**ENVIRONMENTAL
RESTORATION
PROGRAM**

**Sampling Results, DNAPL
Monitoring Well GW-730,
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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Monitoring Well GW-730,
Oak Ridge Y-12 Plant,
Oak Ridge, Tennessee,
First and Second Quarter,
FY 1995**

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Dear Associates:

***Transmittal of Sampling Results, DNAPL Monitoring Well GW-730, First and Second Quarter
FY 1995, Y/ER-203***

Enclosed you will find a copy of *Sampling Results, DNAPL Monitoring Well GW-730, First and Second Quarter, FY 1995, Y/ER-203*. This report has been developed by the Environmental Restoration Program for your information and use. The purpose of the document is to provide initial groundwater sampling results from multiport wells constructed around the Y-12 Burial Grounds. These wells were constructed in response to discovery of free phase DNAPL at the Burial Grounds. Results in this report provide contaminate monitoring information and, where appropriate, information for groundwater reference concentrations.

If you have any questions or comments regarding this document please contact RaNaye Dreier at (413) 574-7422.

Sincerely,

J. A. Hodgins
Project Manager

cc w/encl:

G. W. Bodenstein, DOE-ORO
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PREFACE

This document, *Sampling Results, DNAPL Monitoring Well GW-730, 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.

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The authors also wish to thank C. T. Rightmire and D. B. Watson for their constructive review of the report.

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-730, and presents analytical results for GW-730.

To date, each of the eleven sampling zones in GW-730 has been sampled for VOCs, metals and anions. Based on the presence of very low levels of benzene at and below the base of the middle Nolichucky Shale, it is recommended that VOC monitoring of GW-730 be continued. Additional data is required in order to statistically confirm the presence or absence of VOCs through the use of "J" qualifiers. Zones 7 and 11 will be resampled in order to confirm or disprove the presence of nitrate in the deeper portions of the borehole. Purging activities will continue for zones 2, 7, 11, 15, and 18 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 fractured units with low storativity, such as those in GW-730, 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
mg/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-730 and presents analytical results for GW-730.

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.

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-730 is located down dip 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-730 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.

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. GW-730 is highlighted. Estimated locations of geologic contacts are shown.

Table 1. GW-730 construction and well design information

BOREHOLE CONSTRUCTION					
Surface Casing (ft bgs)		420.3			
Total Depth (ft bgs)		1424.8			
SURVEY COORDINATES			ELEVATIONS (ft amsl)		
Grid System		Y-12	Ground surface		922.64
Northing		28920.84	Top of concrete pad		923.25
Easting		44607.57	Top of steel casing		926.19
			Top of MP casing		926.09
MULTIPOINT 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	1374-1384	1374	1364.5	-438.4	
2	1359-1369	1364	1354.5	-428.4	1369
3	1344-1354	1344	1334.6	-408.5	
4	1298-1339	1298	1290.1	-364.1	
5	1263-1293	1263	1255.3	-329.3	
6	1253-1258	1253	1245.6	-319.5	
7	1233-1248	1243	1235.6	-309.5	1248
8	1223-1228	1223	1215.7	-289.6	
9	1183-1218	1182	1176.1	-250.0	
10	1168-1178	1168	1161.3	-235.2	
11	1153-1163	1158	1151.3	-225.2	1163
12	1143-1148	1143	1136.4	-210.4	
13	1108-1138	1108	1101.4	-175.4	
14	1098-1103	1098	1091.4	-165.3	
15	1078-1093	1088	1081.6	-155.5	1093
16	1048-1073	1048	1042.0	-115.9	
17	1018-1043	1018	1012.3	-86.2	
18	1003-1013	1008	1002.4	-76.3	1013
19	968-998	968	962.8	-36.7	
20	942-963	942	937.9	-11.8	
21	912-937	922	918.1	8.0	932
22	887-907	887	883.4	42.7	
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, which are marked in bold.					
NOTE: Only depths and not elevations are provided for the pumping ports because samples are not collected from these ports. Samples are collected from measurement ports.					
* MP = Westbay Multiport Casing, ags = above ground surface.					
* bgs = below ground surface, amsl = above mean sea level.					
* TOMP = Top of MP casing					

Table 1. cont.

MULTIPOINT 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)
23	862-882	862	858.5	67.6	
24	847-587	847	843.7	82.4	
25	832-842	837	833.7	92.3	842
26	792-827	792	789.1	137.0	
27	767-787	767	764.2	161.9	
28	747-762	757	754.4	171.7	762
29	732-742	732	729.4	196.7	
30	717-727	722	719.6	206.5	727
31	687-712	687	684.7	241.4	
32	657-682	657	655.0	271.1	
33	627-652	627	625.2	300.9	
34	597-622	597	595.4	330.7	
35	576-592	586	585.2	340.9	592
36	551-571	551	550.6	375.5	
37	526-546	526	525.6	400.5	
38	496-521	496	495.7	430.4	
39	471-491	481	480.7	445.3	491
40	436-466	436	436.0	490.1	
41	0-431	421	420.8	505.2	

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, which are marked in bold.

NOTE: Only depths and not elevations are provided for the pumping ports because samples are not collected from these ports. Samples are collected from measurement 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-730 SAMPLING ZONES

The multiport completion design for GW-730 is shown in Table 1. On the basis of core samples, geophysical logs and flowmeter results, 11 sampling zones, 10-to-25 ft. long, were selected from GW-730. 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 11 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-730 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-730 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 zone 28 and 30. In addition, GW-730 was drilled substantially deeper than the other Westbay-instrumented well in order to intercept the Maryville Formation, which underlies Burial Ground A-North. Waste oils, coolants and spent solvents were disposed in Burial Ground A-North as well as Burial Ground A-South. This well, which of the 5 monitoring wells is located closest to the immediate down-dip direction from Burial Ground A-North (Fig. 1), will be used to monitor potential strata-bound DNAPL migration pathways from the northern burial ground.

Table 2. Sampling zones for GW-730^a

Multiport Zone^b	Depth (ft.)^{c,d}	Samp. port depth (ft.)^{c,d}	Purpose	Logs/Core
39	471-491 (470-490)	481 (480)	Sample fracture at top of cored interval	core: Fractures 478',480' logs: Long-short normal difference 490' stratigraphy: middle Nolichucky Shale
35	576-592 (575-590)	586 (585)	Sample fracture, vertical distribution	core: Fractures 576', 577', 580', 583', 587' logs: Large long-short normal difference; In zone of high SP stratigraphy: middle Nolichucky Shale
30	717-727 (715-725)	722 (720)	Sample fractures within potential zone of DNAPL migration at base of middle Nolichucky Shale.	core: Fractures 715', 717', 724', 726' logs: Large long-short normal difference 720', small temperature anomaly stratigraphy: base of middle Nolichucky Shale
28	747-762 (745-760)	757 (755)	Sample fractures within potential zone of DNAPL migration at base of middle Nolichucky Shale.	core: Fractures 753.2', 753.8', 756' logs: Minor SP change 750'. Long-short normal difference 760', small temperature anomaly stratigraphy: base of middle Nolichucky Shale
25	832-842 (830-840)	837 (835)	Sample fracture below potential DNAPL zone.	core: Fractures 832.1', 832.2' logs: No fractures identified. stratigraphy: lower Nolichucky Shale
21	912-937 (910-935)	922 (920)	Sample fracture.	core: Fracture 921.6'; fault 920.2' logs: Caliper 912', 920', 929', SP high (get change to lower 920'), minor long-short normal difference, small temperature anomaly. stratigraphy: lower Nolichucky Shale
18	1003-1013 (1000-1010)	1008 (1005)	Sample stratigraphy of burial Ground A-North, vertical distribution.	core: No fractures identified. logs: Slightly high SP & long-short normal difference stratigraphy: Maryville Formation
15	1078-1093 (1075-1090)	1087 (1085)	Sample deformation zone and fracture. Sample stratigraphy of Burial Ground A-North.	core: fault--fold zone 1076-1085', fracture 1086' logs: High SP & long-short normal difference. stratigraphy: Maryville Formation
11	1153-1163 (1150-1160)	1158 (1155)	Sample fractures in Maryville Formation.	core: fracture 1159' probably tight logs: not available stratigraphy: Maryville Formation

Table 2. (cont.)

7	1233- 1248 (1230- 1245)	1243 (1240)	Sample fractures in Maryville Formation.	core: fractures 1234', 1245'; fault 1244' logs: not available stratigraphy: Maryville Formation
2	1359- 1379 (1355- 1365)	1364 (1360)	Sample well bottom (TD=1424')	core: No fractures identified. logs: not available stratigraphy: Maryville Formation

^arepeated verbatim from Dreier and Caldanaro (1994), Table 11.

^bMultiport zone number.

^cDepth measured from ground surface, not corrected for borehole deviation

^dParentheses denote planned depth. Other number is correct downhole depth.

Figure 3. Multiport sampling zones for GW-730. The region marked Potential DNAPL is not meant to imply that DNAPL occurs in this interval at this location. Rather, this zone correlates to the same stratigraphic interval at shallower depths up dip where DNAPL was visually observed and where dissolved phase plumes were identified.

2.0 PURGING AND SAMPLING ACTIVITIES

2.1 PURGING

Initial purging of the sample zones in GW-730 began in May of 1993, several months after hydraulic heads had stabilized from multiport installation, and continued through March 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-730, only three produced the requisite three annular volumes within a month of purging. These zones (zones 21, 25 and 35) are in the upper portion of the well and may indicate that permeability decreases with increasing depth. However note that purge times for zones 25 and 21 were approximately 2 and 6 months respectively. It is only the uppermost zones (zones 35 and 39) that appear to have the potential to purge in less than two weeks. Purge volumes for zones 28, 30 and 39 are slightly under three annular volumes (Table 3). This is because a purge volume calculation provided by Westbay Instruments proved to over estimate produced water volumes, and this mistake was discovered after these zones had been purged. Of the remaining 5 zones at the base of the well, two produced at least one annular volume (zones 15 and 17). Zones 2, 11 and 18 were open for approximately one month and did not produce one annular volume. However, they did produce approximately 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.

Table 3. GW-730 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)	2nd Purge Date Opened	2nd Purge Date Closed	Produced purge vol. (gals)	Total no. annular vols.	Difference of actual (-) recom. (gals)
2	11	14	1/31/95	3/7/95	1.9				0.4	-12
7	16	20	12/29/94	1/31/95	11.5				1.7	-8.7
11	11	14	9/21/93	10/14/93	**na	11/29/94	12/29/94	2.2	0.5	-11.7
15	16	20	9/2/93	9/20/93	**na	10/20/94	11/29/94	7.5	1.1	-12.7
18	11	14	8/23/93	9/1/93	**na	8/4/94	10/20/94	2.0	0.4	-11.8
21	26	33	8/3/93	8/20/93	**na	1/26/94	8/4/94	37.9	3.5	5.1
25	11	14	7/29/93	8/3/93	**na	11/30/93	1/25/94	16.8	3.6	3.0
28	16	20	7/23/93	7/29/93	**na	10/26/93	11/30/93	18.3	2.7	-1.9
30	11	14	7/12/93	7/22/93	**na	10/18/93	10/22/93	13.2	2.9	-0.6
35	16	20	5/18/93	6/1/93**	30.64				4.6	10.5
39	21	26	5/5/93	5/11/93	25.59				2.9	-0.9
<p>* 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 purge port for zone 35 is partially open from 6/1/93 to 10/18/93. Therefore purging of zones 11, 15, 18, 21, 25, 28 and 30 during that period is voided. Zones shown in bold did not produce the requisite three annular volumes of formation water.</p>										

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.

As of February, 1995, several types of control samples are collected during sampling: (1) A trip blank sample is obtained each time a VOC sample is collected; (2) A field blank is prepared for 10% of the VOC sampling events; (3) A duplicate sample is collected for 10% of all sampling events. (4) An equipment rinsate, consisting of the final DI water rinse from the inside of the sample bottle, is collected for 10% of all sampling events. Zones 2, 7, 11 and 15 were sampled after February 1995, but these samples were not part of the 10% population used for duplicates or equipment rinsates.

Table 4. Sampling and analysis plan.

High to Moderate Permeability

Sample		Parameter	Container	Volume	Filtered	Preservative	Procedure No.	Analytical Method
Run No.	Bottle No.		Type	(ml)				
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	N/A	YES	N/A	N/A	N/A
2	1	Metals	Plastic	100	YES	HNO3 (<2pH)	EPA-6010	ICP
2	1	Anions (Br*, Cl, Fl, 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		Parameter	Container	Volume	Filtered	Preservative	EPA	Analytical Method
Run No.	Bottle No.		Type	(ml)			Procedure No.	
1	1	Alkalinity	Plastic	50-100	YES	NONE	done in field OR EPA-310.1	titration
1	1	Anions (Br*, Cl, Fl, 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 between 50 and 110 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-730 is given in Table 5. Zones that show the low permeability characteristics mentioned above include zones 30 and below. Of these nine zones, seven did not produce the requisite purge water volumes in four weeks of purging (Table 3), which is another indication of low permeability.

Table 5. GW-730 sampling history.

Zone	Date	Parameters	Comments
2	3/15/95	VOC Metals, Anions, Alk. field parameters	Bromide included with Anions used nitrogen gas no separate rinsate run 1st run void
7	3/15/95	VOC Metals, Anions, Alk. field parameters	Bromide included with Anions used nitrogen gas no separate rinsate run
11	3/15/95	VOC Metals, Anions, Alk. field parameters	used nitrogen gas no separate rinsate run
15	3/23/95	VOC Metals, Anions, Alk. field parameters	Bromide included with Anions used nitrogen gas no separate rinsate run
18	11/3/94	VOC Metals, Anions, Alk. field parameters	Bromide included with Anions used nitrogen gas no separate rinsate run
21	11/2/94	VOC Metals, Anions, Alk. field parameters	Bromide included with Anions used nitrogen gas no separate rinsate run
25	11/2/94	VOC Metals, Anions, Alk. field parameters	Bromide included with Anions used nitrogen gas no separate rinsate run
28	10/26/94	VOC Metals, Anions, Alk. field parameters	used nitrogen gas 1st run voided
30	10/26/94	VOC Metals, Anions, Alk. field parameters	
35	9/22/94	VOC Metals, Anions, Alk. field parameters	
39	9/22/94	VOC Metals, Anions, Alk. field parameters	

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 9/22/94, 10/26/94, 11/2/94, 3/16/95 and 3/23/95 and their results are listed in Appendix A. VOCs were detected three times in the trip blanks (Appendix A); two for methylene chloride (9/22/94 and 3/23/95) and one for 2-Butanone (9/22/94). The methylene chloride detects had "J" qualifiers showing that the levels were estimated were estimated at values that are below the detection limit, and the 3/27/95 detect had a "B" qualifier, showing that methylene chloride was also detected with a similar concentration in the lab blank. Laboratory blank data are given in Appendix B and show detects with "J" qualifiers of 2-Hexanone and Acetone for the 9/27/94 sample and Toluene for the 10/31/94 sample, as well as the previously mentioned methylene chloride detect.

VOC results from the sample zones are presented in Appendix C and a list of 22 VOCs detects is given in Table 6. Most detectable values are flagged with a "J" qualifier and represent low (1.0 - 10.0 $\mu\text{g/L}$) but discernible responses from the analytical instrumentation. Of the 22 VOC detects, 8 corresponded to the lab or trip blanks associated with the sample. The remaining detects with "J" qualifiers include one for methylene chloride (a common laboratory reagent) in zone 35, carbon disulfide in zones 18 and 39; and benzene is observed in all of the zones below and including zone 30. Based on results from GW-727 (Dreier and Caldanaro, in prep.), and GW-790 (Dreier and Caldanaro, in prep.), benzene appears to be a common detect in the low-permeability, deeper portions of the DNAPL monitoring wells. 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-730 VOC analytical results that are tagged with a "J" qualifier.

Lab	Sample No.	Zone No.	Date Sampled	Analysis	Result	Tag	Units	Date Analyzed	Zone Depth (ft.)
	950316-090	2	15-Mar-95	Benzene	2.0	J	ug/L	17-Mar-95	1355
	950316-091	7	15-Mar-95	Benzene	2.0	J	ug/L	17-Mar-95	1236
	950316-092	11	15-Mar-95	Benzene	3.0	J	ug/L	17-Mar-95	1151
	950323-109	15	23-Mar-95	Benzene	6.0	J	ug/L	27-Mar-95	1082
	950323-109	15	23-Mar-95	Methylene Chloride	3.0	JB	ug/L	27-Mar-95	1082
	941103-049	18	3-Nov-94	Benzene	2.0	J	ug/L	8-Nov-94	1002
	941103-049	18	3-Nov-94	Carbon Disulfide	2.0	J	ug/L	8-Nov-94	1002
	941103-048	21	2-Nov-94	Benzene	2.0	J	ug/L	4-Nov-94	918
	941103-047	25	2-Nov-94	Benzene	2.0	J	ug/L	4-Nov-94	834
	941027-007	28	26-Oct-94	Benzene	3.0	J	ug/L	31-Oct-94	754
	941027-007	28	26-Oct-94	Toluene	4.0	JB	ug/L	31-Oct-94	754
	941027-008	30	26-Oct-94	Benzene	2.0	J	ug/L	31-Oct-94	720
	941027-008	30	26-Oct-94	Methylene Chloride	3.0	J	ug/L	31-Oct-94	720
	941027-008	30	26-Oct-94	Toluene	4.0	JB	ug/L	31-Oct-94	720
	940922-100	35	22-Sep-94	2-Butanone	13.0		ug/L	27-Sep-94	585
	940922-100	35	22-Sep-94	Acetone	6.0	JB	ug/L	27-Sep-94	585
	940922-100	35	22-Sep-94	Chloroform	1.0	J	ug/L	27-Sep-94	585
	940922-100	35	22-Sep-94	Methylene Chloride	2.0	J	ug/L	27-Sep-94	585
	940922-099	39	22-Sep-94	2-Butanone	10.0	J	ug/L	27-Sep-94	481
	940922-099	39	22-Sep-94	Acetone	6.0	JB	ug/L	27-Sep-94	481
	940922-099	39	22-Sep-94	Carbon Disulfide	2.0	J	ug/L	27-Sep-94	481
	940922-099	39	22-Sep-94	Methylene Chloride	2.0	J	ug/L	27-Sep-94	481
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. Available background screening levels listed in the GWQAR for Bear Creek Valley (HSW, 1994) are also listed in Appendix D, and detection limits are given as less than (<) values in Appendix D. Samples from zones 28 and below were diluted because of high ionic concentrations. All of these zones showed TDS values greater than 6000 mg/L and dilution rates vary as a function of TDS: Zone 28 (TDS = 6346 mg/L) had the least dilution with a dilution factor of 5, and zone 7 (TDS = 176000 mg/L) had the greatest dilution with a dilution factor of 200. As a result of the dilutions, detection limits are raised and some are raised above the background screening levels. This is the case for antimony, beryllium, cadmium, cobalt, lead, molybdenum, thorium, and vanadium (see Appendix D). Note also in Appendix D that the undiluted sample detection limits listed for antimony, lead, and thorium are equivalent to the background screening level for that constituent. Nevertheless, except for molybdenum, all analytical results for constituents with background screening levels below detection limits are below the detection limit, even though concentrations are expected to rise with an increase in TDS (TDS values are listed in Appendix E).

Boron, molybdenum, zinc, iron, manganese and strontium are above background screening levels for selected zones. The upper two zones in GW-730 (35 and 39) show boron levels above the background 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. The upper three zones (30, 35 and 39) show molybdenum values above the background screening level, and the remaining lower zones have a detection limit for molybdenum that is above the background screening level. Except for zone 11, all the zones below a depth of 740 ft at the base of the borehole show elevated values of zinc that are above the background screening level of 0.079 mg/L. Iron and manganese values are above background screening levels for zones 7, 21 and 25. These three zones showed the highest TDS values in the borehole (all TDS values are above 60,000 mg/L).

Strontium also shows concentrations above the background screening level. The elevated concentrations occur in the deepest 9 zones (zones 2, 7, 11, 15, 18, 21, 25, 28 and 30) where there is also a corresponding increase in TDS. These zones show TDS values greater than 6300 mg/L. 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.

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. Of immediate note is the potential presence of nitrate in zones 7 and 11. However, it is important to realize that ion chromatography, the analytical technique used for anion analysis, may give misleading results for high chloride waters, which is the type of water that most of the zones in GW-730 produce. Zones 7 and 11 will be resampled specifically for nitrate analysis, and an analytical technique will be used where there is no interference between chloride and nitrate peaks. Similarly, there is a potential problem with the bromide results because of chloride interference. Although the specific conductance of zones 11, 20 and 28 are above 2000 umho/cm, Br was not collected for analysis for these zones; for zone 11 it was an oversight, and zones 20 and 28 were sampled before the bromide procedure was initiated.

In general, ionic concentrations are given with two significant digits. Note, however, that for chloride, the significant digits range from two to five. At present, the reason for this change has not been determined and is being investigated with the K-25 Analytical Laboratory. Nine of the eleven zones showed a charge balance that is less than 10%. The other two zones, zones 7 and 18, had balances of -20% and 16% respectively.

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 two zones (zones 35 and 39 which show a depth range of 450 - 600 ft) are a Na-HCO₃ type water. The lowest nine zones (zones 30, 28, 25, 21, 18, 15, 11, 7, and 2 which show a depth range of 700 - 1370 ft) are a Na-Cl type water. The change in water type with depth also roughly corresponds to an increase in TDS with depth (Fig. 5), although TDS values within the Na-Cl type water vary considerably and are not directly related to increasing depth. There may be some correlation between the presence of fractures and high TDS values but this requires further evaluation of the multiport data together.

Figure 4. Plot of strontium vs. calcium concentrations from GW-730.

Figure 5. Piper diagram of GW-730 water chemistry. It should be noted that zones 7 and 18 were plotted for comparison purposes only. Both had charge balances greater than $\pm 10\%$ (-20 and +16 respectively).

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-730 has been sampled for VOCs, metals and anions. Based on the presence of very low levels of benzene at and below the base of the middle Nolichucky Shale, it is recommended that VOC monitoring of GW-730 be continued. Additional data is required in order to statistically confirm the presence or absence of VOCs through the use of "J" qualifiers. Zones 7 and 11 will be resampled in order to confirm or disprove the presence of nitrate in the deeper portions of the borehole. Purging activities will continue for zones 2, 7, 11, 15, and 18 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-730, 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:	940922-101	941027-009	941103-050	950316-106	950323-110
Trip Date:	9/22/94	10/26/94	11/2/94	3/16/95	3/23/95
Date Analyzed:	9/27/94	11/1/94	11/8/94	3/17/95	3/27/95
Units:	µg/L	µg/L	µg/L	µg/L	µg/L
1,1,1-Trichloroethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,1,2,2-Tetrachloroethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,1,2-Trichloroethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,1-Dichloroethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,1-Dichloroethene	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichloroethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichloroethene (total)	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichloropropane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
2-Butanone	11.0	< 10.0	< 10.0	< 10.0	< 10.0
2-Hexanone	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
4-Methyl-2-pentanone	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Acetone	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Benzene	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Bromodichloromethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Bromoform	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Bromomethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Carbon Disulfide	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Carbon Tetrachloride	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Chlorobenzene	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Chloroethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Chloroform	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Chloromethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Dibromochloromethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Ethylbenzene	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Methylene Chloride	1.0 J	< 10.0	< 10.0	< 10.0	3.0 JB
Styrene	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Tetrachloroethene	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Toluene	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Trichloroethene	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Vinyl Acetate	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Vinyl Chloride	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Xylene (total)	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
cis-1,3-Dichloropropene	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
trans-1,3-Dichloropropene	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0

Appendix B

LABORATORY BLANK VOC ANALYTICAL RESULTS.

Laboratory Blank VOC Analytical Results.

Sample Number:	940928-056	941101-015	941104-040	941108-010	950317-011	950327-044
Date Completed:	9/27/94	10/31/94	11/4/94	11/8/94	3/17/95	3/27/95
Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
1,1,1-Trichloroethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,1,2,2-Tetrachloroethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,1,2-Trichloroethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,1-Dichloroethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,1-Dichloroethene	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichloroethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichloroethene (total)	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichloropropane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
2-Butanone	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
2-Hexanone	2.0 J	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
4-Methyl-2-pentanone	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Acetone	6.0 J	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Benzene	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Bromodichloromethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Bromoform	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Bromomethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Carbon Disulfide	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Carbon Tetrachloride	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Chlorobenzene	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Chloroethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Chloroform	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Chloromethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Dibromochloromethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Ethylbenzene	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Methylene Chloride	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	4.0 J
Styrene	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Tetrachloroethene	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Toluene	< 10.0	4.0 J	< 10.0	< 10.0	< 10.0	< 10.0
Trichloroethene	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Vinyl Acetate	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Vinyl Chloride	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Xylene (total)	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
cis-1,3-Dichloropropene	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
trans-1,3-Dichloropropene	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0

Appendix C
VOC ANALYTICAL RESULTS.

VOC Analytical Results

Well/Zone Number:	GW-730-2	GW-730-7	GW-730-11
Sample Number:	950316-090	950316-091	950316-092
Date Sampled:	3/15/95	3/15/95	3/15/95
Date Analyzed:	3/17/95	3/17/95	3/17/95
Corresponding Trip Blank:	950316-106	950316-106	950316-106
Corresponding Lab Blank:	950317-011	950317-011	950317-011
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	< 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	< 10.0
Benzene	2.0 J	2.0 J	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	< 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	< 10.0	< 10.0	< 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-730-15	GW-730-18	GW-730-21	GW-730-25
Sample Number:	950323-109	941103-049	941103-048	941103-047
Date Sampled:	3/23/95	11/3/94	11/2/94	11/2/94
Date Analyzed:	3/27/95	11/8/94	11/4/94	11/4/94
Corresponding Trip Blank:	950323-110	941103-050	941103-050	941103-050
Corresponding Lab Blank:	950327-044	941108-010	941104-040	941104-040
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	2.0 J	2.0 J	2.0 J
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	2.0 J	< 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	3.0 JB	< 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-730-28	GW-730-30
Sample Number:	941027-007	941027-008
Date Sampled:	10/26/94	10/26/94
Date Analyzed:	10/31/94	10/31/94
Corresponding Trip Blank:	941027-009	941027-009
Corresponding Lab Blank:	941101-015	941101-015
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	3.0 J	2.0 J
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	3.0 J
Styrene	< 10.0	< 10.0
Tetrachloroethene	< 10.0	< 10.0
Toluene	4.0 JB	4.0 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-730-35	GW-730-39
Sample Number:	940922-100	940922-100
Date Sampled:	9/22/94	9/22/94
Date Analyzed:	9/27/94	9/27/94
Corresponding Trip Blank:	940922-101	940922-101
Corresponding Lab Blank:	940928-056	940928-056
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	13.0	10.0 J
2-Hexanone	< 10.0	< 10.0
4-Methyl-2-pentanone	< 10.0	< 10.0
Acetone	6.0 JB	6.0 JB
Benzene	< 10.0	< 10.0
Bromodichloromethane	< 10.0	< 10.0
Bromoform	< 10.0	< 10.0
Bromomethane	< 10.0	< 10.0
Carbon Disulfide	< 10.0	2.0 J
Carbon Tetrachloride	< 10.0	< 10.0
Chlorobenzene	< 10.0	< 10.0
Chloroethane	< 10.0	< 10.0
Chloroform	1.0 J	< 10.0
Chloromethane	< 10.0	< 10.0
Dibromochloromethane	< 10.0	< 10.0
Ethylbenzene	< 10.0	< 10.0
Methylene Chloride	2.0 J	2.0 J
Styrene	< 10.0	< 10.0
Tetrachloroethene	< 10.0	< 10.0
Toluene	< 10.0	< 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-730 Trace Metal Analytical Results

Well/Zone Number:		GW-730-2		GW-730-7		GW-730-11		GW-730-15		GW-730-18		GW-730-21	
Date Sampled:		3/15/95		3/15/95		3/15/95		3/23/95		3/13/94		11/2/94	
METALS (mg/L)	Background Screening levels*												
Aluminum	7.9	< 0.2	d	< 4.0	d	< 0.2	d	0.22		< 0.2	d	3.0	
Antimony	0.05	< 0.5	d	< 10.0	d	< 0.5	d	< 0.5	d	< 0.5	d	< 5.0	d
Arsenic		< 0.5	d	< 10.0	d	< 0.5	d	< 0.5	d	0.52		< 5.0	d
Barium		39.0		1100.0		20.0		42.0		20.0		280.0	
Beryllium	0.0019	< 0.003	d	< 0.06	d	< 0.003	d	< 0.003	d	< 0.003	d	< 0.03	d
Boron	0.57	0.16		< 0.8	d	0.17		0.14		0.16		0.53	
Cadmium	0.005	< 0.03	d	< 0.6	d	< 0.03	d	< 0.03	d	< 0.03	d	< 0.3	d
Chromium		< 0.1	d	< 2.0	d	< 0.1	d	< 0.1	d	< 0.1	d	< 1.0	d
Cobalt	0.025	< 0.05	d	< 1.0	d	< 0.05	d	< 0.05	d	< 0.05	d	< 0.5	d
Copper	0.3	< 0.04	d	< 0.8	d	< 0.04	d	< 0.04	d	< 0.04	d	< 0.4	d
Iron	13.0	6.5		52.0		4.2		2.0		6.0		46.0	
Lead	0.05	< 0.5	d	< 10.0	d	< 0.5	d	< 0.5	d	< 0.5	d	< 5.0	d
Manganese	2.7	1.5		19.0		0.39		0.85		0.47		5.2	
Molybdenum	0.01	< 0.1	d	< 2.0	d	< 0.1	d	< 0.1	d	< 0.1	d	< 1.0	d
Nickel	0.33	< 0.1	d	< 2.0	d	< 0.1	d	< 0.1	d	0.32		< 1.0	d
Selenium		< 0.5	d	< 10.0	d	< 0.5	d	< 0.5	d	< 0.5	d	< 5.0	d
Silver		< 0.06	d	< 1.2	d	< 0.06	d	< 0.06	d	< 0.06	d	< 0.6	d
Strontium	0.83	94.0		2400.0		60.0		100.0		80.0		920.0	
Thorium	0.2	< 2.0	d	< 40.0	d	< 2.0	d	< 2.0	d	< 2.0	d	< 20.0	d
Vanadium	0.058	< 0.05	d	< 1.0	d	< 0.05	d	< 0.05	d	< 0.05	d	< 0.5	d
Zinc	0.079	0.23		1.3		0.05		0.76		0.2		1.1	
Dilution factor		10		200		10		10		10		100	

* Background 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 background screening level.

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

GW-730 Trace Metal Analytical Results

Well/Zone Number:		GW-730-25	GW-730-28	GW-730-30	GW-730-35	GW-730-39
Date Sampled:		11/2/94	10/26/94	10/26/94	9/22/94	9/22/94
METALS (mg/L)	Background Screening levels*					
Aluminum	7.9	< 2.0	d < 0.1	d 0.025	< 0.02	0.037
Antimony	0.05	< 5.0	d < 0.25	d < 0.05	< 0.05	< 0.05
Arsenic		< 5.0	d 0.28	0.088	< 0.05	< 0.05
Barium		190.0	4.4	0.31	0.084	0.05
Beryllium	0.0019	< 0.03	d < 0.0015	d < 0.0003	< 0.0003	< 0.0003
Boron	0.57	< 0.4	d 0.32	0.42	1.2	1.7
Cadmium	0.005	< 0.3	d < 0.0015	d < 0.003	< 0.003	< 0.003
Chromium		< 1.0	d < 0.05	d < 0.01	< 0.01	< 0.01
Cobalt	0.025	< 0.5	d < 0.025	d < 0.005	< 0.005	< 0.005
Copper	0.3	< 0.4	d < 0.02	d < 0.004	< 0.004	< 0.004
Iron	13.0	41.0	0.9	0.0092	0.034	0.026
Lead	0.05	< 5.0	d < 0.25	d < 0.05	< 0.05	< 0.05
Manganese	2.7	3.4	0.11	0.01	0.0021	0.0028
Molybdenum	0.01	< 1.0	d < 0.05	d 0.024	0.021	0.017
Nickel	0.33	< 1.0	d < 0.05	d < 0.01	< 0.01	< 0.01
Selenium		< 5.0	d < 0.25	d < 0.05	< 0.05	< 0.05
Silver		< 0.6	d < 0.03	d < 0.006	< 0.006	< 0.006
Strontium	0.83	640.0	19.0	1.2	0.29	0.31
Thorium	0.2	< 20.0	d < 1.0	d < 0.2	< 0.2	< 0.2
Vanadium	0.058	< 0.5	d < 0.025	d < 0.005	< 0.005	< 0.005
Zinc	0.079	1.3	0.14	0.011	0.016	0.021
Dilution factor		100	5	1	1	1

* Background 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 background screening level.

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

Appendix E**MAJOR ANIONS AND CATIONS AND FIELD PARAMETERS.**

Major Anions and Cations and Field Parameters.

Well/Zone Number:	GW-730-2	GW-730-7	GW-730-11	GW-730-15	GW-730-18	GW-730-21	GW-730-25
Date Sampled:	3/15/95	3/15/95	3/15/95	3/23/95	11/3/94	11/2/94	11/2/94
Date Field Alkalinity determined:	3/15/95	3/15/95	3/15/95	na	na	na	na
ANIONS (mg/L)							
Alkalinity (Field Kit)	103.2	29.2	111.2	na	na	na	na
Alkalinity (K-25 Lab)	106.0	22.0	108.0	39.0	85.0	17.0	36.0
Alkalinity-HCO ₃ *	129.0	27.0	132.0	48.0	104.0	21.0	44.0
Alkalinity-CO ₃ *	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bromide	134.0	2000.0	na	100.0	664.0	622.0	102.0
Chloride IC	12000.0	120000.0	7600.0	8800.0	6268.0	43476.0	34968.0
Fluoride SIE	0.53	0.17	1.4	0.92	1.1	0.3	0.4
Nitrate	< 100.0 d	2600.0	360.0	< 100.0 d	< 1000.0	< 1000.0	< 1000.0
Sulfate	< 100.0 d	< 1000.0 d	< 100.0 d	< 100.0 d	< 2.0	< 2.0	< 2.0
CATIONS (mg/L)							
Calcium	810.0	15000.0	470.0	840.0	640.0	6700.0	4900.0
Iron	6.5	52.0	4.2	2.0	6.0	46.0	41.0
Magnesium	160.0	2800.0	120.0	220.0	150.0	1500.0	1100.0
Potassium	26.0	< 120.0 d	18.0	41.0	24.0	190.0	62.0
Sodium	6000.0	30000.0	4000.0	4600.0	4600.0	21000.0	19000.0
TDS (mg/L)†	19266.3	172479.0	12705.3	14651.5	11792.7	72933.0	60115.3
FIELD PARAMETERS							
pH	6.5	6.5	6.0	6.5	6.5	6.0	6.8
Temperature (°C)	14.0	17.0	19.0	18.0	11.0	18.0	17.0
Specific Conductance (µmho/cm)	23000.0	50000.0	18000.0	22500.0	17000.0	> 50000.0	50000.0

*values determined by speciating total alkalinity (CaCO₃) from K-25 labs, based on pH of water sample.

Bolded alkalinity values (zones 2, 7, and 11) denote use of a field alkalinity test kit. These values are used for comparison purposes only.

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

d = indicates sample diluted for analysis.

na = not analyzed

Major Anions and Cations and Field Parameters.

Well/Zone Number:	GW-730-28	GW-730-30	GW-730-35	GW-730-39
Date Sampled:	10/26/94	10/26/94	9/22/94	9/22/94
Date Field Alkalinity determined:	na	na	na	na
ANIONS (mg/L)				
Alkalinity (Field Kit)	na	na	na	na
Alkalinity (K-25 Lab)	131.0	333.0	789.0	749.0
Alkalinity-HCO ₃ *	160.0	406.0	962.0	895.0
Alkalinity-CO ₃ *	0.0	0.0	0.0	9.0
Bromide	na	na	na	na
Chloride IC	3528.0	795.0	93.0	78.0
Fluoride SIE	1.5	3.0	4.4	4.1
Nitrate	< 1.0	< 1.0	< 1.0	< 1.0
Sulfate	5.0	11.0	77.0	160.0
CATIONS (mg/L)				
Calcium	170.0	13.0	3.3	3.8
Iron	0.9	0.009	0.034	0.026
Magnesium	44.0	3.7	0.89	0.98
Potassium	13.0	5.4	3.6	4.7
Sodium	2400.0	780.0	440.0	450.0
TDS (mg/L)†	6322.1	2017.1	1584.2	1605.5
FIELD PARAMETERS				
pH	6.5	7.5	8.0	8.5
Temperature (°C)	15.0	11.5	18.0	17.5
Specific Conductance (µmho/cm)	10000.0	2900.0	1500.0	1700.0

*values determined by speciating total alkalinity (CaCO₃) from K-25 labs, based on pH of water sample.

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

d = indicates sample diluted for analysis.

na = not analyzed

Appendix F
CHARGE BALANCE CALCULATIONS.

Charge Balance Calculations

Well/Zone Number:	GW-730-2	GW-730-7	GW-730-11	GW-730-15	GW-730-18	GW-730-21
Date Sampled:	3/15/95	3/15/95	3/15/95	3/23/95	11/3/94	11/2/94
ANIONS (meq/L)						
Alkalinity-HCO ₃	2.1	0.4	2.2	0.8	1.7	0.3
Alkalinity-CO ₃	0.0	0.0	0.0	0.0	0.0	0.0
Bromide	1.7	25.0	0.0	1.3	0.0	0.0
Chloride IC	338.4	3384.4	214.3	248.2	176.8	1226.2
Fluoride SIE	0.0	0.0	0.1	0.0	0.1	0.0
Nitrate	0.0	41.9	5.8	0.0	0.0	0.0
Sulfate IC	0.0	0.0	0.0	0.0	0.0	0.0
Total Anions	342.3	3451.8	222.4	250.3	178.5	1226.5
CATIONS (meq/L)						
Calcium	40.4	748.5	23.5	41.9	31.9	334.3
Iron	0.3	2.8	0.2	0.1	0.3	2.5
Magnesium	13.2	230.3	9.9	18.1	12.3	123.4
Potassium	0.7	0.0	0.5	1.0	0.6	4.9
Sodium	260.9	1304.5	173.9	200.0	200.0	913.2
Total Cations	315.5	2286.1	207.9	261.2	245.2	1378.2
CHARGE BALANCE (%)	-4	-20	-3	2	16	6

Charge Balance Calculations

Well/Zone Number:	GW-730-25	GW-730-28	GW-730-30	GW-730-35	GW-730-39
Date Sampled:	11/2/94	10/26/94	10/26/94	9/22/94	9/22/94
ANIONS (meq/L)					
Alkalinity-HCO ₃	0.7	2.6	6.7	15.8	14.7
Alkalinity-CO ₃	0.0	0.0	0.0	0.0	0.3
Bromide	0.0	0.0	0.0	0.0	0.0
Chloride IC	986.2	99.5	22.4	2.6	2.2
Fluoride SIE	0.0	0.1	0.2	0.2	0.2
Nitrate	0.0	0.0	0.0	0.0	0.0
Sulfate IC	0.0	0.1	0.2	1.6	3.3
Total Anions	986.9	102.3	29.5	20.2	20.7
CATIONS (meq/L)					
Calcium	244.5	8.5	0.6	0.2	0.2
Iron	2.2	0.0	0.0	0.0	0.0
Magnesium	90.5	3.6	0.3	0.1	0.1
Potassium	1.6	0.3	0.1	0.1	0.1
Sodium	826.2	104.4	33.9	19.1	19.6
Total Cations	1165.0	116.8	35.0	19.5	20.0
CHARGE BALANCE (%)	8	7	9	-2	-2

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