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Z-AREA SALTSTONE DISPOSAL FACILITY GROUNDWATER MONITORING REPORT (U)

1996 ANNUAL REPORT

Publication Date: December 1996

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Westinghouse Savannah River Company
Savannah River Site
Aiken, SC 29808

MASTER

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

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Key Words

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low-level radioactive waste
ZBG wells**

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

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Abstract

Samples from the ZBG wells at the Z-Area Saltstone Disposal Facility are analyzed for constituents required by South Carolina Department of Health and Environmental Control (SCDHEC) Industrial Solid Waste Permit #025500-1603 (formerly IWP-217).

During second quarter 1996, lead was reported above the SCDHEC-proposed groundwater monitoring standard in one well. No other constituents were reported above SCDHEC-proposed groundwater monitoring standards or final Primary Drinking Water Standards during first, second, or third quarters 1996. Antimony was detected above SRS flagging criteria during third quarter 1996.

In the past, tritium has been detected sporadically in the ZBG wells at levels similar to those detected before Z Area began radioactive operations.

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Executive Summary

The three monitoring wells at the Z-Area Saltstone Disposal Facility, ZBG 1, 1A, and 2, are sampled as part of the Savannah River Site (SRS) Groundwater Monitoring Program and to comply with conditions of the facility's Industrial Solid Waste Permit #025500-1603 (formerly IWP-217), issued by the South Carolina Department of Health and Environmental Control (SCDHEC). During first, second, and third quarters 1996, samples from wells ZBG 1 and 2 were analyzed for selected inorganic constituents, volatile organic compounds, radionuclides, and other constituents. Well ZBG 1A was dry and could not be sampled. No wells were scheduled for sampling fourth quarter 1996.

During second quarter 1996, lead exceeded the SCDHEC-proposed groundwater monitoring standard in well ZBG 1. No other constituent exceeded the SCDHEC-proposed groundwater monitoring standards or final Primary Drinking Water Standards (PDWS) (see Appendix A of this report for these standards) during 1996.

Antimony exceeded the Flag 1 criterion in well ZBG 2 during third quarter 1996. The result for antimony (4.6 µg/L) was qualified as an estimated quantity; it was above the sample-specific estimated quantitation limit but below the method detection limit. This value does not exceed the SCDHEC-proposed standard of 50 µg/L.

Tritium did not exceed standards or flagging criteria in either ZBG well sampled during 1996. Tritium has not been detected above the Flag 1 criterion since 1994, when it was slightly elevated in downgradient well ZBG 2 during first, second, and fourth quarters. The tritium levels detected previously are similar to levels detected before Z Area began radioactive operations on June 12, 1990. The source of the tritium in the Z-Area wells, therefore, is not from activities at the waste disposal facility.

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Introduction

The Z-Area Saltstone Disposal Facility is located in the Separations Area, north of H and S Areas, at the Savannah River Site (SRS) (Figures 1 and 2, Appendix C). The facility permanently disposes of low-level radioactive waste in accordance with South Carolina Department of Health and Environmental Control (SCDHEC) Industrial Solid Waste Permit #025500-1603 (formerly IWP-217). The facility blends low-level radioactive salt solution with cement, slag, and flyash to form a nonhazardous cementitious waste that is pumped to aboveground disposal vaults. Z Area began these operations in June 1990.

The site is monitored by three groundwater monitoring wells (Figure 3, Appendix C). Wells ZBG 1 and 2 monitor the water table, while well ZBG 1A monitors a zone where perched water has been observed in the past. Based on piezometric data for Z Area obtained prior to application for the permit (DOE, 1989), wells ZBG 1 and 1A are located upgradient of the disposal vaults, and well ZBG 2 is located downgradient of the vaults (Figure 3, Appendix C).

Discussion

Groundwater Monitoring Data

The Environmental Protection Department/Environmental Monitoring Section (EPD/EMS) collects groundwater samples from wells at the Z-Area Saltstone Disposal Facility as part of the SRS Groundwater Monitoring Program and to satisfy the requirements of the facility's waste permit. The 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 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 generated to be considered the result of a single sampling event. On the second visit within 24 hours, samples are taken without further purging or stability measurements; thus, these samples may not be representative of groundwater quality.

Wells ZBG 1 and 2 have single-speed centrifugal downhole pumps, and well ZBG 1A is sampled with an open-bucket bailer.

During first, second, and third quarters of 1996, groundwater samples were analyzed for constituents required by SCDHEC Industrial Solid Waste Permit #025500-1603 (formerly IWP-217), including inorganic constituents, selected radionuclides, volatile organic compounds, and other constituents.

Groundwater monitoring results were compared to SCDHEC-proposed groundwater monitoring standards (Table A-1 of Appendix A). If a constituent does not have a SCDHEC-proposed groundwater monitoring standard, final Primary Drinking Water Standards (PDWS) or drinking water screening levels established by the U.S. Environmental Protection Agency (EPA) (Table A-2 of Appendix A) were used as standards for comparison. Radium-226, radium-228, and pH do not have SCDHEC-proposed standards or final PDWS.

Monitoring results also were compared to SRS flagging criteria (Appendix B). 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 SCDHEC-proposed standards, final PDWS, screening levels, or Flag 2 criteria are described as *exceeding* standards or as *elevated*, and constituent levels that equal or exceed Flag 1 criteria (but not Flag 2 levels) are described as *exceeding* Flag 1 or as *slightly elevated*.

The standards for individual analytes given in Appendix A may not always match the SRS flagging criteria in Appendix B. The Appendix A standards 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.

Analytical Results Exceeding Standards

Lead exceeded the SCDHEC-proposed groundwater monitoring standard in well ZBG 1 during second quarter 1996. No other constituents exceeded SCDHEC-proposed groundwater monitoring standards or final PDWS (see Appendix A) at the Z-Area Saltstone Disposal Facility during first, second, or third quarter 1996 (Table D-1, Appendix D). The wells were not sampled during fourth quarter 1996.

Table D-2 (Appendix D) shows the constituents that exceeded the SRS Flag 1 or 2 criteria during 1996 in the ZBG wells. During third quarter, antimony was detected above Flag 1 in well ZBG 2.

Table D-3 (Appendix D) shows all the results for individual wells. Well ZBG 1A was dry and could not be sampled. Those results that received modifiers (which help identify laboratory accuracy and precision), exceeded the SCDHEC-proposed standards or the final PDWS (where there are no SCDHEC-proposed standards), or exceeded the EPA-approved holding times during third quarter 1996 are noted in this table. Table D-3 (Appendix D) also lists the number of well volumes purged from each ZBG well during 1996.

Statistical Analysis

The CERCLA, Groundwater and Permitting Section of the Environmental Protection Department of the Westinghouse Savannah River Company provided the calculations and the text for this section of the report.

This section discusses the comparison of results from downgradient well ZBG 2 to background levels. In most cases, ZBG 1 data were used to estimate background.

Arsenic - Historical data from ZBG 1 can be used to calculate a Poisson Tolerance Limit of 4 µg/L. The Poisson method is used because the data are over 90% nondetect. The results are under this limit. It should also be noted that the results are only estimates (modifier J).

Antimony - The result is an estimate (modifier J). It is below the quantitation limit and is therefore not reliable. Since antimony has never been detected here before, EPD considers this a spurious result.

Barium - A tolerance limit of 10.4 µg/L was calculated using historical results from ZBG 1. Results from the downgradient well fall below that value.

Cadmium - CD has only been detected in recent quarters since the detection limit was dropped. There are not enough data with the new detection limit to develop statistical limits. It should also be noted that the reported value from ZBG 2 is an estimate (modifier J).

Chromium - Same as above.

Lead - ZBG 2 results are well below the tolerance limit of 9.8 µg/L calculated using ZBG 1 data.

Mercury - not detected

Nitrate-Nitrite - ZBG 2 results are well below the tolerance limit of 1886.9 µg/L calculated using ZBG 1 data.

Selenium - not detected

Silver - not detected

Benzene - not detected

Toluene - not detected

Total Rad. - Data have multiple detection limits and are not normally distributed. Only a nonparametric tolerance limit of 4.1 pCi/L can be used. The reported results from ZBG 2 are well below this.

Gross Alpha - Results are below nonparametric tolerance limit of 6 pCi/L.

Gross Beta - Results are below nonparametric tolerance limit of 3.4 pCi/L.

Specific Conductance - ZBG 2 results are below parametric tolerance limit of 32.18 µS/cm.

pH - A tolerance range (5.8 - 4.7) was constructed using ZBG 2 data collected prior to startup of the facility. The 3rd quarter ZBG 2 result (4.2) falls below that envelope. It is the opinion of EPD that pH is greatly influenced by well construction and well performance, and is not a reliable indicator parameter. At this time, EPD does not feel that this pH reading is significant.

Upgradient vs. Downgradient Results

ZBG 1 and 1A are the designated upgradient wells at the Z-Area Saltstone Disposal Facility. Lead exceeded the SCDHEC-proposed groundwater monitoring standard during second quarter 1996 in well ZBG 1. No other constituents exceeded the SCDHEC-proposed standards or final PDWS (see Appendix A) in upgradient well ZBG 1 or downgradient well ZBG 2 during first, second, or third quarters 1996. Well ZBG 1A was dry and could not be sampled.

One constituent exceeded SRS flagging criteria (see Appendix B) during 1996. Downgradient well ZBG 2 contained antimony above its Flag 1 criterion during third quarter 1996.

Conclusions

Lead exceeded the SCDHEC-proposed groundwater monitoring standard during second quarter 1996 in well ZBG 1. No other constituents exceeded the SCDHEC-proposed groundwater monitoring standards or final PDWS at the Z-Area Saltstone Disposal Facility during first, second, or third quarter 1996. The wells were not scheduled for sampling during fourth quarter 1996.

One constituent exceeded SRS flagging criteria during 1996. Antimony exceeded its Flag 1 criterion in well ZBG 2 during third quarter 1996. The level of antimony detected (4.6 $\mu\text{g/L}$) was between the sample-specific estimated quantitation limit and the method detection limit, and the result was qualified as an estimated quantity. The result does not exceed the SCDHEC-proposed standard of 50 $\mu\text{g/L}$.

Tritium, which has been slightly elevated in the past, did not exceed standards in any ZBG well sampled during first, second, or third quarter 1996. The tritium levels detected previously are similar to levels detected before Z Area began radioactive operations on June 12, 1990. The source of the tritium in Z Area, therefore, is not from activities at the waste disposal facility.

Errata

In tables with four quarters of data, some values for earlier quarters may differ from values for those same quarters presented in earlier reports because some reanalyses may have been performed by the laboratories after the reports were printed.

Fourth quarter 1994 through second quarter 1996:

- No errata have been reported.

Appendix A

Standards

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Table A-1. South Carolina Department of Health and Environmental Control Proposed Groundwater Monitoring Standards (SCDHEC, 1986)

Analyte	Standard	Unit
Antimony	50	µg/L
Arsenic	50	µg/L
Barium	1,000	µg/L
Cadmium	10	µg/L
Chromium	50	µg/L
Lead	10	µg/L
Mercury	2	µg/L
Nitrate as nitrogen	10,000	µg/L
Nitrite as nitrogen	1,000	µg/L
Selenium	10	µg/L
Silver	50	µg/L

Note: Benzene and toluene concentrations are not to exceed concentrations or amounts that interfere with use, actual or intended, as determined by SCDHEC. Proposed standards for radionuclides at SRS are under jurisdictional assessment; therefore, no radionuclide standards are proposed for groundwater quality monitoring for the current permit application.

Table A-2. Final Primary Drinking Water Standards

Analyte	Level	Unit	Status	Source
Alachlor	2	µg/L	Final	EPA, 1995
Aldicarb	3	µg/L	Final	EPA, 1995
Aldicarb sulfone	2	µg/L	Final	EPA, 1995
Aldicarb sulfoxide	4	µg/L	Final	EPA, 1995
Antimony	6	µg/L	Final	EPA, 1995
Arsenic	50	µg/L	Final	EPA, 1995
Asbestos	7,000,000	Fibers/L	Final	EPA, 1995
Atrazine	3	µg/L	Final	EPA, 1995
Barium	2,000	µg/L	Final	EPA, 1995
Benzene	5	µg/L	Final	EPA, 1995
Benzo[a]pyrene	0.2	µg/L	Final	EPA, 1995
Beryllium	4	µg/L	Final	EPA, 1995
Bis(2-ethylhexyl) phthalate	6	µg/L	Final	EPA, 1995
Bromodichloromethane	100	µg/L	Final	EPA, 1995
Bromoform	100	µg/L	Final	EPA, 1995
2-sec-Butyl-4,6-dinitrophenol	7	µg/L	Final	EPA, 1995
Cadmium	5	µg/L	Final	EPA, 1995
Carbofuran	40	µg/L	Final	EPA, 1995
Carbon tetrachloride	5	µg/L	Final	EPA, 1995
Chlordane	2	µg/L	Final	EPA, 1995
Chlorobenzene	100	µg/L	Final	EPA, 1995
Chloroethene (Vinyl chloride)	2	µg/L	Final	EPA, 1995
Chloroform	100	µg/L	Final	EPA, 1995
Chromium	100	µg/L	Final	EPA, 1995
Copper	1,000	µg/L	Final	SCDHEC, 1981
Cyanide	200	µg/L	Final	EPA, 1995
Dalapon	200	µg/L	Final	EPA, 1995
Dibromochloromethane	100	µg/L	Final	EPA, 1995
1,2-Dibromo-3-chloropropane	0.2	µg/L	Final	EPA, 1995
1,2-Dibromoethane	0.05	µg/L	Final	EPA, 1995
1,2-Dichlorobenzene	600	µg/L	Final	EPA, 1995
1,4-Dichlorobenzene	75	µg/L	Final	EPA, 1995
1,2-Dichloroethane	5	µg/L	Final	EPA, 1995
1,1-Dichloroethylene	7	µg/L	Final	EPA, 1995
cis-1,2-Dichloroethylene	70	µg/L	Final	EPA, 1995
trans-1,2-Dichloroethylene	100	µg/L	Final	EPA, 1995
Dichloromethane (Methylene chloride)	5	µg/L	Final	EPA, 1995
2,4-Dichlorophenoxyacetic acid	70	µg/L	Final	EPA, 1995
1,2-Dichloropropane	5	µg/L	Final	EPA, 1995
Di(2-ethylhexyl) adipate	400	µg/L	Final	EPA, 1995
Diquat dibromide	20	µg/L	Final	EPA, 1995
Endothall	100	µg/L	Final	EPA, 1995
Endrin	2	µg/L	Final	EPA, 1995
Ethylbenzene	700	µg/L	Final	EPA, 1995
Fluoride	4,000	µg/L	Final	EPA, 1995
Glyphosate	700	µg/L	Final	EPA, 1995
Gross alpha ^a	1.5E+01	pCi/L	Final	EPA, 1995

Analyte	Level	Unit	Status	Source
Heptachlor	0.4	µg/L	Final	EPA, 1995
Heptachlor epoxide	0.2	µg/L	Final	EPA, 1995
Hexachlorobenzene	1	µg/L	Final	EPA, 1995
Hexachlorocyclopentadiene	50	µg/L	Final	EPA, 1995
Lead	50	µg/L	Final	SCDHEC, 1981
Lindane	0.2	µg/L	Final	EPA, 1995
Mercury	2	µg/L	Final	EPA, 1995
Methoxychlor	40	µg/L	Final	EPA, 1995
Nickel	100	µg/L	Final	EPA, 1995
Nitrate as nitrogen	10,000	µg/L	Final	EPA, 1995
Nitrate-nitrite as nitrogen	10,000	µg/L	Final	EPA, 1995
Nitrite as nitrogen	1,000	µg/L	Final	EPA, 1995
Nonvolatile beta	5E+01	pCi/L	Interim Final	EPA, 1977
Oxamyl	200	µg/L	Final	EPA, 1995
PCB 1016	0.5	µg/L	Final	EPA, 1995
PCB 1221	0.5	µg/L	Final	EPA, 1995
PCB 1232	0.5	µg/L	Final	EPA, 1995
PCB 1242	0.5	µg/L	Final	EPA, 1995
PCB 1248	0.5	µg/L	Final	EPA, 1995
PCB 1254	0.5	µg/L	Final	EPA, 1995
PCB 1260	0.5	µg/L	Final	EPA, 1995
PCB 1262	0.5	µg/L	Final	EPA, 1995
Pentachlorophenol	1	µg/L	Final	EPA, 1995
Picloram	500	µg/L	Final	EPA, 1995
Selenium	50	µg/L	Final	EPA, 1995
Simazine	4	µg/L	Final	EPA, 1995
Strontium-89/90 ^b	8E+00	pCi/L	Final	EPA, 1995
Strontium-90	8E+00	pCi/L	Final	EPA, 1995
Styrene	100	µg/L	Final	EPA, 1995
2,3,7,8-TCDD	0.014	µg/L	Final	EPA, 1995
Tetrachloroethylene	5	µg/L	Final	EPA, 1995
Thallium	2	µg/L	Final	EPA, 1995
Toluene	1,000	µg/L	Final	EPA, 1995
Total coliform	0	N/A	Final	EPA, 1995
Toxaphene	3	µg/L	Final	EPA, 1995
2,4,5-TP (Silvex)	50	µg/L	Final	EPA, 1995
1,2,4-Trichlorobenzene	70	µg/L	Final	EPA, 1995
1,1,1-Trichloroethane	200	µg/L	Final	EPA, 1995
1,1,2-Trichloroethane	5	µg/L	Final	EPA, 1995
Trichloroethylene	5	µg/L	Final	EPA, 1995
Tritium	2E+01	pCi/mL	Final	EPA, 1995
Xylenes	10,000	µg/L	Final	EPA, 1995

^a The standard given is for gross alpha including radium-226 but excluding radon and uranium.

^b For double radionuclide analyses where each separate radionuclide has its own standard, the more stringent standard is used.

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Appendix B

Flagging Criteria

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Flagging Criteria

Beginning first quarter 1992, flagging criteria were established for all constituents analyzed as part of the EPD/EMS Groundwater Monitoring Program. Only the flagging criteria for environmental screening analyses are used to trigger scheduling for designated wells in the environmental screening program, while all flagging criteria in Table B-1 are used to flag constituents in the analytical results tables.

The following rules are used in determining flagging criteria and scheduling sampling:

- **Flag 0:** Analysis for a constituent below Flag 1 is classified as Flag 0. Constituents classified as Flag 0 in each well series will be scheduled for analyses only by custodian request or as part of the triennial environmental screening program for wells designated as environmental screening wells.
- **Flag 1:** The Flag 1 criterion for a constituent equals half of the EPA primary drinking water standard (PDWS), the EPA proposed PDWS, or the EPA secondary drinking water standard (SDWS) for that constituent. If a constituent does not have an EPA drinking water standard, the Flag 1 criterion equals 5 times a recently published 90th percentile detection limit obtained by one of the primary laboratories. If a constituent exceeds Flag 1 in a monitoring well series, environmental screening wells in that series are sampled and analyzed for that constituent once a year. If a constituent falls below Flag 1 for three consecutive sampling episodes, the well's flag is reduced from Flag 1 status to Flag 0 status and follows the rules for Flag 0.
- **Flag 2:** The Flag 2 criterion for a constituent equals the EPA PDWS, the EPA proposed PDWS, or the EPA SDWS for that constituent. If a constituent does not have a drinking water standard, the Flag 2 criterion equals 10 times a recently published 90th percentile detection limit obtained by one of the primary laboratories. If a constituent exceeds Flag 2 in a monitoring well series, environmental screening wells in that series are sampled and analyzed for that constituent once a year. If a constituent falls below Flag 2 for three consecutive sampling episodes, the well's flag is reduced from Flag 2 status to Flag 1 or Flag 0 status and follows the rules for the lower flag.

The following constituents are exceptions to the flagging rules:

- Specific conductance and pH, which are indicator parameters, have flagging criteria but do not trigger the scheduling mechanism. No flags are set for alkalinity, 5-day biochemical oxygen demand, calcium, carbonate, chemical oxygen demand, magnesium, potassium, silica, sodium, total dissolved solids, total phosphates (as P), and total phosphorous because they are indicator parameters or major cations. Analyses for these constituents are conducted as part of the triennial environmental screening program or by special request.
- Aesthetic analyses such as color, odor, corrosivity, Eh, turbidity, and surfactants are not assigned flagging criteria but are analyzed by special request.
- Common laboratory contaminants and cleaners including phthalates, dichloromethane, ketones, and toluene are not assigned flagging criteria unless they have PDWS. These constituents are analyzed by special request.

Table B-1. Flagging Criteria

Analyte	Unit	Flag 1	Flag 2	Source
Acenaphthene	µg/L	5.1	10.2	EPA Method 8270
Acenaphthylene	µg/L	5.1	10.2	EPA Method 8270
Acetone	µg/L	500	1,000	EPA Method 8240 (Set by EPD/EMS)
Acetonitrile (Methyl cyanide)	µg/L	50	100	EPA Method 8240
Acetophenone	µg/L	85	170	EPA Method 8270

Analyte	Unit	Flag 1	Flag 2	Source
2-Acetylaminofluorene	µg/L	81	162	EPA Method 8270
Acrolein	µg/L	166.5	333	EPA Method 8240
Acrylonitrile	µg/L	250	500	EPA Method 8240
Actinium-228	µCi/mL	1.64E-06	3.27E-06	Proposed DWS (EPA, 1991a)
Alachlor	µg/L	1	2	Final DWS (CFR, 1995a)
Aldicarb	µg/L	1.5	3	Final DWS (CFR, 1995a)
Aldicarb sulfone	µg/L	1	2	Final DWS (CFR, 1995a)
Aldicarb sulfoxide	µg/L	2	4	Final DWS (CFR, 1995a)
Aldrin	µg/L	0.4	0.8	EPA Method 8080
Alkalinity (as CaCO ₃)		No flag	No flag	Set by EPD/EMS
Allyl chloride	µg/L	416.5	833	EPA Method 8240
Aluminum	µg/L	25	50	Secondary DWS (CFR, 1995b)
Aluminum, dissolved	µg/L	25	50	Secondary DWS (CFR, 1995b)
Aluminum, total recoverable	µg/L	25	50	Secondary DWS (CFR, 1995b)
Americium-241	µCi/mL	3.17E-09	6.34E-09	Proposed DWS (EPA, 1991a)
Americium-243	µCi/mL	3.19E-09	6.37E-09	Proposed DWS (EPA, 1991a)
4-Aminobiphenyl	µg/L	81	162	EPA Method 8270
Ammonia	µg/L	250	500	APHA Method 417B
Ammonia nitrogen	µg/L	500	1,000	EPA Method 350.1
Aniline	µg/L	81	162	EPA Method 8270
Anthracene	µg/L	5.1	10.2	EPA Method 8270
Antimony	µg/L	3	6	Final DWS (CFR, 1995a)
Antimony, dissolved	µg/L	3	6	Final DWS (CFR, 1995a)
Antimony, total recoverable	µg/L	3	6	Final DWS (CFR, 1995a)
Antimony-124	µCi/mL	3E-08	6E-08	Interim Final DWS (EPA, 1977)
Antimony-125	µCi/mL	1.5E-07	3E-07	Interim Final DWS (EPA, 1977)
Aramite	µg/L	81	162	EPA Method 8270
Arsenic	µg/L	25	50	Final DWS (CFR, 1995a)
Arsenic, dissolved	µg/L	25	50	Final DWS (CFR, 1995a)
Arsenic, total recoverable	µg/L	25	50	Final DWS (CFR, 1995a)
Asbestos	Fibers/L	3,500,000	7,000,000	Final DWS (CFR, 1995a)
Atrazine	µg/L	1.5	3	Final DWS (CFR, 1995a)
Azobenzene	µg/L	50	100	EPA Method 625
Barium	µg/L	1000	2,000	Final DWS (CFR, 1995a)
Barium, dissolved	µg/L	1000	2,000	Final DWS (CFR, 1995a)
Barium, total recoverable	µg/L	1000	2,000	Final DWS (CFR, 1995a)
Barium-133	µCi/mL	7.6E-07	1.52E-06	Proposed DWS (EPA, 1991a)
Barium-140 ^a	µCi/mL	4.5E-08	9E-08	Interim Final DWS (EPA, 1977)
Benzene	µg/L	2.5	5	Final DWS (CFR, 1995a)
alpha-Benzene hexachloride	µg/L	0.15	0.3	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	83.5	167	EPA Method 8270
Benzo[a]anthracene	µg/L	0.05	0.1	Proposed DWS (EPA, 1990)
Benzo[b]fluoranthene	µg/L	0.1	0.2	Proposed DWS (EPA, 1990)
Benzo[k]fluoranthene	µg/L	0.1	0.2	Proposed DWS (EPA, 1990)
Benzoic acid	µg/L	5	10	EPA Method 8270
Benzo[g,h,i]perylene	µg/L	5.1	10.2	EPA Method 8270
Benzo[a]pyrene	µg/L	0.1	0.2	Final DWS (CFR, 1995a)
1,4-Benzoquinone	µg/L	50	100	EPA Method 8270
Benzyl alcohol	µg/L	5	10	EPA Method 8270
Beryllium	µg/L	2	4	Final DWS (CFR, 1995a)

Analyte	Unit	Flag 1	Flag 2	Source
Beryllium, dissolved	µg/L	2	4	Final DWS (CFR, 1995a)
Beryllium, total recoverable	µg/L	2	4	Final DWS (CFR, 1995a)
Beryllium-7	µCi/mL	3E-06	6E-06	Interim Final DWS (EPA, 1977)
5-day Biochemical oxygen demand		No flag	No flag	Set by EPD/EMS
Bis(2-chloroethoxy) methane	µg/L	5.1	10.2	EPA Method 8270
Bis(2-chloroethyl) ether	µg/L	5.1	10.2	EPA Method 8270
Bis(2-chloroisopropyl) ether	µg/L	100	200	EPA Method 8270
Bis(chloromethyl) ether	µg/L	50	100	EPA Method 8270
Bis(2-ethylhexyl) phthalate	µg/L	3	6	Final DWS (CFR, 1995a)
Bismuth-214	µCi/mL	9.4E-06	1.89E-05	Proposed DWS (EPA, 1991a)
Boron	µg/L	2,500	5,000	EPA Method 6010
Boron, dissolved	µg/L	2,500	5,000	EPA Method 6010
Boron, total recoverable	µg/L	2,500	5,000	EPA Method 6010
Bromide	µg/L	5,000	10,000	EPA Method 300.0
Bromobenzene	µg/L	25	50	EPA Method 8260
Bromochloromethane	µg/L	5	10	EPA Method 8260
Bromodichloromethane	µg/L	50	100	Final DWS (CFR, 1995a)
Bromoform	µg/L	50	100	Final DWS (CFR, 1995a)
Bromomethane (Methyl bromide)	µg/L	10	20	EPA Method 8240
4-Bromophenyl phenyl ether	µg/L	5.1	10.2	EPA Method 8270
n-Butylbenzene	µg/L	5	10	EPA Method 8260
sec-Butylbenzene	µg/L	5	10	EPA Method 8260
tert-Butylbenzene	µg/L	5	10	EPA Method 8260
Butylbenzyl phthalate		No flag	No flag	Set by EPD/EMS
2-sec-Butyl-4,6-dinitrophenol	µg/L	3.5	7	Final DWS (CFR, 1995a)
Cadmium	µg/L	2.5	5	Final DWS (CFR, 1995a)
Cadmium, dissolved	µg/L	2.5	5	Final DWS (CFR, 1995a)
Cadmium, total recoverable	µg/L	2.5	5	Final DWS (CFR, 1995a)
Calcium		No flag	No flag	Set by EPD/EMS
Calcium, dissolved		No flag	No flag	Set by EPD/EMS
Calcium, total recoverable		No flag	No flag	Set by EPD/EMS
Carbofuran	µg/L	20	40	Final DWS (CFR, 1995a)
Carbon disulfide	µg/L	25	50	EPA Method 8240
Carbon tetrachloride	µg/L	2.5	5	Final DWS (CFR, 1995a)
Carbon-14	µCi/mL	1E-06	2E-06	Interim Final DWS (EPA, 1977)
Carbonate		No flag	No flag	Set by EPD/EMS
Cerium-141 ^a	µCi/mL	1.5E-07	3E-07	Interim Final DWS (EPA, 1977)
Cerium-144	µCi/mL	1.31E-07	2.61E-07	Proposed DWS (EPA, 1991a)
Cesium-134 ^b	µCi/mL	4.07E-08	8.13E-08	Proposed DWS (EPA, 1991a)
Cesium-137	µCi/mL	1E-07	2E-07	Interim Final DWS (EPA, 1977)
Chemical oxygen demand		No flag	No flag	Set by EPD/EMS
Chlordane	µg/L	1	2	Final DWS (CFR, 1995a)
alpha-Chlordane	µg/L	0.25	0.5	EPA Method 8080
gamma-Chlordane	µg/L	0.25	0.5	EPA Method 8080
Chloride	µg/L	125,000	250,000	Secondary DWS (CFR, 1995b)
4-Chloroaniline	µg/L	5	10	EPA Method 8270
Chlorobenzene	µg/L	50	100	Final DWS (CFR, 1995a)
Chlorobenzilate	µg/L	81	162	EPA Method 8270
4-Chloro-m-cresol	µg/L	5.1	10.2	EPA Method 8270
Chloroethane	µg/L	10	20	EPA Method 8240
Chloroethene (Vinyl chloride)	µg/L	1	2	Final DWS (CFR, 1995a)
Chloroethyl vinyl ether	µg/L	5	10	EPA Method 8240

Analyte	Unit	Flag 1	Flag 2	Source
2-Chloroethyl vinyl ether	µg/L	50	100	EPA Method 8240
Chloroform	µg/L	50	100	Final DWS (CFR, 1995a)
Chloromethane (Methyl chloride)	µg/L	10	20	EPA Method 8240
2-Chloronaphthalene	µg/L	5.1	10.2	EPA Method 8240
2-Chlorophenol	µg/L	5.1	10.2	EPA Method 8270
4-Chlorophenyl phenyl ether	µg/L	5.1	10.2	EPA Method 8270
Chloroprene	µg/L	1,665	3,330	EPA Method 8240
2-Chlorotoluene	µg/L	25	50	EPA Method 8260
4-Chlorotoluene	µg/L	5	10	EPA Method 8260
Chromium	µg/L	50	100	Final DWS (CFR, 1995a)
Chromium, dissolved	µg/L	50	100	Final DWS (CFR, 1995a)
Chromium, total recoverable	µg/L	50	100	Final DWS (CFR, 1995a)
Chromium-51 ^a	µCi/mL	3E-06	6E-06	Interim Final DWS (EPA, 1977)
Chrysene	µg/L	0.1	0.2	Proposed DWS (EPA, 1990)
Cobalt	µg/L	50	100	EPA Method 6010
Cobalt, dissolved	µg/L	50	100	EPA Method 6010
Cobalt, total recoverable	µg/L	50	100	EPA Method 6010
Cobalt-57	µCi/mL	5E-07	1E-06	Interim Final DWS (EPA, 1977)
Cobalt-58	µCi/mL	4.5E-06	9E-06	Interim Final DWS (EPA, 1977)
Cobalt-60	µCi/mL	5E-08	1E-07	Interim Final DWS (EPA, 1977)
Color		No flag	No flag	Set by EPD/EMS
Copper	µg/L	500	1,000	Primary DWS (SCDHEC, 1981)
Copper, dissolved	µg/L	500	1,000	Primary DWS (SCDHEC, 1981)
Copper, total recoverable	µg/L	500	1,000	Primary DWS (SCDHEC, 1981)
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	5	10	EPA Method 8270
p-Cresol (4-Methylphenol)	µg/L	60	120	EPA Method 8270
Curium-242	µCi/mL	6.65E-08	1.33E-07	Proposed DWS (EPA, 1991a)
Curium-243	µCi/mL	4.15E-09	8.3E-09	Proposed DWS (EPA, 1991a)
Curium-243/244 ^c	µCi/mL	4.15E-09	8.3E-09	Proposed DWS (EPA, 1991a)
Curium-244	µCi/mL	4.92E-09	9.84E-09	Proposed DWS (EPA, 1991a)
Curium-245/246 ^a	µCi/mL	3.12E-09	6.23E-09	Proposed DWS (EPA, 1991a)
Curium-246	µCi/mL	3.14E-09	6.27E-09	Proposed DWS (EPA, 1991a)
Cyanide	µg/L	100	200	Final DWS (CFR, 1995a)
Dalapon	µg/L	100	200	Final DWS (CFR, 1995a)
p,p'-DDD	µg/L	0.55	1.1	EPA Method 8080
p,p'-DDE	µg/L	0.25	0.5	EPA Method 8080
p,p'-DDT	µg/L	0.85	1.7	EPA Method 8080
Diallate	µg/L	81	162	EPA Method 8270
Dibenz[a,h]anthracene	µg/L	0.15	0.3	Proposed DWS (EPA, 1990)
Dibenzofuran	µg/L	5	10	EPA Method 8270
Dibromochloromethane	µg/L	50	100	Final DWS (CFR, 1995a)
1,2-Dibromo-3-chloropropane	µg/L	0.1	0.2	Final DWS (CFR, 1995a)
1,2-Dibromoethane	µg/L	0.025	0.05	Final DWS (CFR, 1995a)
Dibromomethane (Methylene bromide)	µg/L	10	20	EPA Method 8240
Di-n-butyl phthalate		No flag	No flag	Set by EPD/EMS
1,2-Dichlorobenzene	µg/L	300	600	Final DWS (CFR, 1995a)
1,3-Dichlorobenzene	µg/L	81	162	EPA Method 8270
1,4-Dichlorobenzene	µg/L	37.5	75	Final DWS (CFR, 1995a)
3,3'-Dichlorobenzidine	µg/L	5.1	10.2	EPA Method 8270
trans-1,4-Dichloro-2-butene	µg/L	250	500	EPA Method 8240

Analyte	Unit	Flag 1	Flag 2	Source
Dichlorodifluoromethane	µg/L	10	20	EPA Method 8240
1,1-Dichloroethane	µg/L	10	20	EPA Method 8240
1,2-Dichloroethane	µg/L	2.5	5	Final DWS (CFR, 1995a)
cis-1,2-Dichloroethylene	µg/L	35	70	Final DWS (CFR, 1995a)
1,1-Dichloroethylene	µg/L	3.5	7	Final DWS (CFR, 1995a)
1,2-Dichloroethylene	µg/L	25	50	EPA Method 8240
trans-1,2-Dichloroethylene	µg/L	50	100	Final DWS (CFR, 1995a)
Dichloromethane (Methylene chloride)	µg/L	2.5	5	Final DWS (CFR, 1995a)
2,4-Dichlorophenol	µg/L	5.1	10.2	EPA Method 8270
2,6-Dichlorophenol	µg/L	83.5	167	EPA Method 8270
2,4-Dichlorophenoxyacetic acid	µg/L	35	70	Final DWS (CFR, 1995a)
1,2-Dichloropropane	µg/L	2.5	5	Final DWS (CFR, 1995a)
2,2-Dichloropropane	µg/L	5	10	EPA Method 8260
cis-1,3-Dichloropropene	µg/L	10	20	EPA Method 8240
trans-1,3-Dichloropropene	µg/L	10	20	EPA Method 8240
Dieldrin	µg/L	4.15	8.3	EPA Method 8080
Diethyl phthalate		No flag	No flag	Set by EPD/EMS
Di(2-ethylhexyl) adipate	µg/L	200	400	Final DWS (CFR, 1995a)
Dimethoate	µg/L	81	162	EPA Method 8270
2,4-Dimethyl phenol	µg/L	5.1	10.2	EPA Method 8270
Dimethyl phthalate		No flag	No flag	Set by EPD/EMS
p-Dimethylaminoazobenzene	µg/L	81	162	EPA Method 8270
p-(Dimethylamino)ethylbenzene	µg/L	50	100	EPA Method 8270
7,12-Dimethylbenz[a]anthracene	µg/L	81	162	EPA Method 8270
3,3'-Dimethylbenzidine	µg/L	81	162	EPA Method 8270
a,a-Dimethylphenethylamine	µg/L	81	162	EPA Method 8270
1,3-Dinitrobenzene	µg/L	81	162	EPA Method 8270
2,4-Dinitrophenol	µg/L	51	102	EPA Method 8270
2,4-Dinitrotoluene	µg/L	0.5	1	EPA Method 8270
2,6-Dinitrotoluene	µg/L	0.5	1	EPA Method 8270
Di-n-octyl phthalate		No flag	No flag	Set by EPD/EMS
1,4-Dioxane	µg/L	500	1,000	EPA Method 8270
Diphenylamine	µg/L	81	162	EPA Method 8270
1,2-Diphenylhydrazine	µg/L	83.5	167	EPA Method 8270
Diquat dibromide	µg/L	10	20	Final DWS (CFR, 1995a)
Dissolved organic carbon	µg/L	10,500,000	21,000,000	EPA Method 9060
Disulfoton	µg/L	81	162	EPA Method 8270
Eh		No flag	No flag	Set by EPD/EMS
Endosulfan I	µg/L	0.25	0.5	EPA Method 8080
Endosulfan II	µg/L	0.55	1.1	EPA Method 8080
Endosulfan sulfate	µg/L	0.55	1.1	EPA Method 8080
Endothall	µg/L	50	100	Final DWS (CFR, 1995a)
Endrin	µg/L	1	2	Final DWS (CFR, 1995a)
Endrin aldehyde	µg/L	0.85	1.7	EPA Method 8080
Endrin ketone		No flag	No flag	Set by EPD/EMS
Ethyl ether	µg/L	50	100	EPA Method 8260
Ethyl methacrylate	µg/L	2.5	5	EPA Method 8270
Ethyl methanesulfonate	µg/L	81	162	EPA Method 8270
Ethylbenzene	µg/L	350	700	Final DWS (CFR, 1995a)
Europium-152	µCi/mL	3E-08	6E-08	Interim Final DWS (EPA, 1977)
Europium-154	µCi/mL	1E-07	2E-07	Interim Final DWS (EPA, 1977)
Europium-155	µCi/mL	3E-07	6E-07	Interim Final DWS (EPA, 1977)

Analyte	Unit	Flag 1	Flag 2	Source
Famphur	µg/L	81	162	EPA Method 8270
Fluoranthene	µg/L	5.1	10.2	EPA Method 8270
Fluorene	µg/L	5.1	10.2	EPA Method 8270
Fluoride	µg/L	2,000	4,000	Final DWS (CFR, 1995a)
Glyphosate	µg/L	350	700	Final DWS (CFR, 1995a)
Gross alpha	µCi/mL	7.5E-09	1.5E-08	Final DWS (CFR, 1995a)
Heptachlor	µg/L	0.2	0.4	Final DWS (CFR, 1995a)
Heptachlor epoxide	µg/L	0.1	0.2	Final DWS (CFR, 1995a)
Heptachlorodibenzo-p-dioxin isomers	µg/L	0.007	0.014	EPA Method 8280
1,2,3,4,6,7,8-HPCDD	µg/L	0.007	0.014	EPA Method 8280
Heptachlorodibenzo-p-furan isomers	µg/L	0.008	0.016	EPA Method 8280
1,2,3,4,6,7,8-HPCDF	µg/L	0.008	0.016	EPA Method 8280
Hexachlorobenzene	µg/L	0.5	1	Final DWS (CFR, 1995a)
Hexachlorobutadiene	µg/L	5	10	EPA Method 8270
Hexachlorocyclopentadiene	µg/L	25	50	Final DWS (CFR, 1995a)
Hexachlorodibenzo-p-dioxin isomers	µg/L	0.008	0.016	EPA Method 8280
1,2,3,4,7,8-HXCDD	µg/L	0.0105	0.021	EPA Method 8280
Hexachlorodibenzo-p-furan isomers	µg/L	0.006	0.012	EPA Method 8280
1,2,3,4,7,8-HXCDF	µg/L	0.0085	0.017	EPA Method 8280
Hexachloroethane	µg/L	0.5	1	EPA Method 8270
Hexachlorophene	µg/L	83.5	167	EPA Method 8270
Hexachloropropene	µg/L	81	162	EPA Method 8270
2-Hexanone	µg/L	50	100	EPA Method 8240
Indeno[1,2,3-c,d]pyrene	µg/L	0.5	1	EPA Method 8270
Iodine	µg/L	250	500	APHA Method 415A
Iodine-129	µCi/mL	5E-10	1E-09	Interim Final DWS (EPA, 1977)
Iodine-131 ^a	µCi/mL	1.5E-09	3E-09	Interim Final DWS (EPA, 1977)
Iodomethane (Methyl iodide)	µg/L	125	250	EPA Method 8240
Iron	µg/L	150	300	Secondary DWS (CFR, 1995b)
Iron, dissolved	µg/L	150	300	Secondary DWS (CFR, 1995b)
Iron, total recoverable	µg/L	150	300	Secondary DWS (CFR, 1995b)
Iron-55 ^a	µCi/mL	1E-06	2E-06	Interim Final DWS (EPA, 1977)
Iron-59 ^a	µCi/mL	1E-07	2E-07	Interim Final DWS (EPA, 1977)
Isobutyl alcohol	µg/L	834.5	1,669	EPA Method 8240
Isodrin	µg/L	81	162	EPA Method 8270
Isophorone	µg/L	5.1	10.2	EPA Method 8270
Isopropylbenzene	µg/L	5	10	EPA Method 8260
p-Isopropyltoluene	µg/L	5	10	EPA Method 8260
Isosafrole	µg/L	81	162	EPA Method 8270
Kepone	µg/L	81	162	EPA Method 8270
Lanthanum-140 ^a	µCi/mL	3E-08	6E-08	Interim Final DWS (EPA, 1977)
Lead	µg/L	25	50	Final DWS (SCDHEC, 1981)
Lead, dissolved	µg/L	25	50	Final DWS (SCDHEC, 1981)
Lead, total recoverable	µg/L	25	50	Final DWS (SCDHEC, 1981)
Lead-212	µCi/mL	6.2E-08	1.23E-07	Proposed DWS (EPA, 1991a)
Lindane	µg/L	0.1	0.2	Final DWS (CFR, 1995a)
Lithium	µg/L	125	250	EPA Method 6010
Lithium, dissolved	µg/L	125	250	EPA Method 6010
Lithium, total recoverable	µg/L	125	250	EPA Method 6010
Magnesium		No flag	No flag	Set by EPD/EMS
Magnesium, dissolved		No flag	No flag	Set by EPD/EMS
Magnesium, total recoverable		No flag	No flag	Set by EPD/EMS

Analyte	Unit	Flag 1	Flag 2	Source
Manganese	µg/L	25	50	Secondary DWS (CFR, 1995b)
Manganese, dissolved	µg/L	25	50	Secondary DWS (CFR, 1995b)
Manganese, total recoverable	µg/L	25	50	Secondary DWS (CFR, 1995b)
Manganese-54	µCi/mL	1.5E-07	3E-07	Interim Final DWS (EPA, 1977)
Mercury	µg/L	1	2	Final DWS (CFR, 1995a)
Mercury, dissolved	µg/L	1	2	Final DWS (CFR, 1995a)
Mercury, total recoverable	µg/L	1	2	Final DWS (CFR, 1995a)
Methacrylonitrile	µg/L	416.5	833	EPA Method 8240
Methapyrilene	µg/L	81	162	EPA Method 8270
Methoxychlor	µg/L	20	40	Final DWS (CFR, 1995a)
Methyl tert-butyl ether	µg/L	5	10	EPA Method 8260
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	81	162	EPA Method 8270
3-Methylcholanthrene	µg/L	81	162	EPA Method 8270
2-Methyl-4,6-dinitrophenol	µg/L	51	102	EPA Method 8270
2-Methylnaphthalene	µg/L	5	10	EPA Method 8270
Molybdenum	µg/L	250	500	EPA Method 6010
Molybdenum, dissolved	µg/L	250	500	EPA Method 6010
Molybdenum, total recoverable	µg/L	250	500	EPA Method 6010
Naphthalene	µg/L	83.5	167	EPA Method 8270
1,4-Naphthoquinone	µg/L	81	162	EPA Method 8270
1-Naphthylamine	µg/L	81	162	EPA Method 8270
2-Naphthylamine	µg/L	81	162	EPA Method 8270
Neptunium-237	µCi/mL	3.53E-09	7.06E-09	Proposed DWS (EPA, 1991a)
Neptunium-239	µCi/mL	8.4E-07	1.68E-06	Proposed DWS (EPA, 1991a)
Nickel	µg/L	50	100	Final DWS (CFR, 1995a)
Nickel, dissolved	µg/L	50	100	Final DWS (CFR, 1995a)
Nickel, total recoverable	µg/L	50	100	Final DWS (CFR, 1995a)
Nickel-59	µCi/mL	1.5E-07	3E-07	Interim Final DWS (EPA, 1977)
Nickel-63	µCi/mL	2.5E-08	5E-08	Interim Final DWS (EPA, 1977)
Niobium-95 ^a	µCi/mL	1.5E-07	3E-07	Interim Final DWS (EPA, 1977)
Nitrate as nitrogen	µg/L	5,000	10,000	Final DWS (CFR, 1995a)
Nitrate-nitrite as nitrogen	µg/L	5,000	10,000	Final DWS (CFR, 1995a)
Nitrite as nitrogen	µg/L	500	1,000	Final DWS (CFR, 1995a)
m-Nitroaniline	µg/L	5	10	EPA Method 8270
o-Nitroaniline	µg/L	5	10	EPA Method 8270
p-Nitroaniline	µg/L	5	10	EPA Method 8270
Nitrobenzene	µg/L	5.1	10.2	EPA Method 8270
Nitrogen by Kjeldahl method	µg/L	500	1,000	EPA Method 351.2
2-Nitrophenol	µg/L	5.1	10.2	EPA Method 8270
4-Nitrophenol	µg/L	5.1	10.2	EPA Method 8270
4-Nitroquinoline-1-oxide	µg/L	81	162	EPA Method 8270
N-Nitrosodi-n-butylamine	µg/L	81	162	EPA Method 8270
N-Nitrosodiethylamine	µg/L	81	162	EPA Method 8270
N-Nitrosodimethylamine	µg/L	83.5	167	EPA Method 8270
N-Nitrosodiphenylamine	µg/L	5.1	10.2	EPA Method 8270
N-Nitrosodipropylamine	µg/L	5.1	10.2	EPA Method 8270
N-Nitrosomethylethylamine	µg/L	81	162	EPA Method 8270
N-Nitrosomorpholine	µg/L	81	162	EPA Method 8270
N-Nitrosopiperidine	µg/L	81	162	EPA Method 8270

Analyte	Unit	Flag 1	Flag 2	Source
N-Nitrosopyrrolidine	µg/L	81	162	EPA Method 8270
5-Nitro-o-toluidine	µg/L	81	162	EPA Method 8270
Nonvolatile beta	µCi/mL	2.5E-08	5E-08	Interim Final DWS (EPA, 1977)
Octachlorodibenzo-p-dioxin isomers	µg/L	0.0085	0.017	EPA Method 8280
Octachlorodibenzo-p-furan isomers	µg/L	0.0065	0.013	EPA Method 8280
Odor		No flag	No flag	Set by EPD/EMS
Oil and grease	µg/L	8,350	16,700	EPA Method 413.1
Oxamyl	µg/L	100	200	Final DWS (CFR, 1995a)
Parathion	µg/L	0.4	0.8	EPA Method 8080
Parathion methyl	µg/L	0.4	0.8	EPA Method 8080
PCB 1016	µg/L	0.25	0.5	Final DWS (CFR, 1995a)
PCB 1221	µg/L	0.25	0.5	Final DWS (CFR, 1995a)
PCB 1232	µg/L	0.25	0.5	Final DWS (CFR, 1995a)
PCB 1242	µg/L	0.25	0.5	Final DWS (CFR, 1995a)
PCB 1248	µg/L	0.25	0.5	Final DWS (CFR, 1995a)
PCB 1254	µg/L	0.25	0.5	Final DWS (CFR, 1995a)
PCB 1260	µg/L	0.25	0.5	Final DWS (CFR, 1995a)
PCB 1262	µg/L	0.25	0.5	Final DWS (CFR, 1995a)
Pentachlorobenzene	µg/L	81	162	EPA Method 8270
Pentachlorodibenzo-p-dioxin isomers	µg/L	0.008	0.016	EPA Method 8280
1,2,3,7,8-PCDD	µg/L	0.0075	0.015	EPA Method 8280
Pentachlorodibenzo-p-furan isomers	µg/L	0.0085	0.017	EPA Method 8280
1,2,3,7,8-PCDF	µg/L	0.0085	0.017	EPA Method 8280
Pentachloroethane	µg/L	81	162	EPA Method 8270
Pentachloronitrobenzene	µg/L	81	162	EPA Method 8270
Pentachlorophenol	µg/L	0.5	1	Final DWS (CFR, 1995a)
pH ^d	pH	8	10	Set by EPD/EMS
pH ^d	pH	4	3	Set by EPD/EMS
Phenacetin	µg/L	81	162	EPA Method 8270
Phenanthrene	µg/L	5.1	10.2	EPA Method 8270
Phenol	µg/L	83.5	167	EPA Method 8270
Phenols	µg/L	50	100	EPA Method 420.1
p-Phenylenediamine	µg/L	81	162	EPA Method 8270
Phorate	µg/L	0.85	1.7	EPA Method 8080
Picloram	µg/L	250	500	Final DWS (CFR, 1995a)
2-Picoline	µg/L	81	162	EPA Method 8270
Plutonium-238	µCi/mL	3.51E-09	7.02E-09	Proposed DWS (EPA, 1991a)
Plutonium-239	µCi/mL	3.11E-08	6.21E-08	Proposed DWS (EPA, 1991a)
Plutonium-239/240 ^c	µCi/mL	3.11E-08	6.21E-08	Proposed DWS (EPA, 1991a)
Plutonium-240	µCi/mL	3.11E-08	6.22E-08	Proposed DWS (EPA, 1991a)
Plutonium-241 ^a	µCi/mL	3.13E-08	6.26E-08	Proposed DWS (EPA, 1991a)
Plutonium-242 ^a	µCi/mL	3.27E-08	6.54E-08	Proposed DWS (EPA, 1991a)
Potassium		No flag	No flag	Set by EPD/EMS
Potassium, dissolved		No flag	No flag	Set by EPD/EMS
Potassium, total recoverable		No flag	No flag	Set by EPD/EMS
Potassium-40	µCi/mL	1.5E-07	3E-07	Proposed DWS (EPA, 1986a)
Promethium-144	µCi/mL	5E-08	1E-07	EPA Method 901.1
Promethium-146	µCi/mL	5E-08	1E-07	EPA Method 901.1
Promethium-147	µCi/mL	2.62E-06	5.24E-06	Proposed DWS (EPA, 1991a)
Pronamid	µg/L	81	162	EPA Method 8270
Propionitrile	µg/L	1,665	3,330	EPA Method 8240
n-Propylbenzene	µg/L	5	10	EPA Method 8260

Analyte	Unit	Flag 1	Flag 2	Source
Pyrene	µg/L	5.1	10.2	EPA Method 8270
Pyridine	µg/L	81	162	EPA Method 8270
Radium, total alpha-emitting	µCi/mL	1E-08	2E-08	Proposed DWS (EPA, 1991a)
Radium-226	µCi/mL	1E-08	2E-08	Proposed DWS (EPA, 1991a)
Radium-228	µCi/mL	1E-08	2E-08	Proposed DWS (EPA, 1991a)
Radon-222	µCi/mL	1.5E-07	3E-07	Proposed DWS (EPA, 1991a)
Ruthenium-103 ^a	µCi/mL	1E-07	2E-07	Interim Final DWS (EPA, 1977)
Ruthenium-106	µCi/mL	1.5E-08	3E-08	Interim Final DWS (EPA, 1977)
Safrole	µg/L	81	162	EPA Method 8270
Selenium	µg/L	25	50	Final DWS (CFR, 1995a)
Selenium, dissolved	µg/L	25	50	Final DWS (CFR, 1995a)
Selenium, total recoverable	µg/L	25	50	Final DWS (CFR, 1995a)
Silica		No flag	No flag	Set by EPD/EMS
Silica, dissolved		No flag	No flag	Set by EPD/EMS
Silica, total recoverable		No flag	No flag	Set by EPD/EMS
Silver	µg/L	50	100	Secondary DWS (CFR, 1995b)
Silver, dissolved	µg/L	50	100	Secondary DWS (CFR, 1995b)
Silver, total recoverable	µg/L	50	100	Secondary DWS (CFR, 1995b)
Simazine	µg/L	2	4	Final DWS (CFR, 1995a)
Sodium		No flag	No flag	Set by EPD/EMS
Sodium, dissolved		No flag	No flag	Set by EPD/EMS
Sodium, total recoverable		No flag	No flag	Set by EPD/EMS
Sodium-22	µCi/mL	2.33E-07	4.66E-07	Proposed DWS (EPA, 1991a)
Specific conductance ^a	µS/cm	250	500	Set by EPD/EMS
Strontium-89	µCi/mL	1E-08	2E-08	Interim Final DWS (EPA, 1977)
Strontium-89/90 ^c	µCi/mL	4E-09	8E-09	Final DWS (CFR, 1995a)
Strontium-90	µCi/mL	4E-09	8E-09	Final DWS (CFR, 1995a)
Styrene	µg/L	50	100	Final DWS (CFR, 1995a)
Sulfate	µg/L	200,000	400,000	Proposed DWS (EPA, 1990)
Sulfide	µg/L	8,350	16,700	EPA Method 9030
Sulfotep	µg/L	81	162	EPA Method 8270
Surfactants		No flag	No flag	Set by EPD/EMS
2,3,7,8-TCDD	µg/L	0.007	0.014	Final DWS (CFR, 1995a)
2,3,7,8-TCDF	µg/L	0.00425	0.0085	EPA Method 8280
Technetium-99	µCi/mL	4.5E-07	9E-07	Interim Final DWS (EPA, 1977)
1,2,4,5-Tetrachlorobenzene	µg/L	81	162	EPA Method 8270
Tetrachlorodibenzo-p-dioxin isomers	µg/L	0.007	0.014	EPA Method 8280
Tetrachlorodibenzo-p-furan isomers	µg/L	0.0055	0.011	EPA Method 8280
1,1,1,2-Tetrachloroethane	µg/L	10	20	EPA Method 8240
1,1,2,2-Tetrachloroethane	µg/L	50	100	EPA Method 8240
Tetrachloroethylene	µg/L	2.5	5	Final DWS (CFR, 1995a)
2,3,4,6-Tetrachlorophenol	µg/L	83.5	167	EPA Method 8270
Thallium	µg/L	1	2	Final DWS (CFR, 1995a)
Thallium, dissolved	µg/L	1	2	Final DWS (CFR, 1995a)
Thallium, total recoverable	µg/L	1	2	Final DWS (CFR, 1995a)
Thionazin	µg/L	81	162	EPA Method 8270
Thorium-228	µCi/mL	6.25E-08	1.25E-07	Proposed DWS (EPA, 1991a)
Thorium-230	µCi/mL	3.96E-08	7.92E-08	Proposed DWS (EPA, 1991a)
Thorium-232	µCi/mL	4.4E-08	8.8E-08	Proposed DWS (EPA, 1991a)
Thorium-234 ^a	µCi/mL	2E-07	4.01E-07	Proposed DWS (EPA, 1991a)
Tin	µg/L	250	500	EPA Method 282.2
Tin, dissolved	µg/L	250	500	EPA Method 282.2

Analyte	Unit	Flag 1	Flag 2	Source
Tin, total recoverable	µg/L	250	500	EPA Method 282.2
Tin-113	µCi/mL	1.5E-07	3E-07	Interim Final DWS (EPA, 1977)
Toluene	µg/L	500	1,000	Final DWS (CFR, 1995a)
o-Toluidine	µg/L	81	162	EPA Method 8270
Total carbon	µg/L	5,000	10,000	EPA Method 9060
Total coliform	N/A	0	0	Final DWS (CFR, 1995a)
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	8,350	16,700	EPA Method 9060
Total organic carbon	µg/L	500,000	1,000,000	EPA Method 9060
Total organic halogens	µg/L	50	100	EPA Method 9020
Total organic nitrogen	µg/L	500	1,000	APHA Method 420
Total petroleum hydrocarbons	µg/L	8,350	16,700	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 DWS (CFR, 1995a)
2,4,5-TP (Silvex)	µg/L	25	50	Final DWS (CFR, 1995a)
Tributyl phosphate	µg/L	86	172	EPA Method 8270
1,2,3-Trichlorobenzene	µg/L	5	10	EPA Method 8260
1,2,4-Trichlorobenzene	µg/L	35	70	Final DWS (CFR, 1995a)
1,1,1-Trichloroethane	µg/L	100	200	Final DWS (CFR, 1995a)
1,1,2-Trichloroethane	µg/L	2.5	5	Final DWS (CFR, 1995a)
Trichloroethylene	µg/L	2.5	5	Final DWS (CFR, 1995a)
Trichlorofluoromethane	µg/L	10	20	EPA Method 8240
2,4,5-Trichlorophenol	µg/L	5	10	EPA Method 8270
2,4,6-Trichlorophenol	µg/L	0.5	1	EPA Method 8270
2,4,5-Trichlorophenoxyacetic acid	µg/L	0.25	0.5	EPA Method 8150
1,2,3-Trichloropropane	µg/L	10	20	EPA Method 8240
Trichlorotrifluoroethane	µg/L	50	100	EPA Method 8260
O,O,O-Triethyl phosphorothioate	µg/L	81	162	EPA Method 8270
1,2,4-Trimethylbenzene	µg/L	5	10	EPA Method 8260
1,3,5-Trimethylbenzene	µg/L	5	10	EPA Method 8260
1,3,5-Trinitrobenzene	µg/L	81	162	EPA Method 8270
Tritium	µCi/mL	1E-05	2E-05	Final DWS (CFR, 1995a)
Turbidity ^a		No flag	No flag	Set by EPD/EMS
Uranium	µg/L	10	20	Proposed DWS (EPA, 1991a)
Uranium alpha activity	µCi/mL	1.5E-08	3E-08	Proposed DWS (EPA, 1991a)
Uranium, dissolved	µg/L	10	20	Proposed DWS (EPA, 1991a)
Uranium, total recoverable	µg/L	10	20	Proposed DWS (EPA, 1991a)
Uranium-233/234 ^c	µCi/mL	6.9E-09	1.38E-08	Proposed DWS (EPA, 1991a)
Uranium-234	µCi/mL	6.95E-09	1.39E-08	Proposed DWS (EPA, 1991a)
Uranium-235	µCi/mL	7.25E-09	1.45E-08	Proposed DWS (EPA, 1991a)
Uranium-238	µCi/mL	7.3E-09	1.46E-08	Proposed DWS (EPA, 1991a)
Vanadium	µg/L	66.5	133	EPA Method 6010
Vanadium, dissolved	µg/L	66.5	133	EPA Method 6010
Vanadium, total recoverable	µg/L	66.5	133	EPA Method 6010
Vinyl acetate	µg/L	50	100	EPA Method 8240
m/p-Xylene	µg/L	81	162	EPA Method 8260
o-Xylene	µg/L	5	10	EPA Method 8260
Xylenes	µg/L	5,000	10,000	Final DWS (CFR, 1995a)
Yttrium-88	µCi/mL	5E-08	1E-07	EPA Method 901.1
Zinc	µg/L	2,500	5,000	Secondary DWS (CFR, 1995b)

Analyte	Unit	Flag 1	Flag 2	Source
Zinc, dissolved	µg/L	2,500	5,000	Secondary DWS (CFR, 1995b)
Zinc, total recoverable	µg/L	2,500	5,000	Secondary DWS (CFR, 1995b)
Zinc-65	µCi/mL	1.5E-07	3E-07	Interim Final DWS (EPA, 1977)
Zirconium-95	µCi/mL	1E-07	2E-07	Interim Final DWS (EPA, 1977)
Zirconium/Niobium-95 ^a	µCi/mL	1E-07	2E-07	Interim Final DWS (EPA, 1977)

-
- ^a EMS discontinued monitoring this radionuclide because it is inappropriate for the SRS groundwater monitoring program.
- ^b EPD/EMS set this flagging criterion using the 1991 proposed DWS because the final DWS in 1977 may have been in error.
- ^c When radionuclide analyses are combined, the lowest DWS of the two isotopes is used for flagging.
- ^d Will not trigger scheduling.
- ^e The primary maximum contaminant level range for turbidity is 1–5 NTU, which is inappropriate for the SRS groundwater monitoring program.

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Appendix C

Figures

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Figure 1. Location of the Z-Area Saltstone Disposal Facility at the Savannah River Site

Figure 2. Location of the Z-Area Saltstone Disposal Facility within the Separations Area

Figure 3. Location of Groundwater Monitoring Wells at the Z-Area Saltstone Disposal Facility

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Appendix D

Groundwater Monitoring Results Tables

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Key to Reading the Tables

The following abbreviations may appear in the data tables:

Constituents

Sp. conductance specific conductance

Laboratories

CN	Clemson Technical Center, Inc.
EM	Environmental Protection Department/Environmental Monitoring Section (EPD/EMS) Laboratory
GE or GP	General Engineering Laboratories, Inc.
SC	Savannah River Technology Center
SP	Spencer Testing Services, Inc.
TM	Thermo NUtech
WA or WS	Roy F. Weston, Inc.

Sampling Codes

B	blank sample was collected
C	well was pumping continuously
D	well was dry
E	equipment blank was collected
I	well went dry during sampling; insufficient water to collect all samples
L	well went dry before sampling began; only depth to water can be determined
N	well was not stabilized before sampling began
P	inaccessibility or mechanical failure prevented sample collection and field analysis of the water
S	no water in standpipe; for water-level events only
W	purged water must be containerized; only water-level measurements were obtained
X	well went dry during purging; samples collected after well recovered

Sampling Methods

B	sample collected using an open-bucket bailer
O	sample collected by method other than bailer or pump
P	sample collected using a bladder pump
S	sample collected using a single-speed centrifugal downhole pump
V	sample collected using a variable-speed pump

Units

mg/L	milligrams per liter
msl	mean sea level
MSL	million structures per liter
NTU	nephelometric turbidity unit
pCi/L	picocuries per liter

pCi/mL	picocuries per milliliter
pH	pH unit
µg/L	micrograms per liter
µS/cm	microsiemens per centimeter
Other	
CS	carbon steel
DF	dilution factor column in data tables
E	exponential notation (e.g., $1.1\text{E}-09 = 1.1 \times 10^{-9} = 0.0000000011$)
H	holding time column in data tables
Mod	modifier column in data tables
PDWS	primary drinking water standard
PVC	polyvinyl chloride
ST	exceeded the final PDWS or screening level column in data tables
TOC	Top of casing

Results below Detection

For radiological analyses, the analytical result field contains the result recorded on the analytical instrument and reported by the laboratory, even if it is negative. For nonradiological analyses, if the analyte is not detected, the sample-specific estimated quantitation limit (EQL) is entered into the result field and is reported with a less than [$<$] sign. The EQL is defined as the lowest concentration that can be achieved reliably within specified limits of precision and accuracy during routine laboratory operating conditions. The sample-specific EQL is modified for sample concentration or dilution or unusual aliquot size that affects analytical sensitivity.

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 bullet (•) in the *H* (holding time) column indicates that holding time was exceeded. Analyses performed beyond holding times may not yield valid results.

The South Carolina Department of Health and Environmental Control (SCDHEC) 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 always will exceed it.

The laboratory procedure used for the determination of specific conductance allows one day to elapse between sampling and analysis. Thus, laboratory specific conductance measurements may exceed the holding time criterion.

Data Rounding

A constituent result in the analytical results tables that is not marked in the *ST* column but appears to equal an Appendix A standard is below the standard in the database. Values stored in the database contain more significant digits than the reported results. Apparent discrepancies in the tables are due to the rounding of reported results.

Data Qualification

The contract laboratories 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 data modifiers (also referred to as qualifiers) can be a key component in

assessing data usability. Modifiers designed by EPD/EMS and provided to the primary laboratories are defined below. These modifiers appear in the data tables under the column *Mod*. All lettered modifiers except *E* are based on EPA's STORET codes.

Modifiers

(Blank)	Data are not qualified. Numbers should be interpreted exactly as reported.
E	The detected result is between the sample-specific EQL and the method detection limit.
I	The value in the result field is the instrument reading, not the sample quantitation limit. Always used with the result qualifier <i>U</i> .
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.
U	Material analyzed for but not detected. Analytical result reported is less than the sample quantitation limit.
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.
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.

Note: These are only some of the qualifiers present in the database. All modifiers associated with the data are published in the result tables of EPD/EMS' quarterly groundwater monitoring reports, the official repository of the data.

Table D-1. Maximum Levels of Constituents Exceeding the SCDHEC-Proposed Groundwater Monitoring Standards or the Final Primary Drinking Water Standards

<i>Well</i>	<i>Constituent</i>	<i>Unit</i>	<i>1Q96</i>	<i>2Q96</i>	<i>3Q96</i>	<i>Mod</i>
ZBG 1	Lead	µg/L	–	10	–	

– = analyzed but not above standards.

Note: Modifiers apply to third quarter 1996 data only.

Table D-2. Maximum Levels of Constituents Exceeding SRS Flagging Criteria

<i>Well</i>	<i>Constituent</i>	<i>Unit</i>	<i>1Q96</i>	<i>2Q96</i>	<i>3Q96</i>	<i>Mod</i>
ZBG 2	Antimony	µg/L	–	–	4.6 (1)	JE

– = analyzed but not above flagging criteria.

Notes: The flagging level appears in parentheses after the result.
Modifiers apply to third quarter 1996 data only.

Table D-3. Groundwater Monitoring Results for Individual Wells

WELL ZBG 1

SRS Coord.	Lat/Longitude	Screen Zone Elevation	Top of Casing	Casing	Pump	Screen Zone
N76584.2 E65584.1	33.302161 °N 81.642863 °W	240.1-220.0 ft msl	291.1 ft msl	4" PVC	S	Water Table

SAMPLE DATE 02/21/96 05/01/96 09/09/96

FIELD DATA

Parameter	1Q96	2Q96	3Q96	4Q96	Unit
Water elevation	234.5	234.1	233.8		ft msl
pH	5.4	5.2	5.2		pH
Sp. conductance	22	26	32		µS/cm
Water temperature	21.0	23.0	18.0		°C
Alkalinity as CaCO ₃	2	1	1		mg/L
Turbidity	1	1	2		NTU
Volume purged	15	14	5.0		well volume
Sampling code					

ANALYTICAL DATA

H	ST	Parameter	1Q96	2Q96	3Q96	4Q96	DF	Mod	Unit	Lab	Flag
		Antimony, total recoverable	<2.7	2.8	<5.0		1		µg/L	GE	0
		Arsenic, total recoverable	<5.6	<5.0	<5.0		1		µg/L	GE	0
		Barium, total recoverable	18	21	9.5		1	V	µg/L	GE	0
		Benzene	<2.0	<2.0	<2.0		1		µg/L	GE	0
		Cadmium, total recoverable	0.20	<2.0	0.22		1	JE	µg/L	GE	0
		Chromium, total recoverable	0.86	<1.7	<1.2		1	V	µg/L	GE	0
		Gross alpha	1.6E+00	1.9E+00	8.3E-01		1		pCi/L	GP	0
		Lead, total recoverable	9.6	10	8.2		1		µg/L	GE	0
		Mercury, total recoverable	<0.031	<0.048	<0.079		1	V	µg/L	GE	0
		Nitrate as nitrogen									
		Nitrate-nitrite as nitrogen	1,600	1,300	1,400		1	JV	µg/L	GE	0
●		Nitrite as nitrogen	<5.0	<5.0	<5.0		1	J1	µg/L	GE	0
		Nonvolatile beta		1.2E+00	1.1E+00		1		pCi/L	GP	0
●		pH			5.6		1	J1	pH	GE	0
		Radium-226			5.1E-01		1		pCi/L	GP	0
		Radium-228			1.5E+00		1		pCi/L	GP	0
		Selenium, total recoverable	<5.0	<5.0	<5.0		1		µg/L	GE	0
		Silver, total recoverable	<2.0	<2.0	<2.0		1		µg/L	GE	0
		Toluene	<2.0	<2.0	<2.0		1		µg/L	GE	0
		Tritium	9.3E+00	9.0E+00	8.5E+00		1		pCi/mL	GP	0

Note: Concentrations in bold italics exceed the SCDHEC-proposed groundwater monitoring standard, final PDWS, or drinking water screening level listed in Appendix A. Radionuclide result in italics is less than the sample quantitation limit. Dilution factor, modifier, laboratory, and flag are for third quarter 1996 only. See Appendix B for flagging criteria.

● = exceeded holding time during third quarter 1996.

■ = exceeded SCDHEC-proposed groundwater monitoring standard, final PDWS, or drinking water screening level during third quarter 1996.

WELL ZBG 1A

<u>SRS Coord.</u>	<u>Lat/Longitude</u>	<u>Screen Zone Elevation</u>	<u>Top of Casing</u>	<u>Casing</u>	<u>Pump</u>	<u>Screen Zone</u>
N76588.5 E65598.8	33.302195 °N 81.642833 °W	281.0-276.0 ft msl	291 ft msl	4" PVC	B	Perched Zone

SAMPLE DATE 02/22/96 05/01/96

FIELD DATA

<u>Parameter</u>	<u>1Q96</u>	<u>2Q96</u>	<u>3Q96</u>	<u>4Q96</u>	<u>Unit</u>
Water elevation	276.0		275.1		ft msl
pH					pH
Sp. conductance					µS/cm
Water temperature					°C
Alkalinity as CaCO ₃					mg/L
Turbidity					NTU
Volume purged					well volume
Sampling code	D	D	L		

Note: Concentrations in bold italics exceed the SCDHEC-proposed groundwater monitoring standard, final PDWS, or drinking water screening level listed in Appendix A. Radionuclide result in italics is less than the sample quantitation limit. Dilution factor, modifier, laboratory, and flag are for third quarter 1996 only. See Appendix B for flagging criteria.

● = exceeded holding time during third quarter 1996.

■ = exceeded SCDHEC-proposed groundwater monitoring standard, final PDWS, or drinking water screening level during third quarter 1996.

WELL ZBG 2

SRS Coord.	Lat/Longitude	Screen Zone Elevation	Top of Casing	Casing	Pump	Screen Zone
N76170.5 E67472.9	33.304327 °N 81.637084 °W	230.9-210.9 ft msl	278 ft msl	4" PVC	S	Water Table

SAMPLE DATE 02/22/96 05/01/96

FIELD DATA

Parameter	1Q96	2Q96	3Q96	4Q96	Unit
Water elevation	220.9	223.2	222.0		ft msl
pH	4.9	4.8	4.2		pH
Sp. conductance	22	19	22		µS/cm
Water temperature	21.0	23.0	18.0		°C
Alkalinity as CaCO ₃	1	2	2		mg/L
Turbidity	1	1	0.9		NTU
Volume purged	9.8	6.9	4.4		well volume
Sampling code					

ANALYTICAL DATA

H	ST	Parameter	1Q96	2Q96	3Q96	4Q96	DF	Mod	Unit	Lab	Flag
		Antimony, total recoverable	<5.0	<5.0	4.6		1	JE	µg/L	GE	1
		Arsenic, total recoverable	<5.0	2.8	3.0		1	JE	µg/L	GE	0
		Barium, total recoverable	6.8	7.1	7.7		1		µg/L	WA	0
		Benzene	<2.0	<2.0	<2.0		1		µg/L	GE	0
		Cadmium, total recoverable	<2.0	0.17	0.47		1	JE	µg/L	GE	0
		Chromium, total recoverable	0.93	0.95	1.9		1	JE	µg/L	WA	0
		Gross alpha	2.5E+00	4.6E-01	1.1E+00		1		pCi/L	GP	0
		Lead, total recoverable	<5.0	<3.6	1.3		1	JE	µg/L	GE	0
		Mercury, total recoverable	<0.046	<0.11	<0.067		1	V	µg/L	GE	0
		Nitrate as nitrogen									
		Nitrate-nitrite as nitrogen	900	800	1,300		1	JV	µg/L	GE	0
●		Nitrite as nitrogen	<5.0	<5.0	<5.0		1	J1	µg/L	GE	0
		Nonvolatile beta			1.3E-01		1	UI	pCi/L	TM	0
		pH			5.4		1	J1	pH	GE	0
		Radium-226			5.8E-01		1		pCi/L	GP	0
		Radium-228			1.2E+00		1		pCi/L	GP	0
		Selenium, total recoverable	<5.0	<5.0	<5.0		1		µg/L	GE	0
		Silver, total recoverable	<2.0	<2.0	<2.0		1		µg/L	GE	0
		Toluene	<2.0	<2.0	<2.0		1		µg/L	GE	0
		Tritium	8.5E+00	8.4E+00	8.0E+00		1		pCi/mL	TM	0

Note: Concentrations in bold italics exceed the SCDHEC-proposed groundwater monitoring standard, final PDWS, or drinking water screening level listed in Appendix A. Radionuclide result in italics is less than the sample quantitation limit. Dilution factor, modifier, laboratory, and flag are for third quarter 1996 only. See Appendix B for flagging criteria.

● = exceeded holding time during third quarter 1996.

■ = exceeded SCDHEC-proposed groundwater monitoring standard, final PDWS, or drinking water screening level during third quarter 1996.

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Appendix E

Data Quality/Usability Assessment

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Data Quality/Usability 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 QC data are reviewed prior to publication of results. The review by the Environmental Protection Department/Environmental Monitoring Section (EPD/EMS) of the volume of analytical data acquired each quarter and presented in various reports is an ongoing process; EPD/EMS' review of the QC data cannot be completed in time to meet the deadlines for the groundwater monitoring reports required by the Resource Conservation and Recovery Act and associated regulations. Beginning first quarter 1996, the *Quality Control Samples* section of EMS' quarterly groundwater monitoring report contains detailed evaluation of the following indicators of data quality: precision, accuracy, representativeness, comparability, and completeness. Site and regulatory personnel can obtain further information on the data quality and usability 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 QC information either at the same time as analytical results or in quarterly summaries. Properly defined and used modifiers (also referred to as qualifiers) can be a key component in assessing data usability. Modifiers designed by EPA or EPD/EMS and used by the primary laboratories or EMS' data validators 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 evaluation of results obtained from known samples. The contract laboratories analyze commercial reference samples periodically at EPD/EMS' request. The results of these analyses from the nonradionuclide laboratories are presented in the EPD/EMS groundwater monitoring quarterly reports; the results from the radionuclide laboratories should be available on request from the laboratory subcontract representatives. The primary laboratories also seek or maintain state certification by participating periodically in performance studies. Reference samples and evaluation 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 exceed established minimums are identified in the same reports, in tables associating them with groundwater samples analyzed in the same batches. In these regulatory reports, the modifier *V* is assigned to every detected result that is run in the same batch as a laboratory blank with positive results for that analyte. A *U* qualifier (reported as *less than* [*<*]) also is added if the analyte concentration is less than five times the concentration in the blank (or, for common laboratory contaminants, less than ten times).

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 by EPA Method 8270, three surrogates are required and an additional compound is advised for each fraction (acids and base/neutrals). Two surrogates are used in organochlorine pesticides analyses. Percent recoveries for surrogate analyses are calculated by laboratory personnel, reported to EPD/EMS, reviewed, and entered into the database.

Beginning first quarter 1996, statistical summaries are published in the *Quality Control Samples* section of the EPD/EMS quarterly groundwater monitoring report. If recoveries are not within specified limits, the laboratory is expected to reanalyze the samples or attach 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 portion of the sample is analyzed unspiked to determine a baseline set of values. A second portion of the sample is spiked with known concentrations of compounds appropriate to the analyses being performed, typically five volatile organic compounds for volatile organics analyses, eleven semivolatile compounds for semivolatiles, six pesticide compounds for pesticides, all metals for metals analyses by SW-846 methods (EPA, 1986), 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. Beginning first quarter 1996, spike results and a statistical summary are published in the *Quality Control Samples* section of the EPD/EMS quarterly groundwater monitoring report. 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 laboratory 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 assigned by the laboratories on the basis of the percentage of spike recovery are reported in the EPD/EMS 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 initiated by the laboratory and blind replicates provided by EPD/EMS. The results of duplicate and replicate analyses are presented in results tables that report only one quarter of data. Results tables that include more than one quarter of data present only the highest result for each analyte for each quarter of the year.

The laboratories assess precision by calculating the relative percent difference (RPD) for each pair of laboratory-initiated duplicate results. The EMS data validators apply a data qualifier to the results of entire preparation batches of metals analyses when the RPD for laboratory duplicates is greater than 20 percent and either the difference between the two samples is greater than the contract-required detection limit (CRDL) or both sample results are greater than 5 times the CRDL. This qualifier is published in the EPD/EMS quarterly reports.

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 mean relative difference (MRD), which is similar to EPA's RPD except that the MRD is the average of all the RPD values from one laboratory for each compound (intralaboratory MRD) or all the RPD values from all laboratories for each compound (interlaboratory MRD) 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 duplicate and replicate 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 usability. EPA has conducted extensive research and development on the methods approved for the analysis of water and wastewater. Information on the accuracy and precision of a 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 fourth quarter 1995 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. The EPD/EMS quarterly reports provide the methods used by the laboratories each quarter.

Table E-1. Methods Used by the Contract Laboratories

Method	Used to Analyze	Source
EICHROMTC1MOD ^a	Technetium isotopes	EiChrom Industries, Inc.; NA ^b
EMLAM01MOD	Americium, curium isotopes	DOE, 1992
EMLPU02MOD	Neptunium, plutonium isotopes	DOE, 1992
EMLSR02MOD	Strontium isotopes	DOE, 1992
EMLTH01MOD	Thorium isotopes	DOE, 1992
EMLU02MOD	Uranium isotopes	DOE, 1992
ENICMOD	Carbon-14	NA
EPA120.1	Specific conductance	EPA EMSL, 1983
EPA150.1	pH	EPA EMSL, 1983
EPA160.1	Total dissolved solids	EPA EMSL, 1983
EPA160.2	Total dissolved solids, total suspended solids	EPA EMSL, 1983
EPA180.1	Turbidity	EPA EMSL, 1983
EPA200.7	Metals	EPA EMSL, 1983
EPA245.1	Mercury	EPA EMSL, 1983
EPA300.0	Chloride, nitrite, sulfate, fluoride	EPA EMSL, 1983
EPA310.1	Alkalinity (as CaCO ₃)	EPA EMSL, 1983
EPA335.2	Cyanide	EPA EMSL, 1983
EPA335.3	Cyanide	EPA EMSL, 1983
EPA340.2	Fluoride	EPA EMSL, 1983
EPA350.1	Ammonia nitrogen	EPA EMSL, 1983
EPA350.3	Ammonia	EPA EMSL, 1983
EPA353.1	Nitrogen, nitrate-nitrite	EPA EMSL, 1983
EPA353.2	Nitrogen, nitrate, nitrite, or combined	EPA EMSL, 1983
EPA365.2	Phosphorus, all forms (reported as total phosphates)	EPA EMSL, 1983
EPA365.3	Phosphorus, all forms (reported as total phosphates)	EPA EMSL, 1983
EPA365.4	Phosphorus, all forms (reported as total phosphates)	EPA EMSL, 1983
EPA405.1	Five-day biochemical oxygen demand	EPA EMSL, 1983
EPA405.1/SM	Five-day biochemical oxygen demand	EPA EMSL, 1983

Method	Used to Analyze	Source
EPA410.4	Chemical oxygen demand	EPA EMSL, 1983
EPA415.1	Dissolved organic carbon, total inorganic carbon, total organic carbon	EPA EMSL, 1983
EPA418.1	Total petroleum hydrocarbons	EPA EMSL, 1983
EPA420.2	Phenols	EPA EMSL, 1983
EPA450.1	Total organic halogens	NA
EPA900.0MOD	Gross alpha, nonvolatile beta	EPA EMSL, 1980
EPA901.1MOD	Gamma PHA, iodine isotopes	EPA EMSL, 1980
EPA903.0MOD	Total alpha-emitting radium, radium isotopes	EPA EMSL, 1980
EPA904.0MOD	Radium isotopes	EPA EMSL, 1980
EPA906.0MOD	Tritium	EPA EMSL, 1980
EPA6010	Metals	EPA, 1986
EPA6010A	Metals	EPA, 1992
EPA7470	Mercury	EPA, 1986
EPA8080	Organochlorine pesticides and PCBs	EPA, 1986
EPA8150	Chlorinated herbicides	EPA, 1986
EPA8240	GCMS volatiles	EPA, 1986
EPA8260	GCMS volatiles	EPA, 1986
EPA8270	GCMS semivolatiles	EPA, 1986
EPA8280	Dioxins and furans	EPA, 1986
EPA9020A	Total organic halogens	EPA, 1986
EPA9020B	Total organic halogens	EPA, 1994b
EPA9060	Total inorganic carbon	EPA, 1986
EPIA-001 ^c	Gross alpha, nonvolatile beta	EP, 1996
EPIA-002 ^c	Tritium	EP, 1996
EPIA-003 ^c	Carbon-14	EP, 1996
EPIA-004 ^c	Strontium-90	EP, 1996
EPIA-005 ^c	Technetium-99	EP, 1996
EPIA-006 ^c	Iodine-129	EP, 1996
EPIA-008 ^c	Radium-226	EP, 1996
EPIA-009 ^c	Radium-228	EP, 1996
EPIA-010 ^c	Radium, total alpha-emitting	EP, 1996
EPIA-011 ^c	Americium, curium, uranium isotopes	EP, 1996
EPIA-012 ^c	Neptunium, plutonium, thorium isotopes	EP, 1996
EPIA-013 ^c	Gamma PHA	EP, 1996
EPIA-022 ^c	Nickel isotopes	EP, 1996
MMES16009MOD	Technetium-99	NA

Method	Used to Analyze	Source
3Q1-6-1420	Total activity, tritium	NA

^a MOD indicates modifications of applicable EPA, DOE, or other procedures.

^b NA = not available. Sources for some proprietary methods are not available.

^c The methods and detection limits used by GP are in-house methods based on applicable EPA, DOE, or other procedures. Complete method descriptions are available from GP.

Note: One of the labs reports the method for some metals determinations as CLP or CLP-MOD. This is presumed equivalent to Method 6010 or 6010A.

An example of method-specific QC information is that for EPA Method 8270 (EPA, 1986), which is used by both GE and Weston for analyses of semivolatile organics. 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.

Table E-2. Method Accuracy and Precision as Functions of Concentration for EPA Method 8270

Parameter	Accuracy, as recovery, x' (µg/L)	Single analyst precision, s_r' (µg/L)	Overall precision, S' (µg/L)
Acenaphthene	0.96C+0.19	0.15X-0.12	0.21X-0.67
Acenaphthylene	0.89C+0.74	0.24X-1.06	0.26X-0.54
Aldrin	0.78C+1.66	0.27X-1.28	0.43X+1.13
Anthracene	0.80C+0.68	0.21X-0.32	0.27X-0.64
Benzo[a]anthracene	0.88C-0.60	0.15X+0.93	0.26X-0.21
Benzo[b]fluoranthene	0.93C-1.80	0.22X+0.43	0.29X+0.96
Benzo[k]fluoranthene	0.87C-1.56	0.19X+1.03	0.35X+0.40
Benzo[g,h,i]perylene	0.98C-0.86	0.29X+2.40	0.51X-0.44
Benzo[a]pyrene	0.90C-0.13	0.22X+0.48	0.32X+1.35
β-BHC	0.87C-0.94	0.20X-0.58	0.30X+1.94
δ-BHC	0.29C-1.09	0.34X+0.86	0.93X+0.17
Bis(2-chloroethoxy) methane	1.12C-5.04	0.16X+1.34	0.26X+2.01
Bis(2-chloroethyl) ether	0.86C-1.54	0.35X-0.99	0.35X+0.10
Bis(2-chloroisopropyl) ether	1.03C-2.31	0.24X+0.28	0.25X+1.04
Bis(2-ethylhexyl) phthalate	0.84C-1.18	0.26X+0.73	0.36X+0.67
4-Bromophenyl phenyl ether	0.91C-1.34	0.13X+0.66	0.16X+0.66
Butylbenzyl phthalate	0.66C-1.68	0.18X+0.94	0.53X+0.92
4-Chloro-m-cresol	0.84C+0.35	0.23X+0.75	0.29X+1.31
Chloroethane	0.99C-1.53	0.14X-0.13	0.17X-0.28
2-Chloronaphthalene	0.89C+0.01	0.07X+0.52	0.13X+0.34
2-Chlorophenol	0.78C+0.29	0.18X+1.46	0.28X+0.97

Parameter	Accuracy, as recovery, x^- ($\mu\text{g/L}$)	Single analyst precision, s_r^- ($\mu\text{g/L}$)	Overall precision, S^- ($\mu\text{g/L}$)
4-Chlorophenyl phenyl ether	0.91C+0.53	0.20X-0.94	0.30X-0.46
Chrysene	0.93C-1.00	0.28X+0.13	0.33X-0.09
p,p'-DDD	0.56C-0.40	0.29X-0.32	0.66X-0.96
p,p'-DDE	0.70C-0.54	0.26X-1.17	0.39X-1.04
p,p'-DDT	0.79C-3.28	0.42X+0.19	0.65X-0.58
Dibenz[a,h]anthracene	0.88C+4.72	0.30X+8.51	0.59X+0.25
Di-n-butyl phthalate	0.59C+0.71	0.13X+1.16	0.39X+0.60
1,2-Dichlorobenzene	0.80C+0.28	0.20X+0.47	0.24X+0.39
1,3-Dichlorobenzene	0.86C-0.70	0.25X+0.68	0.41X+0.11
1,4-Dichlorobenzene	0.73C-1.47	0.24X+0.23	0.29X+0.36
3,3'-Dichlorobenzidine	1.23C-12.65	0.28X+7.33	0.47X+3.45
2,4-Dichlorophenol	0.87C-0.13	0.15X+1.25	0.21X+1.28
Dieldrin	0.82C-0.16	0.20X-0.16	0.26X-0.07
Diethyl phthalate	0.43C+1.00	0.28X+1.44	0.52X+0.22
2,4-Dimethyl phenol	0.71C+4.41	0.16X+1.21	0.22X+1.31
Dimethyl phthalate	0.20C+1.03	0.54X+0.19	1.05X-0.92
2,4-Dinitrophenol	0.81C-18.04	0.38X+2.36	0.42X+26.29
2,4-Dinitrotoluene	0.92C-4.81	0.12X+1.06	0.21X+1.50
2,6-Dinitrotoluene	1.06C-3.60	0.14X+1.26	0.19X+0.35
Di-n-octyl phthalate	0.76C-0.79	0.21X+1.19	0.37X+1.19
Endosulfan sulfate	0.39C+0.41	0.12X+2.47	0.63X-1.03
Endrin aldehyde	0.76C-3.86	0.18X+3.91	0.73X-0.62
Fluoranthene	0.81C+1.10	0.22X-0.73	0.28X-0.60
Fluorene	0.90C-0.00	0.12X+0.26	0.13X+0.61
Heptachlor	0.87C-2.97	0.24X-0.56	0.50X-0.23
Heptachlor epoxide	0.92C-1.87	0.33X-0.46	0.28X+0.64
Hexachlorobenzene	0.74C+0.66	0.18X-0.10	0.43X-0.52
Hexachlorobutadiene	0.71C-1.01	0.19X+0.92	0.26X+0.49
Hexachloroethane	0.73C-0.83	0.17X+0.67	0.17X+0.80
Indeno[1,2,3-c,d]pyrene	0.78C-3.10	0.29X+1.46	0.50X-0.44
Isophorone	1.12C+1.41	0.27X+0.77	0.33X+0.26
2-Methyl-4,6-dinitrophenol	1.04C-28.04	0.10X+42.29	0.26X+23.10
Naphthalene	0.76C+1.58	0.21X-0.41	0.30X-0.68
Nitrobenzene	1.09C-3.05	0.19X+0.92	0.27X+0.21
2-Nitrophenol	0.07C-1.15	0.16X+1.94	0.27X+2.60
4-Nitrophenol	0.61C-1.22	0.38X+2.57	0.44X+3.24

Parameter	Accuracy, as recovery, x' ($\mu\text{g/L}$)	Single analyst precision, s_r' ($\mu\text{g/L}$)	Overall precision, S' ($\mu\text{g/L}$)
N-Nitrosodi-n-propylamine	1.12C-6.22	0.27X+0.68	0.44X+0.47
PCB 1260	0.81C-10.86	0.35X+3.61	0.43X+1.82
Pentachlorophenol	0.93C+1.99	0.24X+3.03	0.30X+4.33
Phenanthrene	0.87C+0.06	0.12X+0.57	0.15X+0.25
Phenol	0.43C+1.26	0.26X+0.73	0.35X+0.58
Pyrene	0.84C-0.16	0.16X+0.06	0.15X+0.31
1,2,4-Trichlorobenzene	0.94C-0.79	0.15X+0.85	0.21X+0.39
2,4,6-Trichlorophenol	0.91C-0.18	0.16X+2.22	0.22X+1.81

x' = Expected recovery for one or more measurements of a sample containing a concentration of C, in $\mu\text{g/L}$.

s_r' = Expected single analyst standard deviation of measurements at an average concentration of X, in $\mu\text{g/L}$.

S' = Expected interlaboratory standard deviation of measurements at an average concentration of X, in $\mu\text{g/L}$.

C = True value for the concentration, in $\mu\text{g/L}$.

X = Average recovery found for measurements of samples containing a concentration of C, in $\mu\text{g/L}$.

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