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FIRST QUARTER 1993

F- AND H-AREA SEWAGE SLUDGE APPLICATION SITES GROUNDWATER MONITORING REPORT (U)

PUBLICATION DATE: JULY 1993

Authorized Derivative Classifier:

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WESTINGHOUSE SAVANNAH RIVER COMPANY
SAVANNAH RIVER SITE
AIKEN, SC 29808

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

DISCLAIMER

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Abstract

Samples from the four wells at the F-Area Sewage Sludge Application Site (FSS wells) and the three wells at the H-Area Sewage Sludge Application Site (HSS wells) are analyzed quarterly for constituents as required by South Carolina Department of Health and Environmental Control Construction Permit 12,076 and, as requested, for other constituents as part of the Savannah River Site Groundwater Monitoring Program. Annual analyses for other constituents, primarily metals, also are required by the permit.

Historically and currently, no permit-required analytes exceed standards at the F- and H-Area Sewage Sludge Application Sites except iron, lead, and manganese, which occur in elevated concentrations frequently in FSS wells and occasionally in HSS wells. Tritium and aluminum are the primary nonpermit constituents that exceed standards at the F-Area Sewage Sludge Application Site. Other constituents also exceed standards at this site but only sporadically.

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Executive Summary

During first quarter 1993, samples from the four monitoring wells at the F-Area Sewage Sludge Application Site (FSS series) and the three monitoring wells at the H-Area Sewage Sludge Application Site (HSS series) were analyzed for constituents required by Construction Permit 12,076, issued by the South Carolina Department of Health and Environmental Control. These samples were also analyzed for other constituents as part of the Savannah River Site (SRS) Groundwater Monitoring Program. This report describes the monitoring results that exceeded final Primary Drinking Water Standards (PDWS) or SRS flagging criteria.

Upgradient well FSS 1D contained concentrations of lead that exceeded the final PDWS and concentrations of aluminum, iron, and manganese that exceeded the SRS Flag 2 criteria. Downgradient FSS wells contained elevated levels of aluminum, iron, lead, manganese, or tritium. Upgradient well HSS 3D contained elevated aluminum and iron concentrations; downgradient HSS wells exhibited no elevated constituents.

The frequency of occurrence of elevated tritium activities in FSS wells during first quarter 1993 was similar to occurrences during recent quarters. The occurrence of elevated iron and manganese concentrations in HSS wells during first quarter 1993 was similar to first quarter 1992, the most recent quarter in which analyses were conducted for these two constituents in all of the HSS wells. The occurrence of elevated lead concentrations in FSS wells was similar to occurrences during fourth quarter 1992 when metal analyses were first conducted on unfiltered samples. Aluminum was not analyzed for in groundwater samples from FSS or HSS wells during 1992.

During first quarter 1993, groundwater flow beneath the F-Area Sewage Sludge Application Site was toward the southwest, and flow beneath the H-Area Sewage Sludge Application Site was toward the west-southwest (SRS grid coordinates). Flow at these two sites was consistently toward the southwest throughout 1991 and 1992.

Introduction

The F-Area Sewage Sludge Application Site covers approximately 8 acres south of Road E in the southeastern portion of F Area (Figures 1 and 2, Appendix C). The H-Area Sewage Sludge Application Site includes approximately 13 acres south of Road E in the southeastern portion of H Area (Figures 1 and 3, Appendix C). These sites were permitted to receive sludge from SRS sanitary waste water treatment plants in accordance with Construction Permit 12,076, issued by the South Carolina Department of Health and Environmental Control (SCDHEC) April 21, 1986. Sewage sludge was disposed of at the F-Area site from 1987 until third quarter 1990. Sludge was disposed of intermittently at the H-Area site from November 1990 through second quarter 1992.

In 1988, SRS determined that new wells were required at the F- and H-Area sites to assess the effects on groundwater of sewage sludge application to these sites. After receiving approval from SCDHEC, SRS installed four new wells at the F-Area site and three new wells at the H-Area site. These wells, designated FSS 1D, 2D, 3D, and 4D and HSS 1D, 2D, and 3D, were first sampled during fourth quarter 1988. All wells monitor the water table.

The SRS Environmental Protection Department/Environmental Monitoring Section (EPD/EMS) samples these wells each quarter, and the SRS Environmental Restoration Department reports the results of this sampling to SCDHEC as required by Special Condition 4 of Construction Permit 12,076.

Discussion

Groundwater Monitoring Data

The EPD/EMS sampling procedure (WSRC, 1992) 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 from a single sampling event. On the second visit within 24 hours, samples are taken without purging or stability measurements; thus, these samples may not be representative of groundwater quality.

Tables 5 and 6 (Appendix D) list the number of well volumes purged from each FSS and HSS well, respectively, during first quarter 1993. Wells FSS 1D, 2D, 3D, and 4D and HSS 1D and 3D went dry during purging; all recovered sufficiently to sample within 24 hours. Most of these wells consistently have failed to meet the purging and stabilization criteria. At present, all FSS and HSS wells have single-speed centrifugal pumps.

Samples from the monitoring wells at the F- and H-Area Sewage Sludge Application Sites are analyzed for the following parameters as required by SCDHEC Construction Permit 12,076:

- Quarterly analyses for specific conductance and pH (laboratory measurements)
- Quarterly analyses for water quality indicators: chloride, nitrate, nitrite, sodium, and total dissolved solids
- Annual analyses for cadmium, calcium, copper, iron, lead, magnesium, manganese, nickel, potassium, and total phosphates (as phosphorus)

The FSS and HSS wells may also receive additional analyses as part of the SRS Groundwater Monitoring Program.

Monitoring results that equaled or exceeded the Safe Drinking Water Act final Primary Drinking Water Standards (PDWS) or drinking water screening levels, as established by the U.S. Environmental Protection Agency (EPA) (Appendix A); the South Carolina final PDWS for lead (Appendix A); or SRS flagging criteria that are based on final and proposed PDWS, Secondary Drinking Water Standards, or constituent detection limits (Appendix B) are described in this report. Constituent levels that equaled or exceeded final PDWS or SRS Flag 2 criteria are described as *elevated* or as *exceeding* or *above* standards.

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

Appendix C provides locations of the monitored sites at SRS (Figure 1); the individual FSS and HSS monitoring wells (Figures 2 and 3, respectively); the flow directions of the groundwater beneath the sites (Figures 4 and 5); and the tritium activities in the FSS wells compared to the tritium activities in Burial Ground Complex wells (Figure 6). Monitoring results as well as analyses that exceeded EPA-approved holding times are in Appendix D, and information on the assessment of data quality and useability is in Appendix E.

Analytical Results Exceeding Standards

Table 1 (Appendix D) summarizes constituents that exceeded the final PDWS during first quarter 1993 for the F-Area Sewage Sludge Application Site. Table 2 (Appendix D) summarizes constituents in excess of the final PDWS for the H-Area Sewage Sludge Application Site for the quarter. Tritium exceeded the final PDWS in well FSS 2D at 8.5E+01 pCi/mL and in well FSS 3D at 4.5E+01 pCi/mL. Lead exceeded the final PDWS in wells FSS 1D and 3D at 83 μg/L and 327 μg/L, respectively. No constituents exceeded the final PDWS in HSS wells.

Tables 3 and 4 (Appendix D) summarize constituents exceeding half the final PDWS or other Flag 1 or Flag 2 criteria during first quarter 1993 for the F-Area Sewage Sludge Application Site and the H-Area Sewage Sludge Application Site, respectively. Aluminum and iron exceeded their Flag 2 criteria in wells FSS 1D, 2D, 3D, and 4D, with aluminum and iron concentrations up to 2,690 μg/L and 4,120 μg/L, respectively, in well FSS 1D. Manganese concentrations exceeded the Flag 2 criterion in well FSS 1D at 73 μg/L and in well FSS 3D at 54 μg/L. Aluminum and iron concentrations exceeded Flag 2 criteria in well HSS 3D at 162 μg/L and 950 μg/L, respectively, during the quarter.

First quarter 1993 results for all analyzed constituents for the FSS and HSS wells are presented in Tables 5 and 6, respectively (Appendix D).

Results in Tables 1, 2, 5, and 6 that appear to equal the final PDWS but are not marked in the *D* (exceeded final PDWS or screening level) column are below the final PDWS in the database. Values stored in the database, which are the values compared to the final PDWS, contain more significant digits than the reported results. Apparent discrepancies in the tables (i.e., some results equal to the final PDWS are not marked in the *D* column) are due to the rounding of reported results.

Presently, SRS sets no flagging criteria for alkalinity. In the FSS wells, alkalinity ranged up to 67 mg/L (well FSS 2D). In the HSS wells, alkalinity ranged up to 5 mg/L (well HSS 1D).

Water Elevations and Groundwater Flow Directions

Water-table elevations at the F-Area Sewage Sludge Application Site indicate that the groundwater flow direction is toward the southwest (SRS grid coordinates), discharging into Fourmile Branch. During first quarter 1993, groundwater from well FSS 1D, upgradient of the F-Area Sewage Sludge Application Site, contained lead in excess of the final PDWS and aluminum, iron, and manganese in excess of Flag 2 criteria. One or more of the downgradient wells contained elevated levels of aluminum, iron, lead, manganese, or tritium.

The nearly linear orientation of the wells at the H-Area Sewage Sludge Application Site and the fact that wells HSS 1D and 2D are screened well below the water table make the determination of groundwater flow direction difficult. Available data, including water-level elevations from the three wells, indicate that groundwater flow is generally toward the west-southwest (SRS grid coordinates) (Figure 5, Appendix C). During first quarter 1993, upgradient well HSS 3D contained concentrations of aluminum and iron that exceeded SRS Flag 2 criteria; downgradient wells HSS 1D and HSS 2D did not exhibit any constituents that exceeded the final PDWS or Flag 2 criteria.

Conclusions

- During first quarter 1993, upgradient well FSS 1D contained aluminum, iron, lead, and manganese concentrations that exceeded the final PDWS or the SRS Flag 2 criteria. Downgradient FSS wells contained elevated levels of aluminum, iron, lead, manganese, or tritium. Upgradient well HSS 3D contained elevated aluminum and iron concentrations; no constituents were elevated in downgradient HSS wells.

- Generally, elevated levels of constituents found in downgradient wells but not in upgradient wells at a waste management unit, such as tritium activities in the downgradient FSS wells, are considered products of that waste management unit. However, historical records for the F- and H-Area Sewage Sludge Application Sites indicate that no radionuclides were disposed of in the immediate area. The source of the elevated tritium activities in the downgradient FSS wells is believed to be the Old Burial Ground (Figure 6, Appendix C).

- Aluminum, elevated in all of the FSS wells and in well HSS 3D during first quarter 1993, was not analyzed for in groundwater samples from FSS or HSS wells during 1992.

- Elevated lead concentrations did not occur in FSS wells during the first three quarters of 1992; the occurrence of elevated lead in fourth quarter 1992 and first quarter 1993 is concurrent with the change to analyses of unfiltered metals samples.

- The frequency of occurrence of elevated iron and manganese concentrations in FSS wells during first quarter 1993 was similar to past quarters. The occurrence of elevated iron and manganese concentrations in HSS wells during first quarter 1993 was similar to their occurrence during first quarter 1992, the most recent quarter when analyses were conducted for these two constituents in all of the HSS wells.

- Groundwater flow beneath the F- and H-Area Sewage Sludge Application Sites is toward the southwest and west-southwest (SRS grid coordinates), respectively.

- In the FSS wells, alkalinity ranged up to 67 mg/L (well FSS 2D) during first quarter 1993. In the HSS wells, alkalinity ranged up to 5 mg/L (well HSS 1D). These results are similar to those of previous quarters.

- The wells that pumped dry during purging in first quarter 1993, FSS 1D, 2D, 3D, and 4D and HSS 1D and 3D, may have yielded unrepresentative groundwater samples.

References Cited

WSRC (Westinghouse Savannah River Company), 1992. **Hydrogeologic Data Collection Procedures and Specifications: Sampling Groundwater Monitoring Wells.** Manual 3Q5, Chapter 15, Rev. 1. Environmental Protection Department, Environmental Monitoring Section, Savannah River Site, Aiken, SC.

Errata

The results of analyses performed using EPA Method 900.1 have been incorrectly referred to in the past as total radium results and have been inappropriately evaluated against the drinking water standard for combined radium-226 and radium-228. EPA Method 900.1 measures radium-223, -224, and -226 and should be considered a gross radium alpha screening procedure; it may be used to screen drinking water for the necessity of performing a specific radium-226 analysis, but it gives no indication of the presence or quantity of radium-228 in the sample. This analysis is now referred to as total alpha-emitting radium.

First through Third Quarters 1992:

- Chlordane analysis was requested as part of the Base/Neutral/Acid suite of analyses as described in the Environmental Protection Department/Environmental Monitoring Section contract with the analytical laboratory. However, Roy F. Weston, Inc., which conducted the analyses for first through third quarters 1992, does not include chlordane in its Base/Neutral/Acid suite of analyses. Chlordane analysis was conducted by General Engineering Laboratories for fourth quarter 1992.

First through Fourth Quarters 1992:

- Some results for earlier quarters of 1992 that are presented in the results tables of the fourth quarter 1992 report may differ from the results presented in the earlier reports, and reported results may not match reported sample dates. These differences arise from the following: (1) the computer program that creates the results tables was revised beginning second quarter 1992 to present the highest value for analytes with more than one result (previously, the program presented the first value encountered in the database); (2) a new computer program, which rounds numbers differently from the former computer program, was first used during third quarter 1992; and (3) some reanalyses may have been performed by the laboratories after the quarterly reports had gone to press. The sample dates in the tables are the dates when the field data were collected. These dates may differ from the dates of the laboratory analyses if the highest results were obtained for samples collected on different dates.

Appendix A – Final Primary Drinking Water Standards

Final Primary Drinking Water Standards

Analyte	Unit	Level	Status	Reference
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
Selenium	µg/L	50	Final	EPA, 1992a

Analyte	Unit	Level	Status	Reference
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 radium (Radium-226 and -228)	pCi/L	5E+00	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
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)
Asbestos	Fibers/L	3,500,000	7,000,000	Final PDWS (EPA, 1992a)

Analyte	Unit	Flag 1	Flag 2	Source[a]
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
4-Chlorophenyl phenyl ether	µg/L	50	100	EPA Method 8270

Analyte	Unit	Flag 1	Flag 2	Source[a]
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
trans-1,3-Dichloropropene	µg/L	5	10	EPA Method 8240

Analyte	Unit	Flag 1	Flag 2	Source[a]
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
Hexachloroethane	µg/L	50	100	EPA Method 8270

Analyte	Unit	Flag 1	Flag 2	Source[a]
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
4-Nitroquinoline-1-oxide	µg/L	50	100	EPA Method 8270

Analyte	Unit	Flag 1	Flag 2	Source[a]
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
Radium (alpha-emitting)[d]	pCi/L	1E+01	2E+01	Proposed PDWS (EPA, 1991)

Analyte	Unit	Flag 1	Flag 2	Source[a]
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
Toxaphene	µg/L	1.5	3	Final PDWS (EPA, 1992a)

Analyte	Unit	Flag 1	Flag 2	Source[a]
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

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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

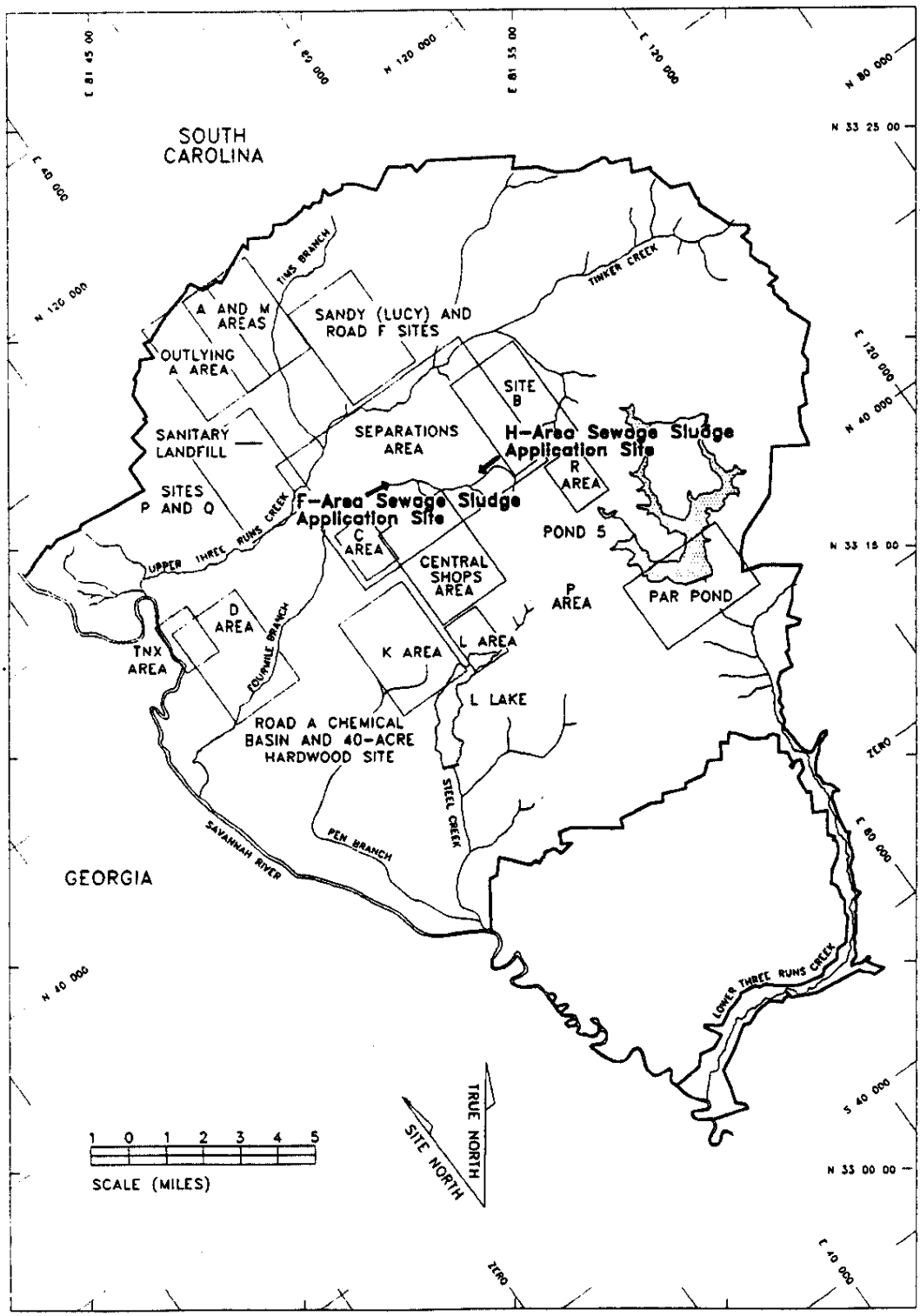

Figure 1. Location of the F- and H-Area Sewage Sludge Application Sites at the Savannah River Site

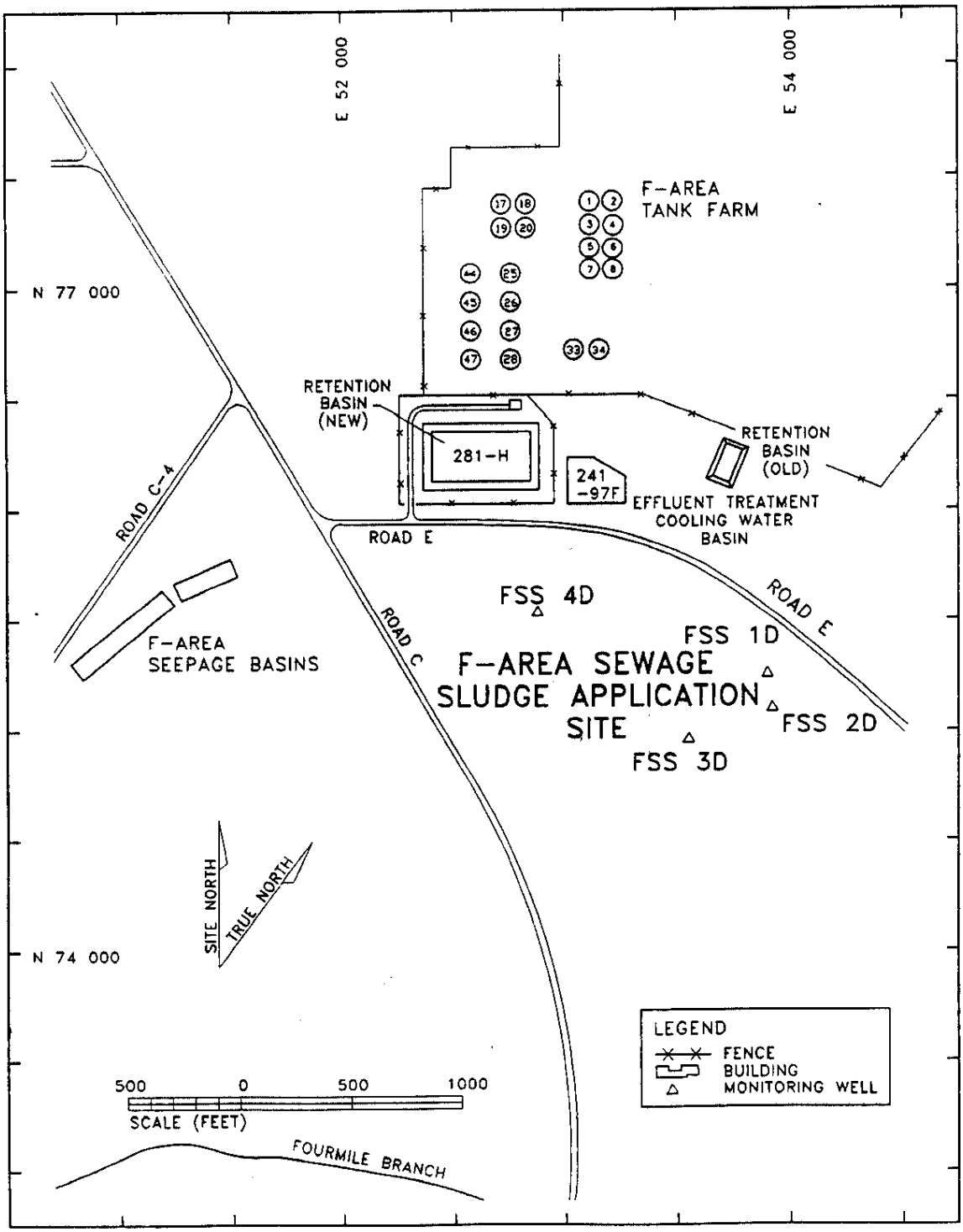

Figure 2. Location of Groundwater Monitoring Wells at the F-Area Sewage Sludge Application Site

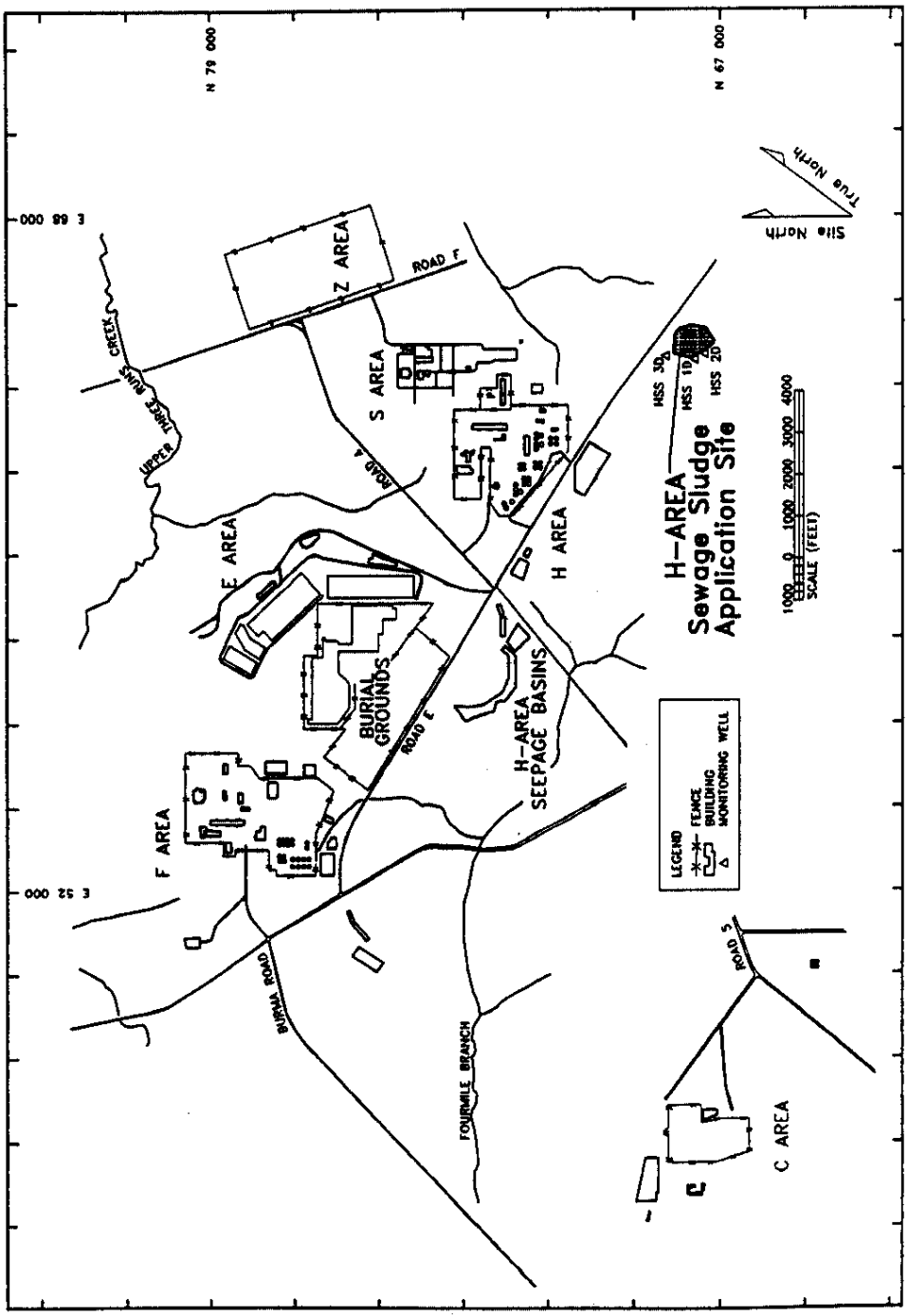

Figure 3. Location of Groundwater Monitoring Wells at the H-Area Sewage Sludge Application Site

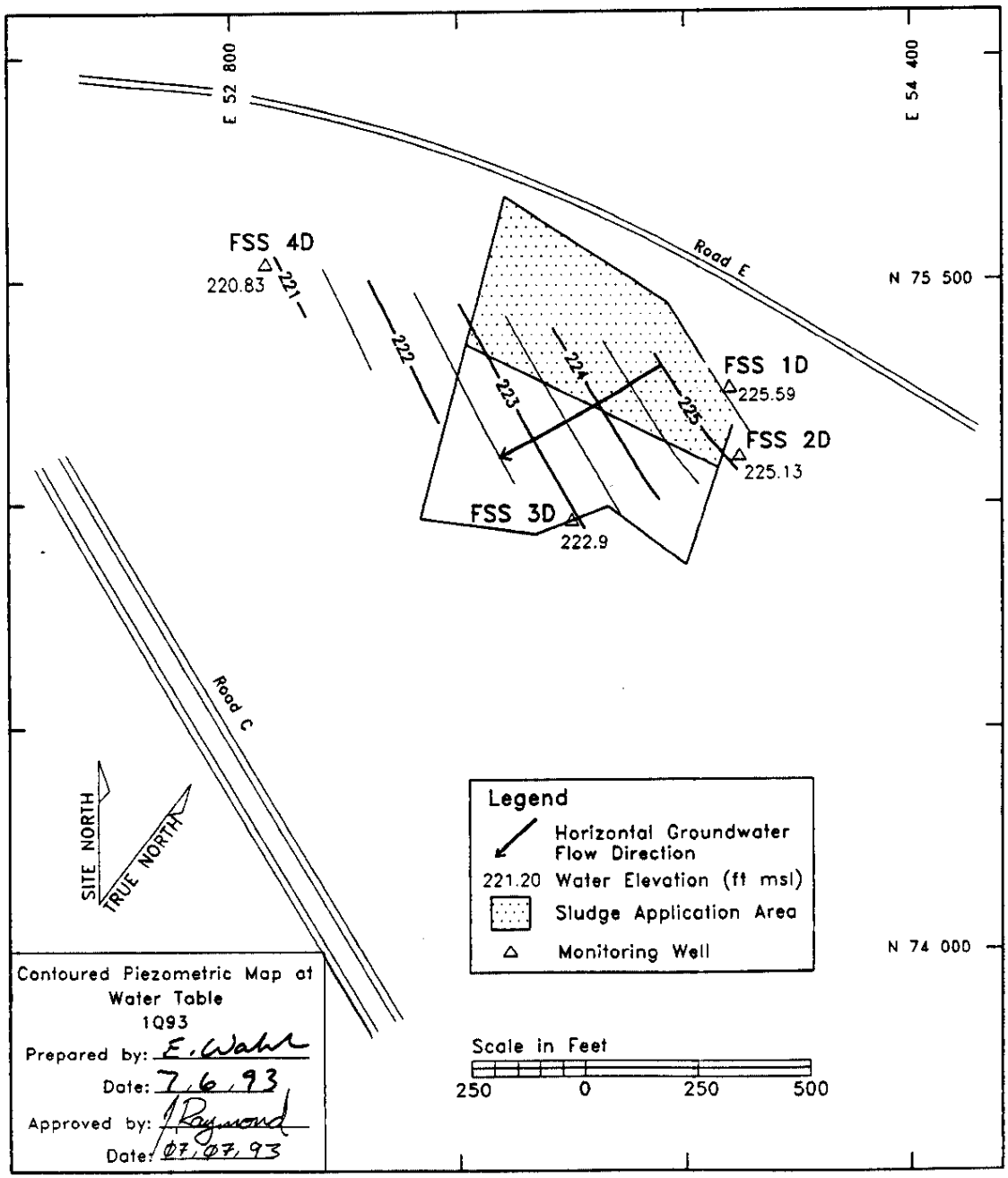

Figure 4. Piezometric Map of the Water Table at the F-Area Sewage Sludge Application Site

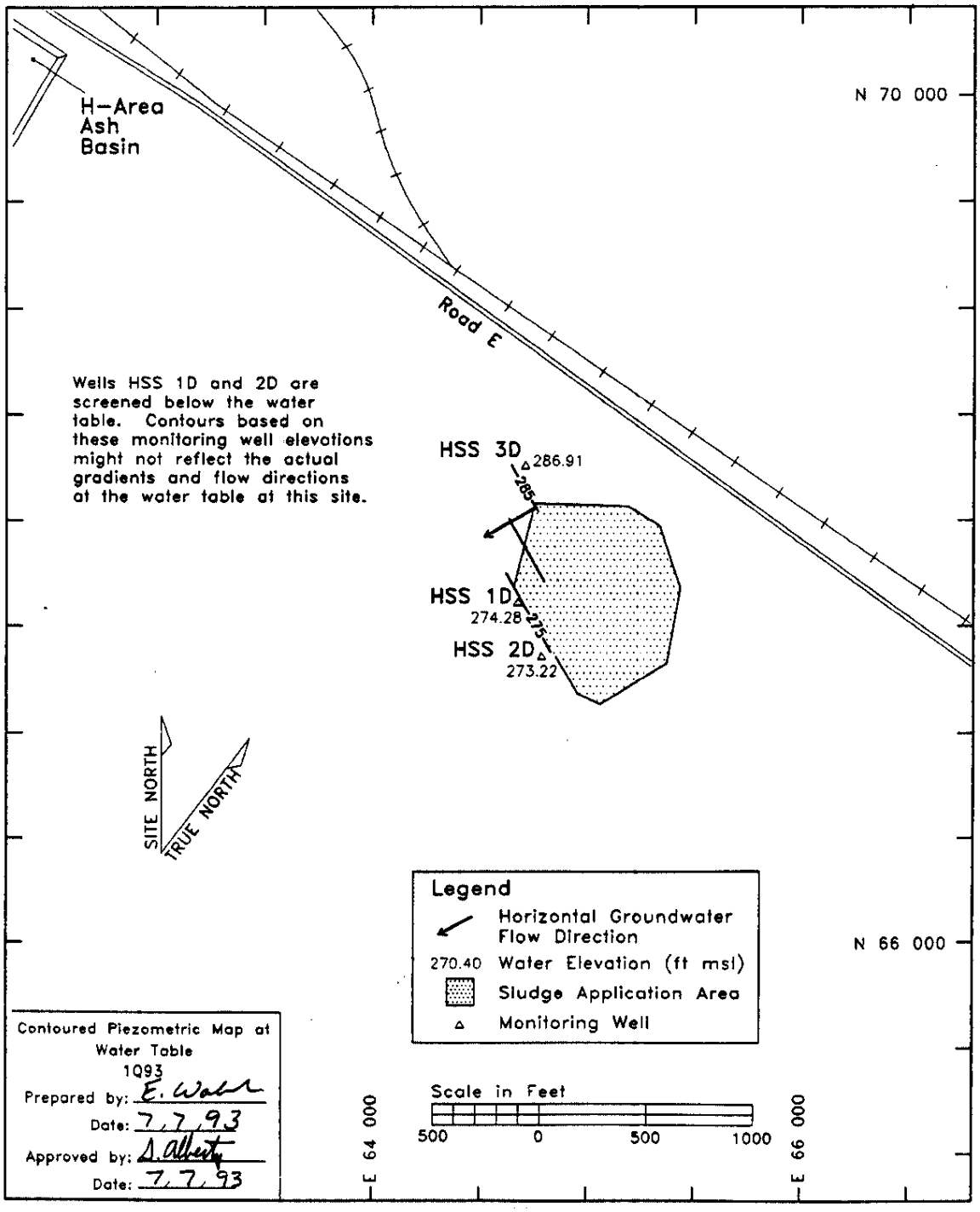

Figure 5. Piezometric Map of the Water Table at the H-Area Sewage Sludge Application Site

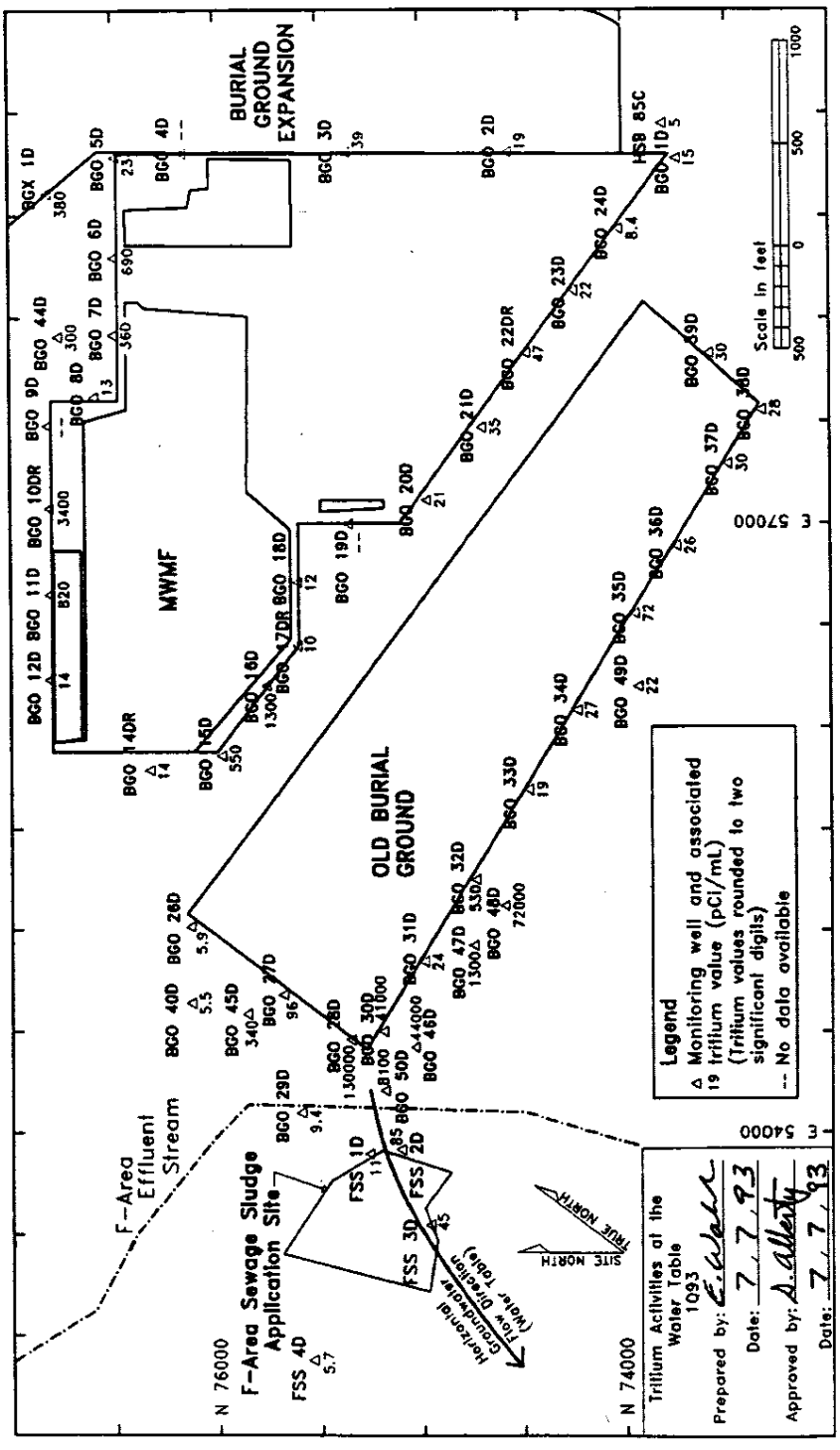

Figure 6. Tritium Activities at the F-Area Sewage Sludge Application Site and the Burial Ground Complex

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. Maximum Levels of Constituents Exceeding the Final Primary Drinking Water Standards at the F-Area Sewage Sludge Application Site

Well	Constituent	Unit	4Q92	1Q93	Mod
FSS 1D	Lead	µg/L	100	83	
FSS 2D	Tritium	pCi/mL	9.8E+01	8.5E+01	Y
FSS 3D	Lead	µg/L	154	327	
	Tritium	pCi/mL	6.2E+01	4.5E+01	

Table 2. Maximum Levels of Constituents Exceeding the Final Primary Drinking Water Standards at the H-Area Sewage Sludge Application Site

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

[a] N = not applicable.

Table 3. Maximum Levels of Constituents Exceeding Half the Final Primary Drinking Water Standards or Other Flag 1 or Flag 2 Criteria at the F-Area Sewage Sludge Application Site

Well	Constituent	Unit	1Q93	Mod	Flag
FSS 1D	Aluminum	µg/L	2,690		2
	Cadmium	µg/L	2.6	J3	1
	Iron	µg/L	4,120		2
	Manganese	µg/L	73		2
	Tritium	pCi/mL	1.1E+01		1
FSS 2D	Aluminum	µg/L	518	Y	2
	Iron	µg/L	1,650	Y	2
	Manganese	µg/L	31	Y	1
FSS 3D	Aluminum	µg/L	584		2
	Iron	µg/L	961		2
	Manganese	µg/L	54		2
FSS 4D	Aluminum	µg/L	231		2
	Iron	µg/L	534		2

Note: Constituents exceeding half the final PDWS appear *italicized*. These results do not include field data.

Table 4. Maximum Levels of Constituents Exceeding Half the Final Primary Drinking Water Standards or Other Flag 1 or Flag 2 Criteria at the H-Area Sewage Sludge Application Site

Well	Constituent	Unit	1Q93	Mod	Flag
HSS 1D	Aluminum	µg/L	44		1
HSS 2D	Aluminum	µg/L	28		1
HSS 3D	Aluminum	µg/L	162		2
	Iron	µg/L	950		2
	Lead	µg/L	12		1

Note: Constituents exceeding half the final PDWS appear *italicized*. These results do not include field data.

Table 5. Groundwater Monitoring Results for Individual Wells at the F-Area Sewage Sludge Application Site

WELL FSS 1D

SRS Coord.	Lat/Longitude	Screen Zone Elevation	Top of Casing	Casing	Pump	Formation
N75257.6 E53897.6	33.280161 °N 81.671063 °W	229.9-209.9 ft msl	266 ft msl	4" PVC	S	Water table

FIELD MEASUREMENTS

Sample date: 02/19/93
Depth to water: 40.41 ft (12.32 m) below TOC
Water elevation: 225.59 ft (68.76 m) msl
Sp. conductance: 74 µS/cm
Water evacuated before sampling: 9 gal
The well went dry during purging.

Time: 15:02
pH: 6.1
Alkalinity: 25 mg/L
Water temperature: 19.0 °C
Volumes purged: 0.9 well volumes

LABORATORY ANALYSES

H	D	Analyte	Result	Mod	Unit	Flag	Lab
•		pH	6.7	J	pH	0	WA
•		pH	6.7	J	pH	0	WA
•		Specific conductance	90	J	µS/cm	0	WA
•		Specific conductance	90	J	µS/cm	0	WA
		Aluminum	2,690		µg/L	2	WA
		Arsenic	<2.0		µg/L	0	WA
		Barium	14		µg/L	0	WA
		Cadmium	2.6	J3	µg/L	1	WA
		Calcium	13,100		µg/L	0	WA
		Chloride	3,710		µg/L	0	WA
		Chromium	18		µg/L	0	WA
		Copper	434		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	4,120		µg/L	2	WA
	■	Lead	83		µg/L	2	WA
		Lindane	<0.053		µg/L	0	WA
		Magnesium	420		µg/L	0	WA
		Manganese	73		µg/L	2	WA
		Mercury	<0.20		µg/L	0	WA
		Methoxychlor	<0.53		µg/L	0	WA
		Nickel	24		µg/L	0	WA
		Nitrate as nitrogen	113		µg/L	0	WA
•		Nitrite as nitrogen	29	J	µg/L	0	WA
		Phenols	<5.0		µg/L	0	WA
		Potassium	<500		µg/L	0	WA
		Selenium	<2.0		µg/L	0	WA
		Silica	6,470		µg/L	0	WA
		Silver	<2.0		µg/L	0	WA
		Sodium	2,060	V	µg/L	0	WA
		Sulfate	1,640		µg/L	0	WA
		Total dissolved solids	71,000		µg/L	0	WA
		Total organic carbon	<1,000		µg/L	0	WA
		Total organic halogens	6.8		µg/L	0	WA
		Total phosphates (as P)	193		µg/L	0	WA
		Toxaphene	<1.1		µg/L	0	WA
		2,4,5-TP (Silvex)	<0.53		µg/L	0	WA

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

WELL FSS 1D collected on 02/19/93, laboratory analyses (cont.)

H	D	Analyte	Result	Mod	Unit	Flag	Lab
		Gross alpha	2.2E+00 ± 1.3E+00		pCi/L	0	TM
		Nonvolatile beta	4.4E+00 ± 1.9E+00		pCi/L	0	TM
		Radium-226	2.6E-01 ± 1.9E-01		pCi/L	0	TM
		Radium-228	1.0E+00 ± 1.2E+00		pCi/L	0	TM
		Tritium	<5.1E-01		pCi/mL	0	TM
		Tritium	1.1E+01 ± 9.0E-01		pCi/mL	1	TM

WELL FSS 2D

SRS Coord.	Lat/Longitude	Screen Zone Elevation	Top of Casing	Casing	Pump	Formation
N75103.5 E53918.9	33.279855 °N 81.670708 °W	224.4-204.4 ft msl	261.6 ft msl	4" PVC	S	Water table

FIELD MEASUREMENTS

Sample date: 02/19/93
Depth to water: 36.47 ft (11.12 m) below TOC
Water elevation: 225.13 ft (68.62 m) msl
Sp. conductance: 184 µS/cm
Water evacuated before sampling: 14 gal
The well went dry during purging.

Time: 14:42
pH: 7.6
Alkalinity: 67 mg/L
Water temperature: 18.9 °C
Volumes purged: 1.0 well volumes

LABORATORY ANALYSES

H	D	Analyte	Result	Mod	Unit	Flag	Lab
•		pH	7.2	JY	pH	0	WA
•		Specific conductance	144	JY	µS/cm	0	WA
		Aluminum	518	Y	µg/L	2	WA
		Arsenic	<2.0	Y	µg/L	0	WA
		Barium	55	Y	µg/L	0	WA
		Cadmium	<2.0	Y	µg/L	0	WA
		Calcium	17,300	Y	µg/L	0	WA
		Chloride	3,900	Y	µg/L	0	WA
		Chromium	<4.0	Y	µg/L	0	WA
		Copper	4.7	J3Y	µg/L	0	WA
		2,4-Dichlorophenoxyacetic acid	<1.1	Y	µg/L	0	WA
		Endrin	<0.11	Y	µg/L	0	WA
		Fluoride	<100	Y	µg/L	0	WA
		Iron	1,650	Y	µg/L	2	WA
		Lead	7.1	J3Y	µg/L	0	WA
		Lindane	<0.058	Y	µg/L	0	WA
		Magnesium	520	Y	µg/L	0	WA
		Manganese	31	Y	µg/L	1	WA
		Mercury	<0.20	Y	µg/L	0	WA
		Methoxychlor	<0.58	Y	µg/L	0	WA
		Nickel	<4.0	Y	µg/L	0	WA
		Nitrate as nitrogen	499	Y	µg/L	0	WA
•		Nitrite as nitrogen	17	JY	µg/L	0	WA
		Phenols	<5.0	Y	µg/L	0	WA
		Potassium	795	J3Y	µg/L	0	WA
		Selenium	<2.0	Y	µg/L	0	WA
		Silica	3,610	Y	µg/L	0	WA
		Silver	<2.0	Y	µg/L	0	WA

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

WELL FSS 2D collected on 02/19/93, laboratory analyses (cont.)

H	D	Analyte	Result	Mod	Unit	Flag	Lab
		Sodium	3,640	VY	µg/L	0	WA
		Sulfate	11,600	Y	µg/L	0	WA
		Total dissolved solids	3,000	Y	µg/L	0	WA
		Total organic carbon	<1,000	Y	µg/L	0	WA
		Total organic carbon	<1,000	Y	µg/L	0	WA
		Total organic halogens	<5.0	Y	µg/L	0	WA
		Total phosphates (as P)	97	Y	µg/L	0	WA
		Toxaphene	<1.1	Y	µg/L	0	WA
		2,4,5-TP (Silvex)	<0.58	Y	µg/L	0	WA
		Gross alpha	1.7E+00 ± 1.2E+00		pCi/L	0	TM
		Nonvolatile beta	5.8E+00 ± 2.1E+00		pCi/L	0	TM
		Radium-226	1.5E+00 ± 4.8E-01		pCi/L	0	TM
		Radium-228	1.8E+00 ± 1.0E+00		pCi/L	0	TM
		Tritium	9.9E-01 ± 1.7E-01	Y	pCi/mL	0	TM
	■	Tritium	8.5E+01 ± 6.4E+00	Y	pCi/mL	2	TM

WELL FSS 3D

SRS Coord.	Lat/Longitude	Screen Zone Elevation	Top of Casing	Casing	Pump	Formation
N74960.5 E53548.0	33.278933 °N 81.671406 °W	225.8-205.8 ft msl	258.2 ft msl	4" PVC	S	Water table

FIELD MEASUREMENTS

Sample date: 02/19/93
Depth to water: 35.30 ft (10.76 m) below TOC
Water elevation: 222.90 ft (67.94 m) msl
Sp. conductance: 55 µS/cm
Water evacuated before sampling: 10 gal
The well went dry during purging.

Time: 14:21
pH: 5.4
Alkalinity: 1 mg/L
Water temperature: 18.4 °C
Volumes purged: 0.9 well volumes

LABORATORY ANALYSES

H	D	Analyte	Result	Mod	Unit	Flag	Lab
•		pH	5.6	J	pH	0	WA
•		Specific conductance	43	J	µS/cm	0	WA
		Aluminum	584		µg/L	2	WA
		Arsenic	<2.0		µg/L	0	WA
		Barium	17		µg/L	0	WA
		Cadmium	<2.0		µg/L	0	WA
		Calcium	719		µg/L	0	WA
		Chloride	3,990		µg/L	0	WA
		Chromium	4.5	J3	µg/L	0	WA
		Copper	140		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	961		µg/L	2	WA
	■	Lead	327		µg/L	2	WA
		Lindane	<0.058		µg/L	0	WA
		Magnesium	545		µg/L	0	WA
		Manganese	54		µg/L	2	WA
		Mercury	<0.20		µg/L	0	WA

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

WELL FSS 3D collected on 02/19/93, laboratory analyses (cont.)

H	D	Analyte	Result	Mod	Unit	Flag	Lab
		Methoxychlor	<0.58		µg/L	0	WA
		Nickel	4.7	J3	µg/L	0	WA
		Nitrate as nitrogen	519		µg/L	0	WA
•		Nitrite as nitrogen	17	J	µg/L	0	WA
		Phenols	<5.0		µg/L	0	WA
		Potassium	700	J3	µg/L	0	WA
		Selenium	<2.0		µg/L	0	WA
		Silica	4,500		µg/L	0	WA
		Silver	<2.0		µg/L	0	WA
		Sodium	3,850	V	µg/L	0	WA
		Sulfate	9,740		µg/L	0	WA
		Total dissolved solids	6,000		µg/L	0	WA
		Total organic carbon	<1,000		µg/L	0	WA
		Total organic halogens	<5.0		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)	<0.58		µg/L	0	WA
		Gross alpha	2.6E+00 ± 1.3E+00		pCi/L	0	TM
		Nonvolatile beta	1.5E+00 ± 1.5E+00		pCi/L	0	TM
		Radium-226	8.0E-01 ± 3.4E-01		pCi/L	0	TM
		Radium-228	6.0E-01 ± 1.1E+00		pCi/L	0	TM
		Tritium	<4.9E-01		pCi/mL	0	TM
	■	Tritium	4.5E+01 ± 3.5E+00		pCi/mL	2	TM

WELL FSS 4D

SRS Coord.	Lat/Longitude	Screen Zone Elevation	Top of Casing	Casing	Pump	Formation
N75537.8 E52876.1	33.279114 °N 81.674297 °W	222.6-202.6 ft msl	291.8 ft msl	4" PVC	S	Water table

FIELD MEASUREMENTS

Sample date: 02/19/93
Depth to water: 70.97 ft (21.63 m) below TOC
Water elevation: 220.83 ft (67.31 m) msl
Sp. conductance: 47 µS/cm
Water evacuated before sampling: 14 gal
The well went dry during purging.

Time: 15:21
pH: 5.1
Alkalinity: 0 mg/L
Water temperature: 17.3 °C
Volumes purged: 1.2 well volumes

LABORATORY ANALYSES

H	D	Analyte	Result	Mod	Unit	Flag	Lab
•		pH	5.1	J	pH	0	WA
•		pH	5.1	J	pH	0	WA
•		Specific conductance	48	J	µS/cm	0	WA
•		Specific conductance	48	J	µS/cm	0	WA
		Aluminum	231		µg/L	2	WA
		Arsenic	<2.0		µg/L	0	WA
		Barium	7.8		µg/L	0	WA
		Cadmium	<2.0		µg/L	0	WA
		Calcium	879		µg/L	0	WA
		Chloride	4,780		µg/L	0	WA
		Chromium	<4.0		µg/L	0	WA

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

WELL FSS 4D collected on 02/19/93, laboratory analyses (cont.)

H	D	Analyte	Result	Mod	Unit	Flag	Lab
		Copper	<4.0		µg/L	0	WA
		2,4-Dichlorophenoxyacetic acid	<1.1		µg/L	0	WA
		Endrin	<0.12		µg/L	0	WA
		Endrin	<0.23		µg/L	0	WA
		Fluoride	<100		µg/L	0	WA
		Iron	534		µg/L	2	WA
		Lead	4.5	J3	µg/L	0	WA
		Lindane	<0.058		µg/L	0	WA
		Lindane	<0.11		µg/L	0	WA
		Magnesium	462		µg/L	0	WA
		Manganese	15		µg/L	0	WA
		Mercury	<0.20		µg/L	0	WA
		Mercury	<0.20		µg/L	0	WA
		Methoxychlor	<1.1		µg/L	0	WA
		Methoxychlor	<1.1		µg/L	0	WA
		Methoxychlor	<0.58		µg/L	0	WA
		Nickel	<4.0		µg/L	0	WA
		Nitrate as nitrogen	1,880		µg/L	0	WA
•		Nitrite as nitrogen	<10	J	µg/L	0	WA
		Phenols	7.9		µg/L	0	WA
		Phenols	6.3	J3	µg/L	0	WA
		Potassium	<500		µg/L	0	WA
		Selenium	<2.0		µg/L	0	WA
		Silica	5,120		µg/L	0	WA
		Silver	<2.0		µg/L	0	WA
		Sodium	2,790	V	µg/L	0	WA
		Sulfate	<1,000		µg/L	0	WA
		Sulfate	<1,000		µg/L	0	WA
		Total dissolved solids	30,000		µg/L	0	WA
		Total organic carbon	<1,000		µg/L	0	WA
		Total organic halogens	<5.0		µg/L	0	WA
		Total phosphates (as P)	129		µg/L	0	WA
		Total phosphates (as P)	145		µg/L	0	WA
		Toxaphene	<1.2		µg/L	0	WA
		Toxaphene	<2.3		µg/L	0	WA
		Toxaphene	<2.3		µg/L	0	WA
		2,4,5-TP (Silvex)	<0.56		µg/L	0	WA
		Gross alpha	1.7E+00 ± 1.0E+00		pCi/L	0	TM
		Nonvolatile beta	1.6E+00 ± 1.5E+00		pCi/L	0	TM
		Radium-226	<2.3E-01		pCi/L	0	TM
		Radium-228	9.0E-01 ± 9.0E-01		pCi/L	0	TM
		Tritium	<5.0E-01		pCi/mL	0	TM
		Tritium	5.7E+00 ± 7.3E-01		pCi/mL	0	TM

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

Table 6. Groundwater Monitoring Results for Individual Wells at the H-Area Sewage Sludge Application Site

WELL HSS 1D

SRS Coord.	Lat/Longitude	Screen Zone Elevation	Top of Casing	Casing	Pump	Formation
N67610.3 E64675.6	33.280828 °N 81.627829 °W	256.5-236.5 ft msl	310.1 ft msl	4" PVC	S	Water table

FIELD MEASUREMENTS

Sample date: 02/19/93
Depth to water: 35.82 ft (10.92 m) below TOC
Water elevation: 274.28 ft (83.60 m) msl
Sp. conductance: 35 µS/cm
Water evacuated before sampling: 23 gal
The well went dry during purging.

Time: 10:10
pH: 6.2
Alkalinity: 5 mg/L
Water temperature: 16.8 °C
Volumes purged: 0.9 well volumes

LABORATORY ANALYSES

H	D	Analyte	Result	Mod	Unit	Flag	Lab
●		pH	5.8	J	pH	0	WA
●		Specific conductance	33	J	µS/cm	0	WA
		Aluminum	44		µg/L	1	WA
		Arsenic	<2.0		µg/L	0	WA
		Barium	47		µg/L	0	WA
		Cadmium	<2.0		µg/L	0	WA
		Calcium	2,630		µg/L	0	WA
		Chloride	1,750		µg/L	0	WA
		Chromium	<4.0		µg/L	0	WA
		Copper	33		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
		Fluoride	<100		µg/L	0	WA
		Iron	62		µg/L	0	WA
		Lead	4.7	J3	µg/L	0	WA
		Lindane	<0.056		µg/L	0	WA
		Magnesium	502		µg/L	0	WA
		Manganese	5.4		µg/L	0	WA
		Mercury	<0.20		µg/L	0	WA
		Methoxychlor	<0.56		µg/L	0	WA
		Nickel	6.2	J3	µg/L	0	WA
		Nitrate as nitrogen	774		µg/L	0	WA
		Nitrite as nitrogen	21	J	µg/L	0	WA
●		Phenols	<5.0		µg/L	0	WA
		Potassium	1,510		µg/L	0	WA
		Selenium	<2.0		µg/L	0	WA
		Silica	10,100		µg/L	0	WA
		Silver	<2.0		µg/L	0	WA
		Sodium	1,700	V	µg/L	0	WA
		Sulfate	<1,000		µg/L	0	WA
		Total dissolved solids	24,000		µg/L	0	WA
		Total organic carbon	<1,000		µg/L	0	WA
		Total organic halogens	<5.0		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)	<1.1		µg/L	0	WA
		2,4,5-TP (Silvex)	<0.56		µg/L	0	WA

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

WELL HSS 1D collected on 02/19/93, laboratory analyses (cont.)

H	D	Analyte	Result	Mod	Unit	Flag	Lab
		Gross alpha	7.0E-01 ± 7.0E-01		pCi/L	0	TM
		Nonvolatile beta	2.4E+00 ± 1.6E+00		pCi/L	0	TM
		Radium-226	<2.9E-01		pCi/L	0	TM
		Radium-228	4.0E-01 ± 8.0E-01		pCi/L	0	TM
		Tritium	<5.0E-01		pCi/mL	0	TM

WELL HSS 2D

SRS Coord.	Lat/Longitude	Screen Zone Elevation	Top of Casing	Casing	Pump	Formation
N67355.9 E64785.9	33.280445 °N 81.627045 °W	254.5-234.5 ft msl	304.4 ft msl	4" PVC	S	Water table

FIELD MEASUREMENTS

Sample date: 02/19/93
Depth to water: 31.18 ft (9.50 m) below TOC
Water elevation: 273.22 ft (83.28 m) msl
Sp. conductance: 27 µS/cm
Water evacuated before sampling: 104 gal
Time: 10:43
pH: 5.5
Alkalinity: 1 mg/L
Water temperature: 18.0 °C
Volumes purged: 4.1 well volumes

LABORATORY ANALYSES

H	D	Analyte	Result	Mod	Unit	Flag	Lab
•		pH	5.6	J	pH	0	GE
•		pH	5.4	J	pH	0	GE
•		pH	5.2	J	pH	0	WA
•		pH	5.2	J	pH	0	WA
		Specific conductance	21		µS/cm	0	GE
		Specific conductance	29		µS/cm	0	GE
•		Specific conductance	25	J	µS/cm	0	WA
•		Specific conductance	27	J	µS/cm	0	WA
		Aluminum	28		µg/L	1	GE
		Aluminum	28		µg/L	1	GE
		Aluminum	20	J3	µg/L	0	WA
		Aluminum	23	J3	µg/L	0	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		µg/L	0	WA
		Barium	25		µg/L	0	GE
		Barium	26		µg/L	0	GE
		Barium	25		µg/L	0	WA
		Barium	26		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		µg/L	0	WA
		Calcium	740		µg/L	0	GE
		Calcium	704		µg/L	0	GE
		Calcium	787		µg/L	0	WA
		Calcium	948		µg/L	0	WA
		Chloride	2,400		µg/L	0	GE

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

WELL HSS 2D collected on 02/19/93, laboratory analyses (cont.)

H	D	Analyte	Result	Mod	Unit	Flag	Lab
		Chloride	2,260		µg/L	0	GE
		Chloride	2,050		µg/L	0	WA
		Chloride	2,070		µg/L	0	WA
		Chloride	<4.0		µg/L	0	GE
		Chromium	<4.0		µg/L	0	GE
		Chromium	<4.0		µg/L	0	WA
		Chromium	<4.0		µg/L	0	WA
		Chromium	<4.0		µg/L	0	GE
		Copper	<4.0		µg/L	0	GE
		Copper	<4.0		µg/L	0	WA
		Copper	<4.0		µg/L	0	WA
		Copper	<0.30		µg/L	0	GE
		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		µg/L	0	WA
		2,4-Dichlorophenoxyacetic acid	<0.0060		µg/L	0	GE
		Endrin	<0.0060		µg/L	0	GE
		Endrin	<0.11		µg/L	0	WA
		Endrin	<0.11		µg/L	0	WA
		Endrin	<100		µg/L	0	GE
		Fluoride	<100		µg/L	0	GE
		Fluoride	<100		µg/L	0	WA
		Fluoride	<100		µg/L	0	WA
		Fluoride	4.3		µg/L	0	GE
		Iron	<4.0		µg/L	0	GE
		Iron	16		µg/L	0	WA
		Iron	36		µg/L	0	WA
		Iron	<3.0		µg/L	0	GE
		Lead	<3.0		µg/L	0	GE
		Lead	<3.0		µg/L	0	WA
		Lead	<3.0		µg/L	0	WA
		Lead	<0.0050		µg/L	0	GE
		Lindane	<0.0050		µg/L	0	GE
		Lindane	<0.055		µg/L	0	WA
		Lindane	<0.058		µg/L	0	WA
		Lindane	495		µg/L	0	GE
		Magnesium	505		µg/L	0	GE
		Magnesium	480		µg/L	0	WA
		Magnesium	501		µg/L	0	WA
		Magnesium	7.4		µg/L	0	GE
		Manganese	7.5		µg/L	0	GE
		Manganese	8.3		µg/L	0	WA
		Manganese	8.3		µg/L	0	WA
		Manganese	<0.20		µg/L	0	GE
		Mercury	<0.20		µg/L	0	GE
		Mercury	<0.20		µg/L	0	GE
		Mercury	<0.20		µg/L	0	WA
		Mercury	<0.20		µg/L	0	WA
		Mercury	<0.50		µg/L	0	GE
		Methoxychlor	<0.50		µg/L	0	GE
		Methoxychlor	<0.55		µg/L	0	WA
		Methoxychlor	<0.58		µg/L	0	WA
		Methoxychlor	<4.0		µg/L	0	GE
		Nickel	<4.0		µg/L	0	GE
		Nickel	4.3	J3	µg/L	0	WA
		Nickel					

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

WELL HSS 2D collected on 02/19/93, laboratory analyses (cont.)

H	D	Analyte	Result	Mod	Unit	Flag	Lab
		Nickel	<4.0		µg/L	0	WA
		Nitrate as nitrogen	1,040		µg/L	0	WA
		Nitrate as nitrogen	998		µg/L	0	WA
		Nitrate-nitrite as nitrogen	1,080		µg/L	0	GE
		Nitrate-nitrite as nitrogen	1,100		µg/L	0	GE
●		Nitrite as nitrogen	<10	J	µg/L	0	GE
●		Nitrite as nitrogen	<10	J	µg/L	0	GE
●		Nitrite as nitrogen	<10	J	µg/L	0	WA
●		Nitrite as nitrogen	<10	J	µg/L	0	WA
		Phenols	<5.0		µg/L	0	GE
		Phenols	<5.0		µg/L	0	GE
		Phenols	<5.0		µg/L	0	WA
		Phenols	<5.0		µg/L	0	WA
		Potassium	1,280		µg/L	0	GE
		Potassium	1,270		µg/L	0	GE
		Potassium	1,340		µg/L	0	WA
		Potassium	1,380		µg/L	0	WA
		Selenium	<2.0	J1	µg/L	0	GE
		Selenium	<2.0	J1	µg/L	0	GE
		Selenium	<2.0		µg/L	0	WA
		Selenium	<2.0		µg/L	0	WA
		Silica	21,700		µg/L	0	GE
		Silica	21,400		µg/L	0	GE
		Silica	18,700		µg/L	0	WA
		Silica	18,900		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		µg/L	0	WA
		Sodium	1,950		µg/L	0	GE
		Sodium	1,940		µg/L	0	GE
		Sodium	2,000	V	µg/L	0	WA
		Sodium	2,010	V	µg/L	0	WA
		Sulfate	<1,000		µg/L	0	GE
		Sulfate	<1,000		µg/L	0	GE
		Sulfate	<1,000		µg/L	0	WA
		Sulfate	<1,000		µg/L	0	WA
		Total dissolved solids	38,000	V	µg/L	0	GE
		Total dissolved solids	39,000	V	µg/L	0	GE
		Total dissolved solids	28,000		µg/L	0	WA
		Total dissolved solids	32,000		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	1,240		µg/L	0	WA
		Total organic carbon	<1,000		µg/L	0	WA
●		Total organic halogens	<5.0	J6	µg/L	0	GE
●		Total organic halogens	<5.0	J6	µg/L	0	GE
		Total organic halogens	<5.0		µg/L	0	WA
		Total organic halogens	<5.0		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		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

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

WELL HSS 2D collected on 02/19/93, laboratory analyses (cont.)

H	D	Analyte	Result	Mod	Unit	Flag	Lab
		Toxaphene	<1.1		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)	<0.090		µg/L	0	GE
		2,4,5-TP (Silvex)	<0.55		µg/L	0	WA
		2,4,5-TP (Silvex)	<0.56		µg/L	0	WA
		Gross alpha	<2.0E+00		pCi/L	0	GE
		Gross alpha	<2.0E+00		pCi/L	0	GE
		Gross alpha	1.1E+00 ± 8.0E-01		pCi/L	0	TM
		Gross alpha	<6.0E-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	2.1E+00 ± 1.3E+00		pCi/L	0	GE
		Nonvolatile beta	2.5E+00 ± 1.6E+00		pCi/L	0	TM
		Nonvolatile beta	<7.0E-01		pCi/L	0	TM
		Nonvolatile beta	<7.0E-01		pCi/L	0	TM
		Radium-226	<2.5E-01		pCi/L	0	TM
		Radium-226	<3.0E-01		pCi/L	0	TM
		Radium-226	<2.8E-01		pCi/L	0	TM
		Radium-228	6.0E-01 ± 1.0E+00		pCi/L	0	TM
		Radium-228	2.9E+00 ± 1.4E+00		pCi/L	0	TM
		Radium-228	7.0E-01 ± 1.0E+00		pCi/L	0	TM
		Radium, total alpha-emitting	1.7E+00 ± 9.0E-01		pCi/L	0	GE
		Radium, total alpha-emitting	1.0E+00 ± 7.0E-01		pCi/L	0	GE
		Tritium	1.9E+00 ± 3.0E-01		pCi/mL	0	GE
		Tritium	1.6E+00 ± 3.0E-01		pCi/mL	0	GE
		Tritium	2.0E+00 ± 3.0E-01		pCi/mL	0	GE
		Tritium	<5.0E-01		pCi/mL	0	TM
		Tritium	2.5E+00 ± 3.4E-01		pCi/mL	0	TM
		Tritium	2.8E+00 ± 2.7E-01		pCi/mL	0	TM
		Tritium	3.1E+00 ± 2.6E-01		pCi/mL	0	TM

WELL HSS 3D

SRS Coord.	Lat/Longitude	Screen Zone Elevation	Top of Casing	Casing	Pump	Formation
N68257.5 E64709.5	33.282315 °N 81.628996 °W	282.6-262.6 ft msl	309.8 ft msl	4" PVC	S	Water table

FIELD MEASUREMENTS

Sample date: 02/19/93
Depth to water: 22.89 ft (6.98 m) below TOC
Water elevation: 286.91 ft (87.45 m) msl
Sp. conductance: 26 µS/cm
Water evacuated before sampling: 22 gal
The well went dry during purging.

Time: 9:53
pH: 4.8
Alkalinity: 0 mg/L
Water temperature: 17.3 °C
Volumes purged: 1.4 well volumes

LABORATORY ANALYSES

H	D	Analyte	Result	Mod	Unit	Flag	Lab
•		pH	4.7	J	pH	0	WA
•		Specific conductance	25	J	µS/cm	0	WA
		Aluminum	162		µg/L	2	WA

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

WELL HSS 3D collected on 02/19/93, laboratory analyses (cont.)

H	D	Analyte	Result	Mod	Unit	Flag	Lab
		Arsenic	<2.0		µg/L	0	WA
		Barium	5.8		µg/L	0	WA
		Cadmium	<2.0		µg/L	0	WA
		Calcium	166		µg/L	0	WA
		Chloride	3,540		µg/L	0	WA
		Chromium	<4.0		µg/L	0	WA
		Copper	9.6		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	613		µg/L	2	WA
		Iron	950		µg/L	2	WA
		Lead	12		µg/L	1	WA
		Lindane	<0.056		µg/L	0	WA
		Magnesium	149		µg/L	0	WA
		Manganese	4.5		µg/L	0	WA
		Mercury	<0.20		µg/L	0	WA
		Methoxychlor	<0.56		µg/L	0	WA
		Nickel	<4.0		µg/L	0	WA
		Nitrate as nitrogen	715		µg/L	0	WA
•		Nitrite as nitrogen	<10	J	µg/L	0	WA
		Phenols	<5.0		µg/L	0	WA
		Potassium	<500		µg/L	0	WA
		Selenium	<2.0		µg/L	0	WA
		Silica	3,150		µg/L	0	WA
		Silver	<2.0		µg/L	0	WA
		Sodium	1,820	V	µg/L	0	WA
		Sulfate	<1,000		µg/L	0	WA
		Total dissolved solids	14,000		µg/L	0	WA
		Total organic carbon	<1,000		µg/L	0	WA
		Total organic halogens	<5.0		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)	<0.57		µg/L	0	WA
		Gross alpha	1.0E+00 ± 8.0E-01		pCi/L	0	TM
		Nonvolatile beta	3.3E+00 ± 1.7E+00		pCi/L	0	TM
		Radium-226	2.4E-01 ± 1.8E-01		pCi/L	0	TM
		Radium-228	1.5E+00 ± 9.0E-01		pCi/L	0	TM
		Tritium	<5.2E-01		pCi/mL	0	TM
		Tritium	5.6E+00 ± 6.8E-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.

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