
		Silver	<2.0		µg/L	0	WA
		Silver	<2.0	Y	µg/L	0	WA
		Sodium	18,800		µg/L	0	GE
		Sodium	18,900		µg/L	0	GE
		Sodium	17,700	V	µg/L	0	WA
		Sodium	16,900	VY	µg/L	0	WA
		Sulfate	26,800		µg/L	0	GE
		Sulfate	26,700		µg/L	0	GE
		Sulfate	26,500		µg/L	0	GE
		Sulfate	25,700		µg/L	0	WA
		Sulfate	26,900	Y	µg/L	0	WA
		Tetrachloroethylene	<1.0		µg/L	0	GE
		Tetrachloroethylene	<1.0		µg/L	0	GE
		Tetrachloroethylene	<1.0		µg/L	0	WA
		Tetrachloroethylene	<1.0	Y	µg/L	0	WA
		Total dissolved solids	64,000	V	µg/L	0	GE

• = exceeded holding time. ■ = exceeded screening level or final primary drinking water standard.

WELL PAC 4 collected on 05/17/93, laboratory analyses (cont.)

H	D	Analyte	Result	Mod	Unit	Flag	Lab
		Total dissolved solids	64,000	V	µg/L	0	GE
		Total dissolved solids	93,000		µg/L	0	WA
		Total dissolved solids	56,000	Y	µg/L	0	WA
		Total organic carbon	<1,000		µg/L	0	GE
		Total organic carbon	<1,000		µg/L	0	GE
		Total organic carbon	<1,000		µg/L	0	WA
		Total organic carbon	<1,000	Y	µg/L	0	WA
		Total organic halogens	5.1		µg/L	0	GE
		Total organic halogens	<5.0		µg/L	0	GE
		Total organic halogens	8.6		µg/L	0	WA
		Total organic halogens	6.9	Y	µg/L	0	WA
		Total phosphates (as P)	<50		µg/L	0	GE
		Total phosphates (as P)	<50		µg/L	0	GE
		Total phosphates (as P)	<50		µg/L	0	WA
		Total phosphates (as P)	<50	Y	µg/L	0	WA
		Toxaphene	<0.24		µg/L	0	GE
		Toxaphene	<0.24		µg/L	0	GE
		Toxaphene	<1.1		µg/L	0	WA
		Toxaphene	<1.1	Y	µg/L	0	WA
		2,4,5-TP (Silvex)	<0.090		µg/L	0	GE
		2,4,5-TP (Silvex)	<0.090		µg/L	0	GE
		2,4,5-TP (Silvex)	<0.55		µg/L	0	WA
		2,4,5-TP (Silvex)	<0.55	Y	µg/L	0	WA
		1,1,1-Trichloroethane	<1.0		µg/L	0	GE
		1,1,1-Trichloroethane	<1.0		µg/L	0	GE
		1,1,1-Trichloroethane	<1.0		µg/L	0	WA
		1,1,1-Trichloroethane	<1.0	Y	µg/L	0	WA
		Trichloroethylene	<1.0		µg/L	0	GE
		Trichloroethylene	<1.0		µg/L	0	GE
		Trichloroethylene	<1.0		µg/L	0	WA
		Trichloroethylene	<1.0	Y	µg/L	0	WA
		Gross alpha	<2.0E+00		pCi/L	0	GE
		Gross alpha	<2.0E+00		pCi/L	0	GE
		Gross alpha	<8.0E-01		pCi/L	0	TM
		Gross alpha	<6.0E-01		pCi/L	0	TM
		Nonvolatile beta	<2.0E+00		pCi/L	0	GE
		Nonvolatile beta	<2.0E+00		pCi/L	0	GE
		Nonvolatile beta	2.6E+00 ± 1.9E+00		pCi/L	0	TM
		Nonvolatile beta	2.3E+00 ± 1.8E+00		pCi/L	0	TM
		Radium-226	<2.9E-01		pCi/L	0	TM
		Radium-226	<2.1E-01		pCi/L	0	TM
		Radium-228	8.0E-01 ± 1.4E+00		pCi/L	0	TM
		Radium-228	2.5E+00 ± 1.6E+00		pCi/L	0	TM
		Radium, total alpha-emitting	<1.0E+00		pCi/L	0	GE
		Radium, total alpha-emitting	1.0E+00 ± 6.0E-01		pCi/L	0	GE
		Tritium	3.7E+00 ± 4.0E-01		pCi/mL	0	GE
		Tritium	3.7E+00 ± 4.0E-01		pCi/mL	0	GE
		Tritium	5.5E+00 ± 5.3E-01		pCi/mL	0	TM
		Tritium	<1.6E-01		pCi/mL	0	TM

● = exceeded holding time. ■ = exceeded screening level or final primary drinking water standard.

WELL PAC 5

SRS Coord.	Lat/Longitude	Screen Zone Elevation	Top of Casing	Casing	Pump	Formation
N43561.7 E66907.1	33.231254 °N 81.575289 °W	275.1-255.1 ft msl	289.3 ft msl	4" PVC	S	Water table

FIELD MEASUREMENTS

Sample date: 05/17/93
Depth to water: 10.92 ft (3.33 m) below TOC
Water elevation: 278.38 ft (84.85 m) msl
Sp. conductance: 259 µS/cm
Water evacuated before sampling: 13 gal
The well went dry during purging.

Time: 15:25
pH: 6.8
Alkalinity: 96 mg/L
Water temperature: 20.2 °C
Volumes purged: 0.9 well volumes

LABORATORY ANALYSES

H	D	Analyte	Result	Mod	Unit	Flag	Lab
•		pH	7.2	J	pH	0	WA
•		Specific conductance	239	J	µS/cm	0	WA
		Turbidity	4.2		NTU	0	WA
		Aluminum	842		µg/L	2	WA
		Arsenic	<2.0		µg/L	0	WA
		Barium	29		µg/L	0	WA
		Cadmium	<2.0		µg/L	0	WA
		Calcium	15,500		µg/L	0	WA
		Carbon tetrachloride	<1.0		µg/L	0	WA
		Chloride	3,230		µg/L	0	WA
		Chloroform	<1.0		µg/L	0	WA
		Chromium	21		µg/L	0	WA
		2,4-Dichlorophenoxyacetic acid	<1.1		µg/L	0	WA
		Endrin	<0.11		µg/L	0	WA
		Fluoride	<100		µg/L	0	WA
		Fluoride	<100		µg/L	0	WA
		Iron	910		µg/L	2	WA
		Lead	15		µg/L	2	WA
		Lindane	<0.056		µg/L	0	WA
		Magnesium	2,890		µg/L	0	WA
		Manganese	81		µg/L	2	WA
		Mercury	<0.20		µg/L	0	WA
		Methoxychlor	<0.56		µg/L	0	WA
		Nitrate as nitrogen	41		µg/L	0	WA
		Phenols	<5.0		µg/L	0	WA
		Potassium	961		µg/L	0	WA
		Selenium	<2.0		µg/L	0	WA
		Silica	9,510		µg/L	0	WA
		Silver	<2.0		µg/L	0	WA
		Sodium	18,900	V	µg/L	0	WA
		Sulfate	24,100		µg/L	0	WA
		Tetrachloroethylene	<1.0		µg/L	0	WA
		Total dissolved solids	97,000		µg/L	0	WA
		Total organic carbon	1,880		µg/L	0	WA
		Total organic halogens	20		µg/L	0	WA
		Total phosphates (as P)	56		µg/L	0	WA
		Toxaphene	<1.1		µg/L	0	WA
		2,4,5-TP (Silvex)	<0.55		µg/L	0	WA
		1,1,1-Trichloroethane	<1.0		µg/L	0	WA

• = exceeded holding time. ■ = exceeded screening level or final primary drinking water standard.

WELL PAC 5 collected on 05/17/93, laboratory analyses (cont.)

H	D	Analyte	Result	Mod	Unit	Flag	Lab
		Trichloroethylene	<1.0		µg/L	0	WA
		Gross alpha	<9.0E-01		pCi/L	0	TM
		Nonvolatile beta	3.9E+00 ± 2.1E+00		pCi/L	0	TM
		Radium-226	5.5E-01 ± 2.8E-01		pCi/L	0	TM
		Radium-228	4.8E+00 ± 1.8E+00		pCi/L	0	TM
		Tritium	4.6E+00 ± 5.0E-01		pCi/mL	0	TM

WELL PAC 6

SRS Coord.	Lat/Longitude	Screen Zone Elevation	Top of Casing	Casing	Pump	Formation
N43580.1 E66894.7	33.231274 °N 81.575358 °W	275.2-255.2 ft msl	289.4 ft msl	4" PVC	S	Water table

FIELD MEASUREMENTS

Sample date: 05/17/93
Depth to water: 11.56 ft (3.52 m) below TOC
Water elevation: 277.84 ft (84.69 m) msl
Sp. conductance: 226 µS/cm
Water evacuated before sampling: 13 gal
The well went dry during purging.

Time: 15:10
pH: 6.3
Alkalinity: 6 mg/L
Water temperature: 21.6 °C
Volumes purged: 0.9 well volumes

LABORATORY ANALYSES

H	D	Analyte	Result	Mod	Unit	Flag	Lab
•		pH	6.8	J	pH	0	WA
•		Specific conductance	209	J	µS/cm	0	WA
		Turbidity	9.3		NTU	0	WA
		Aluminum	113		µg/L	2	WA
		Arsenic	<2.0		µg/L	0	WA
		Barium	24		µg/L	0	WA
		Cadmium	<2.0		µg/L	0	WA
		Calcium	8,370		µg/L	0	WA
		Carbon tetrachloride	<1.0		µg/L	0	WA
		Chloride	5,140		µg/L	0	WA
		Chloroform	<1.0		µg/L	0	WA
		Chromium	<4.0		µg/L	0	WA
		2,4-Dichlorophenoxyacetic acid	<1.1		µg/L	0	WA
		Endrin	<0.11		µg/L	0	WA
		Fluoride	<100		µg/L	0	WA
		Iron	2,550		µg/L	2	WA
		Lead	<3.0		µg/L	0	WA
		Lindane	<0.055		µg/L	0	WA
		Magnesium	2,300		µg/L	0	WA
		Manganese	152		µg/L	2	WA
		Mercury	<0.20		µg/L	0	WA
		Methoxychlor	<0.55		µg/L	0	WA
		Nitrate as nitrogen	<20		µg/L	0	WA
		Phenols	<5.0		µg/L	0	WA
		Potassium	611	J3	µg/L	0	WA
		Selenium	<2.0		µg/L	0	WA
		Silica	13,100		µg/L	0	WA
		Silver	<2.0		µg/L	0	WA

• = exceeded holding time. ■ = exceeded screening level or final primary drinking water standard.

WELL PAC 6 collected on 05/17/93, laboratory analyses (cont.)

H	D	Analyte	Result	Mod	Unit	Flag	Lab
		Sodium	18,300	V	µg/L	0	WA
		Sulfate	31,000		µg/L	0	WA
		Tetrachloroethylene	<1.0		µg/L	0	WA
		Total dissolved solids	137,000		µg/L	0	WA
		Total organic carbon	1,680		µg/L	0	WA
		Total organic halogens	11		µg/L	0	WA
		Total phosphates (as P)	<50		µg/L	0	WA
		Toxaphene	<1.1		µg/L	0	WA
		2,4,5-TP (Silvex)	<0.55		µg/L	0	WA
		1,1,1-Trichloroethane	<1.0		µg/L	0	WA
		Trichloroethylene	<1.0		µg/L	0	WA
		Gross alpha	<9.0E-01		pCi/L	0	TM
		Nonvolatile beta	7.2E+00 ± 2.4E+00		pCi/L	0	TM
		Radium-226	5.1E-01 ± 2.6E-01		pCi/L	0	TM
		Radium-228	3.4E+01 ± 3.8E+00		pCi/L	2	TM
		Tritium	4.8E+00 ± 5.0E-01		pCi/mL	0	TM

● = exceeded holding time. ■ = exceeded screening level or final primary drinking water standard.

Appendix E – Data Quality/Useability Assessment

Data Quality/Useability Assessment

Quality assurance/quality control (QA/QC) procedures relating to accuracy and precision of analyses performed on groundwater samples are followed in the field and laboratory and are reviewed prior to publication of results. The Environmental Protection Department/ Environmental Monitoring Section's (EPD/EMS) review of the volume of analytical data acquired each quarter and presented in various reports is an ongoing process; its review of the QA/QC data cannot be completed in time to meet the deadlines for the reports required by the Resource Conservation and Recovery Act and associated regulations. Other site and regulatory personnel can obtain further information on the data quality and useability in a variety of ways, including those described below.

Data Qualification

The contract laboratories continually assess their own accuracy and precision according to U.S. Environmental Protection Agency (EPA) guidelines. They submit sample- or batch-specific QA/QC information either at the same time as analytical results or in a quarterly summary. Properly defined and used result modifiers (also referred to as qualifiers) can be a key component in assessing data useability. Result modifiers designed by EPD/EMS and used by the primary laboratories are presented in Appendix D.

Assessment of Accuracy of the Data

Accuracy, or the nearness of the reported result to the true concentration of a constituent in a sample, can be assessed in several ways.

A laboratory's general accuracy can be judged by analysis of results obtained from known samples. The non-radionuclide contract laboratories analyze commercial reference samples every quarter at EPD/EMS' request. The results of these analyses are presented in the EPD/EMS quarterly report, *The Savannah River Site's Groundwater Monitoring Program.* The primary laboratories also seek or maintain state certification by participating periodically in performance studies; reference samples and analysis of results are provided by EPA. Results of these studies also are published in the EPD/EMS quarterly reports.

Analysis of blanks provides a tool for assessing the accuracy of both sampling and laboratory analysis. Results for all field blanks for the quarter can be found in the EPD/EMS quarterly reports. Any field or laboratory blanks that exceeded established minimums are identified in the same reports, in tables associating them with groundwater samples analyzed in the same batches.

Surrogates, organic compounds similar in chemical behavior to the compounds of interest but not normally found in environmental samples, are used to monitor the effect of the matrix on the accuracy of analyses for organic parameters. For example, for analyses of volatile organics by EPA Method 8240, three surrogate compounds are added to all samples

and blanks in each analytical batch. In analyses of semivolatile organics, three to four acid compounds and three to four base/neutral compounds are used. Other surrogates are used in pesticides analyses. Percent recoveries for surrogate analyses are calculated by laboratory personnel, reported to EPD/EMS, reviewed, and entered into the database, but they are not published. If recoveries are not within specified limits, the laboratory is expected to re-run the samples or attach result qualifiers to the data identifying the anomalous results.

Sample-specific accuracy for both organic and inorganic parameters can be assessed by examination of matrix spike/matrix spike duplicate results. A sample is analyzed unspiked to determine a baseline set of values. A second portion of sample is spiked with known concentrations of compounds appropriate to the analyses being performed, typically 5 volatile organic compounds for volatile organics analyses, 11 semivolatile compounds for semivolatiles, 6 pesticide compounds for pesticides, all metals for metals analyses, and a known quantity of cyanide for cyanide analysis. The percentage of the spike compound that is recovered (i.e., measured in excess of the value obtained for the unspiked sample) is a direct measure of analytical accuracy. EPA requires matrix spike/matrix spike duplicates to be run at least once per 20 samples of similar matrix.

Matrix spike/matrix spike duplicate results are reported to EPD/EMS but are not published. For organic compounds, according to EPA guidelines, no action is taken on the basis of matrix spike/matrix spike duplicate data alone (i.e., no result modifiers are assigned solely on the basis of matrix spike results); however, the results can indicate if a lab is having a systematic problem in the analysis of one or more analytes.

In the case of inorganic compounds, such as metals, the matrix spike sample analysis provides information about the effect of each sample matrix on the digestion and measurement methodology. Data qualifiers can be assigned on the basis of the percentage of spike recovery and are reported in the published results tables.

Assessment of Precision

Precision of the analyses, or agreement of a set of replicate results among themselves, is assessed through the use of duplicates (laboratory-initiated) and blind replicates (provided by EPD/EMS). The results of duplicate and replicate analyses are presented in the results tables of the first, second, and third quarter reports. Duplicate and replicate results are not presented in fourth quarter reports; the results tables present instead only the highest result for each analyte for each quarter of the year.

The laboratories assess precision by calculating the relative percent difference, or RPD, for each pair of laboratory-initiated duplicate results. During 1992, at least one of the contract laboratories used a data qualifier (J3) to modify metals analyses when the RPD for laboratory duplicates was greater than 20%.

Additional statistical comparisons of laboratory duplicate and blind replicate results, both intra- and interlaboratory, are presented in the EPD/EMS quarterly reports. The calculation used for these reports is the MRD, or mean relative difference, which is similar to EPA's RPD except that the MRD provides a single value for all of the analyses of a particular com-

pound, either inter- or intralaboratory, during one quarter. Because detection limits may vary among samples, the MRD requires calculation of a reference detection limit, which is the detection limit at the 90th percentile of the array of limits in the population of all replicate and duplicate analyses for a given analyte during a particular quarter. The MRD is not method-specific.

Method-Specific Accuracy and Precision

The contract laboratories' EPA-approved laboratory procedures include QA/QC requirements as an integral part of the methods. Thus, knowledge of the method used in obtaining data is an important component of determining data useability. EPA has conducted extensive research and development on the methods approved for the analysis of water and waste water; information on the accuracy and precision of the method is available from EPA publications, as is full information on required QA/QC procedures. A listing of the methods used by the primary laboratories during first quarter 1992 is given below along with the source for the method description. Many, if not all, of these sources include presentations of representative accuracy and precision results.

Method	Used to Analyze	Source
EPA120.1	Specific conductance	EPA EMSL 1983
EPA150.1	pH	EPA EMSL 1983
EPA160.1	Filterable residue (total dissolved solids)	EPA EMSL 1983
EPA160.2	Nonfilterable residue	EPA EMSL 1983
EPA180.1	Turbidity	EPA EMSL 1983
EPA200.7	Trace elements	EPA EMSL 1983
EPA206.2	Arsenic	EPA EMSL 1983
EPA208.2	Barium	EPA EMSL 1983
EPA239.2	Lead	EPA EMSL 1983
EPA245.1	Mercury	EPA EMSL 1983
EPA270.2	Selenium	EPA EMSL 1983
EPA279.2	Thallium	EPA EMSL 1983
EPA300.0	Inorganics, non-metallics	EPA EMSL 1991
EPA310.1	Alkalinity	EPA EMSL 1983
EPA325.2	Chloride	EPA EMSL 1983
EPA335.3	Cyanide	EPA EMSL 1983
EPA340.2	Fluoride	EPA EMSL 1983
EPA353.1	Nitrogen, nitrate-nitrite	EPA EMSL 1983
EPA353.2	Nitrogen, nitrate, nitrite, or combined	EPA EMSL 1983
EPA353.3	Nitrogen, nitrate-nitrite, or nitrite only	EPA EMSL 1983
EPA354.1	Nitrogen, nitrite	EPA EMSL 1983
EPA365.1	Phosphorus, all forms (reported as total phosphates)	EPA EMSL 1983
EPA365.2	Phosphorus, all forms (reported as total phosphates)	EPA EMSL 1983
EPA375.4	Sulfate, turbidimetric	EPA EMSL 1983
EPA376.2	Sulfide	EPA EMSL 1983
APHA403	Alkalinity	APHA 1985
EPA413.1	Oil & grease	EPA EMSL 1983
APHA415A	Iodine	APHA 1985
EPA415.1	Total organic carbon	EPA EMSL 1983
EPA418.1	Petroleum hydrocarbons	EPA EMSL 1983
EPA420.1	Phenolics	EPA EMSL 1983
EPA420.2	Phenolics	EPA EMSL 1983
APHA705	Total alpha-emitting radium	APHA 1985

Method	Used to Analyze	Source
ASTMD3869C	Iodide	ASTM 1992
APHA5320	Dissolved organic halogen	APHA 1989
EPA6010	Metals	EPA 1986
EPA7041	Antimony	EPA 1986
EPA7060	Arsenic	EPA 1986
EPA7421	Lead	EPA 1986
EPA7470	Mercury	EPA 1986
EPA7740	Selenium	EPA 1986
EPA7841	Thallium	EPA 1986
EPA8010	Halogenated volatile organics	EPA 1986
EPA8020	Aromatic volatile organics	EPA 1986
EPA8080	Organochlorine pesticides and PCBs	EPA 1986
EPA8140	Organophosphorus pesticides	EPA 1986
EPA8150	Chlorinated herbicides	EPA 1986
EPA8240	GCMS VOA	EPA 1986
EPA8270	GCMS semivolatiles	EPA 1986
EPA8280	Dioxins and furans	EPA 1986
EPA9012	Total cyanide	EPA 1986
EPA9020	Total organic halides	EPA 1986
EPA9030	Sulfides	EPA 1986

An example of the available method-specific QA/QC information is that for the analysis of metals by EPA Method 6010/200.7 (EPA, 1986/EPA EMSL, 1983). The primary laboratories, General Engineering Laboratories (GE) and Roy F. Weston, Inc. (Weston), use this inductively coupled plasma (ICP) atomic emission spectrometric method.

The following precision and accuracy data are based on the experience of seven laboratories that applied the ICP technique to acid-distilled water matrices that had been dosed with various metal concentrates. (Note: not all seven laboratories analyzed all 14 elements.) The references give results for samples having three concentration ranges; the results here are for samples having the lowest values, similar to actual groundwater results for SRS.

ICP Precision and Accuracy Data

Element	True value (µg/L)	Mean reported value (µg/L)	Mean percent RSD[a]
Aluminum	60	62	33
Arsenic	22	19	23
Beryllium	20	20	9.8
Cadmium	2.5	2.9	16
Chromium	10	10	18
Cobalt	20	20	4.1
Copper	11	11	40
Iron	20	19	15
Lead	24	30	32
Manganese	15	15	6.7
Nickel	30	28	11
Selenium	6	8.5	42

Element	True value (µg/L)	Mean reported value (µg/L)	Mean percent RSD[a]
Vanadium	70	69	2.9
Zinc	16	19	45

Note: In EPA (1986), the column heading is Mean Standard Deviation (%).

[a] Relative standard deviation.

As another example, EPA Method 601/8010 (EPA, 1991/EPA, 1986) is used by both GE and Weston for analyses of halogenated volatile organics. In the presentation of the method in both references, the following table gives method-specific accuracy and precision as functions of concentration. Contract laboratories are expected to achieve or at least approach these limits.

Accuracy and Precision as Functions of Concentration for EPA Method 601/8010

Parameter	Accuracy as recovery, X'[a] (µg/L)	Single analyst precision (µg/L)[b]	Overall precision (µg/L)[c]
Bromodichloromethane	$1.12C - 1.02$[d]	$0.11\bar{X} + 0.04$[e]	$0.20\bar{X} + 1.00$
Bromoform	$0.96C - 2.05$	$0.12\bar{X} + 0.58$	$0.21\bar{X} + 2.41$
Bromomethane	$0.76C - 1.27$	$0.28\bar{X} + 0.27$	$0.36\bar{X} + 0.94$
Carbon tetrachloride	$0.98C - 1.04$	$0.15\bar{X} + 0.38$	$0.20\bar{X} + 0.39$
Chlorobenzene	$1.00C - 1.23$	$0.15\bar{X} - 0.02$	$0.18\bar{X} + 1.21$
Chloroethane	$0.99C - 1.53$	$0.14\bar{X} - 0.13$	$0.17\bar{X} + 0.63$
2-Chloroethyl vinyl ether[f]	$1.00C$	$0.20\bar{X}$	$0.35\bar{X}$
Chloroform	$0.93C - 0.39$	$0.13\bar{X} + 0.15$	$0.19\bar{X} - 0.02$
Chloromethane	$0.77C + 0.18$	$0.28\bar{X} - 0.31$	$0.52\bar{X} + 1.31$
Dibromochloromethane	$0.94C + 2.72$	$0.11\bar{X} + 1.10$	$0.24\bar{X} + 1.68$
1,2-Dichlorobenzene	$0.93C + 1.70$	$0.20\bar{X} + 0.97$	$0.13\bar{X} + 6.13$
1,3-Dichlorobenzene	$0.95C + 0.43$	$0.14\bar{X} + 2.33$	$0.26\bar{X} + 2.34$
1,4-Dichlorobenzene	$0.93C - 0.09$	$0.15\bar{X} + 0.29$	$0.20\bar{X} + 0.41$
1,1-Dichloroethane	$0.95C - 1.08$	$0.09\bar{X} + 0.17$	$0.14\bar{X} + 0.94$
1,2-Dichloroethane	$1.04C - 1.06$	$0.11\bar{X} + 0.70$	$0.15\bar{X} + 0.94$
1,1-Dichloroethene	$0.98C - 0.87$	$0.21\bar{X} - 0.23$	$0.29\bar{X} - 0.40$
trans-1,2-Dichloroethene	$0.97C - 0.16$	$0.11\bar{X} + 1.46$	$0.17\bar{X} + 1.46$
1,2-Dichloropropane[f]	$1.00C$	$0.13\bar{X}$	$0.23\bar{X}$
cis-1,3-Dichloropropene[f]	$1.00C$	$0.18\bar{X}$	$0.32\bar{X}$
trans-1,3-Dichloropropene[f]	$1.00C$	$0.18\bar{X}$	$0.32\bar{X}$
Methylene chloride	$0.91C - 0.93$	$0.11\bar{X} + 0.33$	$0.21\bar{X} + 1.43$
1,1,2,2-Tetrachlorethane	$0.95C + 0.19$	$0.14\bar{X} + 2.41$	$0.23\bar{X} + 2.79$
Tetrachloroethylene	$0.94C + 0.06$	$0.14\bar{X} + 0.38$	$0.18\bar{X} + 2.21$
1,1,1-Trichloroethane	$0.90C - 0.16$	$0.15\bar{X} + 0.04$	$0.20\bar{X} + 0.37$
1,1,2-Trichloroethane	$0.86C + 0.30$	$0.13\bar{X} - 0.14$	$0.19\bar{X} + 0.67$
Trichloroethylene	$0.87C + 0.48$	$0.13\bar{X} - 0.03$	$0.23\bar{X} + 0.30$
Trichlorofluoromethane	$0.89C - 0.07$	$0.15\bar{X} + 0.67$	$0.26\bar{X} + 0.91$
Vinyl chloride	$0.97C - 0.36$	$0.13\bar{X} + 0.65$	$0.27\bar{X} + 0.40$

[a] X' = expected recovery for one or more measurements of a sample containing a concentration of C, in µg/L.
[b] Expected single analyst standard deviation of measurements.

[c] Expected interlaboratory standard deviation of measurements.
[d] C = true value for the concentration, in µg/L.
[e] $\bar{X}$ = average recovery found for measurements of samples containing a concentration of C, in µg/L.
[f] Estimates based on performance in a single laboratory.

References

APHA (American Public Health Association), 1985. **Standard Methods for the Examination of Water and Wastewater**, 16th edition. Washington, DC.

APHA (American Public Health Association), 1989. **Standard Methods for the Examination of Water and Wastewater**, 17th edition. Washington, DC.

ASTM (American Society for Testing and Materials), 1992. **1992 Annual Book of ASTM Standards**, Volume 11.02, Water (II). Philadelphia, PA.

EPA (U.S. Environmental Protection Agency), 1986. **Test Methods for Evaluating Solid Waste (SW-846)**, Volumes IA–IC. Washington, DC.

EPA (U.S. Environmental Protection Agency), 1987. **Data Quality Objectives for Remedial Response Activities**. PB88-131870; EPA/540/G-87/003. Washington, DC.

EPA (U.S. Environmental Protection Agency), 1988a. **Contract Laboratory Program Statement of Work for Inorganics Analysis, Multi-Media, Multi-Concentration**. SOW No. 788. Washington, DC.

EPA (U.S. Environmental Protection Agency), 1988b. **Contract Laboratory Program Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration**. SOW No. 288. Washington, DC.

EPA (U.S. Environmental Protection Agency), 1990. **Guidance for Data Useability in Risk Assessment**. Interim Final. EPA/540/G-90/008. Washington, DC.

EPA (U.S. Environmental Protection Agency), 1991. *Guidelines Establishing Test Procedures for the Analysis of Pollutants,* **Code of Federal Regulations**, Title 40, Part 136, Appendix A. Revised July 1, 1991. Washington, DC.

EPA EMSL (U.S. Environmental Protection Agency, Environmental Monitoring and Systems Laboratory), 1979. **Handbook for Analytical Quality Control in Water and Wastewater Laboratories**. PB-297 451; EPA-600/4-79-019. Cincinnati, OH.

EPA EMSL (U.S. Environmental Protection Agency, Environmental Monitoring and Systems Laboratory), 1983. **Methods for Chemical Analysis of Water and Wastes**. Revised March 1983. Cincinnati, OH.

EPA EMSL (U.S. Environmental Protection Agency, Environmental Monitoring and Systems Laboratory), 1991. **Test Method, The Determination of Inorganic Anions in Water by Ion Chromatography–Method 300.0**. Revised August 1991. Cincinnati, OH.

DATE
FILMED
2/3/94
END