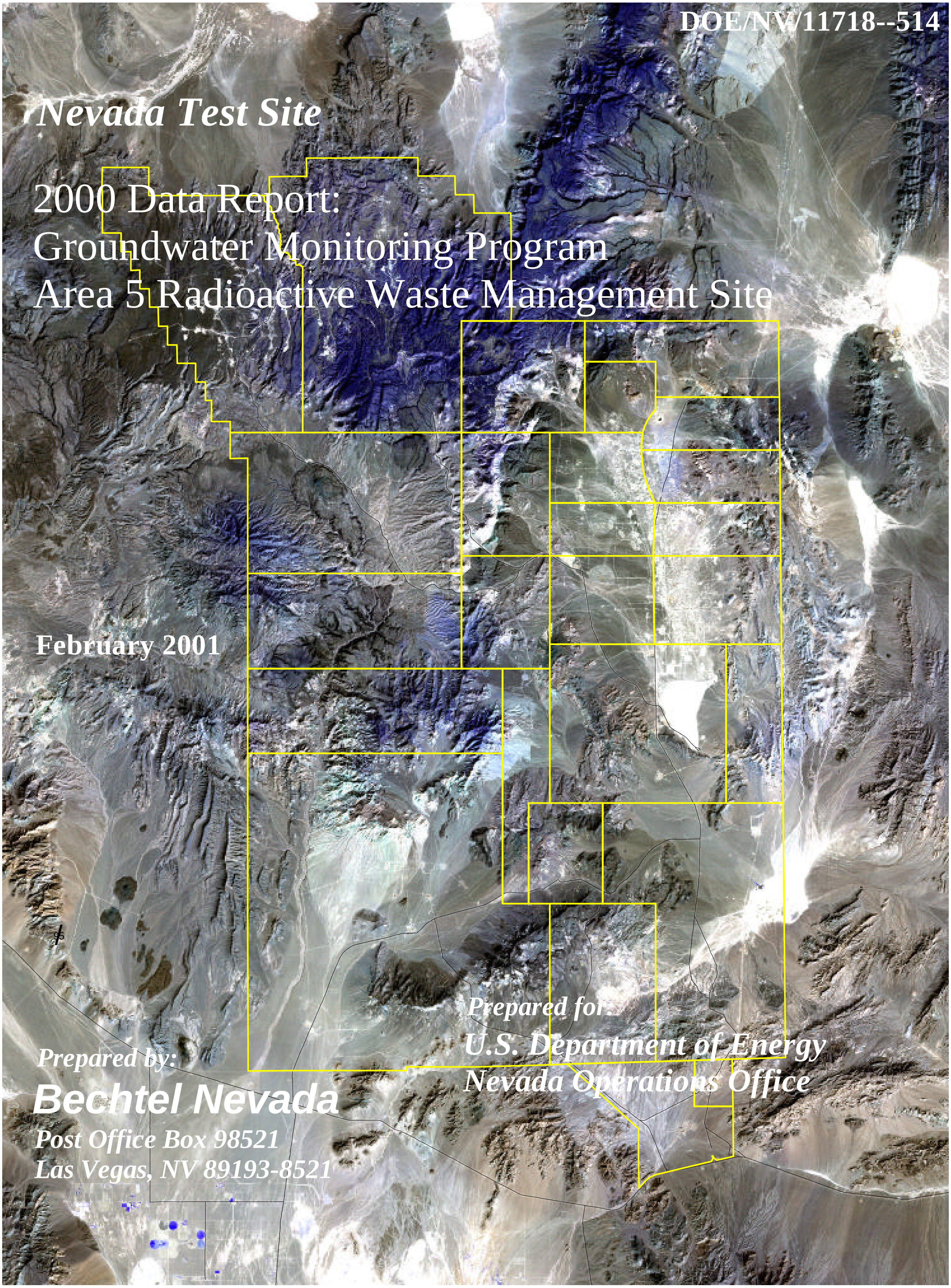
DOE/NV/11718--514

Nevada Test Site

2000 Data Report: Groundwater Monitoring Program Area 5 Radioactive Waste Management Site



February 2001

Prepared for:

U.S. Department of Energy
Nevada Operations Office

Prepared by:

Bechtel Nevada

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DISCLAIMER

DOE/NV/11718--514

NEVADA TEST SITE

2000 DATA REPORT: GROUNDWATER MONITORING PROGRAM AREA 5 RADIOACTIVE WASTE MANAGEMENT SITE

February 2001

Worked Performed Under
Contract No. DE-AC08-96NV11718

Prepared for:
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Nevada Operations Office

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CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
GW	Groundwater
IL	Investigation Level
MDL	Method Detection Limit
MWDU	Mixed Waste Disposal Unit
NDEP	Nevada Division of Environmental Protection
NTS	Nevada Test Site
RCRA	Resource Conservation and Recovery Act
RWMS	Radioactive Waste Management Site
TOC	Total Organic Carbon
TOX	Total Organic Halogen

EXECUTIVE SUMMARY

This report is a compilation of the calendar year 2000 groundwater sampling results from the Area 5 Radioactive Waste Management Site (RWMS). Contamination indicator data are presented in control chart and tabular form with investigation levels (IL) indicated. Gross water chemistry data are presented in graphical and tabular form.

Other information in the report includes, the Cumulative Chronology for Area 5 RWMS Groundwater Monitoring Program, a brief description of the site hydrogeology, and the groundwater sampling procedure.

Wells Ue5PW-1, Ue5PW-2, and Ue5PW-3 were sampled semiannually for pH, specific conductance, major cations/anions, metals, tritium, total organic carbon (TOC), and total organic halogen (TOX). Results from the spring sampling event reported concentrations above ILs in many of the field and blank samples for both TOX and TOC. All wells were resampled in August, with split samples sent to two separate laboratories. TOC results from the August event from both laboratories were below the IL for all samples submitted. TOX results were mixed. One laboratory reported many field and blank samples, with concentrations above the IL, while the second laboratory reported all field samples below the IL but some of the blank samples above the IL. The Nevada Division of Environmental Protection (NDEP) was contacted after each sampling event to report results. Communication with the state resulted in NDEP requiring the United States Department of Energy (DOE) to submit a plan to address potential areas of concern prior to the spring 2001 sampling event. This plan proposes submitting samples to evaluate laboratory performance, as well as increasing the number of sample replicates taken, and taking samples for compound-specific analyses during the next sampling event. Although some indicator analytes have been reported above the IL, it is most likely that these results are a product of sample handling (i.e., laboratory/field contamination) rather than being representative of aquifer conditions. Results from all other parameters analyzed indicate that there has been no measurable impact to the uppermost aquifer from the Resource Conservation and Recovery Act (RCRA) regulated unit within the Area 5 RWMS.

There were no major changes noted in the monitored groundwater elevation. There continues to be an extremely small gradient to the northeast with a flow velocity of less than one foot per year; however, this is subject to change because the wells have a similar groundwater elevation.

Cumulative Chronology for Area 5 RWMS Groundwater (GW) Monitoring Program

Ue5PW-1		Ue5PW-2		Ue5PW-3	
03/20/1990	U.S. Department of Energy (DOE) letter requesting installation of monitoring wells near the Area 5 RWMS.				
03/13/1992	Drilling begins	06/18/1992	Drilling begins	09/16/1992	Drilling begins
06/16/1992	Drilling ends	09/04/1992	Drilling ends	11/09/1992	Drilling ends
09/11/1992	Well Developed				
03/31/1993	GW Sampling	03/24/1993	GW Sampling	04/04/1993	Well Developed
07/06/1993	GW Sampling	03/30/1993	Well Developed	04/14/1993	GW Sampling
		06/22/1993	GW Sampling	06/02/1993	GW Sampling
09/01/1993	GW Sampling	11/15/1993	GW Sampling	10/12/1993	GW Sampling
12/07/1993	GW Sampling			12/20/1993	GW Sampling
12/17/1993	DOE letter to the NDEP requesting to establish pilot wells located in Area 5 as RCRA groundwater monitoring wells.				
		01/19/1994	GW Sampling		
02/24/1994	NDEP letter to DOE stating that the pilot wells appear to meet the applicable design, construction, and development criteria for RCRA groundwater monitoring wells.				
06/15/1994	GW Sampling	06/07/1994	GW Sampling	05/24/1994	GW Sampling
08/01/1994	GW Sampling	11/29/1994	GW Sampling	08/08/1994	GW Sampling
09/30/1994	Submitted to the NDEP the 1993 groundwater monitoring results from quarterly sampling effort.				
01/18/1995	GW Sampling	01/18/1995	GW Sampling	01/18/1995	GW Sampling
02/23/1995	DOE letter to NDEP transmitting Groundwater Monitoring Program Outline.				
03/01/1995	1994 Groundwater Monitoring Report submitted to the NDEP.				
04/04/1995	GW Sampling	04/04/1995	GW Sampling	04/04/1995	GW Sampling
11/09/1995	GW Sampling	11/20/1995	GW Sampling	11/09/1995	GW Sampling
11/09/1995	Ue5PW-1 pump snagged in hole and pulled reel from floor; this resulted in a bent shaft on the reel.				
01/22/1996	Ue5PW-1, 2, and 3 Bennet pump seals replaced.				
03/01/1996	1995 Groundwater Monitoring Report submitted to the NDEP.				
10/25/1996	NDEP letter to DOE requesting clarifications/changes in the GW Monitoring				
03/01/1997	Submitted to the NDEP 1996 GW Monitoring Report and revised GW Monitoring Program Outline.				

Cumulative Chronology for Area 5 RWMS GW Monitoring Program (cont.)

Ue5PW-1		**Ue5PW-2**		**Ue5PW-3**	
04/16/1997	GW Sampling	04/16/1997	GW Sampling	04/16/1997	GW Sampling
08/12/1997	NDEP letter to DOE commenting on 1996 GW Monitoring Report/Proposed Outline.				
10/22/1997	The Ue5PW-1 Bennet pump and water level meter while operating simultaneously were lodged in the well casing. Retrieved 10/23/1997.				
10/22/1997	Ue5PW-1, 2, and 3 larger-diameter air lines were installed.				
11/05/1997	GW Sampling	11/05/1997	GW Sampling	11/05/1997	GW Sampling
02/19/1998	1997 GW Monitoring Report submitted to DOE.				
03/01/1998	1997 GW Monitoring Report and new “outline” submitted to NDEP.				
03/31/1998	NDEP letter to DOE stating that they concur on the indicator parameters and ILs submitted in the groundwater monitoring outline.				
05/13/1998	GW Sampling	05/13/1998	GW Sampling	05/13/1998	GW Sampling
06/22/1998	TOX detected in the 05/13/1998 samples and blanks from Ue5PW-1, 2, and 3. Results reported to DOE.				
07/10/1998	A verbal agreement between DOE and NDEP permitted sampling of one well (Ue5PW-1) to confirm no TOX.				
07/29/1998	GW resampling for 5/13/1998 TOX hits.				
09/10/1998	Results from the 07/29/1998 sampling event are nondetect for TOX; therefore the TOX results from the 05/13/1998 sampling event are determined to be false positives.				
09/10/1998	Ue5PW-1, 2, 3 and spare Bennett pumps returned to manufacture for refurbishing.				
09/12/1998	Ue5PW-1, 2, and 3 reels returned to manufacture for new tubing bundles.				
10/28/1998	GW Sampling	10/28/1998	GW Sampling	10/28/1998	GW Sampling
09/12/1998	Ue5PW-1 reel returned to manufacture for repair of exhaust tube. Spare pump returned to manufacture for the repair of a leaky seal.				
02/12/1999	1998 GW Monitoring Report submitted to DOE.				
03/01/1999	1998 Groundwater Monitoring Report submitted to NDEP.				
03/31/1999	Letter from NDEP to DOE requesting statistical analysis of data. Letter also stated that values determined to be false positives through resampling do not need to be shown graphically.				
05/19/1999	GW Sampling	05/19/1999	GW Sampling	05/19/1999	GW Sampling
10/27/1999	GW Sampling	10/27/1999	GW Sampling	10/27/1999	GW Sampling
		12/13/1999	GW resampling for 10/27/1999 TOC hit.		
12/27/1999	Results from the 12/13/1999 sampling event at Ue5PW-2 are nondetect for TOC therefore the TOC result from the 10/27/1999 sampling event is determined to be a false positive.				
04/17/2000	Letter from NDEP to DOE stating that future reports do not need to include statistical analyses				

Cumulative Chronology for Area 5 RWMS GW Monitoring Program (cont.)					
Ue5PW-1		**Ue5PW-2**		**Ue5PW-3**	
04/26/2000	GW Sampling	04/26/2000	GW Sampling	04/26/2000	GW Sampling
06/28/2000	Verbally contacted the state to report TOX/TOC hits from April sampling event and agreed that the wells would be resampled in August which would also constititute as the Fall sampling event.				
08/09/2000	GW Sampling	08/09/2000	GW Sampling	08/09/2000	GW Sampling
09/20/2000	DOE contacted NDEP to report TOX hits from August sampling.				
11/07/2000	Letter from NDEP to DOE stating that DOE does not have a valid data set for TOX and possibly TOC and requests a plan to address contamination concerns prior to next sampling event.				
11/20/2000	video log borehole	11/20/2000	video log borehole	11/27/2000	video log borehole
12/20/2000	Transmittal of proposed plan to address contamination issues to NDEP				

I. INTRODUCTION

A. Purpose and Scope

This report is a compilation of the calendar year 2000 groundwater sampling results for the Nevada Test Site (NTS) (see Appendix A, Figure A.1 for location) Area 5 Radioactive Waste Management Site (RWMS) as required by Title 40 Code of Federal Regulations (CFR) 265 (see Appendix A, Figures A.2 and A.3 for location). The Resource Conservation and Recovery Act (RCRA) regulated unit within Area 5 is P03U (see Appendix A, Figure A.4), referred to as Pit 3 Mixed Waste Disposal Unit (MWDU). The Pit 3 MWDU is operated in accordance with RCRA Interim Status standards for the disposal of mixed low-level waste. In addition to providing groundwater monitoring results, this report also includes information regarding site hydrogeology, well construction, and sample collection.

The format of this report was requested by the Nevada Division of Environmental Protection (NDEP) in a letter dated August 12, 1997. The appearance and arrangement of this document has been modified slightly since that date to give the reader additional information and to make the document easier to read. Specifically, the following changes have been made: (1) the "<" notation is used in the raw data tables to indicate a value was less than the method detection limit (MDL); (2) gradient and velocity calculations are presented; (3) data plots are presented in portrait fashion with two plots per page; and (4) for the purposes of computing summary statistics and plotting data, nondetect values are assumed to be equal to one-half of their MDL.

B. Objective

The objective of this report is to satisfy the reporting requirements of Title 40 CFR 265.94 as well as the agreements made between the DOE and NDEP.

C. Site Hydrogeology

The Area 5 RWMS is located in northern Frenchman Flat in the southeast corner of the NTS. Thick, unsaturated alluvial deposits separate the facility from the uppermost aquifer. The alluvial aquifer is present beneath the Area 5 facility and is believed to extend throughout much of the Frenchman Flat basin (IT 1998). Monitoring wells (referred to as pilot wells) Ue5PW-1 and Ue5PW-2 are completed in the alluvial aquifer, while Ue5PW-3 is completed in the Timber Mountain Tuff Aquifer in the northwest corner of the facility. The alluvial and Tertiary Tuff contact occurs at a depth of 600 feet at Ue5PW-3. Well construction details are provided in Appendix A, Figures A.5, A.6, and A.7.

The water from all three monitoring wells is characterized as sodium bicarbonate type waters. The alluvial and tuff aquifers have similar hydrochemistry, groundwater elevation, and are believed to be connected, but the connection of these aquifers is an area of current study. Area 5 RWMS hydraulic parameters are presented in Appendix B, Table B.1. Saturated hydraulic conductivity and effective porosity values presented are the mean values from laboratory analysis of the alluvium cores taken from the three pilot wells. Hydraulic conductivity values calculated from slug tests are also in close agreement with values presented in Table B.1. Although Ue5PW-3 is completed in the tuff aquifer, the higher alluvial hydraulic properties are assumed in the groundwater velocity calculation.

Using the hydraulic properties listed in Appendix B, Table B.1, the groundwater flow direction and velocity were calculated. The hydraulic gradient, velocity, and direction values presented in Appendix B, Table B.1 correspond to groundwater elevation measurements made on November 13, 2000. The calculated mean horizontal groundwater flow velocity is less than one foot per year and flows to the northeast (58.5° east of north) in the uppermost aquifer. Details of velocity and direction calculations are given in Appendix C.

Some amount of vertical groundwater flow is thought to occur from the Alluvial Aquifer and Timber Mountain Aquifer to the Lower Carbonate Aquifer; however, this is an area of current study. The Lower Carbonate Aquifer is the regional aquifer that flows from central NTS to the south, where it discharges into Death Valley, California, and into smaller depressions (Amargosa Valley and Ash Meadows) in southwest Nevada (see Appendix A, Figure A.8). For a more detailed description of the site characteristics, refer to “Revised Area 5 Radioactive Waste Management Site Outline of a Comprehensive Groundwater Monitoring Program,” February 1998.

Appendix A, Figure A.9 presents the monthly precipitation measured at the Area 5 RWMS meteorological tower.

II. MONITORING CRITERIA

The Area 5 RWMS pilot wells have been monitored for compliance since 1993 under Title 40 CFR 265. The groundwater monitoring program has transitioned from monitoring all parameters required by Title 40 CFR 265 to a program that monitors parameters applicable to this particular site. The current program is modeled after the Title 40 CFR 264 detection monitoring program. The analytes listed below were agreed upon by DOE and NDEP to be sampled semi-annually and are divided into groups representing indicators of contamination and general water chemistry parameters. The groundwater sampling procedure is presented in Appendix D.

Radiological analyses for 2000 were performed by Bechtel Nevada Analytical Services Laboratory (phone [702] 295-7220). Non-radiological samples for 2000 were sent to Recra Environmental, Inc., Laboratory (phone [610] 280-3000) in April and August, while Barringer Laboratories, Inc., (phone [800] 654-0506) was used only in August as a secondary laboratory.

Indicators of Contamination

- pH
- specific conductance
- total organic carbon (TOC)
- total organic halogen (TOX)
- tritium

General Water Chemistry Parameters

- total Ca, Fe, Mg, Mn, K, Na, SiO_2
- total SO_4, Cl, F
- alkalinity

Control charts have been developed for each of the indicator parameters. These charts show the relationship of the results from the groundwater analysis to the investigation level (IL). ILs denote the values which, if exceeded, trigger a monitoring well resampling for that parameter. The intent of using an IL was to replace the need for rigorous statistical analyses, which attempt to identify if contamination has occurred. Statistical analyses are not presented in this year's report, as agreed upon by NDEP in a letter dated April 17, 2000. ILs for each indicator parameter were negotiated between the DOE and NDEP in 1998 and are listed in Appendix B, Table B.2. The ILs for pH and specific conductance are based on the statistics of data collected from 1993 through 1996. Historic analyses for TOX, TOC, and tritium have reported concentration levels less than the MDL, and therefore statistical methods are not appropriate for determining their ILs. The ILs for TOX and TOC have been set slightly above their MDLs. The tritium IL has been set at 10 percent of the drinking water standard (20,000 pCi/L).

A. pH

Appendix A, Figure A.10 is a time series plot of the mean pH values for wells Ue5PW-1, Ue5PW-2, and Ue5PW-3. All pH values are well within upper and lower ILs and are hydrologically similar. The pH values for Ue5PW-2 and Ue5PW-3 reached a peak in 1994 and then declined over the next two years. Since that time, the pH values have remained relatively constant. A plot of the last two years of data is displayed in Appendix A, Figure A.11. Appendix B, Table B.3 contains the actual pH values.

B. Specific Conductance

Appendix A, Figure A.12 is a time series plot of the mean specific conductance values for wells Ue5PW-1, Ue5PW-2, and Ue5PW-3. All conductance values are below the IL. The plot shows a decrease in conductance from 1993 to 1995 and then an increase to 1996 for all wells. Since 1996, the specific conductance in all wells has remained relatively constant. The last two years of data are plotted in Appendix A, Figure A.13 and shows that the specific conductance has remained constant. Appendix B, Table B.4 contains the actual specific conductance values.

C. Total Organic Carbon

Prior to calendar year 2000, there have been three instances of reported TOC concentrations above the IL. These occurred in years 1994, 1996, and 1999. All of these detections had duplicate analyses, which had concentrations less than the MDL. All detections are likely a product of laboratory/field contamination, as subsequent resamplings had reported concentrations less than the IL. Although the April 1996 TOC result is likely a product of laboratory/field contamination, it is presented graphically because the well was not resampled specifically to confirm the result (resampling procedure was set in 1998).

To aid in describing this year's events, results from calendar year 2000 are shown in Table 1.0 below. The reported concentrations for two field samples from the April sampling were above the IL; however, neither of the samples' duplicate analyses were above the IL. Several of the blank samples from this event also show detections, but they are below the IL. Due to the detections in the control samples, it seems likely that these detections are a product of laboratory/field contamination. All wells were

Table 1.0 TOC Results (mg/L) - 2000

	April	August	
Sample	**RECRA**	**RECRA**	**Barringer***
IL = 1 mg/L	MDL = 0.5 mg/L	MDL = 0.5 mg/L	MDL = 1 mg/L
Trip blank	none taken	<0.5	<1
Ue5PW-1 field sample	1.20	<0.5	<1
Ue5PW-1 field duplicate	0.75	<0.5	<1
Ue5PW-1 field blank	0.58	<0.5	<1
Ue5PW-2 field sample	0.70	<0.5	<1
Ue5PW-2 field duplicate	<0.5	<0.5	<1
Ue5PW-2 field blank	0.54	<0.5	<1
Ue5PW-3 field sample	2.10	<0.5	<1
Ue5PW-3 field duplicate	0.52	<0.5	<1
Ue5PW-3 field blank	<0.5	<0.5	<1

* Samples were 12 °C when received at the laboratory.

resampled in August, which also served as the second semi-annual 2000 sampling, as negotiated verbally with NDEP. Split samples were taken and sent to two laboratories. All August results from both laboratories were below the MDL, confirming the April results as false positives.

Appendix A, Figure A.14 is the time series plot of the mean TOC values (note that nondetect values are shown as being equal to one-half of their MDL). Results confirmed as false positives by resampling are not displayed graphically per NDEP request (March 31, 1999). Appendix A, Figure A.15 shows TOC values over the last two years. Appendix B, Table B.5 contains the actual TOC values reported prior to calendar year 2000. Calendar year 2000 TOC results are not shown graphically or in Table B.5 due to NDEP stating, in a letter dated November 7, 2000, that the TOC data set for the year 2000 may not be valid.

D. Total Organic Halogen

Prior to calendar year 2000, the IL for TOX has been exceeded only once. These samples were collected in May 1998. Eight samples from the three wells (two samples from each well and two trip blanks) had TOX levels above the MDL, and six were above the IL. Review of the data showed the control samples had some of the highest levels of TOX, indicating a possible laboratory or sampling error. A verbal agreement between DOE and NDEP on July 10, 1998, resulted in the resampling of one well (Ue5PW-1) to ensure that TOX was not present. Results from the resampling of Ue5PW-1 were below the MDL for TOX, confirming the May 1998 results as false positives.

To aid in describing this year's events, results from calendar year 2000 are shown in Table 2.0 below. All field samples taken in April showed concentrations above the IL, and all blank samples showed concentrations above the MDL but below the IL.

Table 2.0 TOX Results (ug/L) - 2000

Sample IL = 50 ug/L	**April** **RECRA** MDL =12 ug/L	**August** **RECRA** MDL =12 ug/L	**Barringer*** MDL = 10 ug/L
Trip blank	37.7	44.2	60
Ue5PW-1 field sample	78.8	99.9	<10
Ue5PW-1 field duplicate	64.6	83.6	10
Ue5PW-1 field blank	44.0	47.6	47
Ue5PW-2 field sample	61.5	73.5	<10
Ue5PW-2 field duplicate	57.1	72.4	11
Ue5PW-2 field blank	43.6	53	47
Ue5PW-3 field sample	53.8	87.5	<10
Ue5PW-3 field duplicate	59.7	78.1	<10
Ue5PW-3 field blank	34.2	52.9	65

* Samples were 12 °C when received at the laboratory.

Due to detections in the control samples, as well as the field samples, it is likely that the detections are a product of laboratory/field contamination. All wells were resampled in August, which also served as the second semi-annual 2000 sampling as negotiated verbally with NDEP. Split samples were taken and sent to two laboratories. All but two control samples, sent to the same laboratory (Recra) used in April, showed detections above the IL. Samples sent to a new laboratory showed nondetects for all field samples, but detections both above and below the IL for the control samples. It is likely that there is a problem with Recra Laboratory as all field samples from Barringer Laboratory show nondetect results, although the detections in control samples sent to Barringer are problematic. A plan to address potential contamination issues was submitted to NDEP on December 20, 2000. Appendix A, Figure A.16 is a time series plot of the mean TOX values (note that nondetect values are shown as being equal to one-half of their MDL). The false positives (above the IL) discussed above are not displayed graphically per NDEP request (March 31, 1999). Appendix A, Figure A.17 shows the data of the last two years. Appendix B, Table B.6 contains the actual TOX values reported prior to calendar year 2000. Calendar year 2000 TOX results are not shown graphically or in Table B.6 due to NDEP stating, in a letter dated November 7, 2000, that the TOX data set for the year 2000 may not be valid.

E. Tritium

A time series plot of the mean sample values for tritium is shown in Appendix A, Figure A.18. To plot these data on the vertical log scale requested by NDEP, all negative values were set at 0.001 pCi/L. All tritium results are below the IL and MDL. The November 1993 sample for Ue5PW-2 is not shown on the graph because the standard analysis was performed, not enriched tritium analysis. The variability over time, in Appendix A, Figure A.18, may be attributed to the counting variability of the analytical method and the variability in the enrichment process, as all values are below the MDL (indicated with the dotted line in Figure A.18). Appendix A, Figure A.19 shows the data for the last two years. Appendix B, Table B.7 contains the actual tritium values.

F. General Water Chemistry Parameters

General water chemistry measurements were made to assess the water's gross chemistry, suitability for human consumption, and to evaluate aquifer characteristics such as aquifer continuity and hydraulic connection between wells. Cl, F, Fe, Mn, and SO_4 concentrations were all below National Secondary Drinking Water Standards. A piper diagram showing the concentrations of the major cations and anions from the last two year's sampling events is included as Appendix A, Figure A.20 and indicates that the water from all three wells is sodium bicarbonate type waters. Stiff diagrams from each sampling event from the last two years are also included as Appendix A, Figure A.21, to illustrate water composition differences and similarities. Laboratory notes indicate that samples for metal analyses were not preserved for the April sampling event. Data does not appear to be affected, as results are similar to historical data. Additionally, a charge balance error of less than ±6 percent was achieved at each well for the calendar year 2000 sampling events. Groundwater temperature at time of sample collection ranged from 19.6 - 22.6 °C at all three wells, for the April and August sampling events. Temperature data were collected at the ground surface in a flow-through cell and may be influenced slightly by the ambient air. Raw data with summary statistics are presented in Appendix B, Tables B.8, B.9, and B.10. Visual inspection of graphical data indicate that the water geochemistry from the three wells is similar, and there is no significant change of the gross groundwater chemistry over time.

G. Groundwater Elevation

Water table elevations were measured with an electronic water level tape three times during calendar year 2000 to determine the hydraulic gradient. Inadvertently, Ue5PW-3 water level was not tagged in the first quarter. These measurements are subject to a total error of 0.16 feet (Bechtel Nevada 1998). The approximate depth to groundwater at Ue5PW-1, Ue5PW-2, and Ue5PW-3 is 772 feet, 842 feet, and 891 feet, respectively. Plots of groundwater elevation corrected for borehole deviation with time are shown in Appendix A, Figure A.22. Appendix B, Table B.11 lists all of the groundwater elevation data from the three wells. Appendix A, Figure A.23 shows a time series plot of mean groundwater velocity and flow direction. This plot suggests the flow velocity has remained constant, while the flow direction has become slightly more easterly with time. Additionally, due to the flatness of the water table, small changes in elevation produce large changes in the calculated flow direction. Details for the gradient and velocity calculations are given in Appendix C.

III. SUMMARY

There have been no confirmed significant changes detected in the chemistry of the uppermost aquifer from the two groundwater sampling events conducted in 2000. Indicator parameters pH, specific conductance, and tritium continue to be well within established ILs. A plan was submitted to NDEP to address the detections of the indicator parameters TOX and TOC in some field and control samples. Hydrologic conditions are stable with groundwater flow continuing to the northeast at a velocity of less than one foot per year.

IV. CONCLUSION

Although there have been detections of TOC and TOX above the IL in some field samples, control samples also have had detections of these compounds indicating that the results are likely a product of sample handling and are not representative of the aquifer. Additionally, there has been no measurable impact to the uppermost aquifer from the RCRA regulated unit within the Area 5 RWMS from any of the other indicator parameters.

V. REFERENCES

Bechtel Nevada, 1998. *Revised Area 5 Radioactive Waste Management Site, Outline of a Comprehensive Groundwater Monitoring Program*. Report to U.S. Department of Energy, Nevada Operations Office. February 1998.

Code of Federal Regulations, 1999. *Ground-Water Monitoring*. Title 40, Part 265, Subpart F.

IT Corporation, 1998. *Underground Test Area Subproject Corrective Action Unit 98: Frenchman Flat Data Analysis Task, Vol. 1 - Hydrostratigraphic Model Documentation Package,* Revision 0. Las Vegas, Nevada.

Liebendorfer, P.J., 2000. Nevada Division of Environmental Protection, Carson City, Nevada, Letter to E.F. Di Sanza, U.S. Department of Energy Nevada Operations Office, Las Vegas, NV. *Report of Results and Recommendations for the August 2000 Resampling Event for the Area 5 Radioactive Waste Management Site (RWMS) Pilot Wells.* November 7, 2000.

Liebendorfer, P.J., 2000. Nevada Division of Environmental Protection, Carson City, Nevada, Letter to R.C. Wycoff, U.S. Department of Energy Nevada Operations Office, Las Vegas, NV. *1999 Annual Groundwater Monitoring Report, Area 5 Radioactive Waste Management Site (RWMS).* April 17, 2000.

Reynolds Electrical & Engineering Co., Inc., 1994. *Site Characterization and Monitoring Data from Area 5 Pilot Wells, Nevada Test Site, Nye County, Nevada*. U.S. Department of Energy Report DOE/NV/11432--74.

Waddell, R. K., J. H. Robinson, and R. K Blankennagel, 1984. *Hydrology of Yucca Mountain and Vicinity, Nevada-California. Investigative Results through mid-1983*. USGS Water Resources Investigations Report 84-4267, 72 p.

VI. DISTRIBUTION

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Appendix A

Figures

Figure A.1 Location of the Nevada Test Site within Nevada

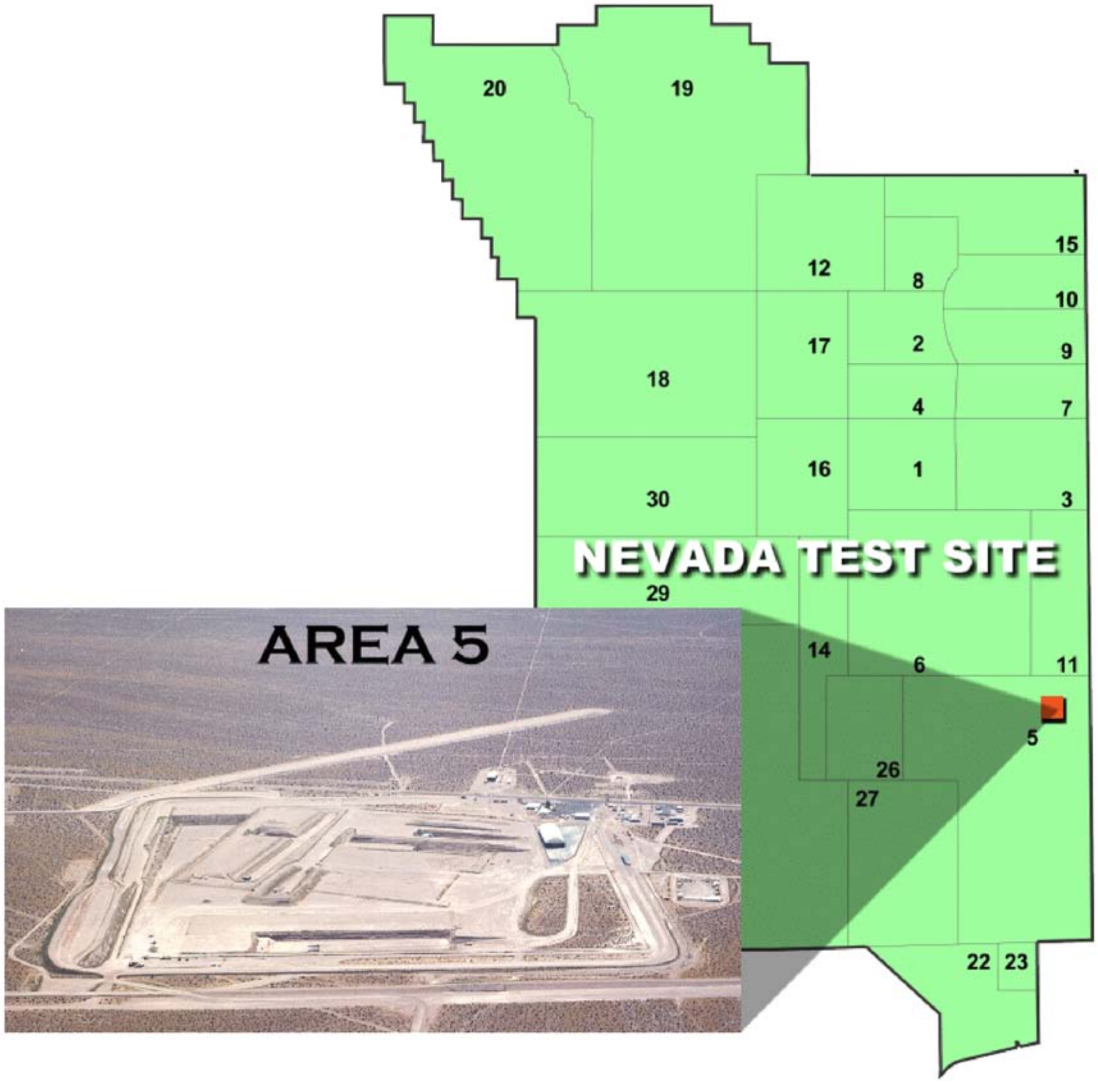

Figure A.2 Location of the Area 5 RWMS within the Nevada Test Site

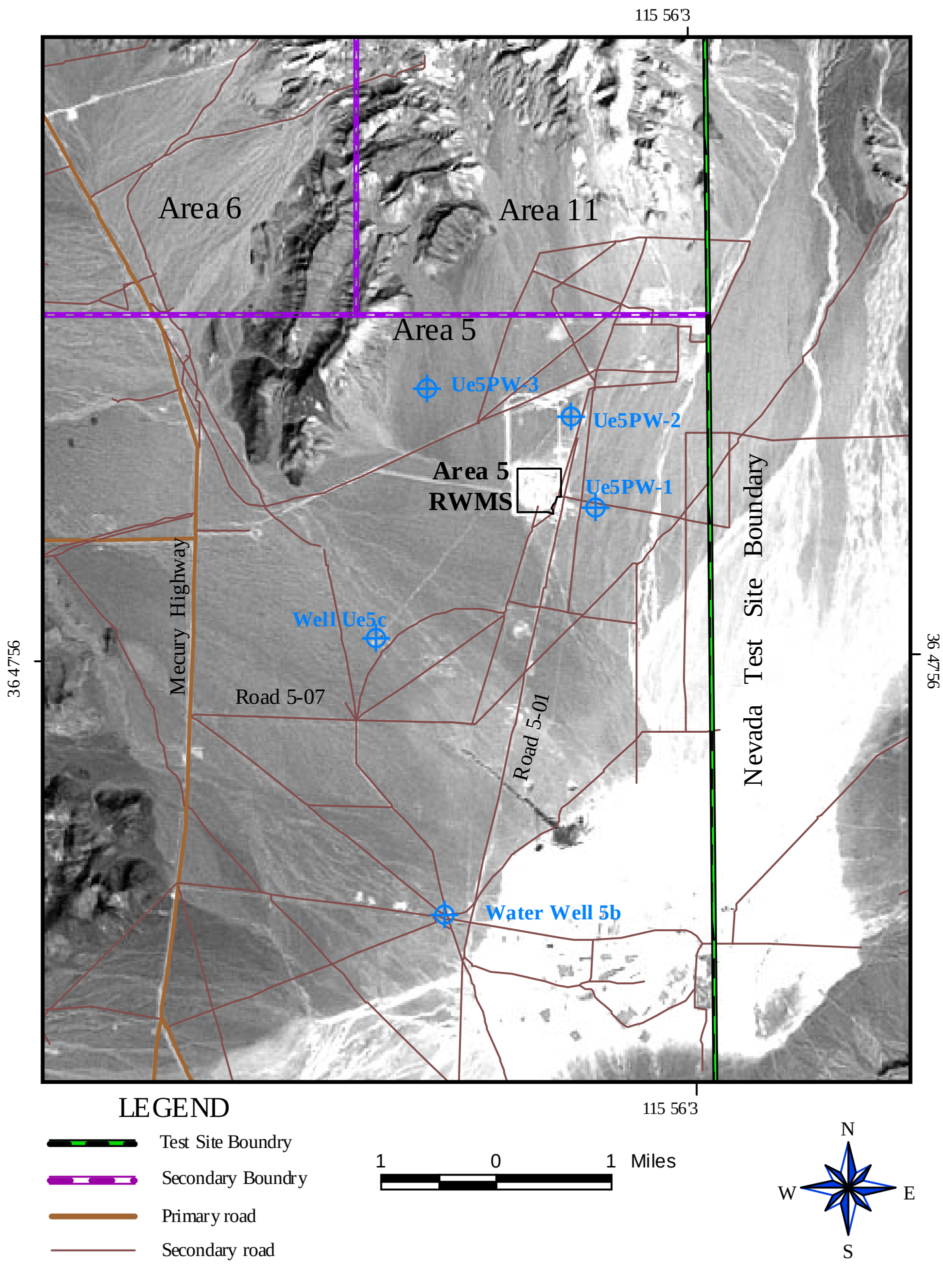

Figure A.3 Location of RWMS Groundwater Monitoring Wells and Other Wells in the Vicinity

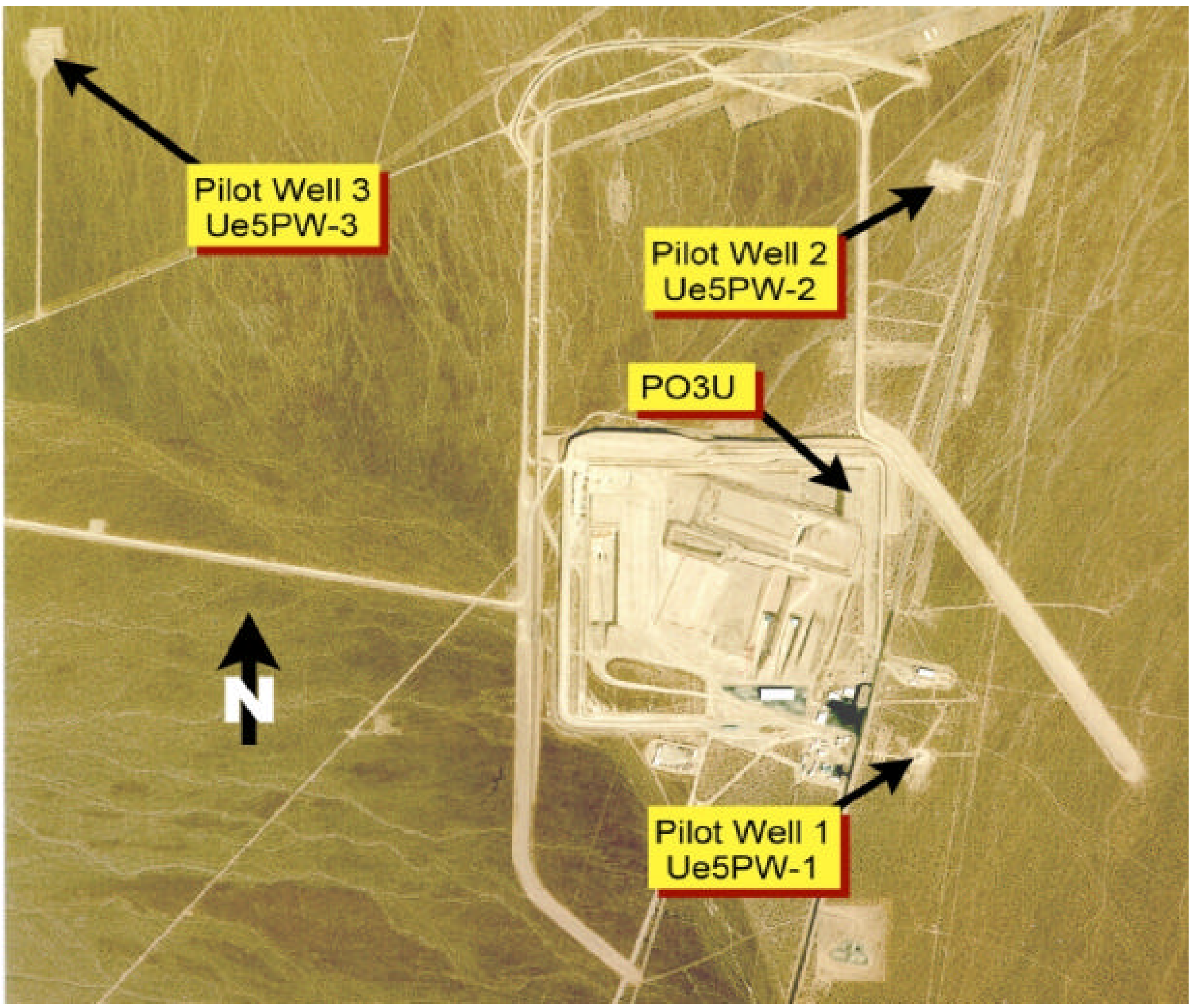

Figure A.4 Location of P03U within the Area 5 RWMS

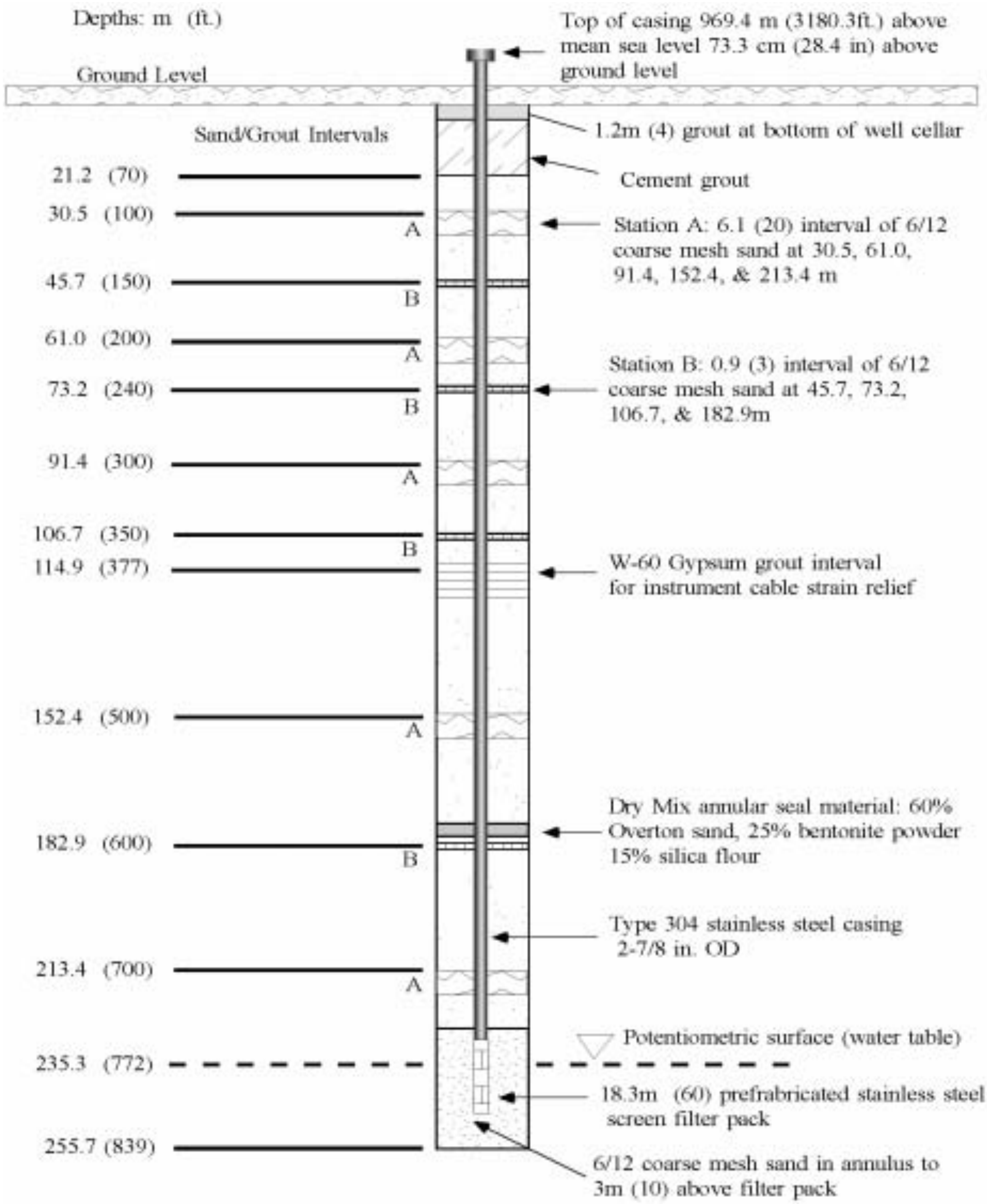

Figure A.5 Completion Detail for Ue5PW-1

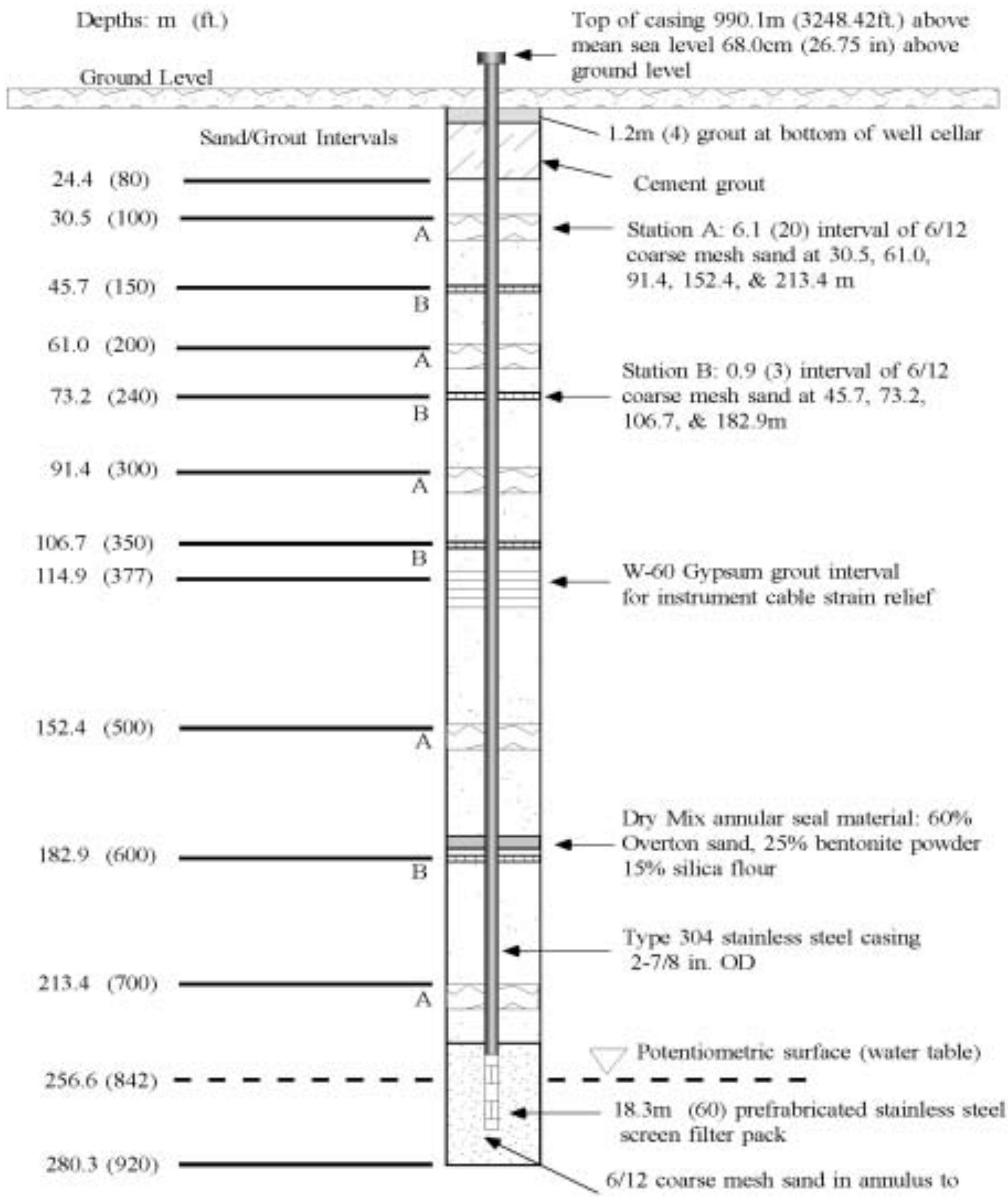

Figure A.6 Completion Detail for Ue5PW-2

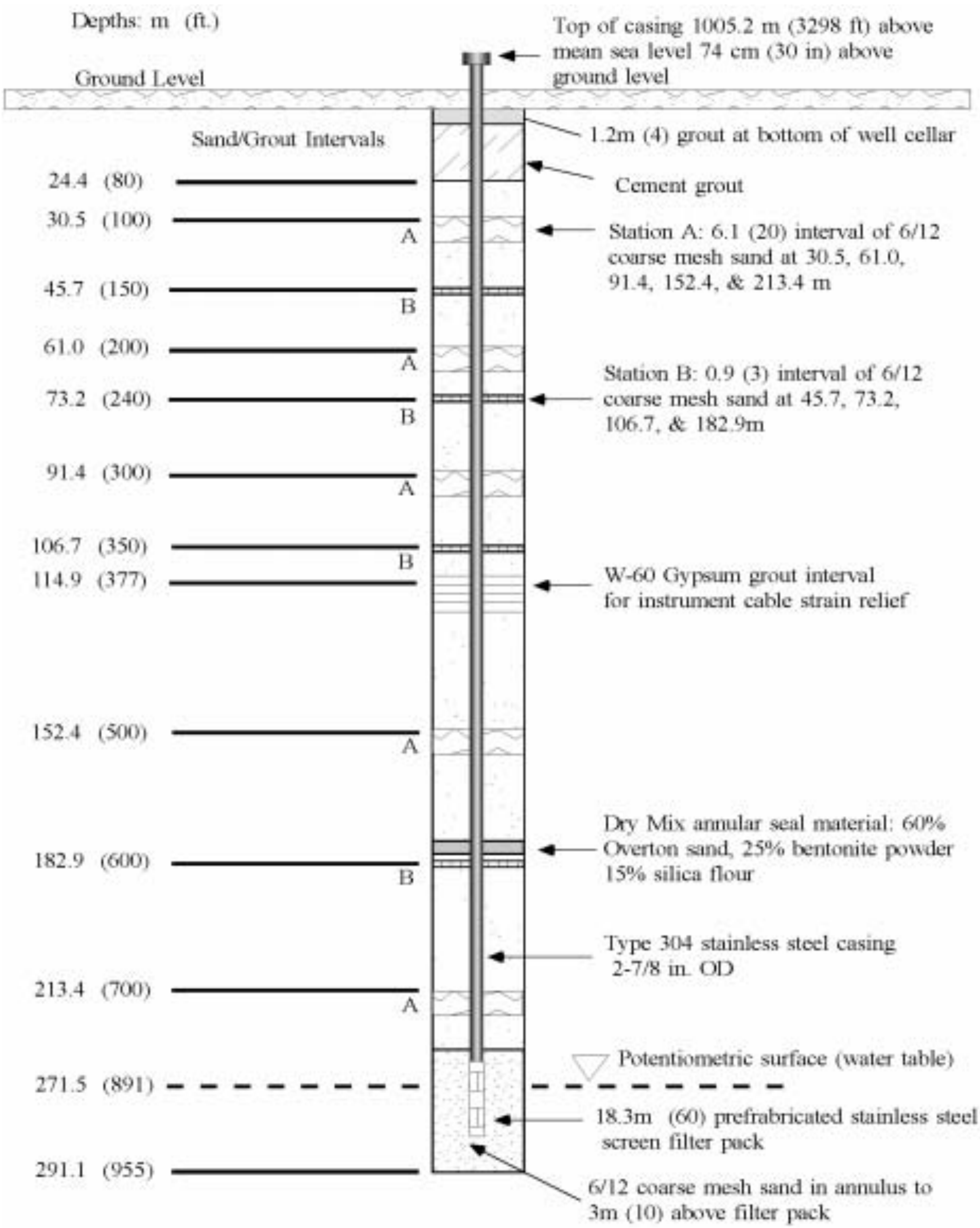

Figure A.7 Completion Detail for Ue5PW-3

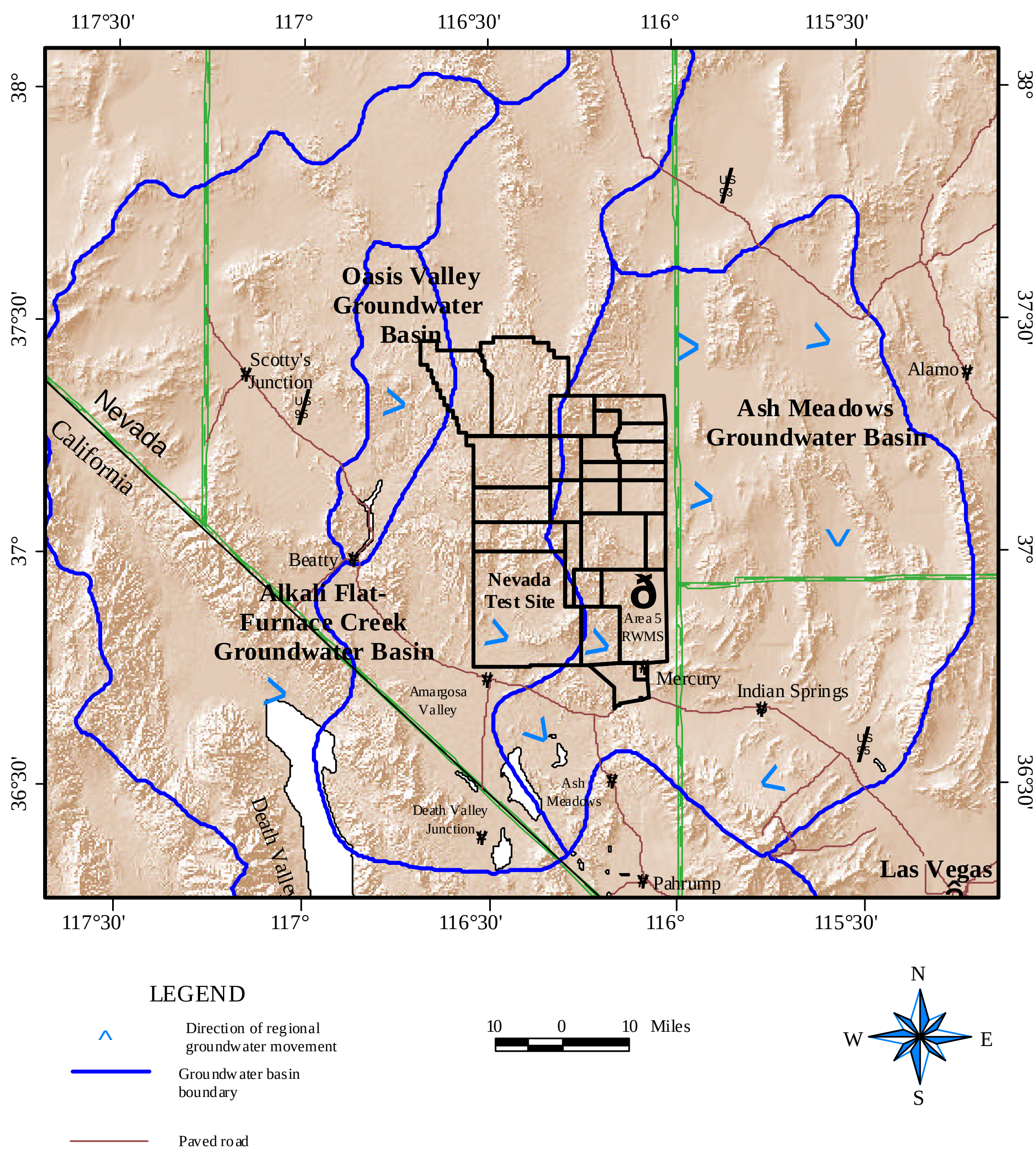

Figure A.8 Regional Groundwater Flow Directions in the NTS Area (Waddell et al.,1984)

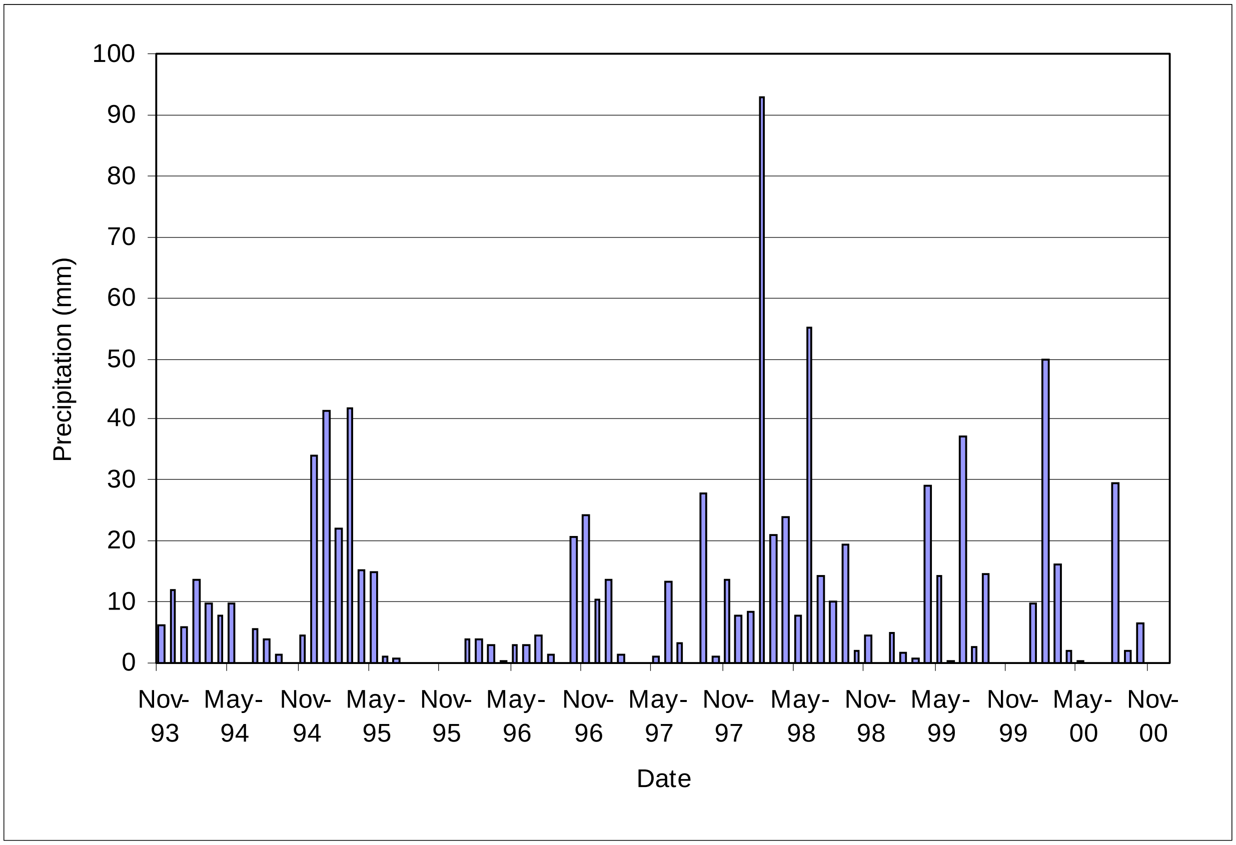

Figure A.9 Area 5 RWMS Monthly Precipitation

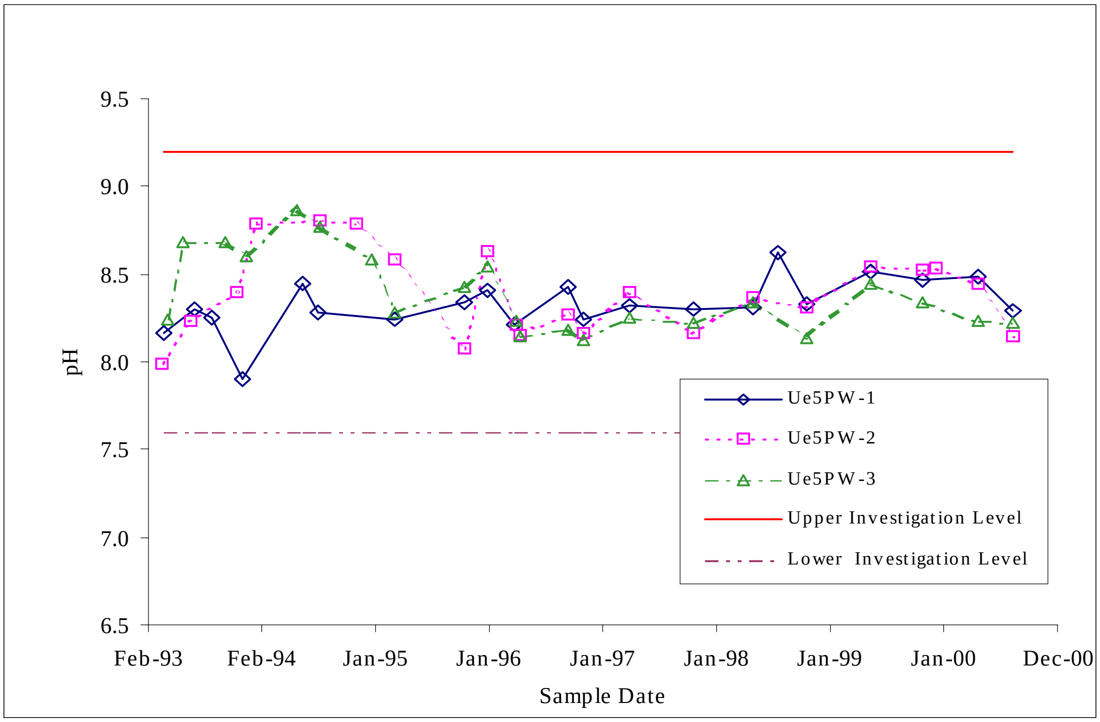

Figure A.10 Area 5 RWMS Time Series Plot of pH

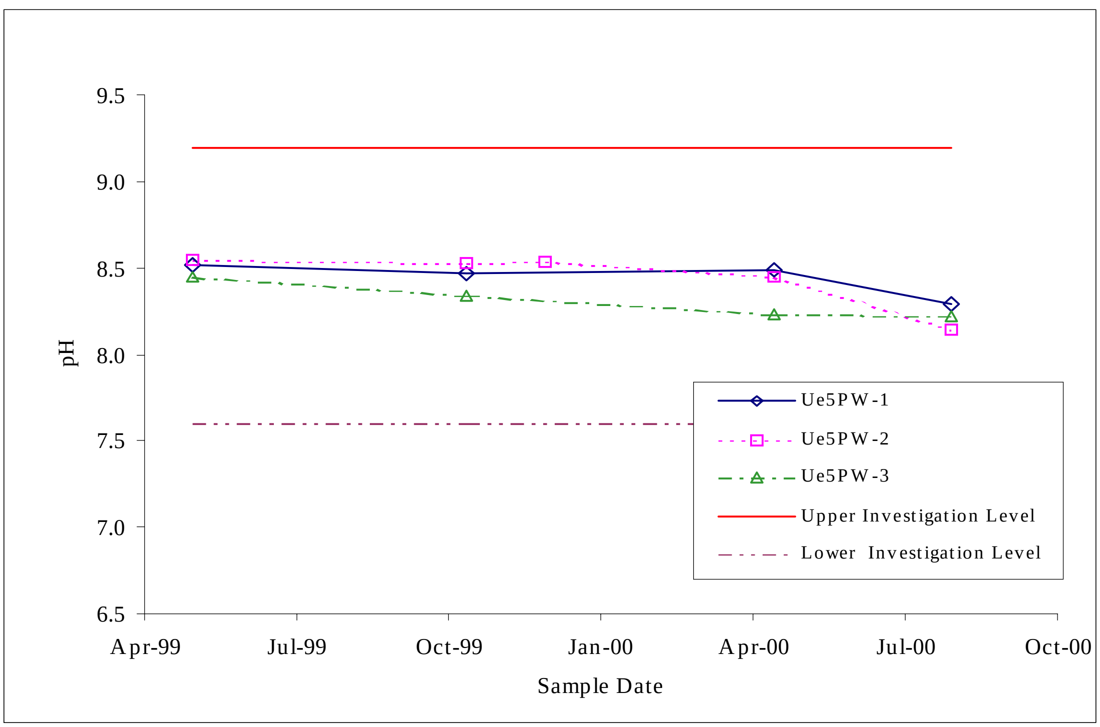

Figure A.11 Area 5 RWMS Two-Year Plot of pH

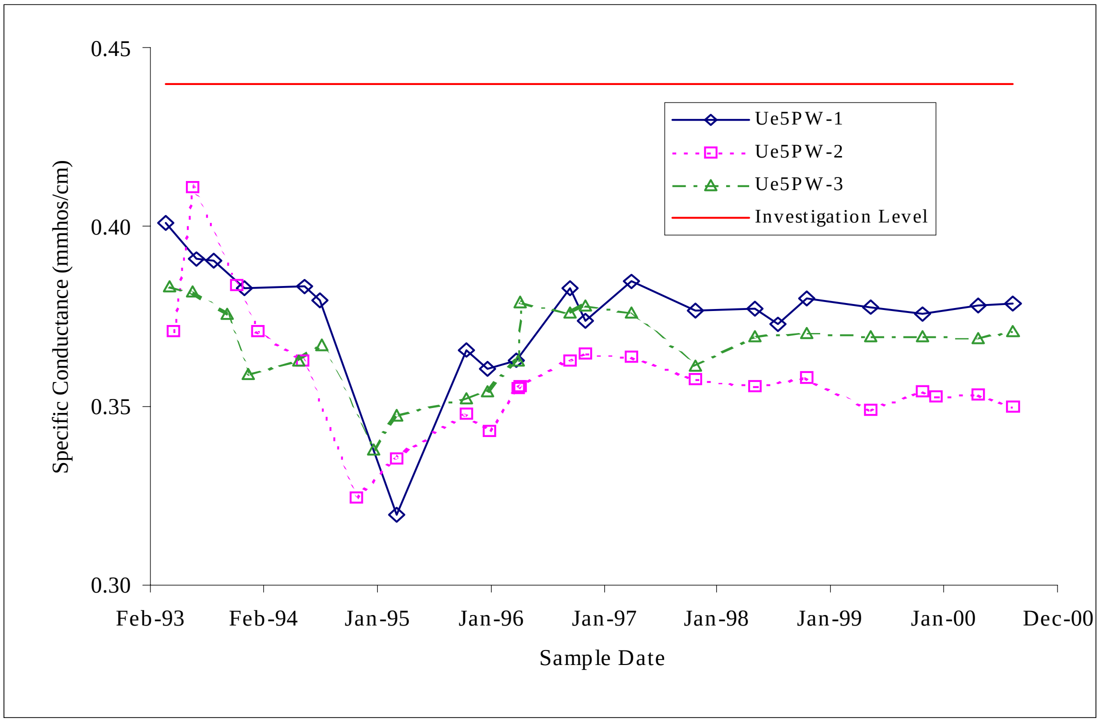

Figure A.12 Area 5 RWMS Time Series Plot of Specific Conductance

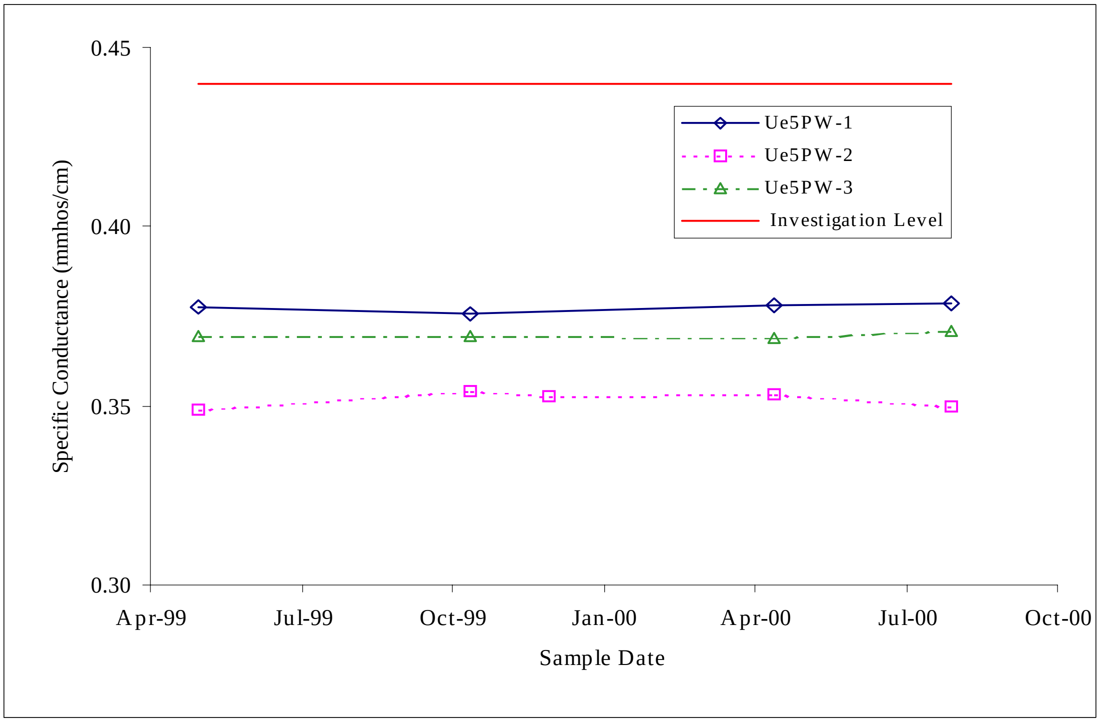

Figure A.13 Area 5 RWMS Two-Year Plot of Specific Conductance

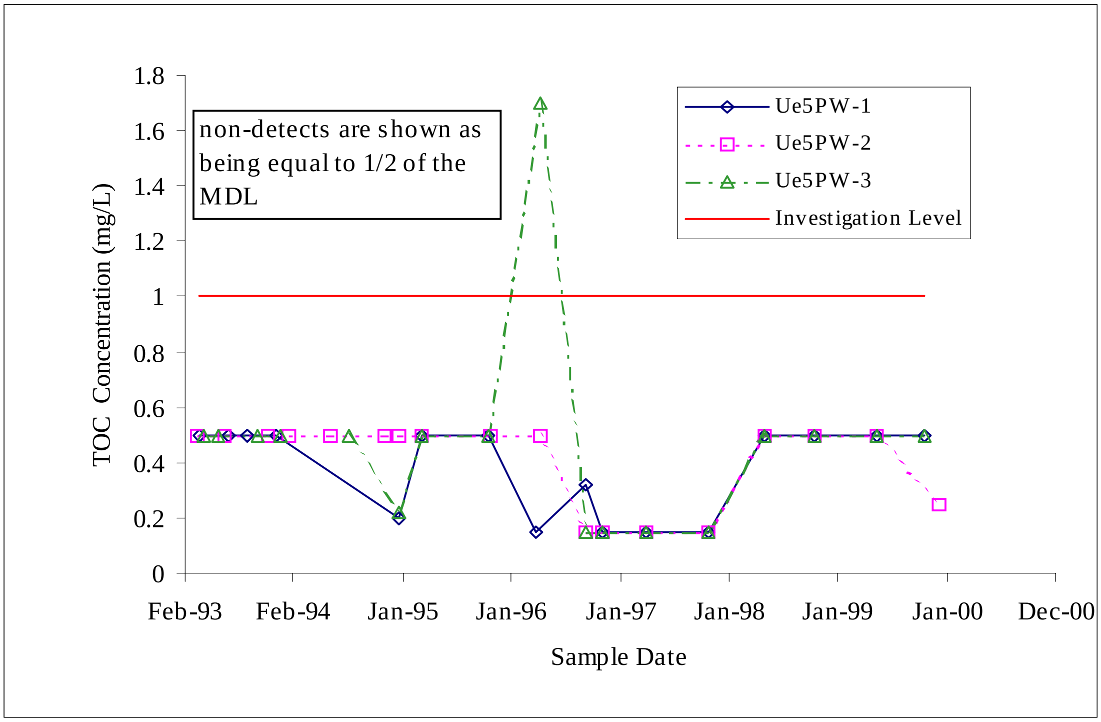

Figure A.14 Area 5 RWMS Time Series Plot of Total Organic Carbon

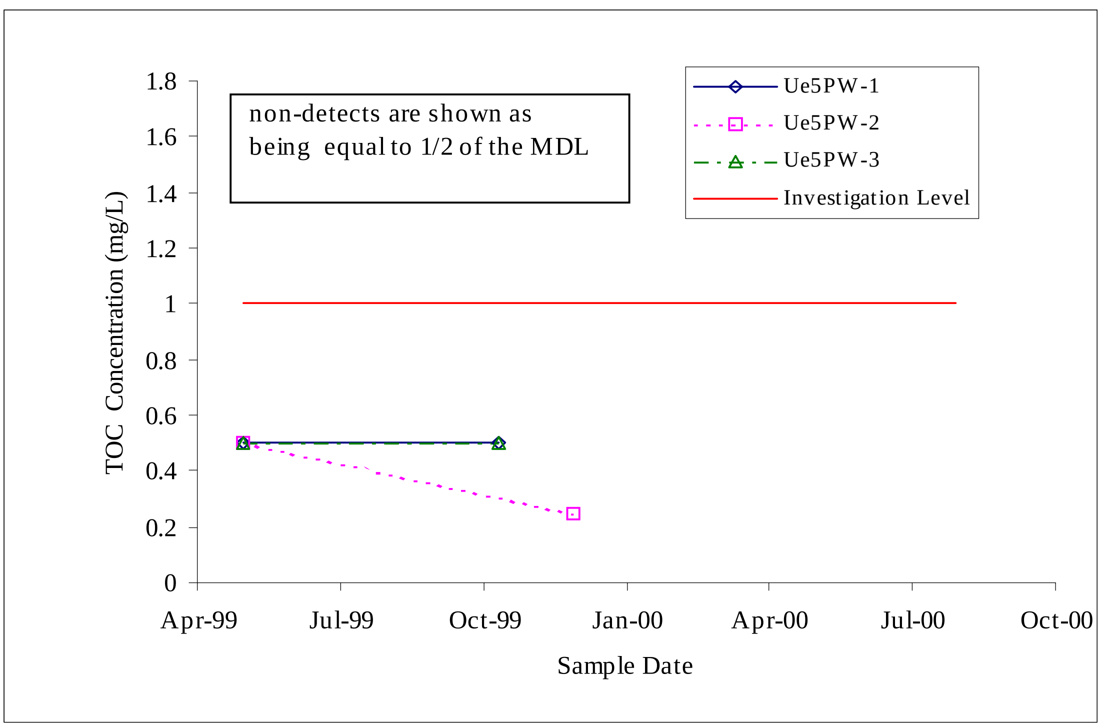

Figure A.15 Area 5 RWMS Two-Year Plot of Total Organic Carbon

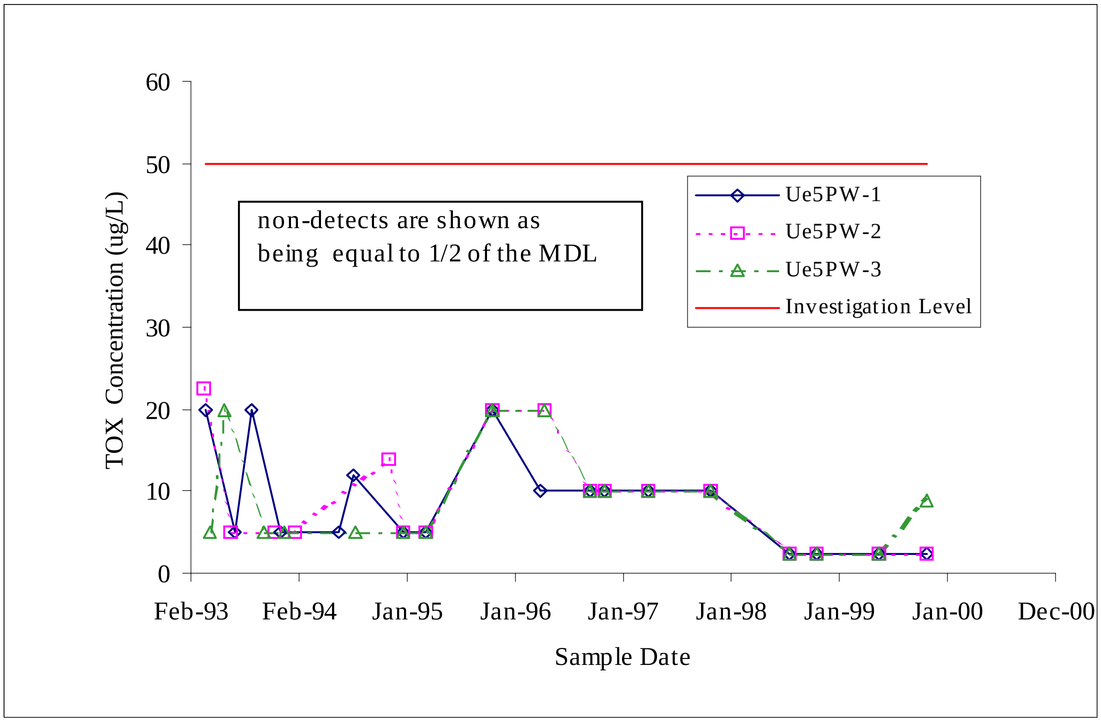

Figure A.16 Area 5 RWMS Time Series Plot of Total Organic Halogen

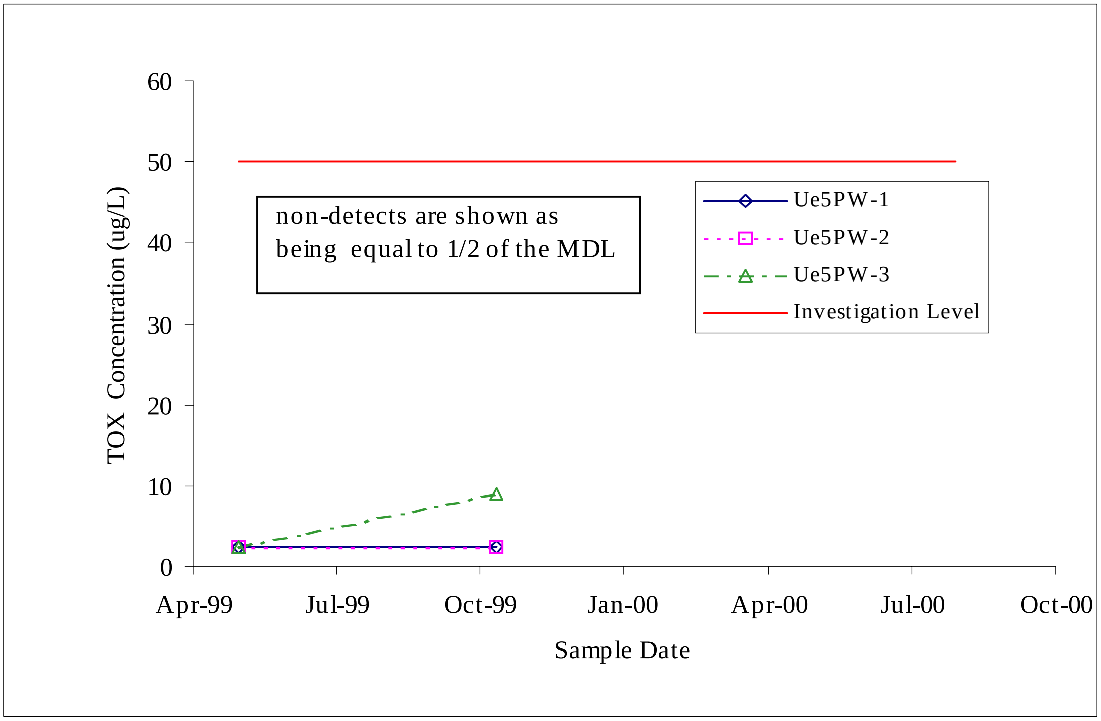

Figure A.17 Area 5 RWMS Two-Year Plot of Total Organic Halogen

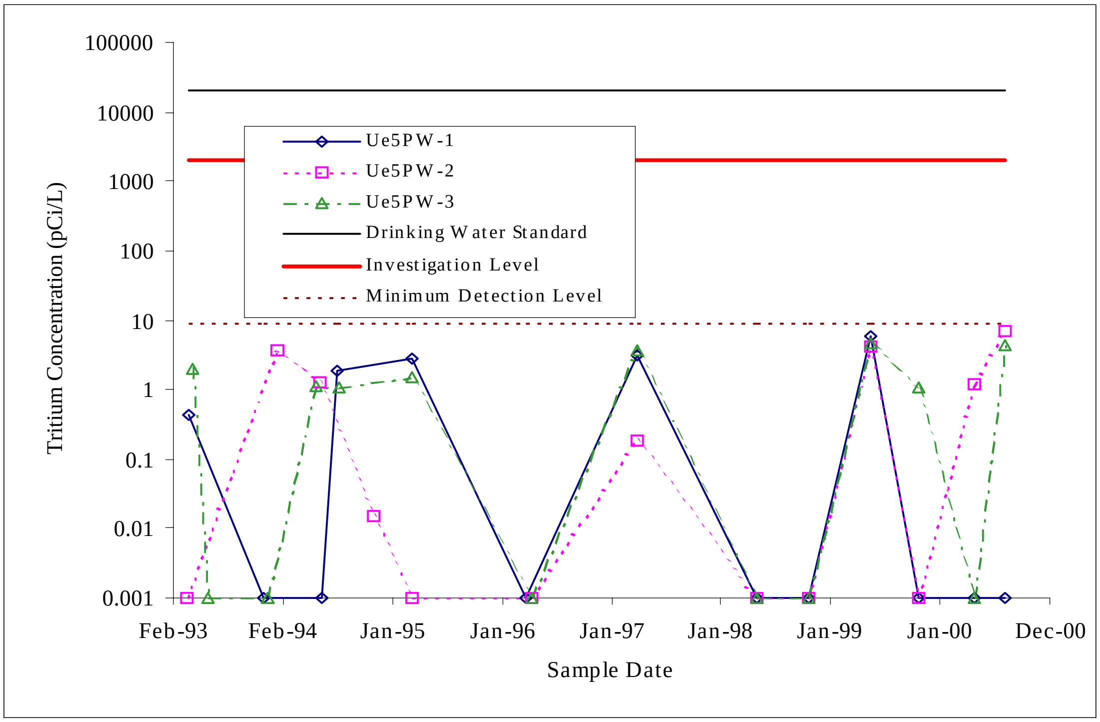

Figure A.18 Area 5 RWMS Time Series Plot of Tritium

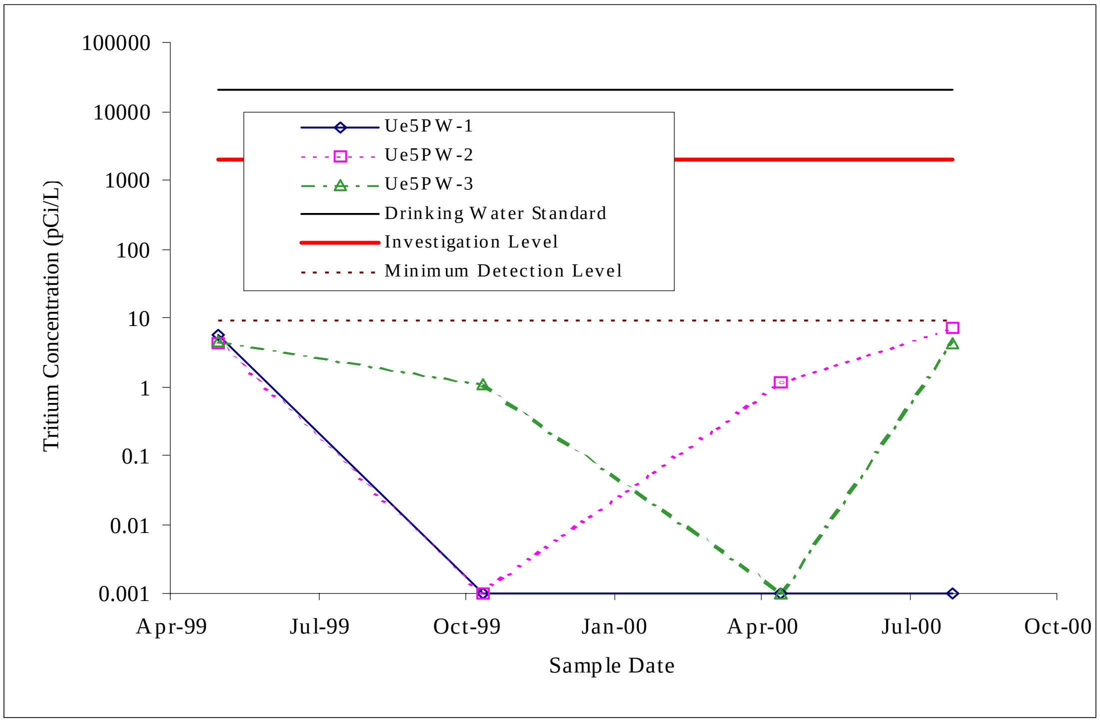

Figure A.19 Area 5 RWMS Two-Year Plot of Tritium

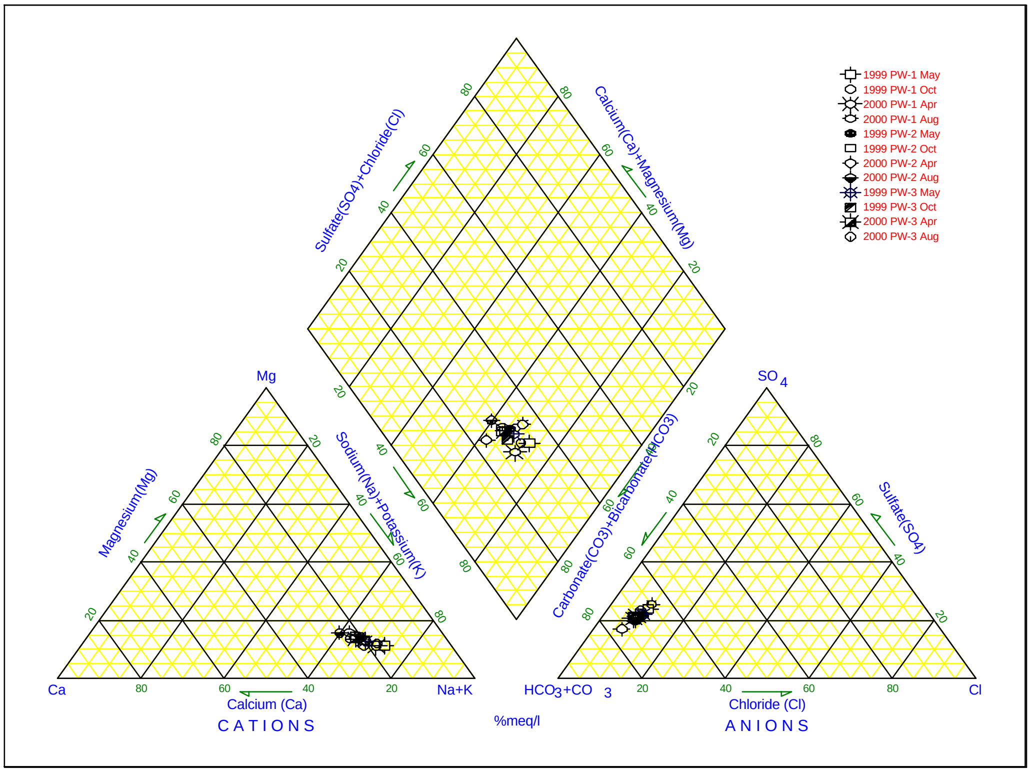

Figure A.20 Area 5 RWMS Two-Year Piper Diagram

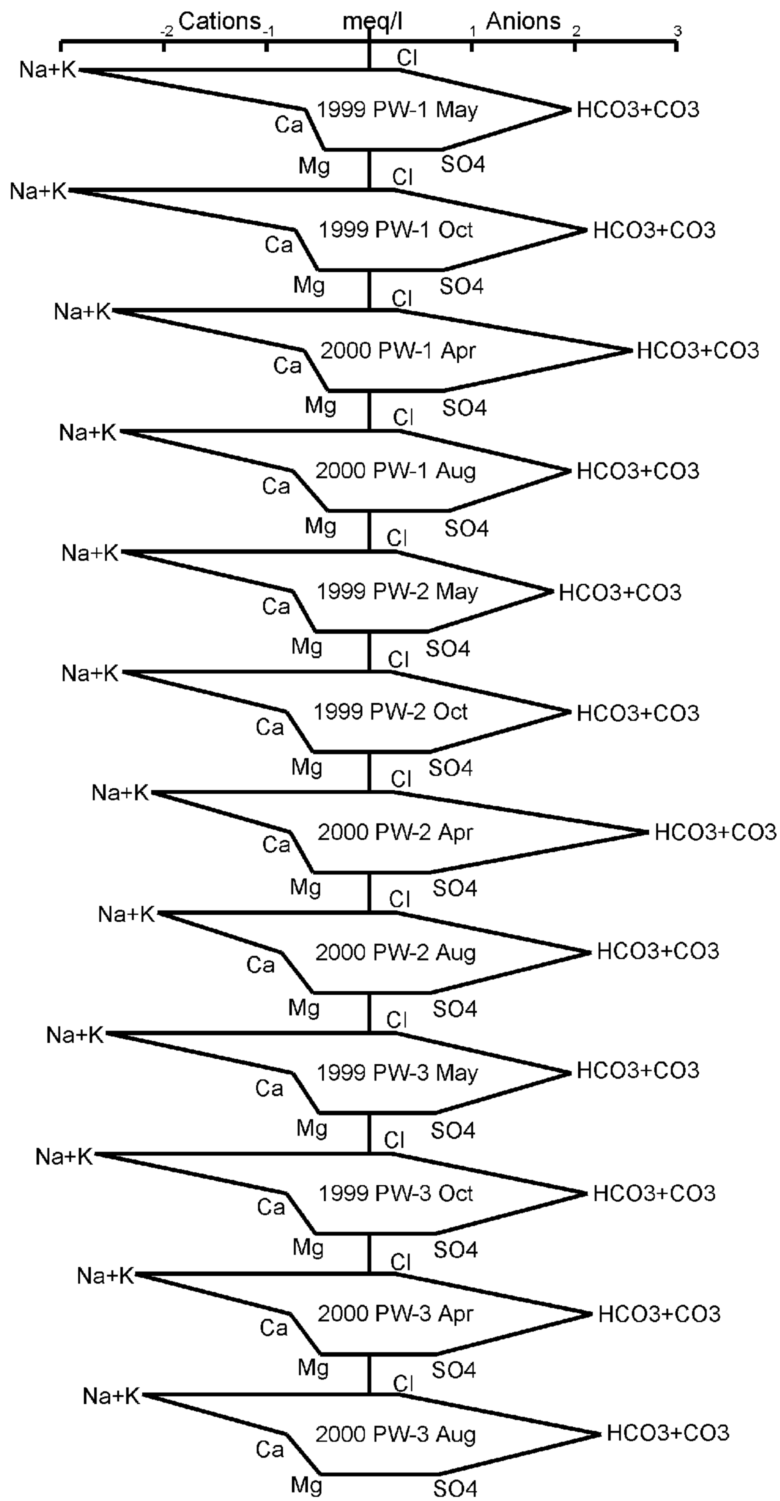

Figure A.21 Area 5 RWMS Stiff Diagrams 1999-2000

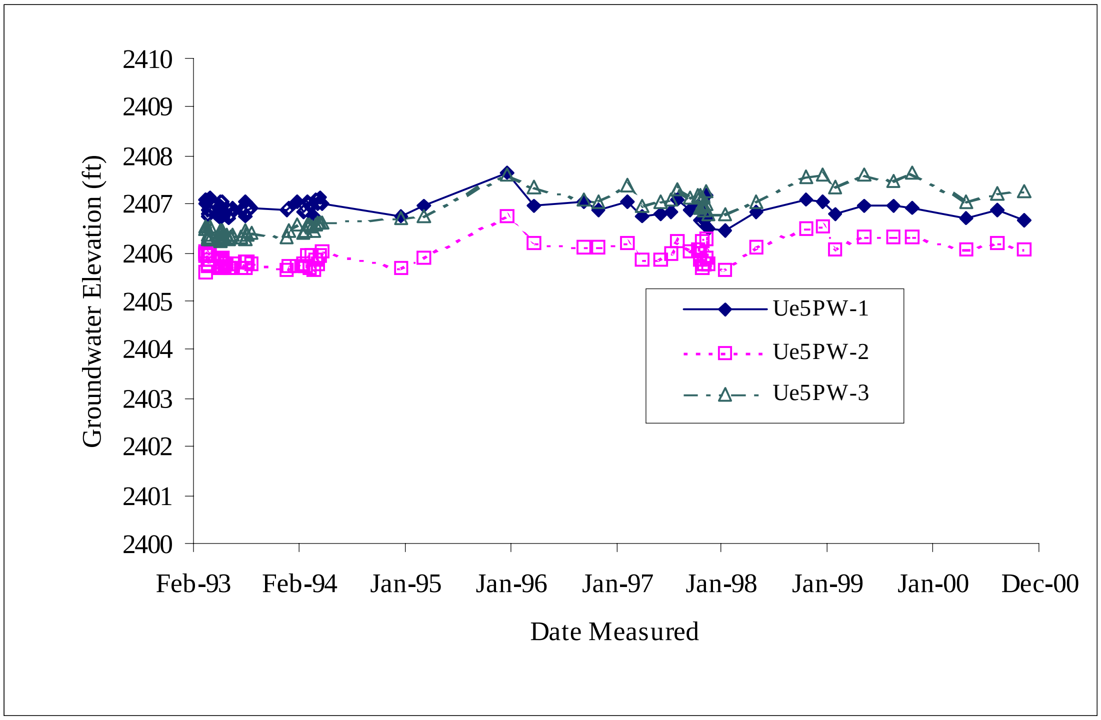

Figure A.22 Area 5 RWMS Time Series Plot of Groundwater Elevation

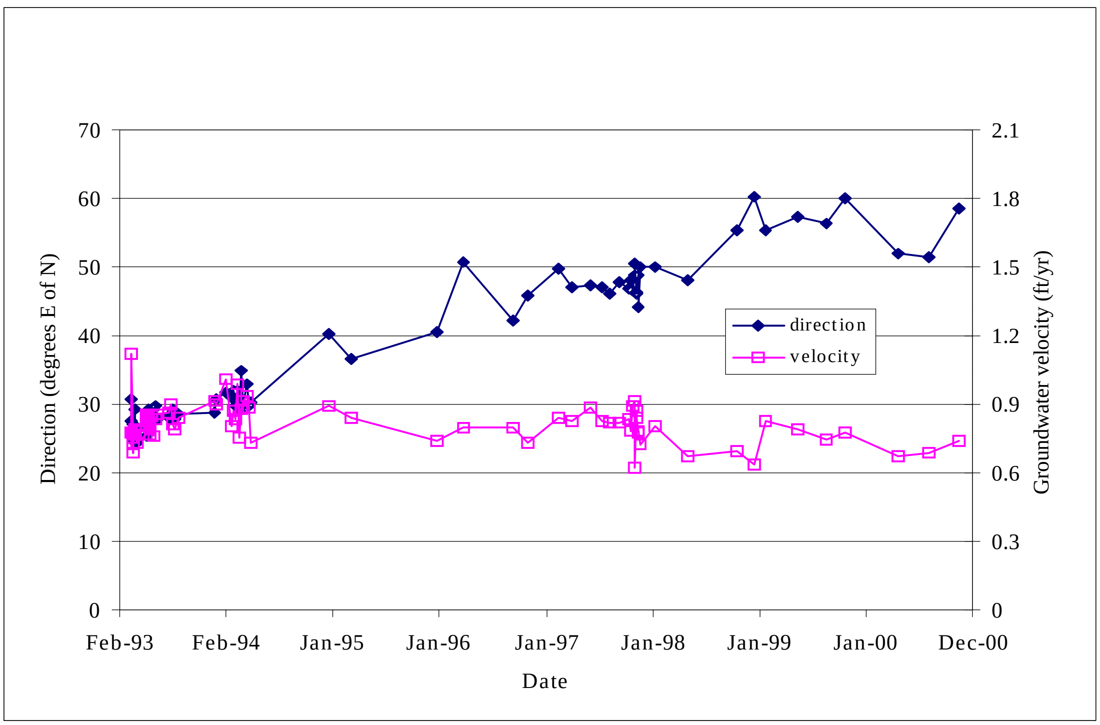

Figure A.23 Area 5 RWMS Time Series Plot of Groundwater Velocity and Direction

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Appendix B

Tables

Table B.1 Area 5 RWMS Hydraulic Parameters

Hydraulic Conductivity	Hydraulic Gradient	Effective Porosity	Mean Velocity	Flow Direction
1.12e-3 cm/s[a] (3.36e-5 ft/s)	0.25 m/km (1.3 ft/mi)	0.38[a]	0.22 m/yr (0.7 ft/yr)	58° E of N

[a](REECO 1994)

Table B.2 Investigation Levels for Indicator Parameters

Parameter	Investigation Level (IL)
TOX	50 ug/L
TOC	1 mg/L
pH	less than 7.6 and greater than 9.2
Specific Conductance	0.440 mmhos/cm
Tritium	2,000 pCi/L

Table B.3 Area 5 RWMS pH Values for Ue5PW-1, Ue5PW-2, and Ue5PW-3 (dates are approximated in 1993 and 1994 to make graphs consistent)

Date Sampled	Ue5PW-1	Ue5PW-2	Ue5PW-3
March 1993	8.17	7.99	8.24
July 1993	8.30	8.24	8.68
September 1993	8.25	8.40	8.68
December 1993	7.90	8.79	8.6
June 1994	8.45	8.81	8.87
August 1994	8.28	8.78	8.77
November 1994	no sample	no sample	8.58
April 1995	8.25	8.58	8.28
November 1995	8.34	8.08	8.42
January 1996	8.41	8.63	8.54
April 1996	8.22	8.21	8.23
April 1996	no sample	8.15	8.15
October 1996	8.43	8.28	8.18
November 1996	8.25	8.16	8.12
April 1997	8.32	8.40	8.25
November 1997	8.30	8.16	8.22
May 1998	8.31	8.37	8.34
July 1998	8.63	no sample	no sample
October 1998	8.34	8.32	8.14
May 1999	8.51	8.54	8.45
October 1999	8.47	8.53	8.34
April 2000	8.49	8.45	8.24
August 2000	8.29	8.14	8.23
Mean	**8.33**	**8.39**	**8.39**
Std Dev	**0.15**	**0.24**	**0.22**

Table B.4 Area 5 RWMS Specific Conductance Values in mmhos/cm for Ue5PW-1, Ue5PW-2, and Ue5PW-3 (dates are approximated in 1993 and 1994 to make graphs consistent)

Date Sampled	Ue5PW-1	Ue5PW-2	Ue5PW-3
March 1993	0.401	0.371	0.383
July 1993	0.391	0.411	0.382
September 1993	0.391	0.384	0.376
December 1993	0.383	0.371	0.359
June 1994	0.383	0.363	0.363
August 1994	0.378	0.324	0.367
November 1994	no sample	no sample	0.347
April 1995	0.320	0.336	0.352
November 1995	0.366	0.348	0.338
January 1996	0.360	0.343	0.354
April 1996	0.362	0.355	0.363
April 1996	no sample	0.356	0.379
October 1996	0.383	0.363	0.376
November 1996	0.374	0.364	0.378
April 1997	0.385	0.363	0.376
November 1997	0.376	0.358	0.361
May 1998	0.377	0.356	0.370
July 1998	0.373	no sample	no sample
October 1998	0.380	0.358	0.370
May 1999	0.378	0.349	0.369
October 1999	0.376	0.354	0.369
April 2000	0.378	0.353	0.369
August 2000	0.379	0.350	0.371
Mean	**0.376**	**0.358**	**0.367**
Std Dev	**0.016**	**0.017**	**0.012**

Table B.5 Area 5 RWMS TOC values in mg/L for Ue5PW-1, Ue5PW-2, and Ue5PW-3 (dates are approximated in 1993 and 1994 to make graphs consistent)

Date Sampled	Ue5PW-1	Ue5PW-2	Ue5PW-3
March 1993	<1.0	<1.0	<1.0
July 1993	<1.0	<1.0	<1.0
September 1993	<1.0	no sample	<1.0
December 1993	<1.0	<1.0	<1.0
June 1994	no sample	<1.0	no sample
August 1994	1.7[1]	<1.0	<1.0
January 1995	0.20	0.5	0.22
April 1995	<1.0	<1.0	<1.0
November 1995	<1.0	<1.0	<1.0
April 1996	<0.3	<1.0	1.7[2]
October 1996	0.32	<0.3	<0.3
November 1996	<0.3	<0.3	<0.3
April 1997	<0.3	<0.3	<0.3
November 1997	<0.3	<0.3	<0.3
May 1998	<1.0	<1.0	<1.0
October 1998	<1.0	<1.0	<1.0
May 1999	<1.0	<1.0	<1.0
October 1999	<1.0	1.6[1,2]	<1.0
December 1999	no sample	<0.5	no sample
April 2000	see Table 1.0	see Table 1.0	see Table 1.0
August 2000	see Table 1.0	see Table 1.0	see Table 1.0
Mean	**0.38** [3,4]	**0.41** [3,4]	**0.47** [3,4]
Std Dev	**0.16** [3,4]	**0.15** [3,4]	**0.35** [3,4]

[1] determined to be a false positive through resampling
[2] duplicate sample results were <1.0
[3] assumes nondetects are equal to one-half the MDL
[4] values do not include year 2000 results

Table B.6 Area 5 RWMS TOX Values in ug/L for Ue5PW-1, Ue5PW-2, and Ue5PW-3 (dates are approximated in 1993 and 1994 to make graphs consistent)

Date Sampled	Ue5PW-1	Ue5PW-2	Ue5PW-3
March 1993	20	23	<10
July 1993	<10	<10	20[2]
September 1993	20[2]	<10	<10
December 1993	<10	<10	<10
June 1994	<10	no sample	no sample
August 1994	12[2]	no sample	<10
November 1994	no sample	14[2]	no sample
January 1995	<10	<10	<10
April 1995	<10	<10	<10
November 1995	<40	<40	<40
April 1996	<20	<40	<40
October 1996	<20	<20	<20
November 1996	<20	<20	<20
April 1997	<20	<20	<20
November 1997	<20	<20	<20
May 1998	391[1]	842[1]	1000[1]
July 1998	<5	no sample	no sample
October 1998	<5	<5	<5
May 1999	<5	<5	<5
October 1999	<5	<5	9[2]
April 2000	see Table 2.0	see Table 2.0	see Table 2.0
August 2000	see Table 2.0	see Table 2.0	see Table 2.0
Mean	**8.7** [3,4]	**8.7** [3,4]	**9.6** [3,4]
Std Dev	**6.1** [3,4]	**6.0** [3,4]	**6.6** [3,4]

[1] determined to be false positive through resampling
[2] duplicate sample results were less than MDL
[3] assumes nondetects are equal to one-half the MDL
[4] values do not include year 2000 results

Table B.7 Area 5 RWMS Tritium Values in pCi/L for Ue5PW-1, Ue5PW-2, Ue5PW-3 (dates are approximated in 1993 and 1994 to make graphs consistent)

Date Sampled	Ue5PW-1	Ue5PW-2	Ue5PW-3
March 1993	0.442	-4.28	1.96
December 1993	-1.58	32.2[1]	-2.74
January 1994	no sample	3.69	-0.46
June 1994	-2.04	1.29	1.13
August 1994	1.86	0.015	1.04
April 1995	2.8	-0.92	1.5
April 1996	-1.72	-1.91	-2.29
April 1997	3.15	0.19	3.69
May 1998	-2.35	-1.95	-4.71
October 1998	-1.09	-1.85	-8.25
May 1999	5.17	4.23	4.60
October 1999	-1.36	-3.37	1.08
April 2000	-2.55	1.67	-0.08
August 2000	-2.52	6.97	4.34
Mean	**-0.14**	**2.53**	**0.06**
Std Dev	**2.56**	**9.08**	**3.58**

[1] standard, not enriched analysis performed

Table B.8 Ue5PW-1 General Water Chemistry Values (mg/L)

Date	Ca	Fe	Mg	Mn	K	SiO_2	Na	SO_4	HCO_3	Cl	F
03-31-1993	no analysis	0.013	no analysis	<0.006	no analysis	no analysis	48	32	137	9.2	1.2
06-06-1993	no analysis	0.059	no analysis	<0.001	no analysis	no analysis	58	37	132	9.7	1.4
09-01-1993	no analysis	0.027	no analysis	0.0066	no analysis	no analysis	56	no analysis	157.5	8.4	5.7
12-07-1993	no analysis	0.012	no analysis	<0.0012	no analysis	no analysis	57	36	150	9.9	1.5
06-15-1994	no analysis	0.01	no analysis	<0.004	no analysis	no analysis	61	no analysis	no analysis	no analysis	no analysis
08-01-1994	no analysis	0.021	no analysis	<0.0012	no analysis	no analysis	53	36	no analysis	10	no analysis
04-04-1995	no analysis	<0.05	no analysis	<0.01	no analysis	no analysis	58	34	no analysis	9.9	no analysis
04-16-1996	no analysis	0.02	no analysis	<0.001	no analysis	no analysis	61	34	no analysis	9.9	no analysis
04-16-1997	15.1	0.012	5.31	<0.001	5.90	no analysis	54.5	32.2	128	9.2	1.3
11-05-1997	15.5	0.012	5.61	no analysis	6.44	no analysis	57.8	35.2	123.5	10.2	1.2
05-13-1998	14.0	0.034	5.36	0.0015	5.21	54.22	55.8	34.6	123.5	9.6	1.1
10-28-1998	14.9	0.024	5.58	0.0015	6.87	60.53	57.6	34	131	9.7	1.1
05-19-1999	12.5	<0.05	5.30	<0.0025	6.85	68.45	61	34	120	10	1
10-27-1999	14.5	<0.1	6.0	<0.005	6.6	62.03	63.5	35	130	8.8	1.1
04-26-2000	12.8	0.032	4.80	0.001	6.69	58.29	53.7	35.6	135	10	1.0
08-09-2000	15.0	<0.0164	4.90	0.00045	6.6	59.89	52.0	37.1	120	10.4	1.1
Mean	**14.3**	**0.025[1]**	**5.37**	**0.002[1]**	**6.40**	**60.57**	**56.75**	**34.77**	**132.3**	**9.66**	**1.56**
Std Dev	**1.10**	**0.014[1]**	**0.37**	**0.002[1]**	**0.57**	**4.69**	**3.95**	**1.54**	**11.5**	**0.54**	**1.31**

[1]assumes nondetects are equal to one-half the MDL

Table B.9 Ue5PW-2 General Water Chemistry Values (mg/L)

Date	Ca	Fe	Mg	Mn	K	SiO_2	Na	SO_4	HCO_3	Cl	F
03-24-1993	no analysis	0.062	no analysis	0.11	no analysis	no analysis	46	28	130	8.4	1
06-22-1993	no analysis	0.25	no analysis	0.032	no analysis	no analysis	54	30	150	9.7	1.1
11-15-1993	no analysis	0.180	no analysis	<0.004	no analysis	no analysis	51	31	140	9.4	1.3
01-19-1994	no analysis	0.074	no analysis	<0.0012	no analysis	no analysis	45	29	130	no analysis	1.2
06-07-1994	no analysis	0.14	no analysis	<0.004	no analysis	no analysis	55	no analysis	no analysis	no analysis	no analysis
11-29-1994	no analysis	no analysis	no analysis	no analysis	no analysis	no analysis	no analysis	28	no analysis	8	no analysis
04-04-1995	no analysis	<0.05	no analysis	<0.01	no analysis	no analysis	50	28	no analysis	8.5	no analysis
04-30-1996	no analysis	0.013	no analysis	<0.001	no analysis	no analysis	51	29	no analysis	8.3	no analysis
04-16-1997	15.9	0.012	5.98	<0.001	5.04	no analysis	47.6	26.4	122	7.9	1.21
11-05-1997	17.4	0.018	6.83	no analysis	4.87	no analysis	50.6	28.9	115	8.6	0.91
05-13-1998	14.8	0.066	5.68	<0.0011	3.83	50.80	45.2	28.4	123.5	8.2	1.0
10-28-1998	15.8	0.015	6.18	0.0009	5.56	55.93	47.4	28.4	128.5	8.3	0.98
05-19-1999	15.0	<0.05	6.3	<0.0025	6.2	62.03	52	27.5	110	8.7	0.92
10-27-1999	16.0	<0.1	6.7	<0.005	5.7	55.61	52	28	125	7.4	0.96
04-26-2000	15.2	0.029	6.53	0.0007	5.6	55.83	45.6	29.1	145	8.6	0.84
08-09-2000	17.0	<0.0164	6.59	<0.0002	5.3	59.25	44.4	28.7	127	9.26	0.94
Mean	**15.90**	**0.064[1]**	**6.35**	**0.011[1]**	**5.11**	**56.58**	**49.13**	**28.56**	**128.8**	**8.51**	**1.03**
Std Dev	**0.92**	**0.071[1]**	**0.39**	**0.030[1]**	**0.82**	**3.80**	**3.45**	**1.07**	**11.58**	**0.62**	**0.14**

[1]assumes nondetects are equal to one-half the MDL

Table B.10 Ue5PW-3 General Water Chemistry Values (mg/L)

Date	Ca	Fe	Mg	Mn	K	SiO_2	Na	SO_4	HCO_3	Cl	F
04-14-1993	no analysis	0.024	no analysis	0.042	no analysis	no analysis	46.0	31	129	8.5	1.3
06-02-1993	no analysis	0.014	no analysis	0.009	no analysis	no analysis	53.0	31	133	9.1	1.2
10-12-1993	no analysis	0.11	no analysis	<0.006	no analysis	no analysis	57.0	30	128	7.9	1.2
12-20-1993	no analysis	0.1	no analysis	<0.0012	no analysis	no analysis	48.0	33	128	8.7	1.3
05-24-1994	no analysis	0.02	no analysis	<0.0012	no analysis	no analysis	56.0	no analysis	no analysis	no analysis	no analysis
08-08-1994	no analysis	<0.009	no analysis	<0.0012	no analysis	no analysis	51.0	33	no analysis	8.9	no analysis
04-05-1995	no analysis	<0.05	no analysis	<0.01	no analysis	no analysis	55.0	31	no analysis	8.8	no analysis
04-30-1996	no analysis	0.0088	no analysis	<0.001	no analysis	no analysis	57.0	32	no analysis	8.7	no analysis
04-16-1997	15.8	<0.006	5.71	<0.001	3.95	no analysis	54.2	29	127.5	8.39	1.26
11-05-1997	16.8	0.0133	6.06	no analysis	4.32	no analysis	55.5	32.1	115	9.15	1.09
05-13-1998	15.8	0.035	5.8	<0.0011	3.33	56.58	53.8	31	124	8.6	1
10-28-1998	15.6	0.009	5.7	0.0009	4.16	57.11	53.7	31.4	128	8.7	1
05-19-1999	15.0	<0.05	5.8	<0.0025	4.8	66.31	56.0	30.5	120	9.2	0.88
10-27-1999	16.0	<0.1	6.4	<0.005	3.75	59.89	58.5	31	130	7.6	0.94
04-26-2000	15.2	0.014	5.89	0.0003	4.5	58.50	49.8	32	138.5	9.1	0.86
08-09-2000	16.0	<0.016	5.78	<0.0002	4.3	57.75	48.2	32.6	133	9.85	0.96
Mean	**15.78**	**0.029**[1]	**5.88**	**0.004**[1]	**4.13**	**59.36**	**53.30**	**31.34**	**127.8**	**8.75**	**1.08**
Std Dev	**0.55**	**0.032**[1]	**0.22**	**0.011**[1]	**0.45**	**3.60**	**3.67**	**1.09**	**6.14**	**0.53**	**0.16**

[1]assumes nondetects are equal to one-half the MDL

Table B.11 Area 5 Groundwater Elevation Data

Borehole	Nevada State Central Zone Coordinates North (m)	East (m)	Top of Casing Elevation (ft)	Top of Casing to Land Surface (ft)	Land Surface Elevation (ft)	Deviation Correction (ft)
Ue5PW-1	233,386.48	216,357.08	3180.35	2.40	3177.99	-0.27
Ue5PW-2	234,817.13	216,376.00	3248.42	2.23	3246.23	-0.67
Ue5PW-3	235,089.93	214,415.04	3297.97	2.49	3295.51	-0.05

	Ue5PW-1 Water Level Measurements Top of Casing Elevation: 3180.35 ft			Ue5PW-2 Water Level Measurements Top of Casing Elevation: 3248.42 ft			Ue5PW-3 Water Level Measurements Top of Casing Elevation: 3297.97 ft		
Date	**Depth to Water (ft)**	**Elevation (ft)**	**Elevation Corrected for Deviation (ft)**	**Depth to Water (ft)**	**Elevation (ft)**	**Elevation Corrected for Deviation (ft)**	**Depth to Water (ft)**	**Elevation (ft)**	**Elevation Corrected or Deviation (ft)**
03/22/1993	773.08	2407.27	2407.00	841.82	2406.60	2405.93	891.43	2406.54	2406.49
03/23/1993	772.99	2407.36	2407.09	842.15	2406.27	2405.60	891.40	2406.57	2406.52
03/24/1993	773.00	2407.35	2407.08	841.75	2406.67	2406.00	891.43	2406.54	2406.49
03/25/1993	772.99	2407.36	2407.09	841.72	2406.70	2406.03	891.43	2406.54	2406.49
03/29/1993	773.20	2407.15	2406.88	841.83	2406.59	2405.92	891.56	2406.41	2406.36
03/30/1993	773.31	2407.04	2406.77	841.98	2406.44	2405.77	891.64	2406.33	2406.28
03/31/1993	773.30	2407.05	2406.78	842.03	2406.39	2405.72	891.59	2406.38	2406.33
04/01/1993	773.03	2407.32	2407.05	841.79	2406.63	2405.96	891.43	2406.54	2406.49
04/05/1993	772.93	2407.42	2407.15	841.71	2406.71	2406.04	891.38	2406.59	2406.54
04/06/1993	773.20	2407.15	2406.88	841.90	2406.52	2405.85	891.63	2406.34	2406.29
05/10/1993	773.37	2406.98	2406.71	842.08	2406.34	2405.67	891.67	2406.30	2406.25
05/11/1993	773.10	2407.25	2406.98	841.94	2406.48	2405.81	891.48	2406.49	2406.44
05/12/1993	773.04	2407.31	2407.04	841.88	2406.54	2405.87	891.52	2406.45	2406.40
05/13/1993	773.28	2407.07	2406.80	842.05	2406.37	2405.70	891.64	2406.33	2406.28
05/17/1993	773.26	2407.09	2406.82	842.05	2406.37	2405.70	891.58	2406.39	2406.34
05/18/1993	773.21	2407.14	2406.87	842.04	2406.38	2405.71	891.60	2406.37	2406.32
05/19/1993	773.20	2407.15	2406.88	842.03	2406.39	2405.72	891.57	2406.40	2406.35
05/20/1993	773.05	2407.30	2407.03	841.87	2406.55	2405.88	891.48	2406.49	2406.44
05/24/1993	773.25	2407.10	2406.83	841.98	2406.44	2405.77	891.60	2406.37	2406.32
05/25/1993	773.27	2407.08	2406.81	842.05	2406.37	2405.70	891.60	2406.37	2406.32
06/01/1993	773.16	2407.19	2406.92	842.00	2406.42	2405.75	891.56	2406.41	2406.36
06/07/1993	773.37	2406.98	2406.71	842.07	2406.35	2405.68	891.65	2406.32	2406.27
06/14/1993	773.28	2407.07	2406.80	842.07	2406.35	2405.68	891.58	2406.39	2406.34
06/21/1993	773.16	2407.19	2406.92	842.00	2406.42	2405.75	891.55	2406.42	2406.37
07/26/1993	773.20	2407.15	2406.88	842.05	2406.37	2405.70	891.58	2406.39	2406.34
08/03/1993	773.05	2407.30	2407.03	841.95	2406.47	2405.80	891.47	2406.50	2406.45
08/09/1993	773.31	2407.04	2406.77	842.08	2406.34	2405.67	891.62	2406.35	2406.30
08/16/1993	773.20	2407.15	2406.88	841.95	2406.47	2405.80	891.55	2406.42	2406.37
08/30/1993	773.17	2407.18	2406.91	841.99	2406.43	2405.76	891.53	2406.44	2406.39
12/28/1993	773.21	2407.14	2406.87	842.12	2406.30	2405.63	891.60	2406.37	2406.32
01/03/1994	773.15	2407.20	2406.93	842.02	2406.40	2405.73	891.45	2406.52	2406.47
02/02/1994	773.02	2407.33	2407.06	842.02	2406.40	2405.73	891.32	2406.65	2406.60
02/22/1994	773.25	2407.10	2406.83	841.99	2406.43	2405.76	891.49	2406.48	2406.43
02/28/1994	773.22	2407.13	2406.86	842.04	2406.38	2405.71	891.45	2406.52	2406.47
03/07/1994	773.03	2407.32	2407.05	841.82	2406.60	2405.93	891.33	2406.64	2406.59
03/14/1994	773.08	2407.27	2407.00	842.05	2406.37	2405.70	891.36	2406.61	2406.56
03/21/1994	773.12	2407.23	2406.96	841.81	2406.61	2405.94	891.40	2406.57	2406.52
03/28/1994	773.34	2407.01	2406.74	842.13	2406.29	2405.62	891.45	2406.52	2406.47
04/04/1994	772.99	2407.36	2407.09	841.89	2406.53	2405.86	891.33	2406.64	2406.59
04/13/1994	773.08	2407.27	2407.00	841.97	2406.45	2405.78	891.30	2406.67	2406.62
04/20/1994	772.95	2407.40	2407.13	841.81	2406.61	2405.94	891.28	2406.69	2406.64
04/26/1994	773.06	2407.29	2407.02	841.71	2406.71	2406.04	891.29	2406.68	2406.63
01/18/1995	773.32	2407.03	2406.76	842.05	2406.35	2405.68	891.20	2406.77	2406.72
04/03/1995	773.13	2407.22	2406.95	841.85	2406.55	2405.88	891.16	2406.81	2406.76

Table B.11 (Area 5 Groundwater Elevation Data, cont.)

Borehole	Nevada State Central Zone Coordinates North (m)	East (m)	Top of Casing Elevation (ft)	Top of Casing to Land Surface (ft)	Land Surface Elevation (ft)	Deviation Correction (ft)
Ue5PW-1	233,386.48	216,357.08	3180.35	2.40	3177.99	-0.27
Ue5PW-2	234,817.13	216,376.00	3248.42	2.23	3246.23	-0.67
Ue5PW-3	235,089.93	214,415.04	3297.97	2.49	3295.51	-0.05

	Ue5PW-1 Water Level Measurements Top of Casing Elevation: 3180.35 ft			Ue5PW-2 Water Level Measurements Top of Casing Elevation: 3248.42 ft			Ue5PW-3 Water Level Measurements Top of Casing Elevation: 3297.97 ft		
Date	**Depth to Water (ft)**	**Elevation (ft)**	**Elevation Corrected for Deviation (ft)**	**Depth to Water (ft)**	**Elevation (ft)**	**Elevation Corrected for Deviation (ft)**	**Depth to Water (ft)**	**Elevation (ft)**	**Elevation Corrected or Deviation (ft)**
01/16/1996	772.45	2407.90	2407.63	841.00	2407.42	2406.75	890.32	2407.65	2407.60
04/15/1996	773.10	2407.25	2406.98	841.56	2406.86	2406.19	890.57	2407.40	2407.35
10/01/1996	773.04	2407.31	2407.04	841.63	2406.79	2406.12	890.84	2407.13	2407.08
11/19/1996	773.19	2407.16	2406.89	841.66	2406.76	2406.09	890.87	2407.10	2407.05
08/20/1997	772.97	2407.38	2407.11	841.53	2406.89	2406.22	890.62	2407.35	2407.30
09/25/1997	773.19	2407.16	2406.89	841.72	2406.70	2406.03	890.77	2407.20	2407.15
10/27/1997	773.13	2407.22	2406.95	841.69	2406.73	2406.06	890.75	2407.22	2407.17
11/03/1997	773.40	2406.95	2406.68	841.89	2406.53	2405.86	890.98	2406.99	2406.94
11/06/1997	773.14	2407.21	2406.94	841.77	2406.65	2405.98	890.75	2407.22	2407.17
11/12/1997	773.44	2406.91	2406.64	842.05	2406.37	2405.70	890.95	2407.02	2406.97
11/13/1997	773.23	2407.12	2406.85	841.52	2406.90	2406.23	890.79	2407.18	2407.13
11/19/1997	773.35	2407.00	2406.73	841.96	2406.46	2405.79	890.97	2407.00	2406.95
11/20/1997	773.41	2406.94	2406.67	841.99	2406.43	2405.76	891.05	2406.92	2406.87
11/25/1997	773.37	2406.98	2406.71	841.84	2406.58	2405.91	890.93	2407.04	2406.99
11/26/1997	772.92	2407.43	2407.16	841.47	2406.95	2406.28	890.65	2407.32	2407.27
12/03/1997	773.60	2406.75	2406.48	842.00	2406.42	2405.75	891.13	2406.84	2406.79
01/26/1998	773.64	2406.71	2406.44	842.12	2406.30	2405.63	891.14	2406.83	2406.78
05/12/1998	773.25	2407.10	2406.83	841.62	2406.80	2406.13	890.87	2407.10	2407.05
10/2719/98	772.98	2407.37	2407.10	841.27	2407.15	2406.48	890.35	2407.62	2407.57
12/22/1998	773.05	2407.30	2407.03	841.22	2407.20	2406.53	890.31	2407.66	2407.61
02/02/1999	773.28	2407.07	2406.80	841.69	2406.73	2406.06	890.56	2407.41	2407.36
05/18/1999	773.10	2407.25	2406.98	841.44	2406.98	2406.31	890.33	2407.64	2407.59
08/25/1999	773.12	2407.23	2406.96	841.44	2406.98	2406.31	890.42	2407.55	2407.50
10/26/1999	773.14	2407.21	2406.94	841.42	2407.00	2406.33	890.29	2407.68	2407.63
04/24/2000	773.37	2406.98	2406.71	841.69	2406.73	2406.06	890.86	2407.11	2407.06
08/07/2000	773.21	2407.14	2406.87	841.55	2406.87	2406.20	890.71	2407.26	2407.21
11/13/2000	773.42	2406.93	2406.66	841.70	2406.72	2406.05	890.65	2407.32	2407.27

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Appendix C

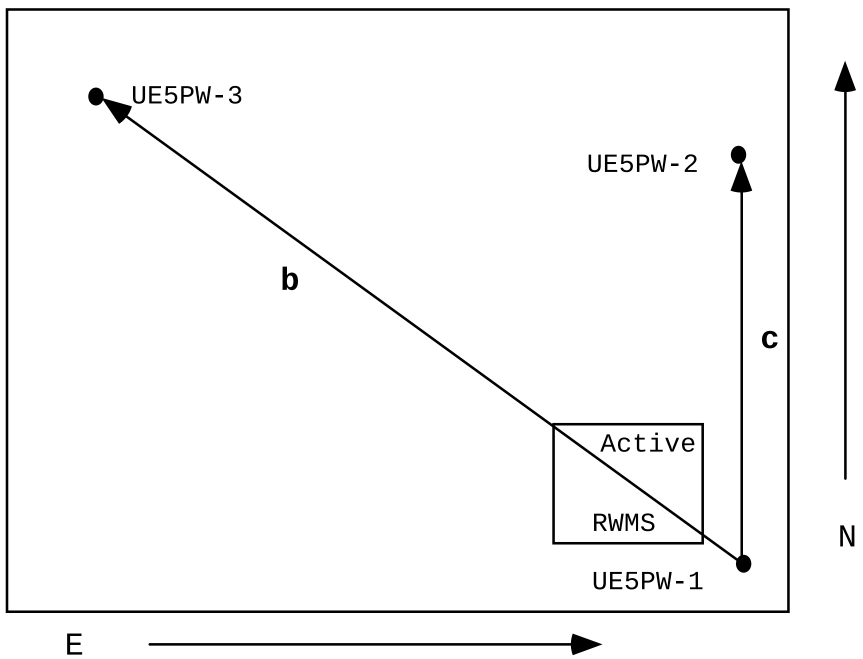
Gradient/Velocity Calculations

CALCULATION OF MAGNITUDE AND DIRECTION OF AREA 5 ALLUVIAL AQUIFER GRADIENT

Water level elevations measured at three wells in the alluvial aquifer near the Area 5 RWMS are used to calculate the magnitude and direction of the hydraulic gradient. The wells sampled are Ue5PW-1, Ue5PW-2, and Ue5PW-3. The locations of the three wells are given in Nevada State Central Zone coordinates in meters as North (N) and East (E) values.

The locations of the wells are shown in the figure below.

Area 5 RWMS Monitoring Wells



(Not to Scale)

The coordinates of each of the three points on the plane are given by (E, N, e) where E is the East coordinate, N is the North coordinate, and e is the water table elevation. The vector **b** representing the line segment $\overrightarrow{13}$ is given by (E_3-E_1)**i** + (N_3-N_1)**j** + (e_3-e_1)**k.** Similarly the vector **c** representing the line segment 12 is given by $(E_2\text{-}E_1)\mathbf{i} + (N_2\text{-}N_1)\mathbf{j} + (e_2\text{-}e_1)\mathbf{k}$. A normal vector to the plane is given by the vector product of **b** and **c**,

$$\mathbf{b} \times \mathbf{c} = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ [E_2\text{-}E_1] & [N_2\text{-}N_1] & [e_2\text{-}e_1] \\ [E_3\text{-}E_1] & [N_3\text{-}N_1] & [e_3\text{-}e_1] \end{vmatrix}$$

Expanding the determinant gives,

$$[[N_2\text{-}N_1]\ [e_3\text{-}e_1] - [N_3\text{-}N_1]\ [e_2\text{-}e_1]]\ \mathbf{i}\ -$$
$$[[E_2\text{-}E_1]\ [e_3\text{-}e_1] - [E_3\text{-}E_1]\ [e_2\text{-}e_1]]\ \mathbf{j}\ +$$
$$[[E_2\text{-}E_1]\ [N_3\text{-}N_1] - [E_3\text{-}E_1]\ [N_2\text{-}N_1]]\ \mathbf{k}.$$

This gives the representation for the plane as,

$$A\ (E) + B\ (N) + C\ (e) = D$$

Where:

$$A = [N_2\text{-}N_1]\ [e_3\text{-}e_1] - [N_3\text{-}N_1]\ [e_2\text{-}e_1]$$

$$B = -[[E_2\text{-}E_1]\ [e_3\text{-}e_1] - [E_3\text{-}E_1]\ [e_2\text{-}e_1]]$$

$$C = [E_2\text{-}E_1]\ [N_3\text{-}N_1] - [E_3\text{-}E_1]\ [N_2\text{-}N_1].$$

The constant D can be determined by substituting the N, E, and e values for PW-1 into the equation for the plane.

The equation is then written in terms of the elevation,

$$e = -A/C\ (E) - B/C\ (N) + D/C.$$

The gradient is given by the derivative of the function e in the direction of the unit vector **u**.

$$D_u e = \nabla e \bullet \mathbf{u}$$

∇e points in the direction **u** that produces the largest directional derivative. $|\nabla e|$ is that largest directional derivative.

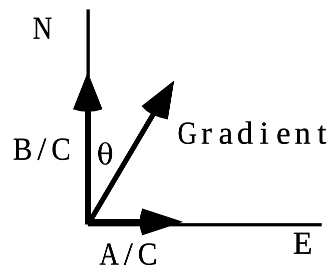
For the water table elevations,

$\nabla e = -A/C\ \mathbf{i} + B/C\ \mathbf{j}$.

The gradient is calculated from the E and N components,

$$\text{Gradient} = \sqrt{(A/C)^2 + (B/C)^2}$$

The direction of the gradient with respect to North is calculated from the component vectors.



The direction of the gradient is given by

$$\theta = 90 - \text{Arctan}\ (B/A).$$

CALCULATION OF MEAN GROUNDWATER VELOCITY

Once the gradient has been calculated, the mean groundwater velocity may be calculated using Darcy's Law,

$$q = Ki$$

where

$$V = q/Ö$$

Where:

q equals the specific discharge or darcian flux
K is the saturated hydraulic conductivity (length/time)
i is the hydraulic gradient (dimensionless)
Ö is the effective porosity (dimensionless)
V is the mean groundwater velocity (length/time)

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Appendix D

Instructions for Area 5 RWMS Groundwater Well Preparation and Groundwater Sampling

Bechtel Nevada

ORGANIZATION PROCEDURE	
Title: **INSTRUCTIONS FOR AREA 5 RWMS GROUNDWATER WELL PREPARATION AND GROUNDWATER SAMPLING**	**Page 1 of 24**
Number: **OP-2151.214**	Revision Number: **0**
Document Control Information	
Responsible Organization: **Environmental Operations**	
Instructions: This is a new procedure.	

Signature Approval:	
_ Manager, Environmental Operations	_ Date

1.0 PURPOSE

1.1 This procedure establishes procedures for sampling groundwater at the Area 5 Radioactive Waste Management Site (RWMS), as required by Title 40 Code of Federal Regulations (CFR) 265, Subpart F, "Storage and Disposal Facilities"; and U.S. Department of Energy (DOE) Order 5820.2A, "Radioactive Waste Management."

2.0 SCOPE

2.1 This procedure applies to the routine collection of groundwater samples for groundwater characterization and detection monitoring at the Area 5 RWMS. The Area 5 RWMS is an interim status treatment, storage, and disposal facility.

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3.0 RESPONSIBILITIES

3.1 The following entities have responsibilities in this procedure:

- **Monitoring Activity Manager**
- **Samplers**
- **Analytical Services Laboratory (ASL) Personnel**

4.0 PROCEDURE

4.1 GENERAL RESPONSIBILITIES

NOTE: It is the responsibility of all personnel to stop work if they feel they are sampling in an unsafe environment.

4.1.1 The **Monitoring Activity Manager** shall:

4.1.1.1 Ensure that the groundwater sampling program is in full compliance with this procedure.

4.1.1.2 Ensure that all work conducted follows safety standards.

4.1.1.3 Order and control supplies for groundwater sampling.

4.1.1.4 Determine groundwater analytes of interest.

4.1.1.5 Act as the point of contact for all issues regarding groundwater sampling procedures, operations, technical questions, and problem reporting.

4.1.1.6 Ensure that there exists a statement of work with qualified laboratories to perform the following actions.

4.1.1.6.1 Provide laboratory analyses which may consist of inorganic, organic, and radiological samples.

4.1.1.6.2 Provide laboratory quality control tests and maintain a laboratory quality assurance program.

ORGANIZATION PROCEDURE

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4.1.1.6.3 Review and report data results, as required.

4.1.1.6.4 Maintain complete data analysis packages.

4.1.1.6.5 Provide requested quality control trip blanks.

4.1.2 **Samplers** shall:

4.1.2.1 Prepare/oversee monitoring wells for sampling.

4.1.2.2 Perform analyses of field parameters.

4.1.2.3 Oversee the collection, preservation, transport, and analysis of groundwater samples.

4.1.2.4 Assure accuracy and completeness of the Chain-of-Custody form for samples taken.

4.1.2.5 Evaluate and maintain laboratory data, and coordinate with the Monitoring Activity Manager to determine parameters to be sampled.

4.1.2.6 Conduct all work in accordance with safety standards.

4.2 GROUNDWATER EQUIPMENT AND SITE PREPARATION

NOTE: All personnel working in and around the sampling location must maintain the highest level of cleanliness and housekeeping and adhere to the following requirements:

- Where appropriate, gloves, safety glasses and other personal protective equipment (PPE) as necessary shall be worn.
- Spills and other sampling material shall be cleaned up immediately.
- All equipment shall be inspected and cleaned prior to entering the sampling well.
- All readings must be recorded in the Groundwater Sampling Logbook.
- For groundwater sampling activities, the process outlined in Appendix A, “Groundwater Sampling Flow Diagram” shall be followed.

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4.2.1 **Samplers** shall perform the following steps prior to sampling:

4.2.1.1 Inspect the area around the transportainer for any possible source of contamination (vehicles, spill test facility, etc.).

4.2.1.2 Have the water master wet the road and area around the pilot well before sampling if dust control is needed.

4.2.1.3 Note weather conditions and direction of the wind to determine if contamination to the sampling area is possible.

4.2.1.4 Ensure that vehicles are located at a safe distance from the sampling area to minimize contamination.

4.2.1.5 Gather the necessary sample collection containers, preservatives, coolers, etc.

4.2.1.6 Inspect the area around the wellhead for cleanliness and any possible contamination.

4.2.1.7 Loosen the wellhead cap to allow borehole pressure to equilibrate.

NOTE: Bennett™ pumps that are dedicated to and permanently located at the pilot well do not require washing unless they have been contaminated in some fashion or have been removed from the pilot well (e.g. shipped to manufacturer for maintenance).

4.2.2 **Samplers** shall clean any nondedicated equipment (except water level probes) used in the collection of water quality data by the following method prior to sampling:

4.2.2.1 Wash with mild Liquinox™ detergent solution.

4.2.2.2 Triple rinse equipment with tap water.

4.2.2.3 Triple rinse equipment with deionized or distilled water.

4.2.2.4 Thoroughly dry all sampling equipment before use.

4.2.2.5 Use this cleaning method on metal bailers, pumps, and associated equipment used in sampling and/or purging of the monitor well.

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4.2.3 When checking and purging Bennett™ pumps, **samplers** shall:

4.2.3.1 Place the Bennett™ pump in a spare purge jar. Turn on the water level sensor.

4.2.3.2 Add enough tap water to cover the top of pump. Listen for audible sound.

4.2.3.3 Remove the pump and dry using Kimwipes™.

4.2.3.4 Check connectors and fittings on pump head.

4.2.3.5 Place the Bennett™ pump in its dedicated purge jar. Add 11 gallons of distilled water.

4.2.3.6 Pump water through the pump until approximately six inches of water remains and water is coming out of the pump.

4.2.4 When measuring the static water level, **samplers** shall:

4.2.4.1 Test the probe's audible electronic signal in tap water.

4.2.4.2 Attach the bell cap and clean the probe and tape with distilled water and Kimwipe™ while lowering down the borehole.

4.2.4.3 Lower the probe down the borehole until an audible electronic signal sounds.

4.2.4.4 Remove bell cap and hold the tape next to the marked rim of the casing to take the measurement. Measure to the nearest 0.01 foot.

4.2.4.5 Repeat measurements until two consecutive measurements are within 0.02 foot.

4.2.4.6 Record the individual's name taking the measurement, the well, the date, the time, and the depth to water from the rim of the casing.

4.2.4.7 The approximate depth to water is 773 feet at Ue5PW-1, 842 feet at Ue5PW-2, and 891 feet at Ue5PW-3.

4.2.4.8 Remove the water level probe, cleaning the tape as it is being wound into the reel.

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4.2.4.9 Clean the probe with distilled water and dry with Kimwipes™.

NOTE: Measuring tapes shall be calibrated annually at well WW 5A. Calibration of measuring tapes shall be noted in the Groundwater Sampling Logbook.

4.2.5 When placing the pump, **samplers** shall:

4.2.5.1 Place the Bennett™ hose bundle through the pulley.

4.2.5.2 Inspect the tubing and tape around the bundle and cut or replace the tape as required.

4.2.5.3 Rinse and wipe the unreeled hose using distilled water and Kimwipes™.

4.2.5.4 Attach a bell cap.

4.2.5.5 Lower the pump into the well until the water sensor sounds.

4.2.5.6 Place the tape on the tubing bundle to indicate 5 feet of water depth.

4.2.5.7 Lower the pump to 5 feet below the water surface.

4.2.5.8 Seal the wellhead using plastic.

4.2.6 When setting up the water quality monitoring equipment calibration, **samplers** shall:

4.2.6.1 Set up the Multi-Parameter Water Quality Monitor System without connecting to the well pump lines.

4.2.6.2 Calibrate the water quality monitoring equipment using the manufacturer's instructions. Note calibration of equipment in the logbook. Re-check calibration at the end of the sampling period to assure that there has been no drift.

NOTE: The temperature probe shall be checked quarterly or prior to use against a certified, calibrated mercury filled thermometer (readings must be within ± 0.5 C of the certified thermometer). Record all calibration data in the Groundwater Sampling Logbook.

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4.2.7 When purging the well, **samplers** shall:

4.2.7.1 Purge the well at least three screened casing volumes (150 liters or 40 gallons) at a flow rate greater than or equal to the expected sample rate.

4.2.7.2 During the purging process, measure the following field parameters approximately every 20 liters.

- pH.
- Specific conductance.
- Temperature.

4.2.7.3 Consider the purging process complete when both of the following conditions are satisfied.

- Three screened casing volumes are removed.
- The field parameters remain relatively constant during pumping (±10 percent over last three measurements (U.S. Environmental Protection Agency [EPA], 1995) **or** pH readings within ±0.1, specific conductance ±50 µmhos/cm, and temperature ±0.5 C [the latter is per DOE ERD-05-304]).

NOTE: Purged water shall be stored until analytical results are available, at which time proper arrangements for disposal should be made.

4.3 GROUNDWATER SAMPLE AND COLLECTION

NOTE: Groundwater samples should be collected according to the volatility of the target analytes (e.g. volatile organic compounds [VOCs], total organic carbon [TOC], semi-volatile organic compounds, metals, water quality cations and anions, and radionuclides).

4.3.1 **Samplers** shall:

4.3.1.1 Record the following information in the Groundwater Sampling Logbook.

- Names of personnel collecting samples
- Type of sampling (detection/assessment)
- Date and time of sampling
- Well identification
- Well depth

- Static water level
- Field parameters
- Total volume purged
- Purge pumping rate
- Well yield (high/low)
- Sample flow rate
- Field observations (sample conditions: sediment, odors, immiscible layers)
- Weather conditions (air temperature, wind, dust, etc.)

4.3.1.2 Measure and record the temperature of all ice chests to be used for sample storage and transport.

4.4 COLLECTION OF LABILE ORGANIC PARAMETERS

4.4.1 **Samplers** shall:

4.4.1.1 Collect samples for the parameters listed in Appendix B (TOX and TOC).

4.4.1.2 Select the appropriate container as specified in Appendix B.

4.4.1.3 Collect the number of samples listed in Appendix B.

4.4.1.4 Partially fill and rinse the container with the sample.

4.4.1.5 Place the rinsate in the waste storage container.

4.4.1.6 Fill the container 95 percent full slowly to minimize turbulence.

4.4.1.7 Add the appropriate preservative from Appendix B, remove a small sample, and check the pH. Fill the container slowly with a minimum of turbulence until the meniscus touches the lip of the bottle and cap. Do not allow any plastic material such as gloves to contact the sample during collection.

4.4.1.8 Fill out and attach the premade sample label.

4.4.1.9 Cap the bottle and gently invert. If any air bubbles are observed rising to the top of the container, repeat the collection procedure.

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4.4.1.10 Record in the Groundwater Sampling Logbook the sequence in which the samples were collected, the sample identification, the sample container volume and type, and the preservative added.

4.4.1.11 Attach the custody seal to the bottle and fill out the Chain-of-Custody form.

4.4.1.12 Place each sample in a plastic bag (to protect the labels from water), then place the bag in an ice chest and cover with ice immediately after collection to avoid unnecessary heating of the sample.

4.5 COLLECTION OF TOTAL METAL AND ANION SAMPLES

4.5.1 **Samplers** shall:

4.5.1.1 Collect samples for the parameters listed in Appendix B.

4.5.1.2 Select the appropriate container as listed in Appendix B.

4.5.1.3 Partially fill and rinse the container with sample. Place the rinsate in the waste storage drum.

4.5.1.4 Fill the container slowly with a minimum of turbulence until the meniscus touches the lip of the bottle.

4.5.1.5 Add the appropriate preservative listed in Appendix B to the sample container.

4.5.1.6 If a pH value is specified in Appendix B, remove a small sample and check the pH with pH paper.

4.5.1.7 Cap the bottle.

4.5.1.8 Fill out and attach the premade sample label.

4.5.1.9 Attach a custody seal to the bottle and fill out the Chain-of-Custody form.

4.5.1.10 Care should be taken (especially on warm days) to place the sample(s) in a plastic bag (to protect the label from water), then place the bag in the ice chest and cover with ice as soon as reasonable to avoid unnecessary heating of the sample.

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4.5.1.11 Record in the Groundwater Sampling Logbook the sequence whereby the samples were collected, the sample identification, the sample container volume and type, and the preservative added.

4.6 COLLECTION OF DISSOLVED METAL SAMPLES

4.6.1 **Samplers** shall:

4.6.1.1 If necessary, attach a 0.45 µm Teflon® in-line filter to the pump outlet (this determination will be made by the Monitoring Activity Manager).

4.6.1.2 Filter approximately 100 ml of the sample and discard.

4.6.1.3 Select the appropriate container as listed in Appendix B.

4.6.1.4 Fill out and attach the premade sample label. Partially fill and rinse the container with the sample. Place the rinse in the waste storage drum.

4.6.1.5 Fill the container slowly with a minimum of turbulence until the meniscus touches the lip of the bottle.

4.6.1.6 Add the appropriate preservative listed in Appendix B to the sample container.

4.6.1.7 If a pH value is specified in Appendix B, remove a small sample and check the pH with pH paper.

4.6.1.8 Cap the bottle.

4.6.1.9 Attach a custody seal to the bottle and fill out the Chain-of-Custody form.

4.6.1.10 Care should be taken (especially on warm days) to place the sample(s) in a plastic bag (to protect the label from water), then place the bag in the ice chest and cover with ice as soon as reasonable to avoid unnecessary heating of the sample.

4.6.1.11 Record in the Groundwater Sampling Logbook the sequence whereby the samples were collected, the sample identification, the sample container volume and type, and the preservative added.

4.7 COLLECTION OF TRITIUM SAMPLES

4.7.1 **Samplers** shall:

4.7.1.1 Remove any luminous materials, such as watch dials, from the immediate area.

4.7.1.2 Rinse the sample bottle with the sample and return the rinse to the waste storage tank.

4.7.1.3 Fill the container slowly (to minimize turbulence) until full and then cap it.

4.7.1.4 Fill out and attach the premade sample label to bottle.

4.7.1.5 Attach a custody seal to the bottle and fill out the Chain-of-Custody form.

4.7.1.6 Care should be taken (especially on warm days) to place the sample(s) in a plastic bag (to protect the label from water), then place the bag in the ice chest and cover with ice as soon as reasonable to avoid unnecessary heating of the sample.

4.7.1.7 Record in the Groundwater Sampling Logbook the sequence whereby the samples were collected, sample identification, sample container volume and type, and preservative added.

4.8 COLLECTION OF COLIFORM BACTERIA SAMPLES

4.8.1 Coliform samples shall be collected by the Bechtel Nevada (BN) Environmental Health Section.

4.9 COMPLETION OF THE GROUNDWATER SAMPLING

4.9.1 **Samplers** shall:

4.9.1.1 Remeasure the field parameters to ensure that the groundwater chemistry has remained constant during sampling.

4.9.1.2 Place the Bennett™ pump in its dedicated purge jar. Add 11 gallons of distilled water.

4.9.1.3 Pump water through the pump until approximately 6 inches of water remains and the water is coming out of the pump

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4.9.1.4 Remove the sample input screen from the pump and connect a source of nitrogen to the inlet.

4.9.1.5 Purge the pump of water by passing nitrogen at 20 to 40 psi through the pump.

4.9.1.6 Replace the input screen.

4.9.1.7 Remove the pump and dry using Kimwipes™.

4.9.1.8 Check connectors and fittings on the pump head.

4.9.1.9 Dismantle and store the equipment and probes per the manufacturer's instructions.

4.9.1.10 Cap and lock the wellhead.

4.10 FIELD QUALITY CONTROL

4.10.1 **Samplers** shall:

4.10.1.1 Prepare field blanks and field duplicates for each parameter (parameters which are analyzed by the same method do not require individual blanks and duplicates), excluding field parameters, at a frequency that is the greater of once per each week whereby sampling occurs or once for every 20 samples. A trip blank shall be prepared for volatile organics (if volatile organics are a target analyte) and tritium for each sampling trip.

NOTE: In the event that nondedicated sampling pumps are used to withdraw samples, a set of equipment blanks will be prepared before placement of the pump in the wells.

4.10.1.2 Prepare field blanks by filling a sample container with laboratory pure water in the field. The blank shall use the same container and preservative as the sample.

4.10.1.3 Prepare equipment blanks by passing distilled water (~10 gallons) through the pump apparatus. The blank shall use the same container and preservative as the target sample.

4.10.1.4 Prepare a field duplicate by collecting two groundwater samples in sequence. The field duplicate is used to assess sampling and analysis precision.

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4.10.1.5 Prepare a trip blank for volatile organics (if volatile organics are a target analyte) and tritium by filling the appropriate container with laboratory pure water at the laboratory.

4.10.1.6 Preserve the trip blank by the same method as the samples. The trip blank shall be carried into the field during the sample collection operations.

4.11 TRANSPORT OF SAMPLES

4.11.1 **Samplers** shall:

4.11.1.1 At the conclusion of each sampling day, measure and record in the Groundwater Sampling Logbook the temperature in each cooler.

4.11.1.2 Whenever control of the samples is passed from one individual to another, enter the transfer on the Chain-of-Custody form. Samples shall be considered to be under a custodian’s control if they are in the custodian’s possession or are in a locked, secure enclosure.

NOTE: A radiological survey of the samples is required before laboratory analysis may be conducted.

4.11.1.3 Ensure that samples to be sent to the ASL are transported to the laboratory receiving area. The person receiving the samples shall sign the Chain-of-Custody form.

4.12 GROUNDWATER DATA QUALITY REVIEW

4.12.1 The **Monitoring Activity Manager** shall ensure that data is reviewed in the following manner:

NOTE: The following instructions pertain to the manual review of analytical data. An automated system (BN Integrated Data Management System [BEIDMS]) is being developed and will perform the specified review automatically when completed.

4.12.1.1 Enter on the Data Quality Summary (Appendix D) or the electronic version, the project, monitoring well identification, sampling date, reviewer’s signature, analytical parameters, and field identification numbers.

4.12.1.2 Verify that the analytical method has been reported. Verify that the method used was the method requested. Mark the "Complete" and "Acceptable" column of the "Method" row with Yes (Y) or No (N), as appropriate.

4.12.1.3 Verify that the analysis date has been reported and the extraction date has been reported for organic parameters. Mark the "Complete" column of the "Method" row with Yes (Y) or No (N), as appropriate.

4.12.1.4 Calculate the analysis holding time for the sample group. If semivolatile organics are a target analyte, calculate the extraction holding time (method 8270 semivolatile organics). Record the holding times on the Data Quality Summary. Mark the "Acceptable" column Yes (Y) or No (N), as appropriate.

4.12.1.5 Verify that the concentration and units have been reported for each sample in the packet. Mark the "Complete" column of the "Sample Concentration" and "Concentration Units" row with Yes (Y) or No (N), as appropriate.

4.12.1.6 Verify that the uncertainty and number of standard deviations have been reported for radiological parameters for each sample in the packet. Mark the "Complete" column of the "Concentration Uncertainty" row with Yes (Y) or No (N), as appropriate.

4.12.1.7 Verify that the detection limit has been reported for each sample in the packet. Mark the "Complete" column of the "Detection Limit" row with Yes (Y) or No (N), as appropriate.

4.12.1.8 Compare the reported detection limit with the data quality objectives. Mark the "Acceptable" column with Yes (Y) or No (N), as appropriate.

4.12.1.9 Verify that the laboratory has analyzed and reported blank values and spike results for inorganic and radiological parameters. Verify that the laboratory has analyzed and reported blank and surrogate spike results for organic parameters. Mark the "Complete" column of the "Laboratory QC" row with yes (Y) or No (N), as appropriate.

4.12.1.10 Compare the matrix spike percent recovery with the data quality objectives. Mark the "Acceptable" column of the "Laboratory QA" row with Yes (Y) or No (N), as appropriate.

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4.12.1.11 Verify that the Chain-of-Custody form is present. Mark the "Complete" column of the "Chain of Custody" row with Yes (Y) or No (N), as appropriate.

4.12.1.12 Verify that laboratory management has reviewed and signed the data package. Mark the "Complete" column of the "Laboratory Approval" row with Yes (Y) or No (N), as appropriate.

4.12.1.13 Calculate the relative percent difference of the field duplicates or co-located samples for any analyte detected in both samples. If the analyte is not detected in both samples, fill the blank with N/A. Otherwise, record the relative percent difference in the blank. Mark the "Acceptable" column of the "Relative Percent Difference" row with Yes (Y) or No (N), as appropriate.

4.12.1.14 Review the field blank and the trip blank for volatile organics (if volatile organics are a target analyte).

4.12.1.15 If all blanks in the complete and acceptable column are marked (Y) or N/A, the package is considered acceptable. If any blank has been marked (N), the package may still be accepted. For these cases, describe the justification for accepting the package under data qualification. Attach additional pages if necessary. Mark the "Acceptable" column on the "Date Package" row, as appropriate.

5.0 TRAINING

5.1 All personnel shall be trained on the safety and operations of the equipment required for the proper implementation of this procedure as described below.

5.2 Personnel involved in this activity shall read and understand this procedure and demonstrate proper implementation of this procedure.

5.3 All sampling personnel shall have the following training:

- Occupational Safety and Health Administration 40-hour Hazardous Waste Site General Worker
- Radiation Worker Training

5.4 Attend the periodic facility safety training program. See Appendix C for the Groundwater Sampling Qualification and Training History documentation.

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6.0 FORMS

NOTE: The implementation of the BEIDMS system may change the number of forms required.

6.1 Analytical Services Laboratory Statement of Work.

6.2 Chain-of-Custody.

7.0 RECORDS MANAGEMENT

7.1 This procedure generates the following records:

Record	Disposition Authority	Disposition Instructions	Office of Record
Analytical Services Laboratory Statement of Work	Draft ENV 5.g.(2)	Keep records throughout life of facility and post-closure care period	RWMS Bldg 5-07
Chain-of-Custody	Draft ENV 5.g.(2)	Keep records throughout life of facility and post-closure care period	RWMS Bldg 5-07
Data Quality Summary	Draft ENV 5.g.(2)	Keep records throughout life of facility and post-closure care period	RWMS Bldg 5-07
Groundwater Sampling Qualification and Training History	Draft ENV 5.g.(2)	Keep records throughout life of facility and post-closure care period	RWMS Bldg 5-07
Groundwater Sampling Logbook	Draft ENV 5.g.(2)	Keep records throughout life of facility and post-closure care period	RWMS Bldg 5-07
Groundwater Sampling Instruction Procedure	Draft ENV 5.g.(2)	Keep records throughout life of facility and post-closure care period	RWMS Bldg 5-07
Laboratory deliverables	Draft ENV 5.g.(2)	Keep records throughout life of facility and post-closure care period	RWMS Bldg 5-07

8.0 REFERENCES

8.1 Title 40 CFR Part 265, U.S. Environmental Protection Agency, “Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities.”

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8.2 U.S. Environmental Protection Agency, "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," SW-846.

8.3 U.S. Environmental Protection Agency, "Methods for Chemical Analysis of Water and Wastes," EPA-600/4-82-055, 1982.

8.4 U.S. EPA, RCRA Ground Water Monitoring: Draft Technical Guidance, 1994.

8.5 Nevada Administrative Code, Public Water Supplies, State of Nevada, Chapter 445, December 30, 1980.

8.6 DOE Order 5820.2A, "Radioactive Waste Management," 1988.

8.7 *Radiological Control Manual*, DOE N 5480.6, 1999, Revision 3.

8.8 DOE, 1995. Revision 0, "Groundwater Monitoring Well Purging and Sampling," ERD-05-304. Las Vegas, Nevada.

8.9 Bechtel Nevada, Revised Area 5 Radioactive Waste Management Site Outline of a Comprehensive Groundwater Monitoring Program, February 1998.

8.10 Bechtel Nevada Company Policy A-A11.01, "Safety and Health Policy."

8.11 Bechtel Nevada Company Safety Procedure M-A11.001, "General Safety Rules."

8.12 Bechtel Nevada Company Safety Procedure M-A11.003, "Safety Meetings."

8.13 Bechtel Nevada Company Safety Procedure M-A11.006, "Employee/Supervisor Safety Inspections."

8.14 Bechtel Nevada Company Safety Procedure M-A11.014, "Selecting, Using, and Storing Chemicals."

8.15 Bechtel Nevada Company Safety Procedure M-A11.015, "Hazard Communication."

8.16 Bechtel Nevada Company Safety Procedure M-A11.050, "Housekeeping/Fire Protection."

8.17 Bechtel Nevada Company Safety Procedure M-A11.060, "Personal Protective Equipment."

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9.0 DEFINITIONS

9.1 **Accuracy**. A measure of the deviation of a measured value from the true value.

9.2 **Completeness**. The percentage of required data that is obtained that meets the data quality objectives.

9.3 **Data Quality Objective**. Data quality requirements used to assure that environmental data is usable for its intended purpose.

9.4 **Equipment Blank**. A field quality control sample prepared by rinsing sampling equipment with laboratory pure water. The equipment blank is used to assess contamination by sampling equipment.

9.5 **Field Blank**. A field quality control sample prepared from laboratory pure water in the field. The field blank is used to assess contamination from sample containers and contamination present in the sampling environment.

9.6 **Field Duplicate**. A field quality control sample prepared by collecting two groundwater samples in sequence. The field duplicate is used to assess sampling and analysis precision.

9.7 **Percent Recovery**. The percentage of an analyte added to a sample that is recovered in analysis. Computationally, the measured concentration of a spiked sample divided by the sum of the concentration of the analyte added and the concentration of the sample, expressed as a percentage.

9.8 **Precision**. A measure of the dispersion of replicate measurements about the mean value.

9.9 **Relative Percent Difference**. An estimate of the precision of replicate samples. Computationally, the difference between two measure values divided by the mean, expressed as a percentage.

9.10 **Representativeness**. The extent to which the concentration of an analyte in a sample represents the concentration of the analyte in the environment.

9.11 **Sensitivity**. A measure of the ability of an analysis system to detect the presence of an analyte.

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9.12 **Trip Blank**. A quality control sample prepared from laboratory pure water in the laboratory and transported to and from the sampling site with the samples. The trip blank is used to assess contamination of samples by volatile parameters during transport.

10.0 APPENDICES

10.1 Appendix A: Groundwater Sampling Flow Diagram.

10.2 Appendix B: Sample Containers and Preservation.

10.3 Appendix C: Groundwater Sampling Qualification and Training History.

10.4 Appendix D: Sample Data Quality Summary.

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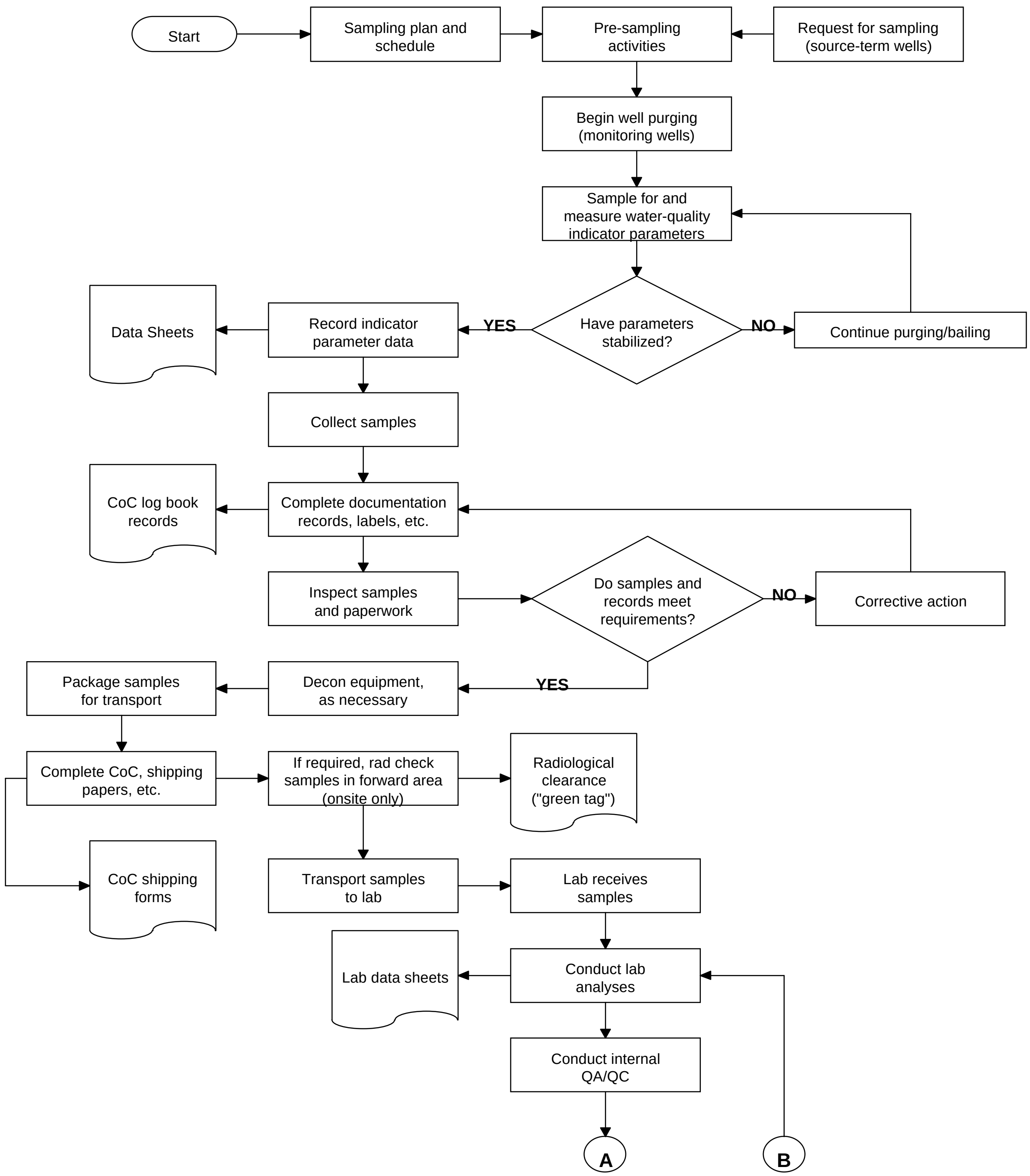
APPENDIX A - Groundwater Sampling Flow Diagram



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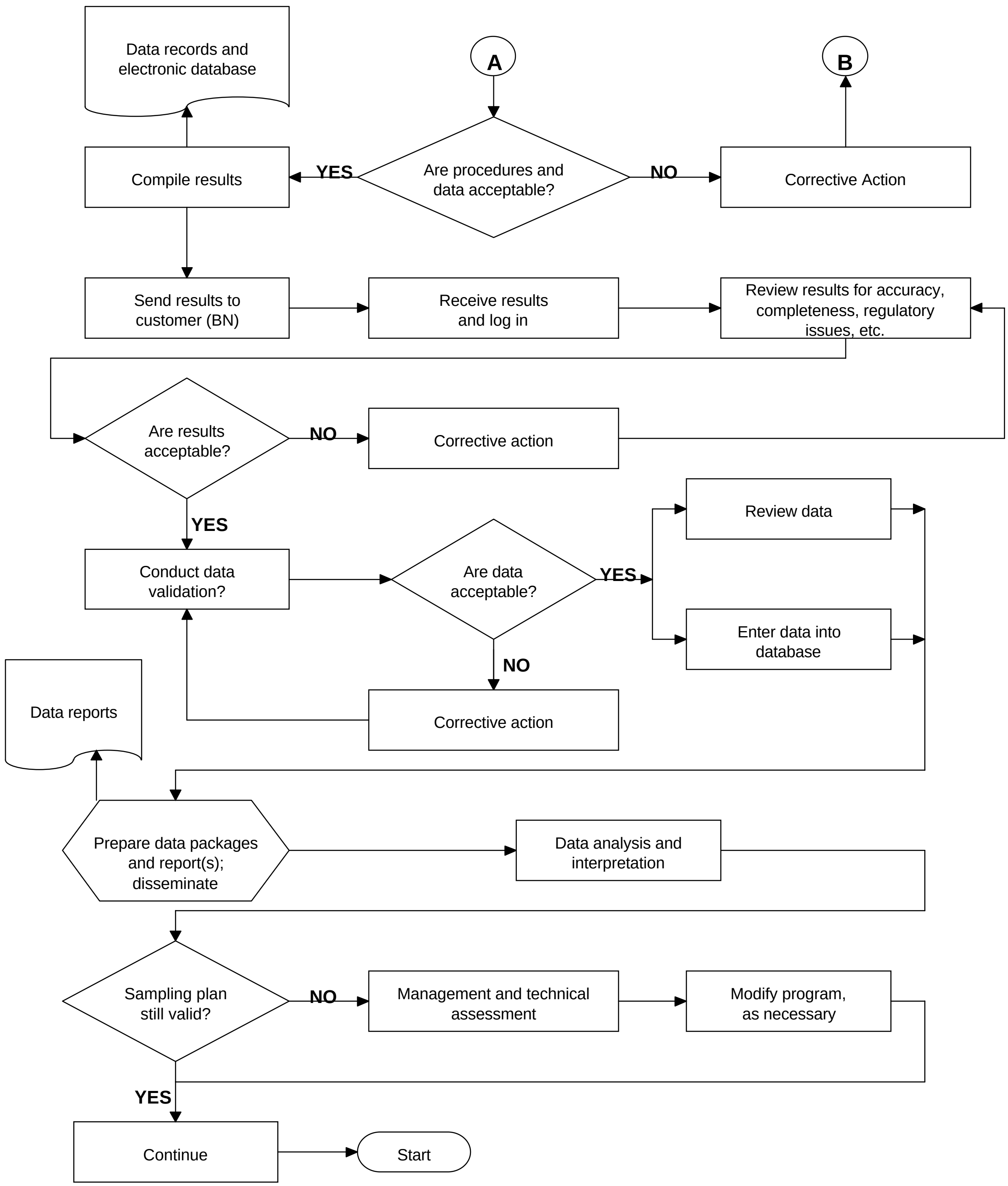

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APPENDIX B

Sample Containers and Preservation

Parameter (Method)	# per Sample	Volume	Container	Preservation	Holding Time
TOX (9020B)	1	500 ml	Amber glass bottle with Teflon™-lined cap	Acidify pH < 2 with concentrated H_2SO_4; cool to 4°C. No headspace.	7 days for extraction 40 days for analysis
TOC (415.2)	1	250 ml	Amber glass bottle with Teflon™-lined cap	Acidify to pH < 2 with concentrated HCl; cool to 4°C. No headspace.	28 days
Cl, SO_4, F (300)	1	250 ml	Polyethylene bottle	None required per method.	28 days
HCO_3 and H_2CO_3 (2320B)	1	250 ml	Polyethylene bottle	None required per method.	14 days
Na, Ca, Mg, Mn, K, Fe, SiO_2 (200.7)	1	500 ml	Polyethylene bottle	Acidify to pH < 2 with HNO_3.	180 days
Enriched Tritium (L-E10.615.PL)	1	1 liter	Glass bottle	None	6 months

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APPENDIX C

Groundwater Sampling Qualification and Training History

Name:	Activity Manager:			
QUALIFICATIONS				
Education:				
Brief Description of Experience				
ASSIGNMENT	Required (Y/N)	1) Initials and Date	2) Initials and Date	3) Initials and Date
Read instruction	Y			
Demonstrate proper implementation of instruction	Y			
Familiar with Facility Safety & Area 5 Contingency Plan	Y			
OSHA 40-hr/Hazardous Waste Site General Worker	Y			
Radiation Worker Training	Y			
Attend Program Safety Training Meetings	Y			
Proper handling of acid	Y			
Familiar with MSDS's	Y			

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APPENDIX D - Sample Data Quality Summary

WELL IDENTIFICATION **Ue5PW-1**
SAMPLE COLLECTION DATE: **DD MM YY**

SAMPLE IDENTIFICATION NUMBER	ID		ID		ID	
Fraction	X=A X=B X=C X=D	X=A X=B X=C X=D	X=A X=B X=C X=D	X=A X=B X=C X=D	X=A X=B X=C X=D	X=A X=B X=C X=D
Parameter	Parameter	Parameter	Parameter	Parameter	Parameter	Parameter
Method	Method	Method	Method	Method	Method	Method
Extraction/Prep Holding Time	NA	NA	NA	NA	NA	NA
Analysis Holding Time	YES	YES	YES	YES	YES	YES
Sample Concentration	YES	YES	YES	YES	YES	YES
Concentration Units	YES	YES	YES	YES	YES	YES
Concentration Uncertainty (Rad)	NA	NA	NA	NA	NA	NA
Number of Standard Deviations (Rad)	NA	NA	NA	NA	NA	NA
Detection Limit	YES	YES	YES	YES	YES	YES
Laboratory QC	YES	YES	YES	YES	YES	YES
Laboratory QA	YES	YES	YES	YES	YES	YES
Chain of Custody	YES	YES	YES	YES	YES	YES
Laboratory Approval	YES	YES	YES	YES	YES	YES
Relative Percent Difference	YES	YES	YES	YES	YES	YES
Field Blank/Trip Blank	NA	NA	NA	NA	YES	YES
Data Package	YES	YES	YES	YES	YES	YES
Data Qualifications	YES	YES	YES	YES	YES	YES
REVIEWER:						
REVIEWER'S INITIALS AND DATE:						
COMMENTS:	YES - Complete and acceptable; NO - Incomplete and/or unacceptable; NA - Nonapplicable					