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**DEMONSTRATION OF INNOVATIVE APPLICATIONS
OF TECHNOLOGY FOR THE CT-121 FGD PROCESS**

Plant Yates

**Environmental Monitoring Program Report:
Third Quarter 1996
(Final)**

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Demonstration of Innovative Applications of Technology for the CT-121 FGD Process

Plant Yates

Environmental Monitoring Program Report: Third Quarter 1996

This progress report summarizes activities associated with the environmental monitoring program (EMP) during the third calendar quarter of 1996 for the U.S. Department of Energy's Innovative Clean Coal Technology project entitled "Demonstration of Innovative Applications of Technology for the CT-121 FGD Process." This demonstration project was conducted at Georgia Power Company's Plant Yates Unit 1, located near Newnan, Georgia, until January 1995, when operational responsibility was permanently transferred to Georgia Power Company from Southern Company Services, Inc., manager of the demonstration project.

No further operational testing is planned, and monitoring under the EMP is now limited to groundwater monitoring.

Post-operational-phase groundwater monitoring is being conducted. A report of monitoring results for the previous quarter (second quarter of 1996) is attached.

Attachment

Groundwater Monitoring Report for the Second Quarter of 1996

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1.0 Introduction

This report summarizes the results of groundwater monitoring performed during the second calendar quarter of 1996 as part of the environmental monitoring program (EMP) for the U.S. Department of Energy's Innovative Clean Coal Technology project entitled "Demonstration of Innovative Applications of Technology for the CT-121 FGD Process." This demonstration project is being conducted at Georgia Power Company's Plant Yates Unit 1, located near Newnan, Georgia.

1.1 Project Summary

The purpose of this ICCT project is to demonstrate the use of the Chiyoda Thoroughbred-121 flue gas desulfurization process as a means of reducing SO₂ and particulate emissions from pulverized-coal utility boilers that use medium-sulfur coal. This project is also designed to demonstrate the lower cost and higher reliability of the CT-121 process compared to conventional wet limestone FGD processes.

The demonstration project at Plant Yates consists of four distinct test periods:

- ▶ Period 0: Site Preparation, Construction, and Startup of the Demonstration Project (including background groundwater monitoring [29 months]);
- ▶ Period 1: Baseline Testing at Low Particulate Loading—ESP In Service (12 months);
- ▶ Period 2: Testing at High Particulate Loading—ESP Detuned or Out of Service (12 months); and
- ▶ Period 3: Post Demonstration Groundwater Testing and Gypsum Byproduct Evaluation.

Period 2 ended in December 1994. Groundwater monitoring was initiated in Period 0 and will continue through Period 3.

1.2 Purpose and Scope of Groundwater Monitoring

The CT-121 process produces gypsum, which is being disposed of in an on-site stacking area where the solids are concentrated as they are allowed to settle, dewater, and dry. The gypsum and gypsum/fly ash stacking area is lined with a synthetic liner to minimize the potential for adverse impacts on the groundwater. Requirements for the liner, leachate collection system, and groundwater monitoring are specified in the permit issued by the Georgia Department of Natural Resources (DNR). One requirement is the regular monitoring of groundwater before, during, and for two years after the demonstration program. The purpose of this monitoring is to demonstrate that the gypsum stacking area can be operated in an environmentally benign and acceptable manner.

In 1990, five groundwater monitoring wells were installed in the vicinity of the proposed gypsum stacking area. These wells were used to monitor baseline groundwater quality prior to construction of the stacking area. Monitoring was conducted every two months from September 1990 through July 1991. Table 1 is a summary of the parameters that were monitored during this period. The results of this monitoring activity were summarized in the report "Environmental Monitoring Program Report of Preconstruction Monitoring: 1990-1991 Background Water Quality."

Following the preconstruction monitoring period, and as a DNR permit requirement, two additional monitoring wells were installed in 1992. The locations of all seven monitoring wells are shown in Figure 1. Because of a delay in the commencement of Phase 1 testing, an additional round of pre-operational groundwater monitoring was conducted on September 3-4 and October 14, 1992. The results from this monitoring effort were presented in the report "Interim Data Report of Pre-operational Groundwater Monitoring: September 3-4 and October 14, 1992."

Operational-phase groundwater monitoring, performed on a quarterly basis, was initiated in the fourth quarter of 1992. Monitoring was conducted for the suite of parameters shown in Table 1. Samples were analyzed each quarter for all parameters shown except for radionuclides, which are monitored semiannually.

Beginning in the second quarter of 1994, quarterly monitoring was initiated for total organic halides (TOX) and annual monitoring was initiated for volatile organic compounds (VOCs). These parameters were added to comply with requirements of the permit issued by the Environmental Protection Division of the Georgia DNR.

Table 1. EMP Groundwater Monitoring Parameters

pH	Conductivity	Temperature
Eh	Alkalinity	Total Dissolved Solids
Bromide	Chloride	Total Organic Carbon
Fluoride	Nitrate-Nitrite	Sulfate
Trace Elements (Dissolved)		
Silver	Aluminum	Arsenic
Boron	Barium	Beryllium
Bismuth	Calcium	Cadmium
Cobalt	Copper	Chromium
Mercury	Iron	Potassium
Lithium	Magnesium	Manganese
Molybdenum	Sodium	Nickel
Phosphorus	Lead	Sulfur
Antimony	Selenium	Silicon
Tin	Strontium	Tellurium
Titanium	Thallium	Uranium
Vanadium	Tungsten	Zinc
Other		
Radionuclides		

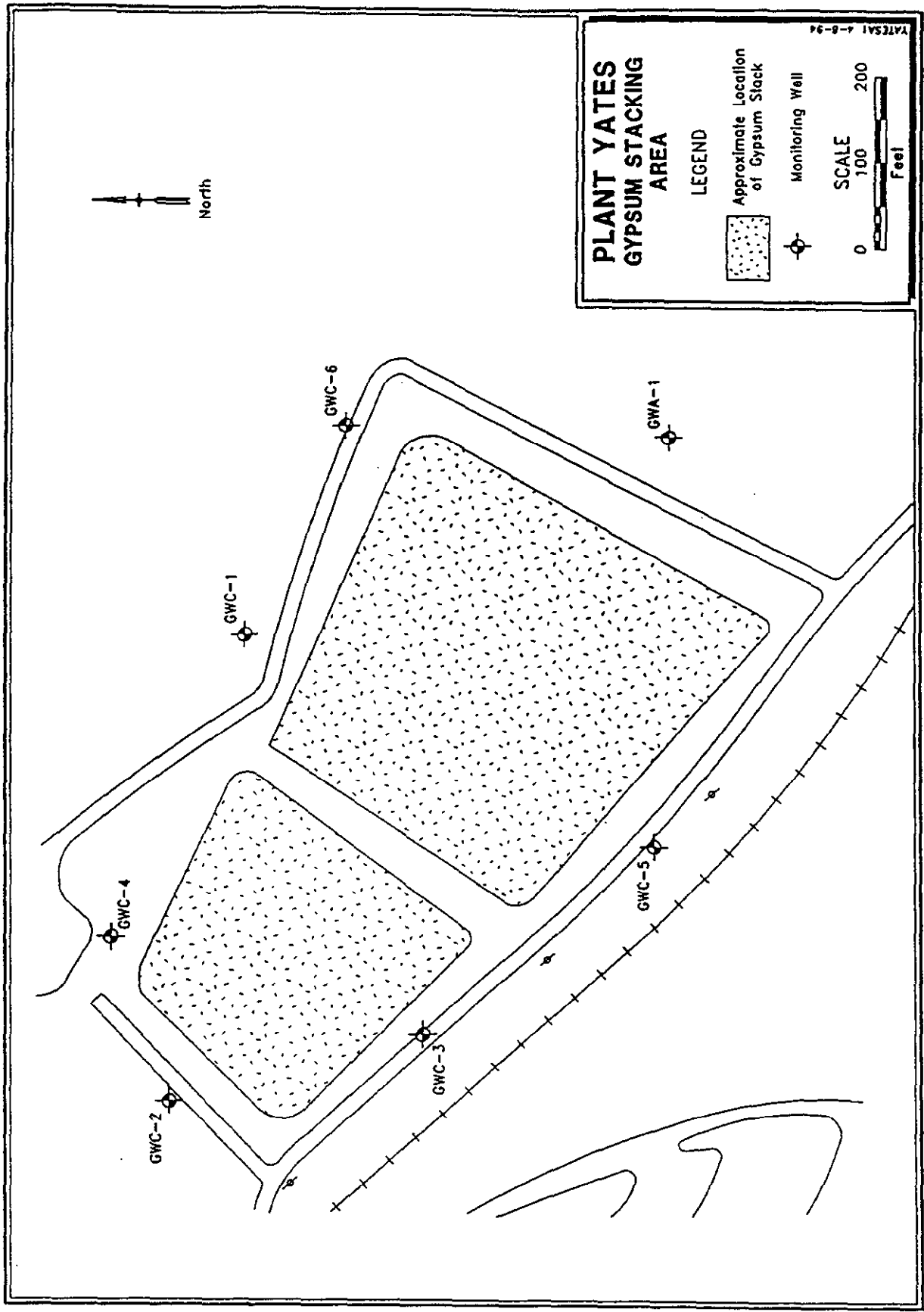


Figure 1. Locations of Groundwater Monitoring Wells

The post-demonstration groundwater monitoring period began in the first quarter of 1995 and will be conducted over a period of two years (i.e., through the end of 1996) for the same parameters and at the same frequency as during the operational phase.

1.3 Report Contents

This report presents the results of quarterly post-demonstration-phase groundwater monitoring for the second calendar quarter of 1996. The groundwater monitoring wells were sampled on June 20-21, 1996.

Section 2 is a brief summary of the groundwater sampling and analytical methods used in this monitoring program. Monitoring results are presented in Section 3. Results of quality assurance/quality control (QA/QC) activities associated with sample analyses are summarized in Section 4. Tables of historical data for selected parameters, and the results for field and laboratory duplicates, are given in the appendices.

2.0 Sampling And Analytical Methods

This section describes the methods used to obtain and analyze groundwater samples. These methods were specified in Radian's "Test Plan for Groundwater Monitoring Around the Plant Yates Gypsum Stacking Area," August 30, 1990, as amended.

2.1 Sampling Methods

The QED Well Wizard dedicated sampling system was used to purge the monitoring wells and collect samples. The Well Wizard system utilizes a dedicated Teflon® bladder pump and portable air compressor to extract groundwater samples.

To ensure the collection of a representative sample, standing water was removed from each well by purging a minimum of three wetted casing volumes. Conductivity, pH, redox potential, and temperature were monitored and recorded on field sampling forms during purging. Samples were collected after these indicator parameters stabilized and (1) after at least three wetted casing volumes of water were removed or (2) immediately following recovery if a well was purged dry.

Samples were obtained from the upgradient well (GWA-1) and five of the six downgradient wells (GWC-1, GWC-2, GWC-3, GWC-4, and GWC-5). More groundwater was

present than usual in upgradient well GWA-1, and a complete set of samples was collected with the exception of the field alkalinity titration. As has been the case during all previous rounds of monitoring, no water was in side-gradient well GWC-6, and no samples were collected at that location. Table 2 summarizes the groundwater samples collected during this monitoring period.

To preserve the integrity of the groundwater samples before analyses, proper sample containment, preservation, holding time, shipment, and chain-of-custody procedures were followed. Sample bottles, preservation methods, and maximum holding times are summarized in Table 3.

2.2 Analytical Procedures

The analytical methods used in this program are listed in Table 4. There were no deviations from these methods.

3.0 Summary of Results

The results of the second-quarter 1996 groundwater monitoring are presented in Table 5. The concentrations of all of the monitored dissolved constituents in the groundwater near the gypsum stacking area continue to be low.

To help determine whether the material in the gypsum stacking area is having an impact on groundwater quality, the monitoring data for a selected number of representative species from all of the monitoring rounds conducted to date were tabulated and examined. The representative species selected are those present in appreciable concentrations in the gypsum slurry, including the major cations and anions (i.e., calcium, magnesium, chloride, and sulfate), as well as several other indicator parameters such as pH, TDS, conductivity, and alkalinity. The complete set of historical data for these species is provided in Appendix A. Examples of concentration-versus-time plots for several species are provided in Figures 2 through 4. Data are presented for the upgradient well, GWA-1, and two downgradient wells, GWC-2 and GWC-4. The locations of these wells were shown previously in Figure 1. Samples were not obtained this quarter from downgradient well GWC-6.

For the upgradient well, GWA-1, and the downgradient well, GWC-2, the measured concentrations for all monitored parameters are generally close to the historically-observed concentrations of these species. The concentrations of chloride, magnesium, and calcium in the

**Table 2. Summary of Groundwater Samples Collected at
Plant Yates on June 20-21, 1996**

Well ID	Sample ID	Analyses
GWA-1	GWA-1-22-1	Anions, TOC, TOX, Metals, and Volatile Organics ^a
GWC-1	GWC-1-22-1	Anions, TOC, TOX, Metals, and Volatile Organics
GWC-2	GWC-2-22-1	Anions, TOC, TOX, Metals, and Volatile Organics
GWC-3	GWC-3-22-1	Anions, TOC, TOX, Metals, and Volatile Organics
GWC-4	GWC-4-22-1	Anions, TOC, TOX, Metals, and Volatile Organics
	GWC-4-22-2	Anions, TOC, TOX, Metals, and Volatile Organics
GWC-5	GWC-5-22-1	Anions, TOC, TOX, Metals, and Volatile Organics
GWC-6	None	Well dry; no samples collected

^a A complete set of samples was collected with the exception of the field alkalinity titration.

Table 3. Sample Containers, Preservation Method, and Maximum Holding Times

Bottle Label	Containers ^a	Parameter	Preservation Method	Maximum Holding Time (days)
Total Organic Carbon	500-mL Amber Glass	Total Organic Carbon	H ₂ SO ₄ pH<2	28
Anions/TDS	1-L Plastic	Bromide	4 °C	28
		Chloride	4 °C	28
		Fluoride	4 °C	28
		Nitrate-Nitrite	4 °C	28
		Sulfate	4 °C	28
		Total Dissolved Solids	4 °C	7
TOX	250-mL Amber Glass, no headspace	Total Organic Halogens	H ₂ SO ₄ pH<2	28
VOCs	(2) 40-mL VOA Vials	Volatile Organics	HCl pH<2	14
Metals	1-L Plastic	Trace Metals	Filtered On Site Ultrex II HNO ₃ pH<2	180
Radioactivity	(3) 1-L Plastic	Radium 226, Radium 228, Gross Alpha, Gross Beta, Gross Gamma	Filtered On Site Ultrex II HNO ₃ pH<2	180

^a Sample containers supplied by either I-Chem or Eagle Picher.

Table 4. Analytical Methods

Parameter	Technique	Reference
pH	Potentiometry	EPA 150.1
Conductivity	Specific Conductance	EPA 120.1
Temperature	Temperature Probe	EPA 170.1
Eh	Electrometry	ASTM D1498
Alkalinity	Titrimetric or Colorimetric	EPA 310.1 or 310.2
Bromide	Ion Chromatography	EPA 300
Chloride	Ion Chromatography	EPA 300
Total Organic Carbon	Combustion/IR	EPA 415.1
TOX	Carbon Adsorption/Combustion/ Electrolytic Titration	SW-846 Method 9020A
VOCs	GC/MS	SW-846 Method 8260
Fluoride	SIE	EPA 340.2
Nitrate/Nitrite	Colorimetry	EPA 353.1
Sulfate	Ion Chromatography	EPA 300
Total Dissolved Solids	Filtration/Evaporation/Gravimetry	EPA 160.2
Mercury	On-site Filtration/Cold Vapor AA	EPA 245.1
Trace Elements	On-site Filtration/AA and ICP-AES	EPA 200.7, 7421 (Cr), 7060 (As), 7421 (Pb), 7041 (Sb), 7740 (Se), and 7841 (Ti)
Radium 226 and 228	Proportional Counter	ASTM D2460
Gross Alpha	Proportional Counter	ASTM D1943
Gross Beta	Proportional Counter	ASTM D1890
Gross Gamma	Gamma Ray Spectrometer	ASTM D2459

Legend:

- AA = Atomic absorption spectrophotometry
- SIE = Specific ion electrode
- ICP-AES = Inductively coupled plasma-atomic emission spectrometry
- IR = Infrared detection
- GC/MS = Gas chromatography/mass spectroscopy

References:

- EPA "Methods for Chemical Analysis of Water and Wastes," EPA-600/4-79-020, revised March 1983.
- ASTM = American Society for Testing and Materials, *Annual Book of ASTM Standards*.
- SW-846 "Test Methods for Evaluating Solid Waste," SW-846, 3rd Ed., November 1986.

Table 5. Results of Groundwater Monitoring Conducted June 20-21, 1996 (Second Quarter 1996)

Parameter	GWA-1-22-1	GWC-1-22-1	GWC-2-22-1	GWC-3-22-1	GWC-4-22-1*	GWC-5-22-1
pH	6.14	5.84	5.48	5.08	4.71	5.24
Conductivity ($\mu\text{S/cm}$)	116	83	59	41	412	64
Temperature ($^{\circ}\text{C}$)	19.3	17.0	18.3	18.3	16.8	17.6
Eh (mV)	103	178	237	262	390	193
Alkalinity (mg/L CaCO_3)	NM	35	15.0	9.2	6.9	10.6
Total Dissolved Solids (mg/L)	105	63	75	49	266	76
Bromide (mg/L)	<0.0493	<0.0493	<0.0493	<0.0493	1.08	<0.0493
Chloride (mg/L)	3.30	2.47	3.93	3.83	106	2.98
Total Organic Carbon (mg/L)	<0.117	<0.117	<0.117	<0.117	<0.117	<0.117
Fluoride (mg/L)	0.0789 ^c	0.0442 ^c	0.0376 ^c	0.0344 ^c	0.0305 ^c	0.0384 ^c
Nitrate-Nitrite (mg/L as N)	0.742	0.233	0.915	0.192	2.10	0.0870
Sulfate (mg/L)	12.0	<0.154	4.52	1.91	4.33	9.87
Silver (mg/L)	<0.000501	<0.000501	<0.000501	<0.000501	<0.000501	<0.000501
Aluminum (mg/L)	0.0155 ^{c,d}	0.0224 ^{c,d}	0.168 ^c	0.168 ^c	0.179 ^c	0.291 ^c
Arsenic (mg/L)	<0.00392	<0.00392	<0.00392	<0.00392	<0.00392	<0.00392
Boron (mg/L)	<0.0479	<0.0479	<0.0479	<0.0479	1.98	<0.0479
Barium (mg/L)	0.0156	0.00838	0.0134	0.0142	0.0634	0.0142
Beryllium (mg/L)	0.000490 ^{c,d}	0.000460 ^{c,d}	0.000480 ^{c,d}	0.000590 ^{c,d}	0.00135 ^c	0.000730 ^{c,d}
Bismuth (mg/L)	<0.0271	<0.0271	<0.0271	<0.0271	<0.0271	<0.0271
Calcium (mg/L)	8.03	5.62	2.46	0.433	10.5	1.96
Cadmium (mg/L)	<0.000156	<0.000156	<0.000156	<0.000156	<0.000156	<0.000156
Cobalt (mg/L)	<0.000580	<0.000580	<0.000580	<0.000580	0.00406	<0.000580
Copper (mg/L)	<0.00136	<0.00136	<0.00136	<0.00136	<0.00136	<0.00136
Chromium (mg/L)	0.000440 ^d	0.000450 ^d	0.000408 ^d	0.00325	0.00275	0.00465
Mercury (mg/L)	<0.000039	<0.000039	<0.000039	<0.000039	0.000230	<0.000039
Iron (mg/L)	<0.0135	<0.0135	0.208	0.217	0.245	0.488
Potassium (mg/L)	1.40	0.611	0.429	0.273	0.523	0.284
Lithium (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Table 5 (continued)

Parameter	GWA-1-22-1	GWC-1-22-1	GWC-2-22-1	GWC-3-22-1	GWC-4-22-1*	GWC-5-22-1
Magnesium (mg/L)	5.16	3.68	1.98	1.32	30.2	2.36
Manganese (mg/L)	0.00151 ^d	0.00052 ^d	0.00529	0.00597	0.424	0.0113
Molybdenum (mg/L)	0.000840 ^d	<0.000705	<0.000705	<0.000705	<0.000705	0.000720 ^d
Sodium (mg/L)	4.34	3.88	6.60	4.89	9.95	5.82
Nickel (mg/L)	0.00184 ^d	<0.000721	0.0114	0.000920 ^d	0.00133 ^d	0.00621
Phosphorus (mg/L)	0.0127 ^{c,d}	0.0199 ^{c,d}	0.0132 ^{c,d}	0.0150 ^{c,d}	0.0370 ^c	0.0446 ^c
Lead (mg/L)	<0.00126	<0.00126	<0.00126	<0.00126	<0.00126	<0.00126
Sulfur (mg/L)	4.63	0.0898	1.44	0.212	1.44	3.91
Antimony (mg/L)	<0.000919	<0.000919	<0.000919	<0.000919	<0.000919	<0.000919
Selenium (mg/L)	0.00309 ^d	<0.00258	0.00295 ^d	0.0421	0.00399 ^d	0.00356 ^d
Silicon (mg/L)	16.8	11.0	13.4	9.63	10.3	11.3
Tin (mg/L)	<0.00111	<0.00111	<0.00111	<0.00111	<0.00111	<0.00111
Strontium (mg/L)	0.0252 ^c	0.0173 ^c	0.0130 ^c	0.00465 ^c	0.0858 ^c	0.0175 ^c
Tellurium (mg/L)	<0.00170	<0.00170	<0.00170	<0.00170	<0.00170	<0.00170
Titanium (mg/L)	0.000660 ^d	0.00149	0.0307	0.0295	0.0241	0.0461
Thallium (mg/L)	<0.00125	<0.00125	<0.00125	<0.00125	<0.00125	<0.00125
Uranium (mg/L)	0.0867	<0.0132	<0.0132	<0.0132	<0.0132	<0.0132
Vanadium (mg/L)	0.000860 ^d	0.000930 ^d	0.00104 ^d	0.000900 ^d	<0.000681	0.00150 ^d
Tungsten (mg/L)	<0.00183	<0.00183	<0.00183	<0.00183	<0.00183	<0.00183
Zinc (mg/L)	<0.00309 ^c	<0.00309 ^c	0.00789 ^{c,d}	<0.00309 ^c	<0.00309 ^c	<0.00309 ^c
TOX (µg/L)	<20.9	<20.9	<20.9	24.6 ^d	27.0 ^d	<20.9

Table 5 (continued)

Parameter	GWA-1-22-1	GWC-1-22-1	GWC-2-22-1	GWC-3-22-1	GWC-4-22-1*	GWC-5-22-1
VOCs (µg/L):						
Acetone	<1.26	<1.26	41.0	<0.274	<0.274	<0.274
Acrolein	<1.21	<1.21	<0.525	<0.525	<0.525	<0.525
Acrylonitrile	<0.435	<0.435	<0.254	<0.254	<0.254	<0.254
Benzene	<0.0470	<0.0470	0.882	<0.0633	<0.0633	<0.0633
Bromodichloromethane	<0.0698	<0.0698	<0.0629	<0.0629	<0.0629	<0.0629
Bromoform	<0.160	<0.160	<0.0854	<0.0854	<0.0854	<0.0854
Bromomethane	<0.190	<0.190	<0.101	<0.101	<0.101	<0.101
2-Butanone (MEK)	<0.289	<0.289	<0.819	<0.819	<0.819	<0.819
Carbon disulfide	<0.0786	<0.0786	<0.0780	<0.0780	<0.0780	<0.0780
Carbon tetrachloride	<0.113	<0.113	<0.0527	<0.0527	<0.0527	<0.0527
Chlorobenzene	<0.0688	<0.0688	<0.0665	<0.0665	<0.0665	<0.0665
Chloroethane	<0.114	<0.114	<0.0693	<0.0693	<0.0693	<0.0693
Chloroform	<0.122	<0.122	<0.0773	<0.0773	<0.0773	<0.0773
Chloromethane	<0.141	<0.141	<0.0454	<0.0454	<0.0454	<0.0454
3-Chloropropene	<0.0951	<0.0951	<0.0735	<0.0735	<0.0735	<0.0735
Dibromochloromethane	<0.166	<0.166	<0.0454	<0.0454	<0.0454	<0.0454
Dibromomethane	<0.169	<0.169	<0.0692	<0.0692	<0.0692	<0.0692
trans-1,4-Dichloro-2-butene	<0.512	<0.512	<0.155	<0.155	<0.155	<0.155
Dichlorodifluoromethane	<0.235	<0.235	<0.0853	<0.0853	<0.0853	<0.0853
1,1-Dichloroethane	<0.0864	<0.0864	<0.0559	<0.0559	<0.0559	<0.0559
1,2-Dichloroethane	<0.125	<0.125	<0.0865	<0.0865	<0.0865	<0.0865
1,1-Dichloroethene	<0.0767	<0.0767	<0.608	<0.608	<0.608	<0.608
cis-1,2-Dichloroethene	<0.0831	<0.0831	<0.0541	<0.0541	<0.0541	<0.0541
trans-1,2-Dichloroethene	<0.103	<0.103	<0.0567	<0.0567	<0.0567	<0.0567
1,2-Dichloropropane	<0.0853	<0.0853	<0.0566	<0.0566	<0.0566	<0.0566
cis-1,3-Dichloropropene	<0.0545	<0.0545	<0.0614	<0.0614	<0.0614	<0.0614
trans-1,3-Dichloropropene	<0.0732	<0.0732	<0.0657	<0.0657	<0.0657	<0.0657

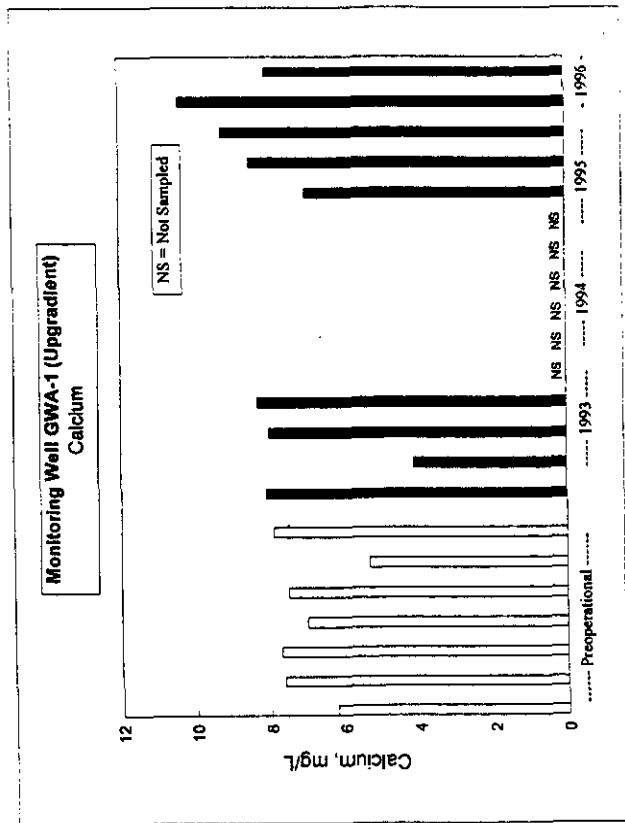
Table 5 (continued)

Parameter	GWA-1-22-1	GWC-1-22-1	GWC-2-22-1	GWC-3-22-1	GWC-4-22-1 ^a	GWC-5-22-1
Ethyl methacrylate	<0.0914	<0.0914	<0.0788	<0.0788	<0.0788	<0.0788
Ethylbenzene	<0.107	<0.107	0.393	<0.0655	<0.0655	<0.0655
2-Hexanone	<0.193	<0.193	<0.211	<0.211	<0.211	<0.211
Iodomethane	<0.0553	<0.0553	<0.0342	<0.0342	<0.0342	<0.0342
4-Methyl-2-pentanone (MIBK)	<0.172	<0.172	<0.146	<0.146	<0.146	<0.146
Methylene chloride	<0.159	<0.159	0.879 ^b	0.796 ^b	1.02 ^b	0.626 ^b
Styrene	<0.0981	<0.0981	<0.0596	0.0697 ^c	<0.0596	0.141 ^c
1,1,1,2-Tetrachloroethane	<0.141	<0.141	<0.0590	<0.0590	<0.0590	<0.0590
1,1,2,2-Tetrachloroethane	<0.227	<0.227	<0.0729	<0.0729	<0.0729	<0.0729
Tetrachloroethene	<0.0959	<0.0959	<0.118	<0.118	<0.118	<0.118
Toluene	<0.0619	<0.0619	2.58	<0.0537	<0.0537	<0.0537
1,1,1-Trichloroethane	<0.0927	<0.0927	<0.0388	<0.0388	<0.0388	<0.0388
1,1,2-Trichloroethane	<0.179	<0.179	<0.0714	<0.0714	<0.0714	<0.0714
Trichloroethene	<0.0931	<0.0931	<0.127	<0.127	<0.127	<0.127
Trichlorofluoromethane	<0.336	<0.336	<0.0681	<0.0681	<0.0681	<0.0681
1,2,3-Trichloropropane	<0.256	<0.256	<0.125	<0.125	<0.125	<0.125
Vinyl acetate	<0.0525	<0.0525	<0.0639	<0.0639	<0.0639	<0.0639
Vinyl chloride	<0.232	<0.232	<0.0307	<0.0307	<0.0307	<0.0307
m & p-Xylene	<0.131	<0.131	0.882 ^c	<0.184	<0.184	<0.184
o-Xylene	<0.789	<0.789	0.474	<0.0627	<0.0627	<0.0627

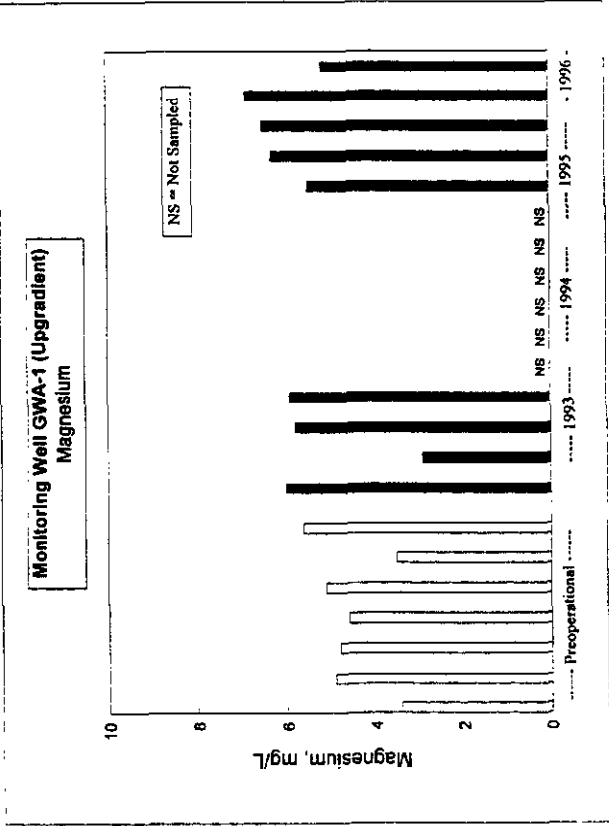
^a A duplicate sample (GWC-4-22-2) was collected from this well.

^b Detected in the method blank.

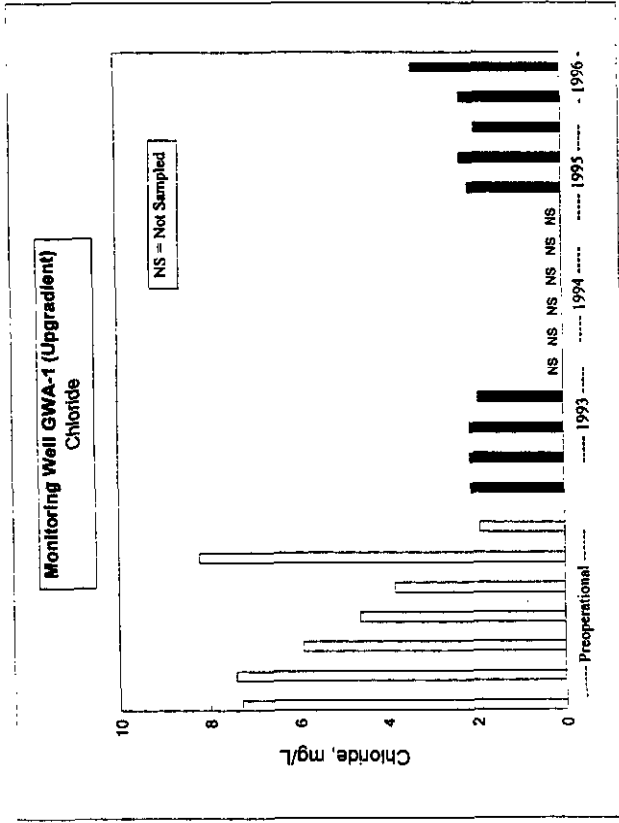
^c Less than five times the detection limit; results are expected to be less accurate as concentrations approach the detection limit.



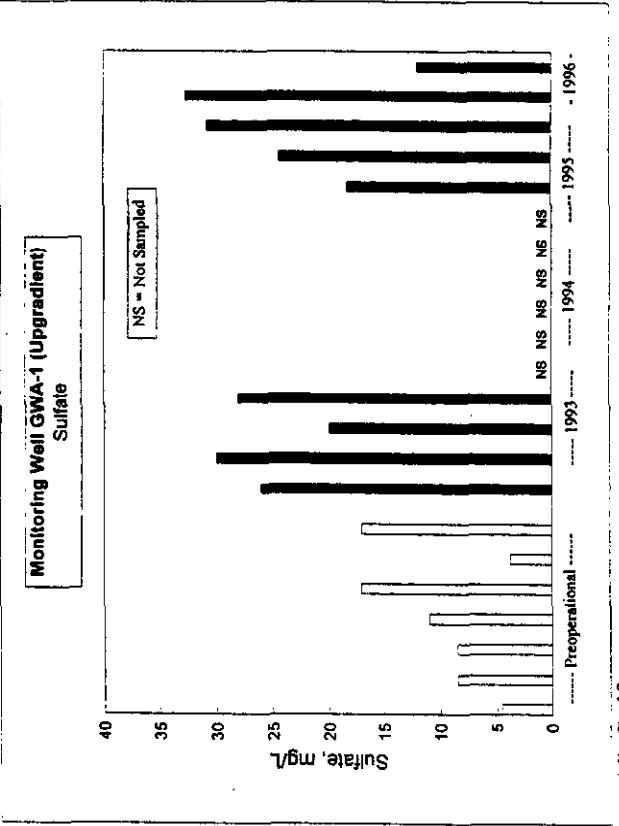
(a) Calcium



(b) Magnesium

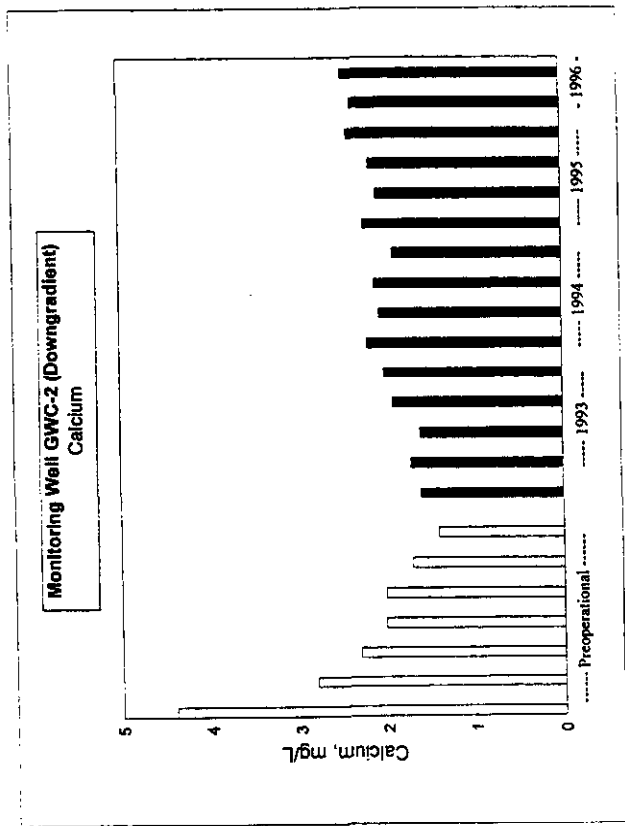


(c) Chloride

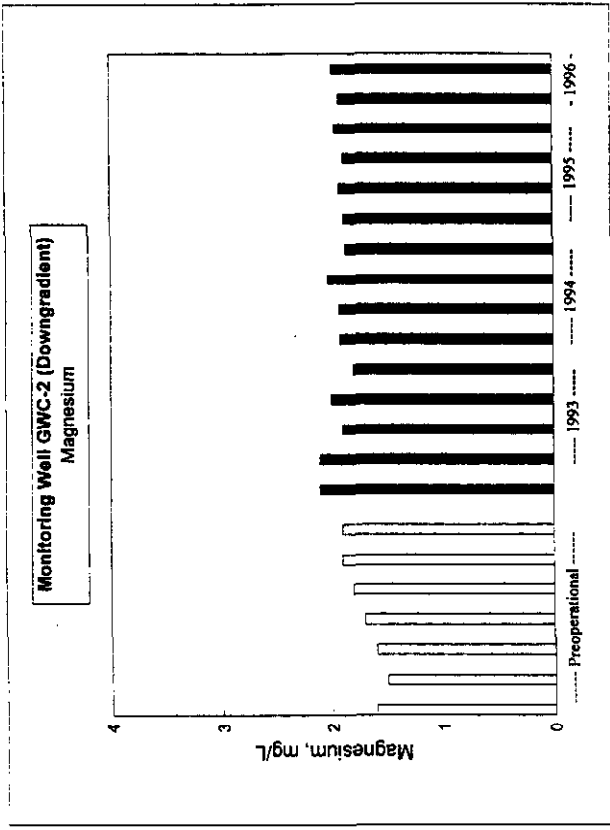


(d) Sulfate

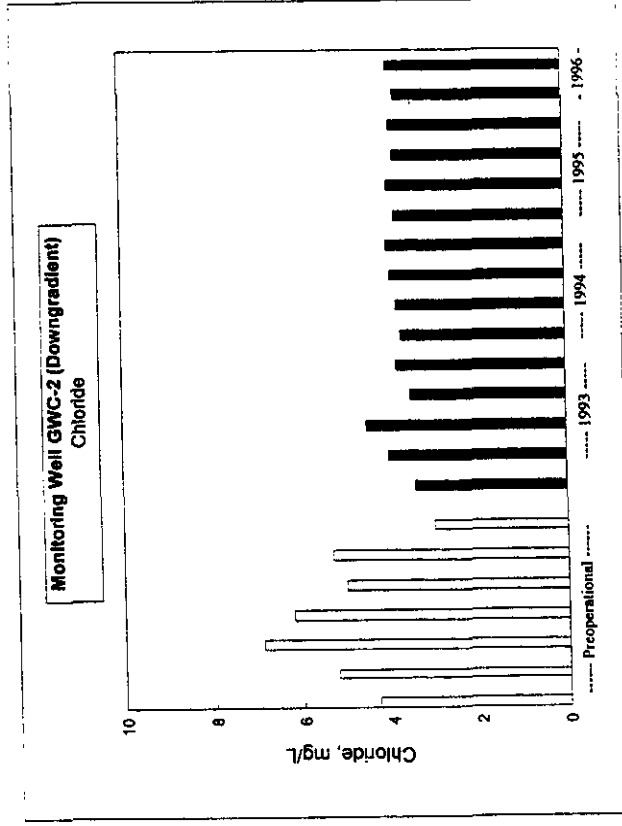
Figure 2. Historical Data for Representative Species from Well GWA-1 (Upgradient)



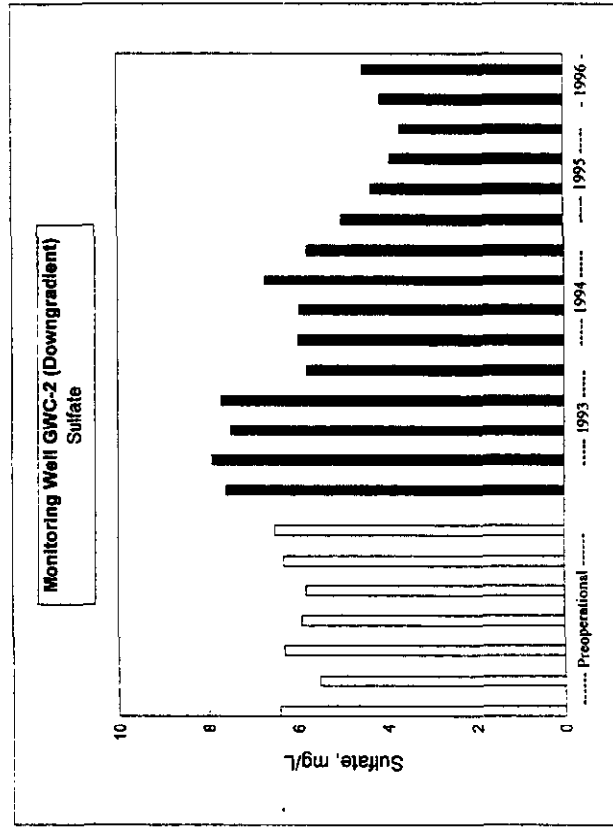
(a) Calcium



(b) Magnesium

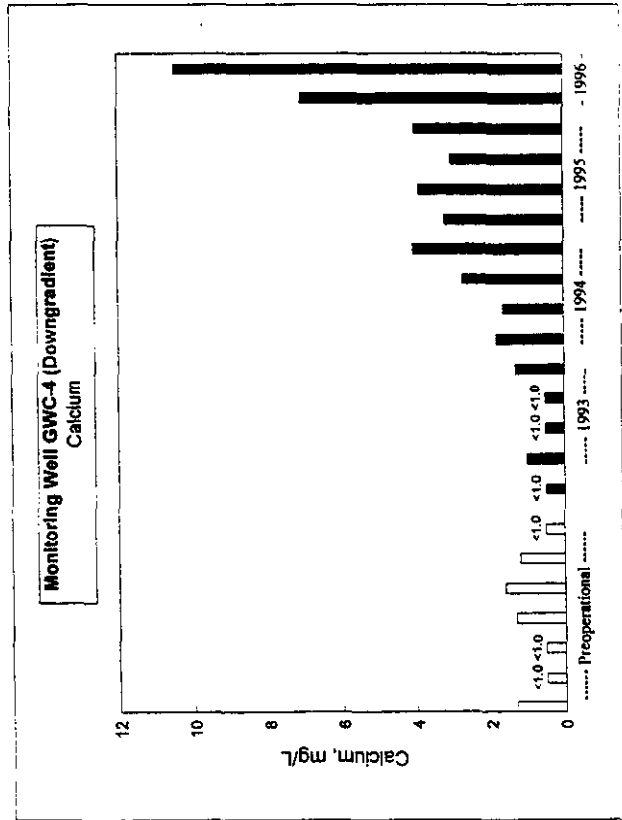


(c) Chloride

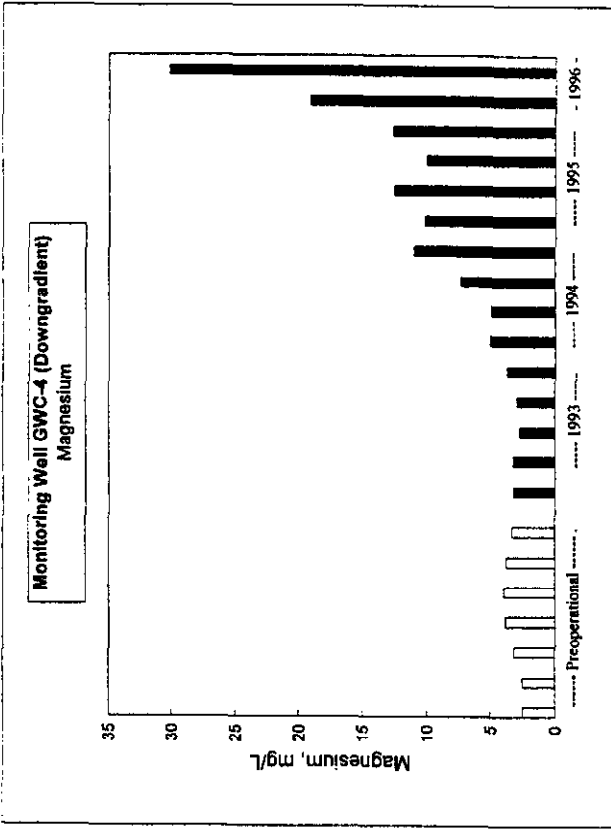


(d) Sulfate

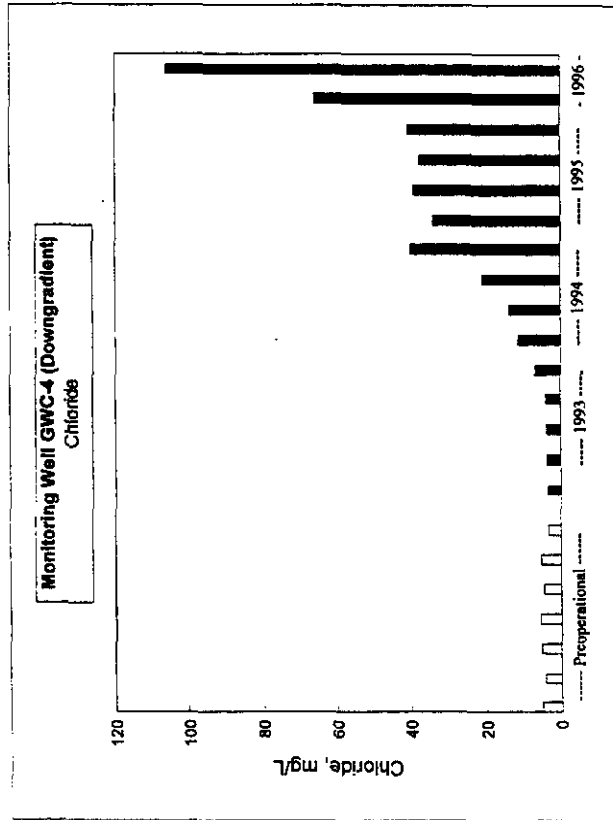
Figure 3. Historical Data for Representative Species from Well GWC-2 (Downgradient)



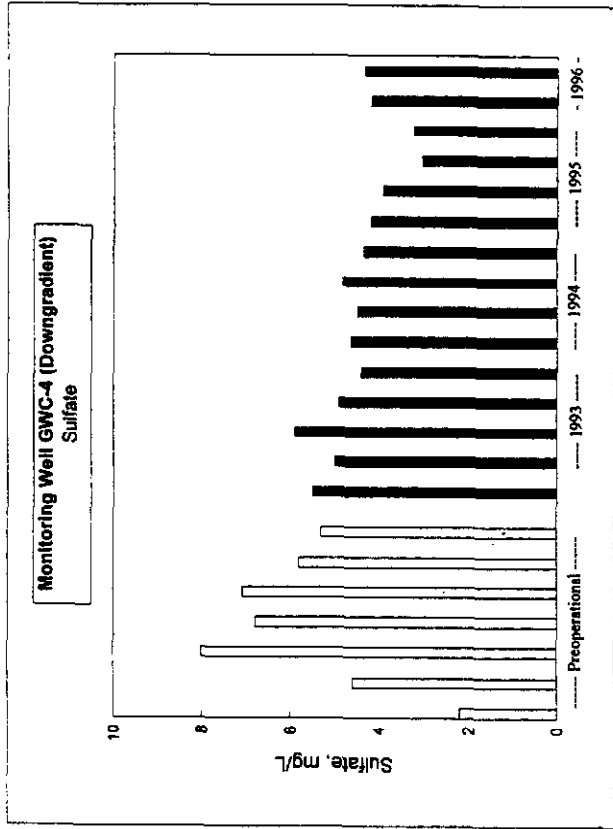
(a) Calcium



(b) Magnesium



(c) Chloride



(d) Sulfate

Figure 4. Historical Data for Representative Species from Well GWC-4 (Downgradient)

water from downgradient well GWC-4 were significantly higher than previously-measured levels. The current monitoring results continue to show a generally upward trend in the concentrations of these gypsum constituents in well GWC-4. This trend was first noticed in the fourth quarter of 1993. There have been no significant increases in the levels of these species in either the upgradient well or the other downgradient wells.

The source(s) of the higher levels of gypsum constituents in well GWC-4 is (are) not clearly apparent. However, there are several potential sources, and three of the more plausible are briefly described below:

- ▶ A breach of the dike surrounding the gypsum pond occurred on July 24, 1993. This breach happened in the vicinity of GWC-4. Since the rise in the levels of chloride, magnesium, and calcium in GWC-4 was first noticed in the fourth quarter of 1993, it seemed likely that the increase was a result of the dike breach. The validity of this assumption appeared to be reinforced in the first quarter of 1995, when the levels of the three species declined in GWC-4. Such a decline would be expected as the amount of spilled material remaining in the soil diminished due to gradual downward migration. However, no further decrease in the GWC-4 concentrations occurred over the following three quarters of 1995. However, further increases in the levels of chloride, magnesium, and calcium have been noted in the last two quarters (first and second quarters of 1996). Although this behavior could still be due to the 1993 breach (changes in rainfall patterns and/or acidity of the rain could cause higher migration rates and/or increased leaching of the soil), other factors could be contributing to or causing higher levels of gypsum constituents in the groundwater in the vicinity of GWC-4.
- ▶ The groundwater sampling team has noticed that there appear to have been periodic leaks from a slurry pump and associated valves/fittings that are situated in close proximity (30-40 feet) to GWC-4. Slurry has periodically leaked onto the ground and flowed across the soil surface to form small pools near (10-15 ft) GWC-4. This material could be the source of at least some of the increased levels of chloride, calcium, and magnesium observed in the 1996 monitoring.
- ▶ The possibility that the increased levels of the slurry constituents in GWC-4 could be caused by a leak in the liner under the gypsum stacking area cannot be discounted. There is no indication of leakage in any of the other groundwater monitoring wells, but this does not preclude the presence of a liner leak at a location immediately upgradient from GWC-4.

At this time, it is not possible to determine which, if any, of the above possible causes is contributing the bulk of the chloride, etc., being seen in GWC-4. Some clarification may be forthcoming as more results of the continuing groundwater monitoring activities become available.

Although the contaminant levels in the groundwater at this location continue to be higher than they were prior to the breach of the gypsum pond dike, they are still low. For example, the latest chloride concentration is less than 43% of the maximum concentration recommended in the National Secondary Drinking Water Standards (i.e., 106 mg/L versus 250 mg/L).

Mercury was detected in the sample from well GWC-4. Although the concentration was very low (0.000230 mg/L), this is the first time that mercury has ever been detected in any of the groundwater samples obtained during this monitoring program.

Low concentrations of several volatile organics were also found in some of the groundwater samples. Methylene chloride was presented in samples from several downgradient wells, (GWC-2, GWC-3, GWC-4, and GWC-5). Since methylene chloride is a common laboratory solvent, these results are considered suspect. Acetone, benzene, ethylbenzene, toluene, and the xylene isomers were all detected in the sample from well GWC-2, and styrene was detected in the sample from well GWC-3. Although it is likely that these organics were present due to sample contamination, it would be prudent to collect samples for volatile organics analysis as part of next quarter's monitoring activities.

4.0 Summary of QA/QC Activities

A number of QA/QC activities are being performed, as specified in the project's EMP, to assure that the data obtained meet project objectives. These include the following:

- ▶ Groundwater samples were split for independent analysis by a laboratory selected by SCS.
- ▶ Established sampling and analytical methods were specified and used. All samples were analyzed within the specified holding times, as outlined in Section 2. There were no deviations from the specified methods during this quarter's monitoring effort.

- ▶ Chain-of-custody procedures established in the test plan for this project were observed.
- ▶ In the laboratory, method blanks, control samples, and matrix spikes were analyzed in conjunction with the sample analyses, following recognized good laboratory practice. Specified recovery limits (typically 80 to 120%) were met for all analytes in the laboratory control samples. Recoveries of silicon were low (i.e., from 31% to 73%), making the results for this analyte somewhat suspect.
- ▶ Duplicate samples were obtained in the field and analyzed for all parameters. Replicate analyses were performed for a smaller number of parameters.

The results of the analysis of field and laboratory duplicates are summarized in Table 6 for those parameters measured above the detection limit in at least one sample. Complete results are provided in Appendix B. Differences in the duplicate analyses results were small for most species (i.e., less than 10-20%). Unusually large differences between sample duplicates were obtained for chromium, iron, and titanium; the results for these analytes may be suspect. The results of the duplicate analyses were all within specified quality limits.

Several volatile organics were found, but usually only in the replicate sample; this may be evidence that their presence was due to sample contamination. Methylene chloride was found in both samples, but this species was also found in the method blank, suggesting that it may have been present due to laboratory contamination.

Table 6. Results for Duplicate Samples—Second Quarter 1996

Parameter	Units	Sample GWC-4-22-1	Field Duplicate GWC-4-22-2	% Diff. ^a	Duplicate Analysis GWC-4-22-2	% RPD ^b	Spec. Limit
Total Dissolved Solids	mg/L	266	262	-1.5	274	4.5	15
Bromide	mg/L	1.08	1.06	-1.9			
Chloride	mg/L	106	99.5	-6.5			
Fluoride	mg/L	0.0305 ^c	0.0379 ^c	19.5			
Sulfate	mg/L	4.33	4.29	-0.9			
Nitrate-Nitrite as N	mg/L	2.10	2.11	0.5			
Total Organic Halides	μg/L	24.6 ^d	32.2 ^d	23.6	27.0 ^d	17.6	20
Aluminum	mg/L	0.179 ^c	1.62 ^c	89.0			
Boron	mg/L	1.98	2.37	16.5			
Barium	mg/L	0.0634	0.11	42.4			
Beryllium	mg/L	0.00135 ^c	0.00156 ^c	13.5			
Calcium	mg/L	10.5	12.8	18.0			
Cadmium	mg/L	<0.000156	0.00038 ^d	NC			
Cobalt	mg/L	0.00406	0.00632	35.8			
Copper	mg/L	<0.00136	0.00278 ^d	NC			
Chromium	mg/L	0.00275	0.025	89.0			
Mercury	mg/L	0.00023	0.00024	4.2			
Iron	mg/L	0.245	2.23	89.0			
Potassium	mg/L	0.523	1.33	60.7			
Magnesium	mg/L	30.2	37.6	19.7			
Manganese	mg/L	0.424	0.534	20.6			
Sodium	mg/L	9.95	11.1	10.4			
Nickel	mg/L	0.00133 ^d	0.00577	77.0			
Phosphorus	mg/L	0.037 ^c	0.158 ^c	76.6			
Sulfur	mg/L	1.44	1.59	9.4			
Selenium	mg/L	0.00399 ^d	<0.00258	NC			
Silicon	mg/L	10.3	14.7	29.9			
Strontium	mg/L	0.0858 ^c	0.104 ^c	17.5			
Titanium	mg/L	0.0241	0.306	92.1			
Vanadium	mg/L	<0.000681	0.00567	NC			
Zinc	mg/L	<0.00309 ^c	0.00602 ^{c,d}	NC			
Acetone	μg/L	<0.274	19.8	NC			
Benzene	μg/L	<0.0633	0.174 ^d	NC			

Table 6 (continued)

Parameter	Units	Sample GWC-4-22-1	Field Duplicate GWC-4-22-2	% Diff. ^a	Duplicate Analysis GWC-4-22-2	% RPD ^b	Spec. Limit
Ethylbenzene	µg/L	<0.0655	0.0724 ^d	NC			
Methylene chloride	µg/L	1.02 ^c	1.17 ^c	12.8			
Toluene	µg/L	<0.0537	0.55	NC			
m&p-Xylene	µg/L	<0.184	0.196 ^d	NC			

^a% Difference = (GWC-4-22-2 - GWC-4-22-1)/GWC-4-22-1 x 100%.

^b RPD = Relative Percent Difference, defined as follows:

$$RPD = \frac{(\text{Larger Value} - \text{Smaller Value})}{(\text{Larger Value} + \text{Smaller Value})/2} \times 100\%$$

^c Detected in the method blank

^d Value is less than five times the detection limit; results are expected to be less accurate as concentrations approach the detection limit.

NC = Not computed.

Appendix A

Historical Monitoring Data for Selected Parameters

Table A-1. Historical Monitoring Data for Selected Parameters

Parameter	Baseline Monitoring							Round 8 29-30 Dec 92
	Round 1 6 Sep 90	Round 2 2 Nov 90	Round 3 8-9 Jan 91	Round 4 11 Mar 91	Round 5 8 May 91	Round 6 1-2 Jul 91	Round 7 3-4 Sep 92	
Well: GWA-1 (Formerly CW-1)								
pH	5.86	6.27	5.6	6.7	6.05	5.94	6.4	5.7
Conductivity	98	114	112	121	104	85	116	101
Alkalinity	15.6	22.3	25.8	27.1	25	16.4	35.4	22.7
TDS	94	87	86	84	90	77	99	110
Chloride	7.3	7.4	5.9	4.6	3.8	8.2	1.9	2.1
Sulfate	4.5	8.5	8.5	11	17	3.7	17	26
Calcium	6.2	7.6	7.7	7	7.5	5.3	7.9	8.1
Magnesium	3.4	4.9	4.8	4.6	5.1	3.5	5.6	6.0
Sodium	4.2	4.8	4.9	4.3	4.4	3.8	4.1	4.2
Silicon	9.8	11	14	16	17	9.6	15	17
Parameter	Round 9 30-31 Mar 93	Round 10 21 Jun 93	Round 11 23-24 Sep 93	Round 12 5 Jan 94	Round 13 22-23 Mar 94	Round 14 21-22 Jun 94	Round 15 31 Aug 94	Round 16 20-21 Dec 94
Well: GWA-1 (Formerly CW-1) (Continued)								
pH	6.82	6.1	5.9	NS	NS	NS	NS	NS
Conductivity	128	100	110	NS	NS	NS	NS	NS
Alkalinity	28	27	24.8	NS	NS	NS	NS	NS
TDS	110	116	99	NS	NS	NS	NS	NS
Chloride	2.1	2.1	1.9	NS	NS	NS	NS	NS
Sulfate	30	20	28	NS	NS	NS	NS	NS
Calcium	4.1	8.0	8.3	NS	NS	NS	NS	NS
Magnesium	2.9	5.8	5.9	NS	NS	NS	NS	NS
Sodium	4.0	4.4	4.3	NS	NS	NS	NS	NS
Silicon	11	18	17	NS	NS	NS	NS	NS
Parameter	Round 17 28-29 Mar 95	Round 18 13-14 Jun 95	Round 19 11-12 Sep 95	Round 20 12-13 Dec 95	Round 21 18-19 Mar 96	Round 22 20-21 Jun 96		
Well: GWA-1 (Formerly CW-1) (Continued)								
pH	NS	6.31	6.38	6.08	NM	6.14		
Conductivity	NS	116	165	118	NM	116		
Alkalinity	NS	28.6	23	NM	NM	NM		
TDS	NS	108	114	93	113	105		
Chloride	NS	2.10	2.27	1.94	2.26	3.3		
Sulfate	NS	18.3	24.4	30.8	32.7	12		
Calcium	NS	6.98	8.47	9.21	10.4	8.03		
Magnesium	NS	5.47	6.30	6.51	6.87	5.16		
Sodium	NS	4.29	4.53	3.50	4.65	4.34		
Silicon	NS	16.6	17.6	13.2	14.3	16.8		

Table A-1 (continued)

Parameter	Baseline Monitoring							Round 8 29-30 Dec 92
	Round 1 6 Sep 90	Round 2 2 Nov 90	Round 3 8-9 Jan 91	Round 4 11 Mar 91	Round 5 8 May 91	Round 6 1-2 Jul 91	Round 7 3-4 Sep 92	
Well: GWC-1 (Formerly CW-2)								
pH	6.09	5.79	5.62	5.93	6.04	5.96	6.1	4.5
Conductivity	81	70	72	63	63	66	78	57
Alkalinity	21.7	22.9	24.4	22.1	20.5	25.8	27.8	23.3
TDS	81	51	59	52	48	64	64	68
Chloride	3.5	2.8	3.1	3.4	2.8	2.5	2.5	2.6
Sulfate	7.6	5	2.8	<0.05	1.2	1.5	3.2	3.3
Calcium	3.9	3.6	3.8	3.2	3.4	3.6	4.3	4.0
Magnesium	2.3	2.5	2.8	2.2	2.4	2.5	3.2	3.0
Sodium	5.9	5.2	4.3	4.1	4.2	4.1	4.0	4.0
Silicon	9	9	9.2	11	11	11	11	12
Parameter	Round 9 30-31 Mar 93	Round 10 21 Jun 93	Round 11 23-24 Sep 93	Round 12 5 Jan 94	Round 13 22-23 Mar 94	Round 14 21-22 Jun 94	Round 15 31 Aug 94	Round 16 20-21 Dec 94
Well: GWC-1 (Formerly CW-2) (Continued)								
pH	5.83	6.0	6.0	6.1	5.89	5.91	6.09	6.09
Conductivity	67	57	61	74	61	60	68	76
Alkalinity	22.5	24.1	27.3	29.9	25	30.1	25	22
TDS	43	74	70	22	66	56	64	46
Chloride	2.6	2.6	2.5	3.5	2.43	2.77	2.71	2.68
Sulfate	2.2	<2.5	2.6	3.3	1.75	1.77	1.64	1.19
Calcium	8.8	4.1	4.1	5.1	4.72	4.65	5.00	4.50
Magnesium	6.2	2.9	3.0	3.7	3.14	3.39	3.70	3.33
Sodium	4.2	4.0	3.8	4.3	4.12	4.16	4.32	4.10
Silicon	16	12	12	12.7	11.9	11.9	11.8	10.9
Parameter	Round 17 28-29 Mar 95	Round 18 13-14 Jun 95	Round 19 11-12 Sep 95	Round 20 12-13 Dec 95	Round 21 18-19 Mar 96	Round 22 20-21 Jun 96		
Well: GWC-1 (Formerly CW-2) (Continued)								
pH	6.05	5.70	6.00	5.92	6.04	5.84		
Conductivity	77	66	79	82	86	83		
Alkalinity	29.1	31.0	31	31.2	24.2	35		
TDS	63	72	58	49	71	63		
Chloride	2.64	2.76	2.77	2.45	2.20	2.47		
Sulfate	1.23	1.10	1.06	<0.0491	1.06	<0.154		
Calcium	5.30	5.12	5.12	5.86	5.91	5.62		
Magnesium	3.65	3.83	3.80	4.23	4.11	3.68		
Sodium	4.21	4.15	4.28	4.44	4.38	3.88		
Silicon	10.9	11.8	12.3	10.0	11.6	11		

Table A-1 (continued)

Parameter	Baseline Monitoring							Round 8 29-30 Dec 92
	Round 1 6 Sep 90	Round 2 2 Nov 90	Round 3 8-9 Jan 91	Round 4 11 Mar 91	Round 5 8 May 91	Round 6 1-2 Jul 91	Round 7 3-4 Sep 92	
Well: GWC-2 (Formerly CW-3)								
pH	5.64	5.6	5.04	5.5	4.97	5.65	5.5	4.6
Conductivity	76	69	64	66	33	71	66	56
Alkalinity	23.5	19.3	15.2	16.9	12.2	17.5	18.2	17.3
TDS	76	50	55	55	63	65	79	71
Chloride	4.3	5.2	6.9	6.2	5	5.3	3.0	3.4
Sulfate	6.4	5.5	6.3	5.9	5.8	6.3	6.5	7.6
Calcium	4.4	2.8	2.3	2	2	1.7	1.4	1.6
Magnesium	1.6	1.5	1.6	1.7	1.8	1.9	1.9	2.1
Sodium	7.3	7.4	6.9	7	7.5	7.6	7.5	7.4
Silicon	10	10	9.3	12	11	11	11	13
Parameter	Round 9 30-31 Mar 93	Round 10 21 Jun 93	Round 11 23-24 Sep 93	Round 12 5 Jan 94	Round 13 22-23 Mar 94	Round 14 21-22 Jun 94	Round 15 31 Aug 94	Round 16 20-21 Dec 94
Well: GWC-2 (Formerly CW-3) (Continued)								
pH	5.29	5.4	5.6	5.75	5.5	5.72	5.63	5.34
Conductivity	67	56	49	53	57	59	60	66
Alkalinity	12.5	14.1	15.9	15.7	14	16.2	7.0	6.9
TDS	68	77	60	27	76	58	60	65
Chloride	4.0	4.5	3.5	3.8	3.7	3.79	3.92	4.00
Sulfate	7.9	7.5	7.7	5.78	5.97	5.95	6.73	5.78
Calcium	1.7	1.6	1.9	2.0	2.19	2.05	2.11	1.89
Magnesium	2.1	1.9	2.0	1.8	1.92	1.93	2.03	1.87
Sodium	7.5	6.7	6.8	7.0	7.15	7.09	7.17	6.96
Silicon	12.0	11	13	12.9	13.3	13.0	12.9	12.2
Parameter	Round 17 28-29 Mar 95	Round 18 13-14 Jun 95	Round 19 11-12 Sep 95	Round 20 12-13 Dec 95	Round 21 18-19 Mar 96	Round 22 20-21 Jun 96		
Well: GWC-2 (Formerly CW-3) (Continued)								
pH	5.53	5.39	5.41	5.45	5.79	5.48		
Conductivity	65	65	67.5	67	66	59		
Alkalinity	13.3	14.5	13.5	13.0	NM	15		
TDS	63	64	54	53	69	75		
Chloride	3.81	3.97	3.83	3.91	3.79	3.93		
Sulfate	4.98	4.33	3.90	3.68	4.11	4.52		
Calcium	2.23	2.08	2.16	2.41	2.37	2.46		
Magnesium	1.88	1.92	1.88	1.96	1.92	1.98		
Sodium	6.79	6.85	6.94	7.11	7.04	6.6		
Silicon	12.2	13.4	13.5	12.9	13.7	13.4		

Table A-1 (continued)

Parameter	Baseline Monitoring							Round 8 29-30 Dec 92
	Round 1 6 Sep 90	Round 2 2 Nov 90	Round 3 8-9 Jan 91	Round 4 11 Mar 91	Round 5 8 May 91	Round 6 1-2 Jul 91	Round 7 3-4 Sep 92	
Well: GWC-3 (Formerly CW-4)								
pH	5.4	5.15	4.8	4.73	6.19	5.08	5.25	3.8
Conductivity	40	35	30	34	32	35	32	27
Alkalinity	11.5	15.2	9.9	11	7	11.1	10.0	8.9
TDS	50	35	31	34	39	41	28	37
Chloride	3	2.8	3.2	3.4	3.1	3.1	2.0	2.3
Sulfate	2.6	2.1	<0.05	<0.05	0.9	1.5	1.7	2.6
Calcium	1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Magnesium	1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sodium	4.4	4.5	4.3	4.1	4.6	4.3	4.1	4.0
Silicon	8	7.8	3.9	8.5	8.6	8.3	8.3	9.3
Parameter	Round 9 30-31 Mar 93	Round 10 21 Jun 93	Round 11 23-24 Sep 93	Round 12 5 Jan 94	Round 13 22-23 Mar 94	Round 14 21-22 Jun 94	Round 15 31 Aug 94	Round 16 20-21 Dec 94
Well: GWC-3 (Formerly CW-4)								
pH	5.23	5.2	5.3	5.5	5.18	5.43	5.41	5.06
Conductivity	33	27	27	22	28	29	30	36
Alkalinity	7.0	8.5	9.1	9.3	7.5	8.5	77	4.8
TDS	44	52	21	<8.7	42	36	39	30
Chloride	2.7	2.9	2.8	2.8	2.77	2.76	2.91	3.02
Sulfate	1.6	<2.5	<2.5	<0.06	1.38	1.52	<0.0471	1.01
Calcium	<1.0	<1.0	<1.0	<1.0	0.392	0.321	0.328	0.335
Magnesium	<1.0	<1.0	<1.0	<1.0	0.962	0.935	1.00	1.02
Sodium	4.1	3.9	3.8	4.1	4.35	4.14	4.17	4.34
Silicon	9.0	8.7	9.2	9.7	10.1	9.16	9.15	8.94
Parameter	Round 17 28-29 Mar 95	Round 18 13-14 Jun 95	Round 19 11-12 Sep 95	Round 20 12-13 Dec 95	Round 21 18-19 Mar 96	Round 22 20-21 Jun 96		
Well: GWC-3 (Formerly CW-4)								
pH	5.10	5.10	5.02	5.27	5.25	5.08		
Conductivity	36	37	45	39	42	41		
Alkalinity	8.6	8.5	9.0	9.1	7.4	9.2		
TDS	44	52	37	36	49	49		
Chloride	3.15	3.13	3.64	3.52	3.46	3.83		
Sulfate	<0.0471	0.968	0.595	0.233	<0.0491	0.192		
Calcium	0.441	0.314	0.389	0.436	0.361	0.433		
Magnesium	1.10	1.08	1.21	1.26	1.11	1.32		
Sodium	4.39	4.47	4.83	5.14	5.14	4.89		
Silicon	8.97	8.90	9.94	5.18	9.48	9.63		

Table A-1 (continued)

Parameter	Baseline Monitoring							Round 8 29-30 Dec 92
	Round 1 6 Sep 90	Round 2 2 Nov 90	Round 3 8-9 Jan 91	Round 4 11 Mar 91	Round 5 8 May 91	Round 6 1-2 Jul 91	Round 7 3-4 Sep 92	
Well: GWC-4 (Formerly CW-5)								
pH	5.34	4.97	4.8	4.6	5.03	5.4	5.05	3.9
Conductivity	62	62	66	72	54	70	72	58
Alkalinity	12.5	15.3	13.1	15.1	8.6	14.2	11.5	8.0
TDS	61	52	60	51	58	64	61	65
Chloride	5	4.2	5	5.6	4.5	5.2	3.1	3.4
Sulfate	2.2	4.6	8	6.8	7.1	5.8	5.3	5.5
Calcium	1.3	<1.0	<1.0	1.3	1.6	1.2	<1.0	<1.0
Magnesium	2.5	2.5	3.1	3.8	3.9	3.7	3.3	3.2
Sodium	5.4	5.8	5.3	5.1	5	5.2	4.8	4.9
Silicon	9.9	9.1	4.7	9.7	9.2	10	8.6	9.5
Parameter	Round 9 30-31 Mar 93	Round 10 21 Jun 93	Round 11 23-24 Sep 93	Round 12 5 Jan 94	Round 13 22-23 Mar 94	Round 14 21-22 Jun 94	Round 15 31 Aug 94	Round 16 20-21 Dec 94
Well: GWC-4 (Formerly CW-5) (Continued)								
pH	5.04	5.2	5.2	5.2	4.98	5.2	5.10	4.92
Conductivity	64	52	54	63	72	81	108	188
Alkalinity	6.0	6.9	7.0	9.2	5.0	10.3	5.0	3.8
TDS	63	55	44	20	64	75	93	110
Chloride	3.6	3.6	3.8	6.7	11.3	13.5	20.8	39.7
Sulfate	5.0	5.9	4.9	4.4	4.64	4.50	4.83	4.34
Calcium	1.0	<1.0	<1.0	1.3	1.81	1.62	2.73	4.04
Magnesium	3.2	2.7	2.9	3.7	5.05	4.98	7.32	11.0
Sodium	4.7	4.4	4.4	5.0	5.33	4.87	5.80	7.86
Silicon	8.7	8.3	9.3	9.8	9.91	9.18	9.91	10.1
Parameter	Round 17 28-29 Mar 95	Round 18 13-14 Jun 95	Round 19 11-12 Sep 95	Round 20 12-13 Dec 95	Round 21 18-19 Mar 96	Round 22 20-21 Jun 96		
Well: GWC-4 (Formerly CW-5) (Continued)								
pH	5.10	4.98	4.79	4.89	4.98	4.71		
Conductivity	163	148	180	196	288	412		
Alkalinity	9.0	4.6	4.5	4.2	5.6	6.9		
TDS	113	132	123	107	175	266		
Chloride	34.1	39.1	37.5	40.5	66	106		
Sulfate	4.18	3.91	3.03	3.21	4.18	4.33		
Calcium	3.21	3.89	3.03	3.99	7.10	10.5		
Magnesium	10.2	12.5	10.0	12.6	19.1	30.2		
Sodium	7.63	8.61	8.42	8.00	9.36	9.95		
Silicon	9.36	10.0	10.4	11.4	10.8	10.3		

Table A-1 (continued)

Parameter	Baseline Monitoring							Round 8 29-30 Dec 92
	Round 1 6 Sep 90	Round 2 2 Nov 90	Round 3 8-9 Jan 91	Round 4 11 Mar 91	Round 5 8 May 91	Round 6 1-2 Jul 91	Round 7 3-4 Sep 92	
Well: GWC-5								
pH							5.6	4.4
Conductivity							61	60
Alkalinity							14.8	13.5
TDS							91	86
Chloride							1.8	2.6
Sulfate							8.8	10
Calcium							2.1	2.7
Magnesium							1.9	2.3
Sodium							6.0	6.2
Silicon							12	14
Parameter	Round 9 30-31 Mar 93	Round 10 21 Jun 93	Round 11 23-24 Sep 93	Round 12 5 Jan 94	Round 13 22-23 Mar 94	Round 14 21-22 Jun 94	Round 15 31 Aug 94	Round 16 20-21 Dec 94
Well: GWC-5 (Continued)								
pH	6.13	5.4	5.6	7.0	5.38	5.42	5.53	5.57
Conductivity	54	41	40	39	43	45	43	47
Alkalinity	12.5	10.2	11.5	10.8	8.6	10.8	13.0	11.2
TDS	67	56	50	29	53	61	61	45
Chloride	2.7	2.9	2.5	2.6	2.34	2.48	2.67	2.70
Sulfate	7.4	6.7	5.5	5.3	6.56	7.65	6.68	5.75
Calcium	2.2	1.6	1.4	1.3	1.65	1.38	1.26	1.20
Magnesium	1.8	1.5	1.4	1.3	1.6	1.55	1.46	1.32
Sodium	5.7	5.5	5.2	5.5	5.74	5.77	5.38	5.43
Silicon	13	12	12	11.4	11.8	11.3	10.5	10.3
Parameter	Round 17 28-29 Mar 95	Round 18 13-14 Jun 95	Round 19 11-12 Sep 95	Round 20 12-13 Dec 95	Round 21 18-19 Mar 96	Round 22 20-21 Jun 96		
Well: GWC-5 (Continued)								
pH	5.52	5.60	5.20	5.28	5.54	5.24		
Conductivity	50	52	60	53	67	64		
Alkalinity	9.5	8.5	11.0	9.1	4.7	10.6		
TDS	50	64	64	45	72	76		
Chloride	2.54	2.62	2.70	2.93	2.78	2.98		
Sulfate	6.45	6.64	6.80	7.20	13.3	9.87		
Calcium	1.51	1.31	1.48	1.97	2.28	1.96		
Magnesium	1.59	1.73	1.78	6.02	2.65	2.36		
Sodium	5.34	5.54	6.12	5.82	6.43	5.82		
Silicon	10.3	11.1	11.5	16.2	11.3	11.3		

Appendix B
QA/QC Results

Table B-1. Results for Duplicate Samples—Second Quarter 1996

Parameter	Units	Sample GWC-4-22-1	Field Duplicate GWC-4-22-2	% Diff. ^a	Duplicate Analysis GWC-4-22-2	% RPD ^b	Spec. Limit
Total Dissolved Solids	mg/L	266	262	-1.5	274	4.5	15
Bromide	mg/L	1.08	1.06	-1.9			
Chloride	mg/L	106	99.5	-6.5			
Fluoride	mg/L	0.0305 ^c	0.0379 ^c	19.5			
Sulfate	mg/L	4.33	4.29	-0.9			
Total Organic Carbon	mg/L	<0.117	<0.117	NC			
Nitrate-Nitrite as N	mg/L	2.10	2.11	0.5			
Total Organic Halides	µg/L	24.6 ^d	32.2 ^d	23.6	27.0 ^d	17.6	20
Silver	mg/L	<0.000501	<0.000501	NC			
Aluminum	mg/L	0.179 ^c	1.62 ^c	89.0			
Arsenic	mg/L	<0.00392	<0.00392	NC			
Boron	mg/L	1.98	2.37	16.5			
Barium	mg/L	0.0634	0.11	42.4			
Beryllium	mg/L	0.00135 ^c	0.00156 ^c	13.5			
Bismuth	mg/L	<0.00271	<0.00271	NC			
Calcium	mg/L	10.5	12.8	18.0			
Cadmium	mg/L	<0.000156	0.00038 ^d	NC			
Cobalt	mg/L	0.00406	0.00632	35.8			
Copper	mg/L	<0.00136	0.00278 ^d	NC			
Chromium	mg/L	0.00275	0.025	89.0			
Mercury	mg/L	0.00023	0.00024	4.2			
Iron	mg/L	0.245	2.23	89.0			
Potassium	mg/L	0.523	1.33	60.7			
Lithium	mg/L	<0.01	<0.01	NC			
Magnesium	mg/L	30.2	37.6	19.7			
Manganese	mg/L	0.424	0.534	20.6			
Molybdenum	mg/L	<0.000705	<0.000705	NC			
Sodium	mg/L	9.95	11.1	10.4			
Nickel	mg/L	0.00133 ^d	0.00577	77.0			
Phosphorus	mg/L	0.037 ^c	0.158 ^c	76.6			
Lead	mg/L	<0.00126	<0.00126	NC			
Sulfur	mg/L	1.44	1.59	9.4			
Antimony	mg/L	<0.000919	<0.000919	NC			
Selenium	mg/L	0.00399 ^d	<0.00258	NC			

Table B-1 (continued)

Parameter	Units	Sample GWC-4-22-1	Field Duplicate GWC-4-22-2	% Diff. ^a	Duplicate Analysis GWC-4-22-2	% RPD ^b	Spec. Limit
Silicon	mg/L	10.3	14.7	29.9			
Tin	mg/L	<0.00111	<0.00111	NC			
Strontium	mg/L	0.0858 ^c	0.104 ^c	17.5			
Tellurium	mg/L	<0.00170	<0.00170	NC			
Titanium	mg/L	0.0241	0.306	92.1			
Thallium	mg/L	<0.00125	<0.00125	NC			
Uranium	mg/L	<0.0132	<0.0132	NC			
Vanadium	mg/L	<0.000681	0.00567	NC			
Tungsten	mg/L	<0.00183	<0.00183	NC			
Zinc	mg/L	<0.00309 ^c	0.00602 ^{c,d}	NC			
Acetone	μg/L	<0.274	19.8	NC			
Acrolein	μg/L	<0.525	<0.525	NC			
Acrylonitrile	μg/L	<0.254	<0.254	NC			
Benzene	μg/L	<0.0633	0.174 ^d	NC			
Bromodichloromethane	μg/L	<0.0629	<0.0629	NC			
Bromoethane	μg/L	<0.0854	<0.0854	NC			
2-Butanone (MEK)	μg/L	<0.819	<0.819	NC			
Carbon disulfide	μg/L	<0.0780	<0.0780	NC			
Carbon tetrachloride	μg/L	<0.0527	<0.0527	NC			
Chlorobenzene	μg/L	<0.0665	<0.0665	NC			
Chloroethane	μg/L	<0.0693	<0.0693	NC			
Chloroform	μg/L	<0.0773	<0.0773	NC			
Chloromethane	μg/L	<0.0454	<0.0454	NC			
3-Chloropropene	μg/L	<0.0735	<0.0735	NC			
Dibromochloromethane	μg/L	<0.0454	<0.0454	NC			
Dibromomethane	μg/L	<0.0692	<0.0692	NC			
trans-1,4-Dichloro-2-butene	μg/L	<0.155	<0.155	NC			
Dichlorodifluoromethane	μg/L	<0.0853	<0.0853	NC			
1,1-Dichloroethane	μg/L	<0.0559	<0.0559	NC			
1,2-Dichloroethane	μg/L	<0.0865	<0.0865	NC			
1,1-Dichloroethene	μg/L	<0.0608	<0.0608	NC			
cis-1,2-Dichloroethene	μg/L	<0.0541	<0.0541	NC			
trans-1,2-Dichloroethene	μg/L	<0.0567	<0.0567	NC			
1,2-Dichloropropane	μg/L	<0.0566	<0.0566	NC			

Table B-1 (continued)

Parameter	Units	Sample GWC-4-22-1	Field Duplicate GWC-4-22-2	% Diff. ^a	Duplicate Analysis GWC-4-22-2	% RPD ^b	Spec. Limit
cis-1,3-Dichloropropene	µg/L	<0.0614	<0.0614	NC			
trans-1,3-Dichloropropene	µg/L	<0.0657	<0.0657	NC			
Ethyl methacrylate	µg/L	<0.0788	<0.0788	NC			
Ethylbenzene	µg/L	<0.0655	0.0724 ^d	NC			
2-Hexanone	µg/L	<0.211	<0.211	NC			
Iodomethane	µg/L	<0.0342	<0.0342	NC			
4-Methyl-2-pentanone (MIBK)	µg/L	<0.0146	<0.0146	NC			
Methylene chloride	µg/L	1.02 ^c	1.17 ^c	12.8			
Styrene	µg/L	<0.0596	<0.0596	NC			
1,1,1,2-Tetrachloroethane	µg/L	<0.0590	<0.0590	NC			
1,1,2,2-Tetrachloroethane	µg/L	<0.0729	<0.0729	NC			
Tetrachloroethene	µg/L	<0.118	<0.118	NC			
Toluene	µg/L	<0.0537	0.55	NC			
1,1,1-Trichloroethane	µg/L	<0.0388	<0.0388	NC			
1,1,2-Trichloroethane	µg/L	<0.0714	<0.0714	NC			
Trichloroethene	µg/L	<0.127	<0.127	NC			
Trichlorofluoromethane	µg/L	<0.0681	<0.0681	NC			
1,2,3-Trichloropropane	µg/L	<0.125	<0.125	NC			
Vinyl acetate	µg/L	<0.0639	<0.0639	NC			
Vinyl chloride	µg/L	<0.0307	<0.0307	NC			
m&p-Xylene	µg/L	<0.184	0.196 ^d	NC			
o-Xylene	µg/L	<0.0627	<0.0627	NC			

^a % Difference = (GWC-4-22-2 - GWC-4-22-1)/GWC-4-22-1 x 100%.

^b RPD = Relative Percent Difference, defined as follows:

$$RPD = \frac{(\text{Larger Value} - \text{Smaller Value})}{(\text{Larger Value} + \text{Smaller Value})/2} \times 100\%.$$

^c Detected in the method blank.

^d Value is less than five times the detection limit; results are expected to be less accurate as concentrations approach the detection limit.

NC = Not computed.

