**ENVIRONMENTAL
RESTORATION
PROGRAM****Sampling Results, DNAPL
Monitoring Well GW-727,
Oak Ridge Y-12 Plant,
Oak Ridge, Tennessee,
First and Second Quarter,
FY 1995**

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Energy Systems Environmental Restoration Program

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PREFACE

This document, *Sampling Results, DNAPL Monitoring Well GW-727, First and Second Quarter FY 1995, was performed under Work Breakdown Structure 1.4.12.1.1.02 (Activity Data Sheet 2312, "Bear Creek Valley")*. This document provides the Environmental Restoration Program (ER) with groundwater concentrations for nonradionuclides in the vicinity of the Oak Ridge Y-12 Plant Burial Grounds. This data can be used to determine reference concentrations for intermediate and deep groundwater systems.

CONTENTS

	<u>Page</u>
PREFACE.....	iii
FIGURES.....	vi
TABLES.....	vii
ACKNOWLEDGMENTS	viii
EXECUTIVE SUMMARY	ix
LIST OF ACRONYMS AND ABBREVIATIONS.....	x
1.0 INTRODUCTION.....	1
1.1 BACKGROUND AND PURPOSE.....	1
1.2 BOREHOLE INFORMATION	3
1.3 MULTIPOINT WELL DESCRIPTION.....	3
1.4 GW-727 SAMPLING ZONES.....	6
2.0 PURGING AND SAMPLING ACTIVITIES	10
2.1 PURGING.....	10
2.2 SAMPLING.....	12
3.0 ANALYTICAL RESULTS	16
3.1 VOLATILE ORGANIC COMPOUNDS	16
3.2 TRACE METALS	18
3.3 MAJOR ELEMENT WATER CHEMISTRY	20
4.0 FUTURE WORK.....	22
REFERENCES.....	23
APPENDIX A. TRIP BLANK VOC ANALYTICAL RESULTS	24
APPENDIX B. LABORATORY BLANK VOC ANALYTICAL RESULTS.....	26
APPENDIX C. VOC ANALYTICAL RESULTS	28
APPENDIX D. TRACE METAL ANALYTICAL RESULTS	33
APPENDIX E. MAJOR ANIONS AND CATIONS AND FIELD PARAMETERS.....	36
APPENDIX F. CHARGE BALANCE CALCULATIONS.....	39

FIGURES

<u>Figure</u>		<u>Page</u>
1	Y-12 Burial Grounds location map.....	2
2	Generalized multiport well design.....	5
3	Multiport sampling zones for GW-727	9
4	Plot of strontium vs. calcium concentrations from GW-727	19
5	Piper Diagram of GW-727 Water Chemistry.....	21

TABLES

<u>Table</u>		<u>Page</u>
1	GW-727 construction and well design information.....	4
2	Sampling zones for GW-727.....	7
3	GW-727 purge history	11
4	Sampling and analysis plan.....	13
5	GW-727 sampling history	15
6	GW-727 "J" Qualifiers of VOC analytical results.....	17

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EXECUTIVE SUMMARY

In January 1990, dense, non aqueous phase liquids (DNAPLs) were discovered at a depth of approximately 274 ft. below ground surface along the southern border of the Y-12 Plant Burial Grounds. Immediately after the discovery, an investigation was conducted to assess the occurrence of DNAPL at the site and to make recommendations for further action. Results of the preliminary DNAPL investigation are presented in detail in Haase and King (1990a), and a work plan for assessment and characterization of the DNAPL is presented in Haase and King (1990b). A major task in the work plan calls for the construction and installation of five multiport wells. This report summarizes purging and sampling activities for one of these multiport wells, GW-726, and presents analytical results for GW-726. This report summarizes purging and sampling activities for GW-727 and presents analytical results for GW-727.

To date, each of the eleven sampling zones in GW-727 has been sampled for VOCs, metals and anions. Based on the presence of very low levels of benzene at the base of the middle Nolichucky Shale, it is recommended that VOC monitoring of GW-727 be continued. Additional data is required in order to statistically confirm the presence or absence of VOCs through the use of "J" qualifiers. Purging activities will continue for zones 2, 5, 8, 9, 13 and 22 to be followed by a second round of sampling. A comparison of the two sets of sampling results will be used to determine the need for a third round of purging. Any additional sampling from zones at the top of the well will be conducted without further purging, unless there is corroborative evidence that the water sample is not representative of the formation. There is a concern that excessive or unnecessary purging of units with low storativity, such as those in GW-727, will mobilize and extend the contaminant plume.

Ongoing and future tasks are directed toward collecting data that will provide information about: (1) the presence or absence of DNAPL or dissolved phase DNAPL and (2) the nature of the groundwater system so that the potential mobility of the dissolved phase plume can be evaluated. With this information we will be prepared to address concerns about the current extent of the contamination, the potential for continued spread of the contamination, and the need, if any, for implementing a remediation strategy.

LIST OF ACRONYMS AND ABBREVIATIONS

cps	counts per second
DNAPL	Dense Non Aqueous Phase Liquid
GC/MS	Gas Chromatography / Mass Spectroscopy
ICP	Inductively Coupled Plasma (spectroscopy)
IC	Ion Chromatography
MCL	Maximum Contaminant level
mg/L	milligrams per liter
MP	Multiport
ND	Not Detected
OD	Outer Diameter
psi	pounds per square inch
PCE	Tetrachloroethene
TCE	Trichloroethene
TD	Total Depth
TDS	Total Dissolved Solids
VOC	Volatile Organic Compounds
µg/L	micrograms per liter

1.0 INTRODUCTION

1.1 BACKGROUND AND PURPOSE

In January 1990, dense, non aqueous phase liquids (DNAPLs) were discovered at a depth of approximately 274 ft. below ground surface along the southern border of the Y-12 Plant Burial Grounds. Immediately after the discovery, an investigation was conducted to assess the occurrence of DNAPL at the site and to make recommendations for further action. To date, free-phase DNAPL contamination has been encountered in GW-625 (the discovery well), and is suspected to occur in GW-628 and GW-629 (Fig. 1) (Haase and King, 1990a). In addition, groundwater from GW-117 (Fig. 1) shows levels of volatile organic compounds suggestive of a dissolved contaminant plume. Results of the preliminary DNAPL investigation are presented in detail in Haase and King (1990a), and a work plan for assessment and characterization of the DNAPL is presented in Haase and King (1990b). A major task in the work plan calls for the construction and installation of five multiport wells. These wells (GW-726, GW-727, GW-729, GW-730, GW-730 and GW-790) were constructed and instrumented with multiport components from August, 1991 to April, 1993 (Dreier and Caldanaro, 1994). Subsequently, purging and sampling activities were started in each well. This report summarizes purging and sampling activities for GW-727 and presents analytical results for GW-727.

The purpose of the multiport wells is two-fold and addresses specific recommendations made by an independent consultant and previous work (Keuper 1990; Haase and King 1990b):

- 1) Define the deep and intermediate groundwater flow system within the Bear Creek Burial Ground and contiguous areas. Place special emphasis on defining and characterizing major conductive zones through which most of the groundwater flow may be occurring or through which DNAPL migration may have occurred.
- 2) Track the dissolved plume from outside inward. With an understanding of the groundwater flow system, determine a nondetect envelope within which all DNAPL and dissolved DNAPL contamination exists. As such, the wells are intended to serve as an early warning system for dissolved plume migration.

Fig. 1. Y-12 Burial Grounds location map. Dark circles are wells with known DNAPL accumulation or are wells that intercept secondary groundwater contaminant plumes. Black squares are the five multiport DNAPL investigation wells. Estimated locations of geologic contacts are shown.

If future technological development provides a feasible method to remove DNAPLs, then data from the multiport wells will provide general knowledge of the DNAPL location. Additionally, the information developed will be necessary to evaluate the effectiveness of the remediation technology (Haase and King, 1990b).

1.2 BOREHOLE INFORMATION

The locations of the five multiport wells (GW-726, GW-727, GW-790, GW-729 and GW-730) are shown in Fig. 1. The rationale for well placement is given in Haase and King (1990b) and Dreier and Caldanaro (1994). Well GW-727 is located down dip and to the west along strike from the discovery of free-phase DNAPL and downdip from localities where secondary groundwater contaminant plumes associated with DNAPL accumulations have been intercepted by other groundwater monitoring wells. Construction logs for GW-727 are presented in Science Applications International Corporation report, 1993, and the reader is referred to that report for a detailed construction history of the well. Condensed well construction information is presented in Table 1.

1.3 MULTIPORT WELL DESCRIPTION

The DNAPL investigation multiport wells use components designed by Westbay Instruments Inc. This system isolates zones of interest from each other by a series of packers fitted about a 1.5 in. diameter PVC (MP) casing (Fig. 2) that acts as an inner standpipe. Within specified sampling zones, fluid pressure data and water samples are collected using specialized probes that are lowered down the inner standpipe to the zones of interest. The probes access the zone through a measurement port coupling in the MP casing. Each sampling zone also contain a pumping port, which is used exclusively for purging. Because the packers isolate each sampling zone from the atmosphere, it is not necessary to purge before each sampling event. Purging is only needed to remove fluids that may have been introduced into the zone during drilling and installation operations.

The sampling zones are isolated from each other by one to two additional zones, called QA zones, containing measurement ports, from which only fluid pressure data are collected (Fig. 2). The zones provide added assurance that the sampling zones are isolated from each other. Although, it is possible to obtain water samples from these zones, the zones do not contain pumping ports and it is not possible to purge these intervals. Thus these zones have limited value for characterizing water chemistry.

Table 1. GW-727 construction and well design information.

BOREHOLE CONSTRUCTION					
Surface Casing (ft bgs)		241.8			
Total Depth (ft bgs)		1000.1			
SURVEY COORDINATES			ELEVATIONS (ft amsl)		
Grid System		Y-12	Ground surface	897.96	
Northing		28734.12	Top of concrete pad	898.57	
Easting		42540.07	Top of steel casing	900.77	
			Top of MP casing	900.63	
MULTI-PORT DESIGN					
COMPLETION ZONE		MEASUREMENT PORT			PUMPING PORT
Zone Number	Interval depth bgs (ft)	Port depth bgs (ft)	True Port depth from TOMP (ft)	Elevation (amsl) (ft)	Port depth bgs (ft)
1	987-997	987	987.11	-86.48	
2	962-982	972	972.18	-71.55	982
3	942-957	942	942.25	-41.62	
4	922-937	922	922.29	-21.66	
5	907-917	912	912.30	-11.67	917
6	887-902	887	887.34	13.29	
7	867-882	867	867.36	33.27	
8	842-862	852	852.40	48.23	862
9	822-837	832	832.42	68.21	837
10	792-817	792	792.45	108.18	
11	762-787	762	762.47	138.16	
12	737-757	737	737.48	163.15	
13	717-732	727	727.48	173.15	732
14	676-711	676	677.47	223.16	
15	651-671	661	662.47	238.16	671
16	616-646	616	617.46	283.17	
17	586-611	586	587.45	313.18	
18	571-581	576	577.44	323.19	581
19	536-566	536	537.43	363.20	
20	511-531	511	512.41	388.22	
21	476-506	476	477.39	423.24	
22	451-471	461	462.38	438.25	471
23	426-446	426	427.36	473.27	
24	396-421	396	397.33	503.30	
25	371-391	381	382.32	518.31	391
26	361-366	361	362.30	538.33	
27	346-356	351	352.28	548.35	356
28	321-341	321	322.26	578.37	
29	296-316	296	297.24	603.39	
30	271-291	281	282.22	618.41	291
31	0-266	261	262.20	638.43	
NOTE: all depths except for "true depth" are measured along the borehole with no correction for borehole deviation.					
NOTE: samples are only collected from those zones with both measurement and pumping ports.					
* MP = Westbay Multiport Casing, ags = above ground surface.					
* bgs = below ground surface, amsl = above mean sea level.					
* TOMP = Top of MP casing

Figure 2. Generalized multiport well design.

1.4 GW-727 SAMPLING ZONES

The multiport completion design for GW-727 is shown in Table 1. On the basis of core samples, geophysical logs and flowmeter results, 11 sampling zones, 10-to-15 ft. long, were selected from GW-727. The reader is referred to Dreier and Caldanaro (1994) for a more detailed description of the technical rationale and component design for each of the DNAPL investigation wells. Table 9 from Dreier and Caldanaro (1994) specifically lists criteria for choosing sampling zones and is repeated here as Table 2 for clarification. The installation history for GW-727 is documented in Westbay Instruments Inc. (1993).

The zones were chosen to sample at least one of the following features, in order of priority. (1) fluids from potential zones of DNAPL migration, (2) fluids from hydraulically conductive fractures or fracture zones, (3) potential changes in fluid chemistry with depth, (4) fluids that show water chemistry signatures associated with a particular rock type, (5) fluids that may show water chemistry correlations between wells, and (6) matrix fluids with long residence times. In general, criteria 3, 4 and 5 can be achieved by having a relatively regular vertical distribution of sampling zones. The spacing between most zones is less than 100 ft, and spacing less than 80 ft is common in potential DNAPL regions.

The stratigraphic positions of the eleven sampling zones in GW-727 are shown in Fig. 3. A zone of potential DNAPL migration, shown as a broad shaded portion, (Dreier and Caldanaro, 1994) was identified before the well was instrumented with Westbay components and is based on stratigraphic correlation with GW-625, GW-628, GW-629 and GW-117. This zone is the oolitic-rich limestone interval that defines the base of the middle Nolichucky Shale (Hatcher et.al, 1992) and is sampled by zones 8 and 9. In addition, two more zones were installed in the underlying strata in order to investigate the potential for migration of DNAPL into the lower Nolichucky Shale.

Table 2. Sampling zones for GW-727

Multiport zone ^a	Depth (ft.) ^{b,c}	Samp. port depth (ft.) ^{b,c}	Purpose	Logs/Core
30	271-291 (270-290)	281 (280)	Sample fracture at top of uncased portion of borehole.	core: Fractures 270',272',277',280',281' logs: Long-short normal difference. 272',286'. SP peak just below zone. Temperature anomaly at 285 - 290. stratigraphy: upper Nolichucky Shale
27	346-356 (345-355)	351 (350)	Sample fracture	core: -- logs: Slight fluid resistivity change 350'. Temperature anomaly at 346' - 350'. flowmeter: Sharp change 350-351' stratigraphy: upper Nolichucky Shale
25	371-391 (370-390)	381 (380)	Sample major fracture	core: Fractures 370',385' logs: Long short normal difference. 370', 385'. Large change in fluid resistivity across zone w/ largest gradient 383-385'. Temperature anomaly at 368' - 342' and 383' - 389'. flowmeter: Large flow increase (+4 L/min) across zone. with highest input at 382-385'. stratigraphy: upper Nolichucky Shale
22	451-471 (450-470)	461 (460)	Sample fracture.	core: Fracture 462' logs: Small long-short normal difference. 450', 470'. Change in fluid resistivity at 454-456' & 465-467'. Four temperature anomaly peaks between 451' and 471'. flowmeter: -- stratigraphy: middle Nolichucky Shale
18	571-581 (570-580)	576 (575)	Sample fracture.	core: Fracture 575' logs: Fluid resistivity change 575'. Temperature anomaly at 574' - 578'. stratigraphy: middle Nolichucky Shale

Table 2. (cont.)

Multiport zone ^a	Depth (ft.) ^{b,c}	Samp. port depth (ft.) ^{b,c}	Purpose	Logs/Core
15	651-671 (650-670)	661 (660)	Sample deformation zone, vertical distribution.	core: Fractures 652', 655', 665' logs: Caliper 655', 660', 665'. sonic disturbance. 660-680'. stratigraphy: middle Nolichucky Shale
13	717-732 (715-730)	727 (725)	Sample deformation zone, vertical distribution.	core: Fractures 720', 725' logs: -- stratigraphy: middle Nolichucky Shale
9	822-837 (820-835)	832 (830)	Sample faults in potential zone of DNAPL migration.	core: Fractures 822', 831' logs: Caliper 826', 834'. Temperature anomaly 826'-836' stratigraphy: middle Nolichucky Shale
8	842-862 (840-860)	852 (850)	Sample fractures in base of middle Nolichucky. Potential DNAPL zone.	core: Fractures 842', 849-850' logs: Caliper 848', 854'. Temperature anomaly 846'-852' stratigraphy: base of middle Nolichucky Shale
5	907-917 (905-915)	912 (910)	Vertical distribution. Sample below potential DNAPL zone.	core: -- logs: -- stratigraphy: lower Nolichucky Shale
2	962-982 (960-980)	972 (970)	Sample well bottom	core: -- logs: -- stratigraphy: lower Nolichucky Shale

^aMultiport zone number.^bDepth measured from ground surface, not corrected for borehole deviation^cParentheses denote planned depth. Other number is correct downhole depth.

Figure 3. Multiport sampling zones for GW-727. The region marked Potential DNAPL is identified from stratigraphic considerations. It does not imply that VOC's will occur at this interval, rather that IF VOC's are identified, we expect to see them in this zone. See text for further discussion.

2.0 PURGING AND SAMPLING ACTIVITIES

2.1 PURGING

Initial purging of the sample zones in GW-727 began in April of 1993, several months after hydraulic heads had stabilized from multiport installation, and continued through January of 1995 (Table 3). During purging, an appropriate volume of water is extracted from the inner standpipe so that the hydraulic head in the standpipe is lower than the hydraulic head in the sampling zone. This induces water to flow from the formation and annular space through the open purge port into the inner standpipe. Recommended purge volumes are calculated at three times the annular volume of the sampling zone (Table 3). The rate at which this volume is produced is a function of the rock permeability and can vary considerably. In particular, it was found that very low permeability zones could take several months or longer to produce the requisite volumes. Because of this, purging procedures were modified so that sampling activities could fit into a reasonable scheduling framework. At present, each zone is purged for one month or until the recommended volume of water is produced, whichever occurs first. The zone is then sampled. If the zone does not produce enough water during the first round of purging, purging is continued for another month, to be followed by a second round of sampling. Additional purging requirements will be determined on a case-by-case basis, but in general, the removal of one annular volume for very low permeability zones at the base of the borehole may be considered adequate in the future.

Of eleven sampling zones in GW-727, only five produced the requisite three annular volumes within a month of purging. These zones (zones 30, 27, 25, 18, and 15) are in the upper portion of the well and may indicate that permeability decreases with increasing depth. Purge time varied from one day to two weeks. In addition, zone 22, which is also in the upper portion of the well, probably will produce enough water within one to two weeks. Zone 22 was only open for four days and produced 16.9 gals of the recommended 26 gals. It was inadvertently closed too soon. Of the remaining 5 zones at the base of the well, three produced at least one annular volume (zones 5, 8 and 9). Zones 2 and 13 were both open for approximately one month and did not produce one annular volume.

Table 3. GW-727 purge history

Zone	Packed-off Sampling Zone Height (ft)	Recom. purge volume (gals)*	1st Purge Date Opened	1st Purge Date Closed	Produced purge vol. (gals)	No. annular vols.	Difference of actual (-) recom. (gals)
2	21	26	12/13/94	1/16/95	0.2	0.0	-26
5	11	14	11/16/94	12/13/94	6.0	1.3	-7.9
8	21	26	1/27/94	10/19/94	13.0	1.5	-13.4
9	16	20	8/17/93	1/27/94	8.9	1.3	-11.2
13	16	20	7/21/93	8/17/93	3.6	0.5	-16.6
15	21	26	7/7/93	7/21/93	30.3	3.4	3.8
18	11	14	5/21/93	6/1/93	25.7	5.6	11.9
22**	21	26	5/17/93	5/21/93	16.9	1.9	-9.6
25	21	26	5/5/93	5/5/93	36.0	4.1	9.5
27	11	14	5/4/93	5/5/93	16.95	3.7	3.1
30	21	30	4/27/93	5/4/93	33.97	3.9	4.0

*** PURGE VOLUME CALCULATION:**

Recommended purge volume = 3 annular volumes

3.7" diameter borehole and 1.81" OD MP casing

"= 0.42 gal/ft for one annular volume or 1.26 gal/ft for three annular volumes"

** The pumping port for zone 22 was closed prematurely.

Zones shown in bold did not produce the requisite three annular volumes of formation water.

However, zone 13 produced 0.5 annular volume in one month. Therefore it is anticipated that with another round of month-long purging, this zone will be able to produce at least one annular volume. The zone produced less than 0.1 of an annular volume, and subsequent sampling results will be suspect because of possible mixing with drilling water and other formation water before the Westbay components were installed in the well.

2.2 SAMPLING

Samples are collected in two evacuated (under vacuum) stainless steel 250 ml sample bottles that are attached in tandem and threaded to a sampling probe. The sample bottles are lowered to the desired zone and water is extracted through the measurement port valve. All equipment is designed specifically for and dedicated to Westbay type multiport wells. Additional information on Westbay-specific sampling procedures is in the Westbay Operation Manuals, which are available from the authors of this report.

The field sampling protocol is given in Table 4. Initially, each zone is sampled for anions, metals, VOCs and field parameters (pH, specific conductance and temperature). The normal suite of anion analysis includes Cl, F, NO₃, and SO₄. If the specific conductance is greater than 2000 umho/cm, Br is added to the suite since its concentration may be above detection at elevated specific conductance levels. Additional sampling events are based on initial analytical results and are determined at the discretion of the project manager or project technical lead.

Using two sample bottles, a maximum sample volume of 500 ml can be obtained each time bottles are lowered to a port (a sample run) (Table 4). In general, either two or three runs are needed to collect the required sample volume, depending on the desired analysis. Two different protocols are used based on the suspected permeability of the sampling zone. For high to moderate permeability zones, the first run is used to collect field parameters and to rinse the sample bottles with formation water. If both inorganic (major and trace elements) and organic constituents are being sampled, the second run is used for the major and trace inorganic water samples and the third run is used for the VOC sample. VOCs are collected last to maximize the number of sample bottle rinses with formation water.

Table 4. Sampling and analysis plan.

High to Moderate Permeability

Sample Run No.	Bottle No.	Parameter	Container Type	Volume (ml)	Filtered	Preservative	EPA Procedure No.	Analytical Method
1	1	pH	N/A	<250	YES	N/A	EPA-150.1	pH meter
1	1	Specific Conductance	N/A	<250	YES	N/A	EPA-120.1	conductivity meter
1	1	Temperature	N/A	<250	YES	N/A	EPA-170.1	thermometer
1	2	rinsate/discard	N/A		YES	N/A		
2	1	Metals	Plastic	100	YES	HNO3 (<2pH)	EPA-6010	ICP
2	1	Anions (Br*, Cl, F, NO3, SO4)	Plastic	100	YES	NONE	EPA-300.0	IC
2	2	Alkalinity	Plastic	100	YES	NONE	EPA-310.1	titration
3	1	VOC	Amber/Glass	40X2	NO	NONE	OLMO1.8	GC/MS

Low Permeability**

Sample Run No.	Bottle No.	Parameter	Container Type	Volume (ml)	Filtered	Preservative	EPA Procedure No.	Analytical Method
1	1	Alkalinity	Plastic	50-100	YES	NONE	done in field OR EPA-310.1	titration
1	1	Anions (Br*, Cl, F, NO3, SO4)	Plastic	100	YES	NONE	EPA-300.0	ICP
1	2	pH	N/A	<250	YES	N/A	EPA-150.1	pH meter
1	2	Specific Conductance	N/A	<250	YES	N/A	EPA-120.1	conductivity meter
1	2	Temperature	N/A	<250	YES	N/A	EPA-170.1	thermometer
2	1	Metals	Plastic	100	YES	HNO3 (<2pH)	EPA-6010	ICP
2	2	VOC	Amber/Glass	40X2	NO	NONE	OLMO1.8	GC/MS

* Br analysis is requested if specific conductance is greater than 2000 umho/cm

**Nitrogen gas used to aid sampling.

•All samples cooled to 4 degrees celsius unless otherwise noted

A common occurrence with sampling low permeability zones is that the O-ring seal is compromised around the measurement port. This can be determined by monitoring the water level in the MP casing. A drop in water level is attributed to water from the MP casing that moves past the O-rings, through the sample probe, and into the sample bottles. The resultant sample is a mixture of water from the annular space and from the MP casing. If this happens, the zone is treated as a "low permeability zone" and both the sampling order and collection method is modified (Table 4). Field parameters will be collected from the first run second (lower) bottle. This bottle will have the least amount of rinsing with formation waters. Alkalinity and anions will be collected from the first run first (upper) bottle. The remainder of the sample will be collected from the second run. As before, VOCs will not be sampled from the first run to assure that the sample bottle is rinsed with formation water. If a O-ring seal is broken during sampling, water collected from the first run, second bottle will be used to re-rinse the bottle.

In low-permeability zones, the seal around the measurement port may be broken because: (1) the zone could not produce enough water to maintain a sufficient fluid pressure; and (2) there is a large pressure differential between the sample bottles, the MP casing water and the formation water. The purpose of the modified sampling collection procedure is to reduce the pressure differential between the sample bottles and the pressure in the MP casing. This is accomplished by pressurizing the sample bottles with inert nitrogen gas up to 50 psi. This pressure is well below the fluid pressure in the MP casing and the formation, yet is sufficient enough to maintain the integrity of the seal around the measurement port valve allowing water to be drawn from the formation. To date, this method has been successful when used in low permeability zones.

The sampling history for GW-727 is given in Table 5. Zones that show the low permeability characteristics mentioned above include zones 13, 9, 8, and 2. There is a good correspondence between these zones and the zones that did not produce the requisite purge water volumes in four weeks of purging (Table 3).

Table 5. GW-727 sampling history.

Zone	Date	Parameters	Comments
2	1/17/95	VOC Metals, Anions, Alk. field parameters	Bromide included with Anions no rinsate
5	1/17/95	VOC Metals, Anions, Alk. field parameters	Bromide included with Anions
8	11/30/94	VOC Metals, Anions, Alk. field parameters	Bromide included with Anions no rinsate used nitrogen gas
9	11/30/94	VOC Metals, Anions, Alk. field parameters	Bromide included with Anions no rinsate used nitrogen gas
13	11/30/94	VOC Metals, Anions, Alk. field parameters	Bromide included with Anions no rinsate used nitrogen gas
15	11/29/94	VOC Metals, Anions, Alk. field parameters	Bromide included with Anions
18	11/29/94	VOC Metals, Anions, Alk. field parameters	
22	11/16/94	VOC Metals, Anions, Alk. field parameters	
25	11/16/94	VOC Metals, Anions, Alk. field parameters	
27	11/16/94	VOC Metals, Anions, Alk. field parameters	
30	11/16/94	VOC Metals, Anions, Alk. field parameters	Required 3 runs. 2nd run voided because water from MP casing entered sample bottles.

3.0 ANALYTICAL RESULTS

3.1 VOLATILE ORGANIC COMPOUNDS

A sample was collected for VOC analysis for each zone (Table 5). Trip blanks were collected on 11/16/94, 11/29/94 and 1/17/95 and their results are listed in Appendix A. Three VOCs were detected in the trip blanks (Appendix A); two for toluene (11/16/95 and 1/17/95) and one for acetone (1/17/95). All detects had "J" and "B" qualifiers showing that the levels were estimated at values that are below the detection limit and were also detected with a similar concentration in the lab blanks. Laboratory blank data are given in Appendix B. In addition to the detected values observed in the trip blanks, the laboratory blank from 1/19/95 showed the presence of 2-Butanone.

VOC results from the sample zones are presented in Appendix C and a list of 16 detectable VOCs is given in Table 6. Most detectable values are flagged with "J" qualifier and represent low (1.0 - 6.0 $\mu\text{g/L}$) but discernible responses from the analytical instrumentation. Of the 16 detectable VOC concentrations, 9 detects were also observed in the lab or trip blanks. The remainder of the detectable values are flagged with "J" qualifiers and include two detects for methylene chloride, a common laboratory reagent, in zones 2 and 5; one detect for carbon disulfide in zone 2; and benzene in zones 2, 8, 9, 13, and 27. It is possible the pervasive presence of benzene in trace amounts is due to the occurrence of natural hydrocarbons. However, benzene is a VOC of concern because it does occur in more than 5% of wells associated with the Y-12 Burial Grounds (HSW, 1994). In contrast to results from GW-726 (Dreier and Caldanaro, 1995), none of the detects are for VOCs of concern that are known to be present in the DNAPL pool or immediate dissolved-phase plume that was encountered in GW-625 (e.g. PCE, TCE, 1,1,1-TCA, ethyltoluene and 2-Butanone) (Haase and King, 1990a).

Table 6. GW-727 "J" qualifiers of VOC analytical results.

Lab	Sample No.	Zone No.	Date Sampled	Analysis	Result	Tag	Units	Date Analyzed	Zone Depth (ft.)
	950118-021	2	17-Jan-95	2-Butanone	10.0	B	µg/L	19-Jan-95	972
	950118-021	2	17-Jan-95	Acetone	12.0	B	µg/L	19-Jan-95	972
	950118-021	2	17-Jan-95	Carbon Disulfide	1.0	J	µg/L	19-Jan-95	972
	950118-021	2	17-Jan-95	Methylene Chloride	2.0	J	µg/L	19-Jan-95	972
	950118-021	2	17-Jan-95	Toluene	6.0	JB	µg/L	19-Jan-95	972
	950118-020	5	17-Jan-95	2-Butanone	12.0	B	µg/L	19-Jan-95	912
	950118-020	5	17-Jan-95	Acetone	14.0	B	µg/L	19-Jan-95	912
	950118-020	5	17-Jan-95	Methylene Chloride	2.0	J	µg/L	19-Jan-95	912
	950118-020	5	17-Jan-95	Toluene	6.0	JB	µg/L	19-Jan-95	912
	941201-017	8	30-Nov-94	Benzene	3.0	J	µg/L	2-Dec-94	852
	941201-016	9	30-Nov-94	Benzene	6.0	J	µg/L	2-Dec-94	832
	941201-015	13	30-Nov-94	Benzene	3.0	J	µg/L	2-Dec-94	727
	941117-076	22	16-Nov-94	Toluene	1.0	JB	µg/L	21-Nov-94	461
	941117-075	25	16-Nov-94	Toluene	1.0	JB	µg/L	21-Nov-94	381
	941117-074	27	16-Nov-94	Benzene	1.0	J	µg/L	21-Nov-94	351
	941117-074	27	16-Nov-94	Toluene	1.0	JB	µg/L	21-Nov-94	351
J = estimated									
B = analyte found at same concentration in blank as in sample									

3.2 TRACE METALS

One sample per zone was collected for metal analysis (Table 5). Metal concentrations were determined by ICP spectroscopy and are listed in Appendix D. Samples from zones 2, 5, 8, 9, 13, 15 and 18 were diluted because of high ionic concentrations. All of these zones showed specific conductance values greater than 1600 $\mu\text{mho/cm}$ and dilution rates vary as a function of specific conductance: Zone 18 (specific conductance = 1670 $\mu\text{mho/cm}$) had the least dilution with a dilution factor of 5, and zone 8 (specific conductance = 27,500 $\mu\text{mho/cm}$) had the greatest dilution with a dilution factor of 100. As a result of the dilutions, detection limits are raised and some are raised above the background screening levels listed in the GWQAR for Bear Creek Valley (HSW, 1994). This is the case for antimony, beryllium, cadmium, cobalt, lead, molybdenum, thorium, vanadium and zinc (see Appendix D). Note also in Appendix D that the undiluted sample detection limits listed for antimony, lead, molybdenum, and thorium are equivalent to the background screening level for that constituent. Nevertheless, except for zinc, all analytical results for these constituents are below the detection limit, even though concentrations are expected to rise with an increase in specific conductance. Specific conductance values are listed in Appendix E.

Boron, zinc, and strontium values are above background screening levels for selected zones. The upper zones in GW-727 (zones 18, 22, 25, 27, and 30) show boron levels above the screening levels listed in the GWQAR for Bear Creek Valley (HSW, 1994). Boron values noticeably decrease with increase in depth and corresponding increase in TDS. Three zones (zones 5, 15 and 18) show elevated values of zinc that are above the screening level of 0.079 mg/L).

Strontium is the only other trace metal that shows concentrations above the background screening level. The elevated concentrations occur in the 6 deepest zones (zones 2, 5, 8, 9, 13 and 15) where there is also a corresponding increase in specific conductance. These zones show specific conductance over 3900 $\mu\text{mho/cm}$. The increase in strontium is apparently related to the increase in TDS as is suggested by the proportional correspondence between calcium and strontium concentrations (Fig. 4). Strontium will commonly substitute for calcium because they have the same valence state and a similar ionic radius.

Figure 4. Plot of strontium vs. calcium concentrations from GW-727.

3.3 MAJOR ELEMENT WATER CHEMISTRY

Major element water chemistry and field parameters are given in Appendix E and charge balance information is given in Appendix F. All of the zones show a charge balance (in percent) less than 6%. Because of a misunderstanding with the K-25 Analytical Laboratory, lab alkalinities were not determined from samples collected from zones 8, 9, 15 and 18. When it was apparent that the lab alkalinities would not be determined from these zones, the zones were resampled and alkalinities were determined from a field alkalinity test kit. Zone 13 did not produce enough water for a complete standard analysis when it was sampled on 11/30/94. Therefore an alkalinity measurement was not determined from that sample, and an additional sample was collected and submitted to the lab on 12/13/94 for alkalinity analysis.

Water chemistry types are shown in Fig. 5. There is a systematic change in water type with depth from a relatively shallow Na-HCO₃ type water to a deep Na-Cl type water. The upper four zones (zones 30, 27, 25 and 22 which show a depth range of 275 - 500 ft) are a Na-HCO₃ type water. A middle zone (zone 18 which has an approximate depth of 575 ft) is a Na-HCO₃-Cl type water. The lowest six zones (zones 15, 13, 9, 8, 5 and 2 which show a depth range of 650 - 1000 ft) are a Na-Cl type water. The change in water type also corresponds to an increase in TDS, i.e. TDS values for Na-HCO₃ waters are less than for Na-Cl type water (Fig. 5), and to those zones that did not produce a sufficient volume of purge water within one month.

Figure 5. Piper diagram of GW-727 water chemistry.

4.0 SUMMARY / FUTURE WORK

Ongoing and future tasks are directed toward collecting data that will provide information about: (1) the presence or absence of DNAPL or dissolved phase DNAPL and (2) the nature of the groundwater system so that the potential mobility of the dissolved phase plume can be evaluated. With this information we will be prepared to address concerns about the current extent of the contamination, the potential for continued spread of the contamination, and the need, if any, for implementing a remediation strategy.

To date, each of the eleven sampling zones in GW-727 has been sampled for VOCs, metals and anions. Based on the presence of very low levels of benzene at the base of the middle Nolichucky Shale, it is recommended that VOC monitoring of GW-727 be continued. Additional data is required in order to statistically confirm the presence or absence of VOCs through the use of "J" qualifiers. Purging activities will continue for zones 2, 5, 8, 9, 13 and 22 to be followed by a second round of sampling. A comparison of the two sets of sampling results will be used to determine the need for a third round of purging. Any additional sampling from zones at the top of the well will be conducted without further purging, unless there is corroborative evidence that the water sample is not representative of the formation. There is a concern that excessive or unnecessary purging of units with low storativity, such as those in GW-727, will mobilize and extend the contaminant plume.

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Appendix A

TRIP BLANK VOC ANALYTICAL RESULTS.

Trip Blank VOC Analytical Results.

Sample Number	94117-077	941201-018	950118-022
Trip Date	11/16/94	11/29/94	1/17/95
Date Analyzed	11/21/94	12/2/94	1/19/95
Units	µg/L	µg/L	µg/L
1,1,1-Trichloroethane	< 10.0	< 10.0	< 10.0
1,1,2,2-Tetrachloroethane	< 10.0	< 10.0	< 10.0
1,1,2-Trichloroethane	< 10.0	< 10.0	< 10.0
1,1-Dichloroethane	< 10.0	< 10.0	< 10.0
1,1-Dichloroethene	< 10.0	< 10.0	< 10.0
1,2-Dichloroethane	< 10.0	< 10.0	< 10.0
1,2-Dichloroethene (total)	< 10.0	< 10.0	< 10.0
1,2-Dichloropropane	< 10.0	< 10.0	< 10.0
2-Butanone	< 10.0	< 10.0	< 10.0
2-Hexanone	< 10.0	< 10.0	< 10.0
4-Methyl-2-pentanone	< 10.0	< 10.0	< 10.0
Acetone	< 10.0	< 10.0	3.0 JB
Benzene	< 10.0	< 10.0	< 10.0
Bromodichloromethane	< 10.0	< 10.0	< 10.0
Bromoform	< 10.0	< 10.0	< 10.0
Bromomethane	< 10.0	< 10.0	< 10.0
Carbon Disulfide	< 10.0	< 10.0	< 10.0
Carbon Tetrachloride	< 10.0	< 10.0	< 10.0
Chlorobenzene	< 10.0	< 10.0	< 10.0
Chloroethane	< 10.0	< 10.0	< 10.0
Chloroform	< 10.0	< 10.0	< 10.0
Chloromethane	< 10.0	< 10.0	< 10.0
Dibromochloromethane	< 10.0	< 10.0	< 10.0
Ethylbenzene	< 10.0	< 10.0	< 10.0
Methylene Chloride	< 10.0	< 10.0	< 10.0
Styrene	< 10.0	< 10.0	< 10.0
Tetrachloroethene	< 10.0	< 10.0	< 10.0
Toluene	1.0 JB	< 10.0	6.0 JB
Trichloroethene	< 10.0	< 10.0	< 10.0
Vinyl Acetate	< 10.0	< 10.0	< 10.0
Vinyl Chloride	< 10.0	< 10.0	< 10.0
Xylene (total)	< 10.0	< 10.0	< 10.0
cis-1,3-Dichloropropene	< 10.0	< 10.0	< 10.0
trans-1,3-Dichloropropene	< 10.0	< 10.0	< 10.0

Appendix B

LABORATORY BLANK VOC ANALYTICAL RESULTS.

Laboratory Blank VOC Analytical Results.

Sample Number	941118-028	941121-012	941205-139	950123-047
Date Completed	11/18/94	11/21/94	12/2/94	1/19/95
Units	µg/L	µg/L	µg/L	µg/L
1,1,1-Trichloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,1,2,2-Tetrachloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,1,2-Trichloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,1-Dichloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,1-Dichloroethene	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichloroethene (total)	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichloropropane	< 10.0	< 10.0	< 10.0	< 10.0
2-Butanone	< 10.0	< 10.0	< 10.0	14.0
2-Hexanone	< 10.0	< 10.0	< 10.0	< 10.0
4-Methyl-2-pentanone	< 10.0	< 10.0	< 10.0	< 10.0
Acetone	< 10.0	< 10.0	< 10.0	12.0
Benzene	< 10.0	< 10.0	< 10.0	< 10.0
Bromodichloromethane	< 10.0	< 10.0	< 10.0	< 10.0
Bromoform	< 10.0	< 10.0	< 10.0	< 10.0
Bromomethane	< 10.0	< 10.0	< 10.0	< 10.0
Carbon Disulfide	< 10.0	< 10.0	< 10.0	< 10.0
Carbon Tetrachloride	< 10.0	< 10.0	< 10.0	< 10.0
Chlorobenzene	< 10.0	< 10.0	< 10.0	< 10.0
Chloroethane	< 10.0	< 10.0	< 10.0	< 10.0
Chloroform	< 10.0	< 10.0	< 10.0	< 10.0
Chloromethane	< 10.0	< 10.0	< 10.0	< 10.0
Dibromochloromethane	< 10.0	< 10.0	< 10.0	< 10.0
Ethylbenzene	< 10.0	< 10.0	< 10.0	< 10.0
Methylene Chloride	< 10.0	< 10.0	< 10.0	< 10.0
Styrene	< 10.0	< 10.0	< 10.0	< 10.0
Tetrachloroethene	< 10.0	< 10.0	< 10.0	< 10.0
Toluene	< 10.0	1.0	< 10.0	6.0
Trichloroethene	< 10.0	< 10.0	< 10.0	< 10.0
Vinyl Acetate	< 10.0	< 10.0	< 10.0	< 10.0
Vinyl Chloride	< 10.0	< 10.0	< 10.0	< 10.0
Xylene (total)	< 10.0	< 10.0	< 10.0	< 10.0
cis-1,3-Dichloropropene	< 10.0	< 10.0	< 10.0	< 10.0
trans-1,3-Dichloropropene	< 10.0	< 10.0	< 10.0	< 10.0

Appendix C
VOC ANALYTICAL RESULTS.

VOC Analytical Results

Well/Zone Number:	GW-727-2	GW-727-5	GW-727-8
Sample Number:	950118-021	950118-020	950118-017
Date Sampled:	1/17/95	1/17/95	11/30/94
Date Analyzed:	1/19/95	1/19/95	12/2/94
Corresponding Trip Blank:	950118-022	950118-022	941201-018
Corresponding Lab Blank:	950123-047	950123-047	941205-139
VOLATILE ORGANICS (µg/L)			
1,1,1-Trichloroethane	< 10.0	< 10.0	< 10.0
1,1,2,2-Tetrachloroethane	< 10.0	< 10.0	< 10.0
1,1,2-Trichloroethane	< 10.0	< 10.0	< 10.0
1,1-Dichloroethane	< 10.0	< 10.0	< 10.0
1,1-Dichloroethene	< 10.0	< 10.0	< 10.0
1,2-Dichloroethane	< 10.0	< 10.0	< 10.0
1,2-Dichloroethene (total)	< 10.0	< 10.0	< 10.0
1,2-Dichloropropane	< 10.0	< 10.0	< 10.0
2-Butanone	10.0 B	12.0 B	< 10.0
2-Hexanone	< 10.0	< 10.0	< 10.0
4-Methyl-2-pentanone	< 10.0	< 10.0	< 10.0
Acetone	12.0 B	14.0 B	< 10.0
Benzene	< 10.0	< 10.0	3.0 J
Bromodichloromethane	< 10.0	< 10.0	< 10.0
Bromoform	< 10.0	< 10.0	< 10.0
Bromomethane	< 10.0	< 10.0	< 10.0
Carbon Disulfide	1.0 J	< 10.0	< 10.0
Carbon Tetrachloride	< 10.0	< 10.0	< 10.0
Chlorobenzene	< 10.0	< 10.0	< 10.0
Chloroethane	< 10.0	< 10.0	< 10.0
Chloroform	< 10.0	< 10.0	< 10.0
Chloromethane	< 10.0	< 10.0	< 10.0
Dibromochloromethane	< 10.0	< 10.0	< 10.0
Ethylbenzene	< 10.0	< 10.0	< 10.0
Methylene Chloride	2.0 J	2.0 J	< 10.0
Styrene	< 10.0	< 10.0	< 10.0
Tetrachloroethene	< 10.0	< 10.0	< 10.0
Toluene	6.0 JB	6.0 JB	< 10.0
Trichloroethene	< 10.0	< 10.0	< 10.0
Vinyl Acetate	< 10.0	< 10.0	< 10.0
Vinyl Chloride	< 10.0	< 10.0	< 10.0
Xylene (total)	< 10.0	< 10.0	< 10.0
cis-1,3-Dichloropropene	< 10.0	< 10.0	< 10.0
trans-1,3-Dichloropropene	< 10.0	< 10.0	< 10.0

(Continued...)

VOC Analytical Results

Well/Zone Number:	GW-727-9	GW-727-13	GW-727-15	GW-727-18
Sample Number:	950118-016	950118-015	950118-014	950118-013
Date Sampled:	11/30/94	11/30/94	11/29/94	11/29/94
Date Analyzed:	12/2/94	12/2/94	12/2/94	12/2/94
Corresponding Trip Blank:	941201-018	941201-018	941201-018	941201-018
Corresponding Lab Blank:	941205-139	941205-139	941205-139	941205-139
VOLATILE ORGANICS (µg/L)				
1,1,1-Trichloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,1,2,2-Tetrachloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,1,2-Trichloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,1-Dichloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,1-Dichloroethene	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichloroethene (total)	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichloropropane	< 10.0	< 10.0	< 10.0	< 10.0
2-Butanone	< 10.0	< 10.0	< 10.0	< 10.0
2-Hexanone	< 10.0	< 10.0	< 10.0	< 10.0
4-Methyl-2-pentanone	< 10.0	< 10.0	< 10.0	< 10.0
Acetone	< 10.0	< 10.0	< 10.0	< 10.0
Benzene	6.0 J	3.0 J	< 10.0	< 10.0
Bromodichloromethane	< 10.0	< 10.0	< 10.0	< 10.0
Bromoform	< 10.0	< 10.0	< 10.0	< 10.0
Bromomethane	< 10.0	< 10.0	< 10.0	< 10.0
Carbon Disulfide	< 10.0	< 10.0	< 10.0	< 10.0
Carbon Tetrachloride	< 10.0	< 10.0	< 10.0	< 10.0
Chlorobenzene	< 10.0	< 10.0	< 10.0	< 10.0
Chloroethane	< 10.0	< 10.0	< 10.0	< 10.0
Chloroform	< 10.0	< 10.0	< 10.0	< 10.0
Chloromethane	< 10.0	< 10.0	< 10.0	< 10.0
Dibromochloromethane	< 10.0	< 10.0	< 10.0	< 10.0
Ethylbenzene	< 10.0	< 10.0	< 10.0	< 10.0
Methylene Chloride	< 10.0	< 10.0	< 10.0	< 10.0
Styrene	< 10.0	< 10.0	< 10.0	< 10.0
Tetrachloroethene	< 10.0	< 10.0	< 10.0	< 10.0
Toluene	< 10.0	< 10.0	< 10.0	< 10.0
Trichloroethene	< 10.0	< 10.0	< 10.0	< 10.0
Vinyl Acetate	< 10.0	< 10.0	< 10.0	< 10.0
Vinyl Chloride	< 10.0	< 10.0	< 10.0	< 10.0
Xylene (total)	< 10.0	< 10.0	< 10.0	< 10.0
cis-1,3-Dichloropropene	< 10.0	< 10.0	< 10.0	< 10.0
trans-1,3-Dichloropropene	< 10.0	< 10.0	< 10.0	< 10.0

(Continued...)

VOC Analytical Results

Well/Zone Number:	GW-727-22	GW-727-25
Sample Number:	941117-076	941117-075
Date Sampled:	11/16/94	11/16/94
Date Analyzed:	11/21/94	11/21/94
Corresponding Trip Blank:	941117-077	941117-077
Corresponding Lab Blank:	941121-012	941121-012
VOLATILE ORGANICS (µg/L)		
1,1,1-Trichloroethane	< 10.0	< 10.0
1,1,2,2-Tetrachloroethane	< 10.0	< 10.0
1,1,2-Trichloroethane	< 10.0	< 10.0
1,1-Dichloroethane	< 10.0	< 10.0
1,1-Dichloroethene	< 10.0	< 10.0
1,2-Dichloroethane	< 10.0	< 10.0
1,2-Dichloroethene (total)	< 10.0	< 10.0
1,2-Dichloropropane	< 10.0	< 10.0
2-Butanone	< 10.0	< 10.0
2-Hexanone	< 10.0	< 10.0
4-Methyl-2-pentanone	< 10.0	< 10.0
Acetone	< 10.0	< 10.0
Benzene	< 10.0	< 10.0
Bromodichloromethane	< 10.0	< 10.0
Bromoform	< 10.0	< 10.0
Bromomethane	< 10.0	< 10.0
Carbon Disulfide	< 10.0	< 10.0
Carbon Tetrachloride	< 10.0	< 10.0
Chlorobenzene	< 10.0	< 10.0
Chloroethane	< 10.0	< 10.0
Chloroform	< 10.0	< 10.0
Chloromethane	< 10.0	< 10.0
Dibromochloromethane	< 10.0	< 10.0
Ethylbenzene	< 10.0	< 10.0
Methylene Chloride	< 10.0	< 10.0
Styrene	< 10.0	< 10.0
Tetrachloroethene	< 10.0	< 10.0
Toluene	1.0 JB	1.0 JB
Trichloroethene	< 10.0	< 10.0
Vinyl Acetate	< 10.0	< 10.0
Vinyl Chloride	< 10.0	< 10.0
Xylene (total)	< 10.0	< 10.0
cis-1,3-Dichloropropene	< 10.0	< 10.0
trans-1,3-Dichloropropene	< 10.0	< 10.0

(Continued...)

VOC Analytical Results

Well/Zone Number:	GW-727-27	GW-727-30
Sample Number:	941117-074	941117-073
Date Sampled:	11/16/94	11/16/94
Date Analyzed:	11/21/94	11/18/94
Corresponding Trip Blank:	941117-077	941117-077
Corresponding Lab Blank:	941121-012	941118-028
VOLATILE ORGANICS (µg/L)		
1,1,1-Trichloroethane	< 10.0	< 10.0
1,1,2,2-Tetrachloroethane	< 10.0	< 10.0
1,1,2-Trichloroethane	< 10.0	< 10.0
1,1-Dichloroethane	< 10.0	< 10.0
1,1-Dichloroethene	< 10.0	< 10.0
1,2-Dichloroethane	< 10.0	< 10.0
1,2-Dichloroethene (total)	< 10.0	< 10.0
1,2-Dichloropropane	< 10.0	< 10.0
2-Butanone	< 10.0	< 10.0
2-Hexanone	< 10.0	< 10.0
4-Methyl-2-pentanone	< 10.0	< 10.0
Acetone	< 10.0	< 10.0
Benzene	1.0 J	< 10.0
Bromodichloromethane	< 10.0	< 10.0
Bromoform	< 10.0	< 10.0
Bromomethane	< 10.0	< 10.0
Carbon Disulfide	< 10.0	< 10.0
Carbon Tetrachloride	< 10.0	< 10.0
Chlorobenzene	< 10.0	< 10.0
Chloroethane	< 10.0	< 10.0
Chloroform	< 10.0	< 10.0
Chloromethane	< 10.0	< 10.0
Dibromochloromethane	< 10.0	< 10.0
Ethylbenzene	< 10.0	< 10.0
Methylene Chloride	< 10.0	< 10.0
Styrene	< 10.0	< 10.0
Tetrachloroethene	< 10.0	< 10.0
Toluene	1.0 JB	< 10.0
Trichloroethene	< 10.0	< 10.0
Vinyl Acetate	< 10.0	< 10.0
Vinyl Chloride	< 10.0	< 10.0
Xylene (total)	< 10.0	< 10.0
cis-1,3-Dichloropropene	< 10.0	< 10.0
trans-1,3-Dichloropropene	< 10.0	< 10.0

Appendix D
TRACE METAL ANALYTICAL RESULTS.

GW-727 Trace Metal Analytical Results

Well/Zone Number:		GW-727-2		GW-727-5		GW-727-8		GW-727-9		GW-727-13		GW-727-15	
Date Sampled:		1/17/95		1/17/95		11/30/94		11/30/94		11/30/94		11/29/94	
METALS (mg/L)	Screening levels*												
Aluminum	7.9	< 0.2	d	< 0.2	d	< 2.0	d	0.46		< 0.2	d	0.31	
Antimony	0.05	< 0.5	d	< 0.5	d	< 5.0	d	< 0.5	d	< 0.5	d	< 0.5	d
Arsenic		< 0.5	d	< 0.5	d	< 5.0	d	< 0.5	d	< 0.5	d	< 0.5	d
Barium		8.3		6.5		31.0		2.8		0.82		1.6	
Beryllium	0.0019	< 0.003	d	< 0.003	d	< 0.03	d	< 0.003	d	< 0.003	d	< 0.003	d
Boron	0.57	0.26		0.27		< 0.4	d	0.15		0.37		0.59	
Cadmium	0.005	< 0.03	d	< 0.03	d	< 0.3	d	< 0.03	d	< 0.03	d	< 0.03	d
Chromium		< 0.1	d	< 0.1	d	< 1.0	d	< 0.1	d	< 0.1	d	< 0.1	d
Cobalt	0.025	< 0.05	d	< 0.05	d	< 0.5	d	< 0.05	d	< 0.05	d	< 0.05	d
Copper	0.3	< 0.04	d	< 0.04	d	< 0.4	d	< 0.04	d	< 0.04	d	< 0.04	d
Iron	13.0	1.2		0.3		12.0		0.088		< 0.05	d	0.082	
Lead	0.05	< 0.5	d	< 0.5	d	< 5.0	d	< 0.5	d	< 0.5	d	< 0.5	d
Manganese	2.7	0.38		0.25		0.8		0.12		0.021		0.041	
Molybdenum	0.01	< 0.1	d	< 0.1	d	< 1.0	d	< 0.1	d	< 0.1	d	< 0.1	d
Nickel	0.33	< 0.1	d	< 0.1	d	< 1.0	d	< 0.1	d	< 0.1	d	< 0.1	d
Selenium		< 0.5	d	< 0.5	d	< 5.0	d	< 0.5	d	< 0.5	d	< 0.5	d
Silver		< 0.06	d	< 0.06	d	< 0.6	d	< 0.06	d	< 0.06	d	< 0.06	d
Strontium	0.83	45.0		37.0		180.0		6.4		3.4		5.9	
Thorium	0.2	< 2.0	d	< 2.0	d	< 20.0	d	< 2.0	d	< 2.0	d	< 2.0	d
Vanadium	0.058	< 0.05	d	< 0.05	d	< 0.5	d	< 0.05	d	< 0.05	d	< 0.05	d
Zinc	0.079	0.074		0.13		< 0.2	d	0.042		0.034		0.14	
Dilution factor		10		10		100		10		10		10	

* Screening levels obtained from HSW Environmental Consultants, 1994. Levels listed are for ORR Aquitards. Where blank, there is no screening level listed.

** italicized values show a detection limit that is above the recommended screening level.

*** bold face values show levels that are above the detection limit and the screening level.

GW-727 Trace Metal Analytical Results

Well/Zone Number:		GW-727-18	GW-727-22	GW-727-25	GW-727-27	GW-727-30
Date Sampled:		11/29/94	11/16/94	11/16/94	11/16/94	11/16/94
METALS (mg/L)	Screening levels*					
Aluminum	7.9	< 0.1 d	0.046	0.035	< 0.02	< 0.02
Antimony	0.05	< 0.25 d	< 0.05	< 0.05	< 0.05	< 0.05
Arsenic		< 0.25 d	< 0.05	< 0.05	< 0.05	< 0.05
Barium		0.1	0.03	0.039	0.025	0.066
Beryllium	0.0019	< 0.0015 d	< 0.0003	< 0.0003	< 0.0003	< 0.0003
Boron	0.57	0.85	1.2	1.9	1.9	1.7
Cadmium	0.005	< 0.015 d	< 0.003	< 0.003	< 0.003	< 0.003
Chromium		< 0.05 d	< 0.01	< 0.01	< 0.01	< 0.01
Cobalt	0.025	< 0.025 d	< 0.005	< 0.005	< 0.005	< 0.005
Copper	0.3	< 0.02 d	< 0.004	< 0.004	< 0.004	< 0.004
Iron	13.0	0.21	0.059	0.033	< 0.005	0.0062
Lead	0.05	< 0.25 d	< 0.05	< 0.05	< 0.05	< 0.05
Manganese	2.7	0.0064	0.0014	0.0018	< 0.001	0.0015
Molybdenum	0.01	< 0.05 d	< 0.01	< 0.01	< 0.01	< 0.01
Nickel	0.33	< 0.05 d	< 0.01	< 0.01	< 0.01	< 0.01
Selenium		< 0.25 d	< 0.05	< 0.05	< 0.05	< 0.05
Silver		< 0.03 d	< 0.006	< 0.006	< 0.006	< 0.006
Strontium	0.83	0.36	0.088	0.11	0.086	0.33
Thorium	0.2	< 1.0 d	< 0.2	< 0.2	< 0.2	< 0.2
Vanadium	0.058	< 0.025 d	< 0.005	< 0.005	< 0.005	< 0.005
Zinc	0.079	0.081	0.043	0.021	0.023	0.07
Dilution factor		5				

* Screening levels obtained from HSW Environmental Consultants, 1994. Levels listed are for ORR Aquitards. Where blank, there is no screening level listed.

** italicized values show a detection limit that is above the recommended screening level.

*** bold face values show levels that are above the detection limit and the screening level.

Appendix E

MAJOR ANIONS AND CATIONS AND FIELD PARAMETERS.

Major Anions and Cations and Field Parameters.

Well/Zone Number:	GW-727-2	GW-727-5	GW-727-8	GW-727-9	GW-727-13	GW-727-15	GW-727-18
Date Sampled:	1/17/95	1/17/95	11/30/94	11/30/94	11/30/94	11/29/94	11/29/94
Date Alkalinity Sampled:			1/24/95	1/24/95	12/13/94	1/24/95	1/24/95
ANIONS (mg/L)							
Alkalinity	112.0	85.0	34.0	36.0	100.0	130.6	542.0
Alkalinity-HCO ₃ *	137.0	104.0	41.0	44.0	122.0	159.0	661.0
Alkalinity-CO ₃ *	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bromide	81.0	74.0	162.0	41.0	21.0	33.0	na
Chloride IC	7900.0	7900.0	16189.0	4634.0	2275.0	3649.0	486.0
Fluoride SIE	1.3	1.3	0.7	1.6	2.2	1.3	3.5
Nitrate	< 10.0	< 10.0	< 100.0	< 10.0	< 10.0	< 10.0	< 10.0
Sulfate	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	28.0
CATIONS (mg/L)							
Calcium	400.0	340.0	1400.0	120.0	33.0	55.0	4.6
Iron	1.2	0.3	12.0	0.09	< 0.05	0.08	0.21
Magnesium	100.0	97.0	360.0	33.0	8.3	14.0	1.1
Potassium	13.0	9.9	< 60.0	15.0	9.6	15.0	3.8
Sodium	5200.0	4600.0	8200.0	2700.0	1500.0	2200.0	600.0
TDS (mg/L)†	13833.0	13126.1	26365.0	7588.6	3971.0	6126.6	1788.0
FIELD PARAMETERS							
pH	6.5	7.0	6.8	7.0	7.5	7.5	8.0
Temperature (°C)	8.5	9.5	12.5	12.0	8.0	12.5	12.0
Conductivity (µmho/cm)	17000.0	15000.0	27500.0	9000.0	4500.0	7500.0	1670.0

*values determined by speciating total alkalinity (CaCO₃) based on pH of water sample.

Bolded alkalinity values (zones 8, 9, 15 and 18) denote use of a field alkalinity test kit. Analyzed on 1/25/95.

†Sum of major anions and cations (mg/L).

d = indicates sample diluted for analysis.

Major Anions and Cations and Field Parameters.

Well/Zone Number:	GW-727-22	GW-727-25	GW-727-27	GW-727-30
Date Sampled:	11/16/94	11/16/94	11/16/94	11/16/94
Date Alkalinity Sampled:				
ANIONS (mg/L)				
Alkalinity	549.0	545.0	491.0	468.0
Alkalinity-HCO ₃ *	616.0	638.0	599.0	571.0
Alkalinity-CO ₃ *	26.0	13.0	0.0	0.0
Bromide	na	na	na	na
Chloride IC	24.0	13.0	7.8	17.0
Fluoride SIE	4.0	4.0	3.2	3.1
Nitrate	< 1.0	< 1.0	< 1.0	< 1.0
Sulfate	44.0	49.0	36.0	44.0
CATIONS (mg/L)				
Calcium	1.3	1.3	1.1	2.7
Iron	0.06	0.03	< 0.01	0.01
Magnesium	0.31	0.4	0.31	1.1
Potassium	2.2	2.2	1.9	2.5
Sodium	290.0	280.0	240.0	250.0
TDS (mg/L)†	1008.0	1000.9	888.9	891.0
FIELD PARAMETERS				
pH	9.0	8.7	8.3	8.0
Temperature (°C)	17.5	17.0	17.0	12.5
Conductivity (µmho/cm)	910.0	900.0	800.0	1100.0

*values determined by speciating total alkalinity (CaCO₃) based on pH of water sample.

†Sum of major anions and cations (mg/L).

d = indicates sample diluted for analysis.

Appendix F**"CHARGE BALANCE CALCULATIONS.**

Charge Balance Calculations

Well/Zone Number:	GW-727-2	GW-727-5	GW-727-8	GW-727-9	GW-727-13	GW-727-15
Date Sampled:	1/17/95	1/17/95	11/30/94	11/30/94	11/30/94	11/29/94
ANIONS (meq/L)						
Alkalinity-HCO ₃	2.2	1.7	0.7	0.7	2.0	2.6
Alkalinity-CO ₃	0.0	0.0	0.0	0.0	0.0	0.0
Bromide	1.0	0.9	2.0	0.5	0.3	0.4
Chloride IC	222.8	222.8	456.6	130.7	64.2	102.9
Fluoride SIE	0.1	0.1	0.0	0.1	0.1	0.1
Nitrate	0.0	0.0	0.0	0.0	0.0	0.0
Nitrate Brucine	0.0	0.0	0.0	0.0	0.0	0.0
Sulfate IC	0.0	0.0	0.0	0.0	0.0	0.0
Total Anions	226.1	225.5	459.3	132.0	66.5	106.0
CATIONS (meq/L)						
Calcium	20.0	17.0	69.9	6.0	1.6	2.7
Iron	0.1	0.0	0.6	0.0	0.0	0.0
Magnesium	8.2	8.0	29.6	2.7	0.7	1.2
Potassium	0.3	0.3	0.0	0.4	0.2	0.4
Sodium	226.1	200.0	356.6	117.4	65.2	95.7
Total Cations	254.7	225.2	456.7	126.5	67.8	99.9
CHARGE BALANCE (%)	6	0	0	-2	1	-3

Charge Balance Calculations

Well/Zone Number:	GW-727-18	GW-727-22	GW-727-25	GW-727-27	GW-727-30
Date Sampled:	11/29/94	11/16/94	11/16/94	11/16/94	11/16/94
ANIONS (meq/L)					
Alkalinity-HCO ₃	10.8	10.1	10.5	9.8	9.4
Alkalinity-CO ₃	0.0	0.9	0.4	0.0	0.0
Bromide	0.0	0.0	0.0	0.0	0.0
Chloride IC	13.7	0.7	0.4	0.2	0.5
Fluoride SIE	0.2	0.2	0.2	0.2	0.2
Nitrate	0.0	0.0	0.0	0.0	0.0
Nitrate Brucine	0.0	0.0	0.0	0.0	0.0
Sulfate IC	0.6	0.9	1.0	0.8	0.9
Total Anions	25.3	12.8	12.5	10.9	10.9
CATIONS (meq/L)					
Calcium	0.2	0.1	0.1	0.1	0.1
Iron	0.0	0.0	0.0	0.0	0.0
Magnesium	0.1	0.0	0.0	0.0	0.1
Potassium	0.1	0.1	0.1	0.0	0.1
Sodium	26.1	12.6	12.2	10.4	10.9
Total Cations	26.5	12.8	12.3	10.6	11.2
CHARGE BALANCE (%)	2	0	-1	-2	1

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