DOE/NV/11718–894

Nevada Test Site

2003 Data Report:
Groundwater Monitoring Program
Area 5 Radioactive Waste Management Site

February 2004

Prepared for:
U.S. Department of Energy
National Nuclear Security Administration
Nevada Site Office

Prepared by:
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Worked Performed Under
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TABLE OF CONTENTS

Page

LIST OF FIGURES

Page

LIST OF TABLES

Page

LIST OF ACRONYMS

CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
ERA	Environmental Resource Associates
GEL	General Engineering Laboratories
GW	Groundwater
IL	Investigation Level
LCA	Lower Carbonate Aquifer
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
REECo	Reynolds Electrical & Engineering Company, Inc.
RWMS	Radioactive Waste Management Site
SC	Specific Conductance
TOC	Total Organic Carbon
TOX	Total Organic Halides
VOA	Volatile Organic Analysis

MEASUREMENTS

cm	centimeter
ft	feet
in	inch
km	kilometer
L	liter
m	meter
mg	milligram
pCi	picoCurie
SU	standard unit
µg	microgram
yr	year

EXECUTIVE SUMMARY

This report is a compilation of the calendar year 2003 groundwater (GW) sampling results from the Area 5 Radioactive Waste Management Site (RWMS-5). Wells Ue5PW-1, Ue5PW-2, and Ue5PW-3 were sampled semi-annually for the required analytes: pH, specific conductance (SC), total organic carbon (TOC), total organic halides (TOX), tritium, and major cations/anions. Results from all samples collected in 2003 were within established criteria. These data indicate that there has been no measurable impact to the uppermost aquifer from the Resource Conservation and Recovery Act (RCRA) regulated unit within the RWMS-5 and confirm that any previous detections of TOC and TOX were false positives.

Contamination indicator data are presented in control chart and tabular form with investigation levels (ILs) indicated. Gross water chemistry data are presented in graphical and tabular form. There were no major changes noted in the monitored groundwater elevations. There continues to be an extremely small gradient to the northeast with an average flow velocity of less than one foot per year.

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

Cumulative Chronology for Area 5 RWMS Groundwater Monitoring Program					
Date	**Ue5PW-1**	**Date**	**Ue5PW-2**	**Date**	**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 Nevada Division of Environmental Protection (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 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	DOE submits 1993 groundwater-monitoring results from quarterly sampling effort.				
01/18/1995	GW resampling for 08/01/1994 TOC hit.				
02/23/1995	DOE transmits to NDEP Groundwater Monitoring Program Outline.				
03/01/1995	1994 Groundwater Monitoring Report submitted to NDEP.				
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, resulting in a bent shaft on the reel.				
01/22/1996	Bennett pump seals replaced at all three wells.				
03/01/1996	DOE submits to NDEP the 1995 GW Monitoring Report.				
01/16/1996	GW Sampling				
04/16/1996	GW Sampling				
		04/30/1996	GW Sampling		
10/01/1996	GW Sampling				

Cumulative Chronology for Area 5 RWMS Groundwater Monitoring Program					
Date	**Ue5PW-1**	**Date**	**Ue5PW-2**	**Date**	**Ue5PW-3**
10/25/1996	NDEP requests clarifications/changes in the GW Monitoring Report.				
11/19/1996	GW Sampling				
03/01/1997	DOE submits 1996 GW Monitoring Report and revised GW Monitoring Program Outline.				
04/16/1997	GW Sampling				
08/12/1997	NDEP comments on 1996 GW Monitoring Report/Proposed Outline.				
10/22/1997	Pump and water-level meter lodge in Ue5PW-1 well during simultaneous operation, retrieved 10/23/1997.				
10/22/1997	Larger diameter air lines installed at all three wells.				
11/05/1997	GW Sampling				
03/01/1998	DOE submits to NDEP the 1997 GW Monitoring Report and new outline.				
03/31/1998	NDEP letter stating that they concur on the indicator parameters and ILs submitted in the groundwater-monitoring outline.				
05/13/1998	GW Sampling				
06/22/1998	TOX detected in the 05/13/1998 samples and blanks from all three wells.				
07/10/1998	DOE and NDEP agree to resample Ue5PW-1 to confirm no TOX.				
07/29/1998	GW resampling at Ue5PW-1 for 05/13/1998 TOX hits.				
09/10/1998	Results from 07/29/1998 resampling are non-detect for TOX. TOX results from the 05/13/1998 sampling event are determined to be false positives.				
09/10/1998	Bennett pumps from three wells and spare pumps are sent to manufacturer for refurbishing.				
09/12/1998	Reels from three wells are returned to manufacturer for new tubing bundles.				
10/28/1998	GW Sampling				
09/12/1998	Ue5PW-1 reel returned to manufacturer for repair of exhaust tube. Spare pump returned to manufacturer for the repair of a leaky seal.				
03/01/1999	DOE submits to NDEP 1998 Groundwater Monitoring Report.				
03/31/1999	NDEP requests statistical analysis of data and states that values determined to be false positives through resampling do not need to be presented graphically.				
05/19/1999	GW Sampling				
10/27/1999	GW Sampling				
12/13/1999	Resample Ue5PW-2 after TOC hit from 10/27/1999.				
12/27/1999	Results from the resampling of Ue5PW-2 are non-detect for TOC. TOC result from 10/27/1999 is determined to be a false positive.				
04/17/2000	NDEP states that future reports do not need to include statistical analyses.				
04/26/2000	GW Sampling				
06/28/2000	DOE contacts state to report TOX/TOC hits from 04/26/2000. DOE and NDEP agree that the wells will be resampled in August, which would also constitute the Fall sampling event.				
08/09/2000	GW Sampling				

Cumulative Chronology for Area 5 RWMS Groundwater Monitoring Program

Date	Ue5PW-1	Date	Ue5PW-2	Date	Ue5PW-3
09/20/2000	DOE contacts NDEP to report TOX hits from 08/09/2000 sampling.				
11/07/2000	Letter from NDEP 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 well			11/27/2000	Video log well
12/20/2000	DOE transmits to NDEP a proposed plan to address contamination issues.				
01/31/2001	Letter from NDEP generally concurring that the plan submitted to determine the cause of TOX and TOC hits is sound.				
03/14/2001	Letter from NDEP stating that the 2000 Groundwater Monitoring report was received in a timely manner and contains all the data required by Title 40 CFR 265.94. Letter also requests information regarding data in Appendix A of the 2000 Groundwater Monitoring Report (BN, 2001).				
04/19/2001	Letter from DOE responding to NDEP's 3/14/2001 request for information regarding presentation of TOX/TOC data in the 2000 report.				
04/30/2001	Letter from NDEP concurring with the approach to data presentation as outlined by DOE in the 4/19/2001 correspondence.				
05/29/2001	GW Sampling				
10/03/2001	GW Sampling				
05/15/2002	GW Sampling				
10/22/2002	GW Sampling				
04/15/2003	GW Sampling				
10/22/2003	GW Sampling			10/21/2003	GW Sampling

I. INTRODUCTION

A. Purpose and Scope

This report is a compilation of the calendar year 2003 groundwater sampling results for the Nevada Test Site (NTS) RWMS-5, as required by Title 40 CFR 265 (CFR, 1999) (see Figures 1, 2, and 3 [DOE, 1997; Gonzales, 2001; verbal communication]). The RCRA-regulated unit within Area 5 is the Pit 3 Mixed Waste Disposal Unit (MWDU), P03U (Figure 4). 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 NDEP in a letter dated August 12, 1997. The appearance and arrangement of this document has been modified slightly since that date to provide additional information and to facilitate the readability of the document. Specifically, the following changes have been made: (1) the “less than” (<) notation is used in the raw data tables to indicate a value that is less than the method detection limit (MDL); (2) gradient and velocity calculations are presented; (3) data plots are presented in portrait fashion; (4) for the purposes of plotting data, non-detect values are assumed to be equal to one-half of their respective MDL; and (5) due to the lack of providing meaningful information, summary statistics for parameters dominated by non-detect values are not presented.

Meteorological data are also acquired at the RWMS-5. These data include wind speed and direction and precipitation. Monthly precipitation measured at the RWMS-5 is included in this document (Figure 5).

For calendar year 2003 Sanford Cohen and Associates of Southern Environmental Laboratory performed all tritium analyses, subsequent to enrichment by Bechtel Nevada (BN). Non-radiological samples for 2003 were sent for analysis to Lionville Laboratory Incorporated. The current groundwater sampling procedure is presented as Appendix A.

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 the NDEP.

C. Site Hydrogeology

The RWMS-5 is located in northern Frenchman Flat in the southeast portion of the NTS. Thick, unsaturated alluvial deposits separate the facility from the uppermost aquifer. An alluvial aquifer is present beneath the Area 5 facility and is believed to extend throughout much of the Frenchman Flat basin (International Technology, 1998).

Monitoring wells (also referred to as pilot wells at this facility) Ue5PW-1 and Ue5PW-2 are completed in the Alluvial Aquifer, while Well Ue5PW-3 is completed in the Timber Mountain Tuff Aquifer northwest of the facility (Figures 6,7, and 8). The alluvium-Tertiary Tuff contact occurs at a depth of 617 feet (ft) at Ue5PW-3 (Reynolds Electrical & Engineering Company, Inc. [REECo], 1994).

The water from all three monitoring wells is characterized as sodium-bicarbonate type. Although the hydrologic connection between these aquifers continues to be studied, it is believed that the alluvial and tuff aquifers are locally connected near the RWMS-5 as indicated by the similar hydrochemistry and groundwater elevations of the three wells.

Hydraulic properties (as mean saturated hydraulic conductivity and effective porosity values) have been derived from laboratory analyses of alluvium cores taken from the three wells (Table 1). Groundwater flow direction and velocity and hydraulic gradient have been calculated using these values and water-level elevations (Figures 9 and 10). Although Ue5PW-3 is completed in a volcanic tuff aquifer, the greater hydraulic-property values associated with the alluvium are used in the groundwater velocity calculation. The calculated mean local horizontal groundwater flow velocity is less than one foot per year and flows to the northeast (40.6° east of north) in the uppermost aquifer. Details on the velocity and direction calculations are given in Appendix B.

Some vertical groundwater flow is thought to occur from the Alluvial Aquifer and Timber Mountain Aquifer to the underlying regional Lower Carbonate Aquifer (LCA). However, this is an area of current study by the Underground Test Area Project. The LCA is a regional aquifer that underlies the south-central portions of the NTS. Groundwater in the LCA flows to the south and southwest, where it eventually discharges into Death Valley, California, and also into smaller depressions such as Amargosa Valley and Ash Meadows in southwest Nevada (Figure 11 [Rehfeldt, 2001; written communication]). For more detailed descriptions of the site characteristics of the RWMS-5, refer to “Revised Area 5 Radioactive Waste Management Site Outline of a Comprehensive Groundwater Monitoring Program (Bechtel Nevada, 1998).

II. MONITORING CRITERIA

The RWMS-5 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.

Indicators of Contamination
- pH
- Specific Conductance
- Total Organic Carbon (TOC)
- Total Organic Halides (TOX)
- Tritium

General Water Chemistry Parameters
- Total Ca, Fe, Mg, Mn, K, Na, Si
- Total SO_4, Cl, F
- Alkalinity (HCO_3)

Control charts have been developed for each of the indicator parameters. These charts show the relationship of the groundwater analytical results to their respective IL. The 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 report, as agreed upon by NDEP in a letter dated April 17, 2000, (Liebendorfer, 2000). The IL for each indicator parameter was negotiated between the DOE and NDEP in 1998 (Table 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 2,000 pCi/L, which is10 percent of the National Primary Drinking Water Standard of 20,000 pCi/L.

A. pH

The measured pH at each well has remained within the lower and upper ILs of 7.6 and 9.2 standard units (SUs), respectively. Equilibration of the wells with the local aquifer may be observed in the pH measurements from 1993 through 1996. Subsequently, pH values for all three wells have remained relatively stable. Recent measurements from Well Ue5PW-1 appear to be slightly greater than those from the other two wells. A time-series plot of mean pH values since 1993 has been developed (Figure 12). Additionally, a time-series plot over the most recent 2-year period has also been developed (Figure 13). Measured pH values are also provided in a tabular format (Table 3).

B. Specific Conductance

The measured specific conductance at each well has remained below the IL of 0.44 mmhos/cm. The fluctuating measurements from 1993 through 1996 suggest a 3-year equilibration period after the wells were completed. After this time, the values for all three wells have remained relatively stable. The specific conductance measured from Well Ue5PW-2 has historically been less than the other two wells. A time-series plot of mean specific conductance values since 1993 has been developed (Figure 14). A plot of the most recent 2-year data has also been completed (Figure 15). Specific conductance values are also provided in a tabular format (Table 4).

C. Total Organic Carbon

All results for the 2003 TOC analyses were below the IL of 1 mg/L. Prior to calendar year 2003, there have been several instances of reported TOC concentrations above the IL. These occurred in 1994, 1996, 1999, 2000, 2001, and 2002. All of these detections had duplicate analyses, which had concentrations less than the IL or MDL. All detections are likely a product of laboratory/field contamination, as subsequent resampling events had reported concentrations less than the IL. A time-series plot of mean TOC values since 1993 has been developed (Figure 16). Non-detect values are presented as being equal to one-half of their respective MDL. Additionally, any results confirmed as false positives by resampling are not displayed graphically per NDEP request (Liebendorfer, 1999). A time-series plot over the most recent 2-year period is also provided in this document (Figure 17). The TOC results are also provided in a tabular format (Table 5).

D. Total Organic Halides

All of the 2003 TOX results were well below the IL of 50 μg/L. All results were actually non-detect (less than 5.2 μg/L), with the exception of one sample from Well Ue5PW-2 which had a result of 6.1 μg/L. Detections of TOX have been reported in samples collected in 1998, 2000, and 2002. Subsequent sampling events have confirmed these detections as false positives. A time-series plot of mean TOX values since 1993 has been developed (Figure 18). Non-detect values are presented as being equal to one-half of their respective MDL. Additionally, any results confirmed as false positives are not displayed graphically per NDEP request (Liebendorfer, 1999). A time-series plot over the most recent 2-year period is also provided (Figure 19). The TOX plots display the mean MDL based on the higher MDLs of the past (up to 40 μg/L) and the current MDL of 5.2 μg/L. The TOX results are also provided in a tabular format (Table 6).

E. Tritium

All tritium results from 2003 remained below the IL of 2,000 pCi/L. The majority of the results continue to be less than their respective MDLs. A time-series plot of mean tritium values since 1993 is provided in this document (Figure 20). The result from November 1993 for Well Ue5PW-2 is not presented on the graph because a standard (non-enriched) analysis was performed on this sample. A time-series plot over the most recent 2-year period is also included (Figure 21). The tritium results are also provided in a tabular format (Table 7).

F. General Water Chemistry Parameters

General water chemistry analyses of samples are conducted to assess the gross chemistry of the local groundwater and the suitability for human consumption. These analyses are also conducted to evaluate characteristics such as aquifer continuity and the hydraulic connection between the three wells. Evaluations of the data indicate that the hydrochemistry of the three wells is similar, and there is no significant change in the gross groundwater chemistry over time. The measured concentrations of the regulated ions (e.g., Cl, F, Fe, Mn, and SO_4) have remained below National Secondary Drinking Water Standards. Groundwater temperatures at the time of sample collection ranged from 18.7 to 19.7°C during the 2003 sampling events. Temperature measurements are collected at the ground surface and may be influenced slightly by the ambient air temperature.

A piper diagram showing the concentrations of the major cations and anions from the most recent 2-year period is included in this document (Figure 22). The data indicate that the local groundwater is a sodium-bicarbonate type. To evaluate water composition, stiff plots have been developed from the data acquired over the most recent 2-year period (Figures 23 and 24). Only one charge-balance error exceeded 10 percent for all of the 2003 sampling events. The percent error from the April sampling of Well Ue5PW-3 was calculated at 12.80 percent. The data from the general water chemistry analyses, and associated summary statistics, are included in this document (Tables 8, 9, and 10). No anionic data are presented for the May 2001 sampling event due to the laboratory erroneously acidifying the samples. Additionally, the bicarbonate result for Well Ue5PW-1 from the October 2003 sampling event has been rejected.

G. Groundwater Elevation

During the 2003 calendar year, quarterly depth-to-water measurements were conducted using an electronic water-level tape. The measurements are made to derive potentiometric surface elevations; to assess any changes in hydraulic heads; and to determine the local hydraulic gradient. The measurements are subject to a total error of 0.16 feet (BN, 1998) and are corrected for borehole deviation. The approximate depth to groundwater at wells Ue5PW-1, Ue5PW-2, and Ue5PW-3 are 773 feet, 842 feet, and 891 feet, respectively.

A plot of the corrected water-table elevations over time is included in this document (Figure 9). The water-level data are also presented in a tabular format (Table 11). A time-series plot of mean groundwater flow velocity and flow direction is also provided (Figure 10). Figure 10 suggests the groundwater flow velocity has remained fairly constant around 0.7 ft/year, while the flow direction has become slightly more easterly over time. It should be noted that small changes in water-table elevations may produce rather large changes in the calculated flow direction as a function of the small hydraulic gradient in the area. Details on the groundwater gradient, velocity, and flow direction calculations are provided in Appendix B.

III. SUMMARY

The hydrologic conditions within the uppermost aquifer below the RWMS-5 continue to remain stable. Groundwater flow continues toward the northeast at a velocity of less than one foot per year. There have been no significant changes detected in the chemistry of the uppermost aquifer. Indicator parameters have remained within the established ILs. The 2003 data continue to indicate that previous detections of TOC and TOX in field samples were false positives.

IV. CONCLUSION

There has been no measurable impact to the uppermost aquifer from the RCRA regulated unit within the RWMS-5.

Figures

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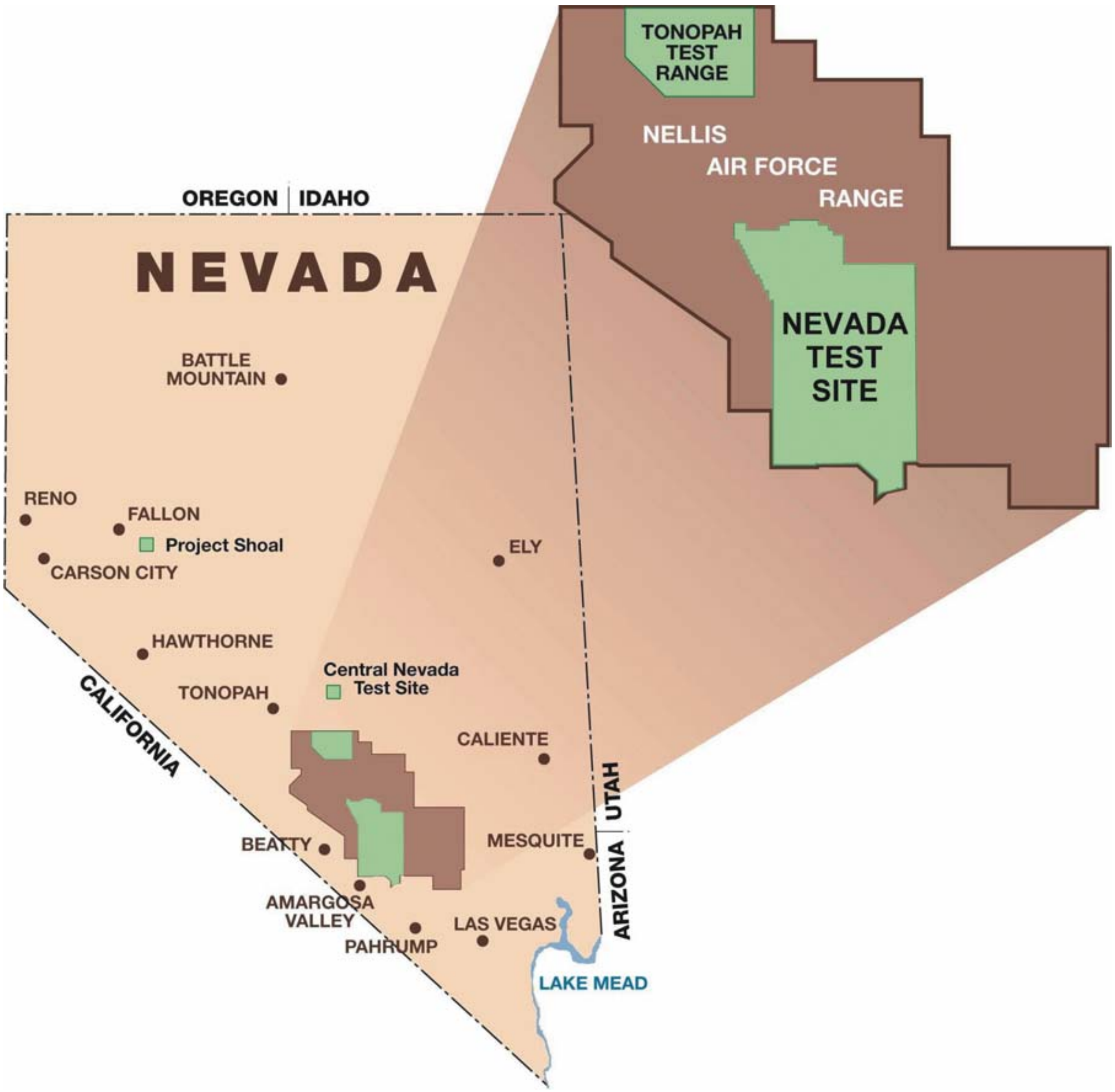

Figure 1 Location of the Nevada Test Site within Nevada

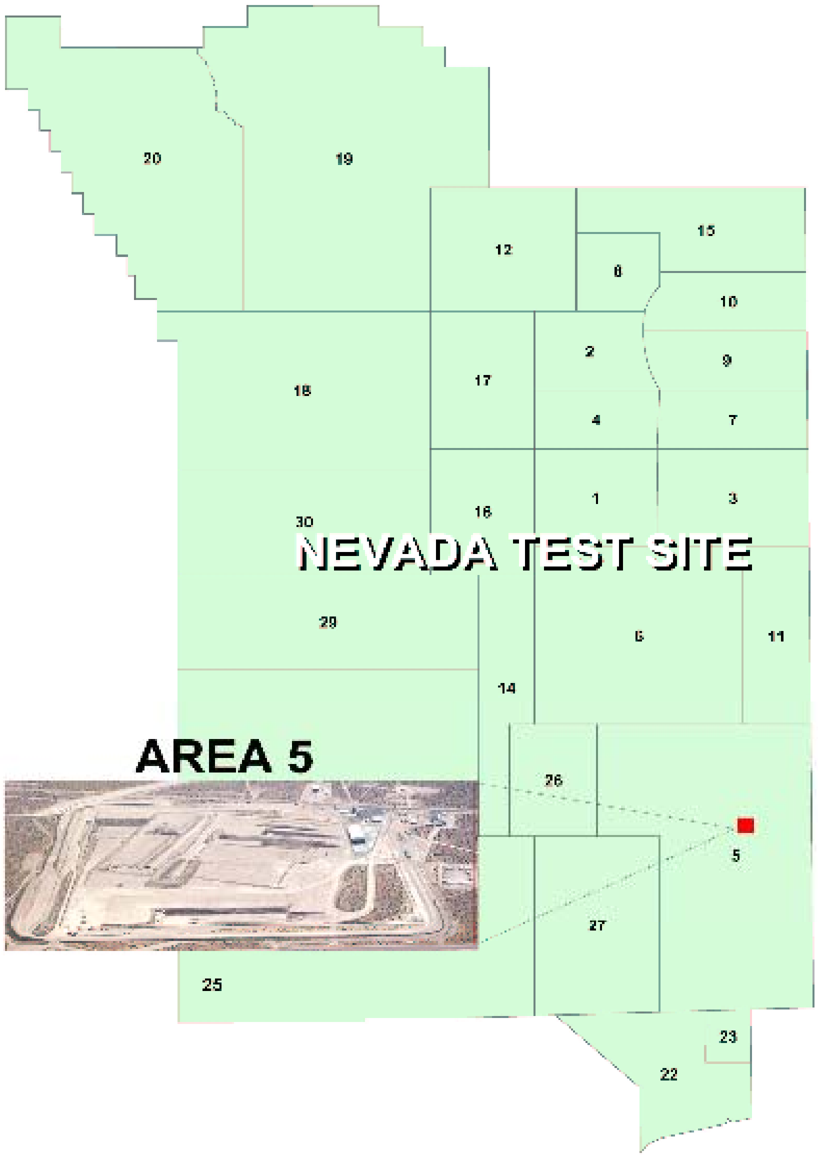

Figure 2 Location of the Area 5 RWMS within the Nevada Test Site

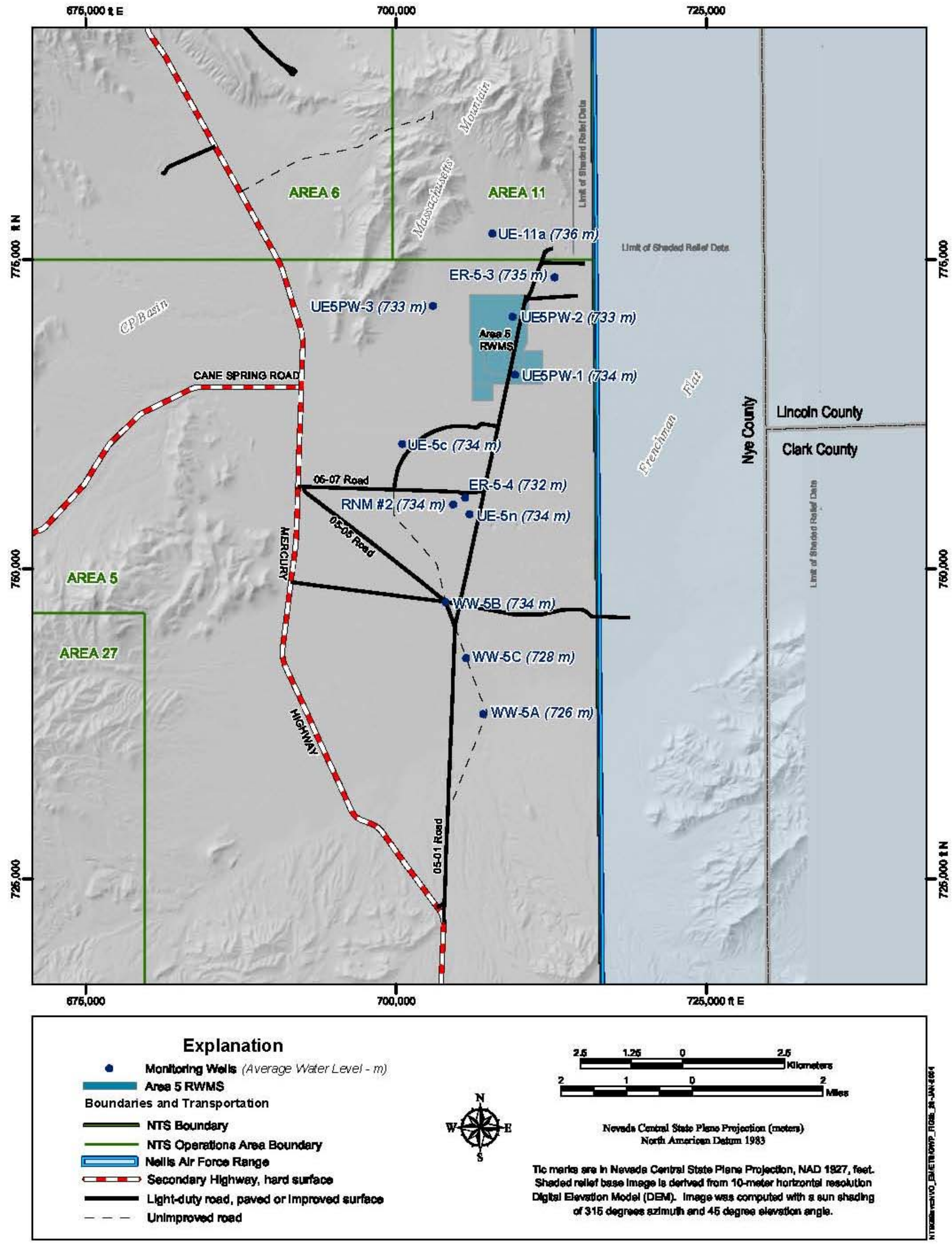

Figure 3 Location and Average Water Levels of RWMS Monitoring Wells and Other Wells in the Vicinity in Meters Above Mean Sea Level (DOE, 1997; Gonzales, 2001; verbal communication)

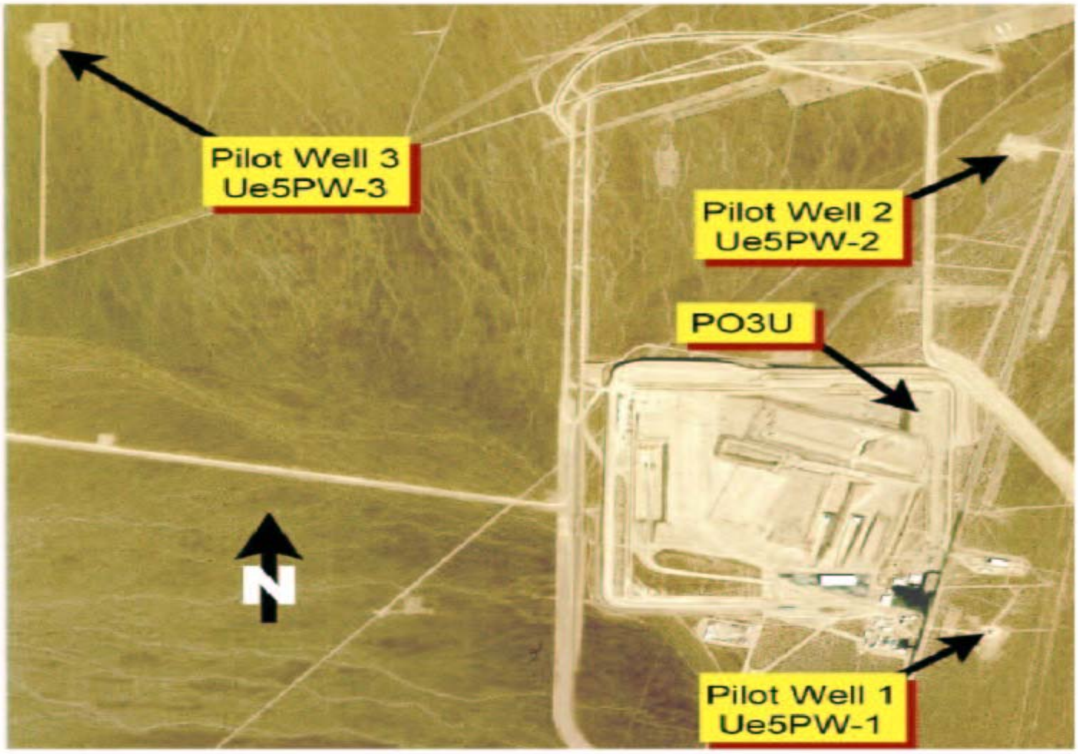

Figure 4 Location of P03U within the Area 5 RWMS

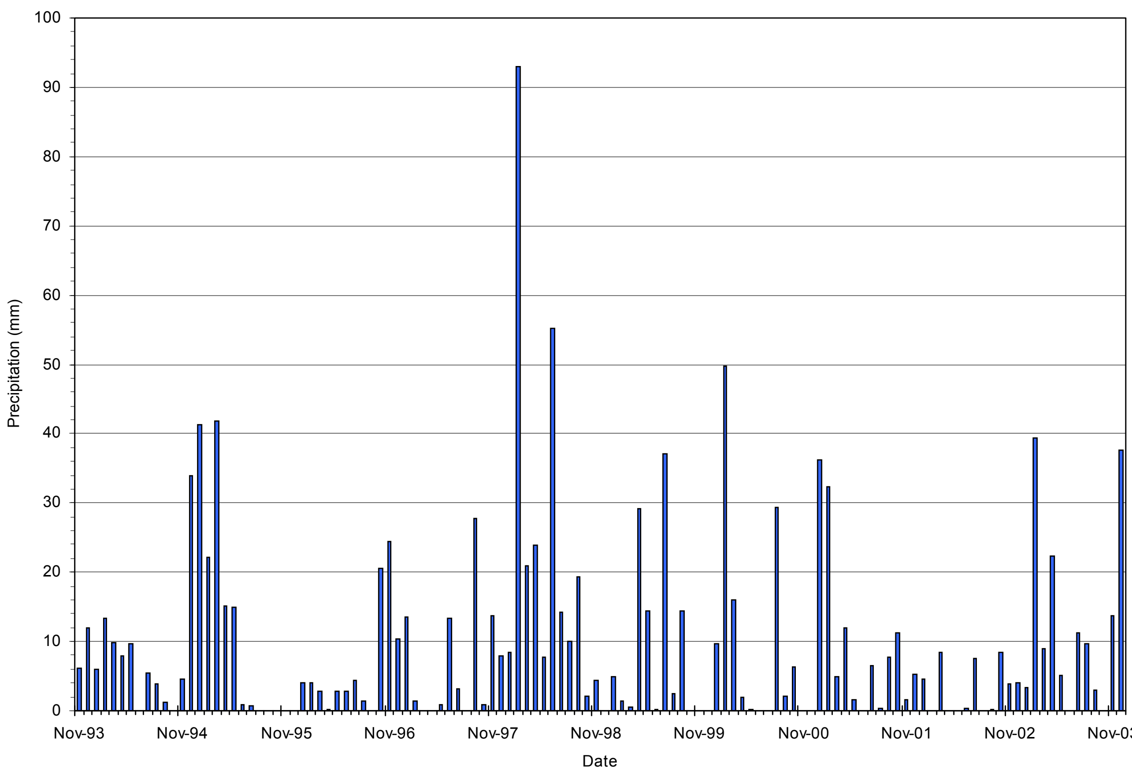

Figure 5 Area 5 RWMS Monthly Precipitation

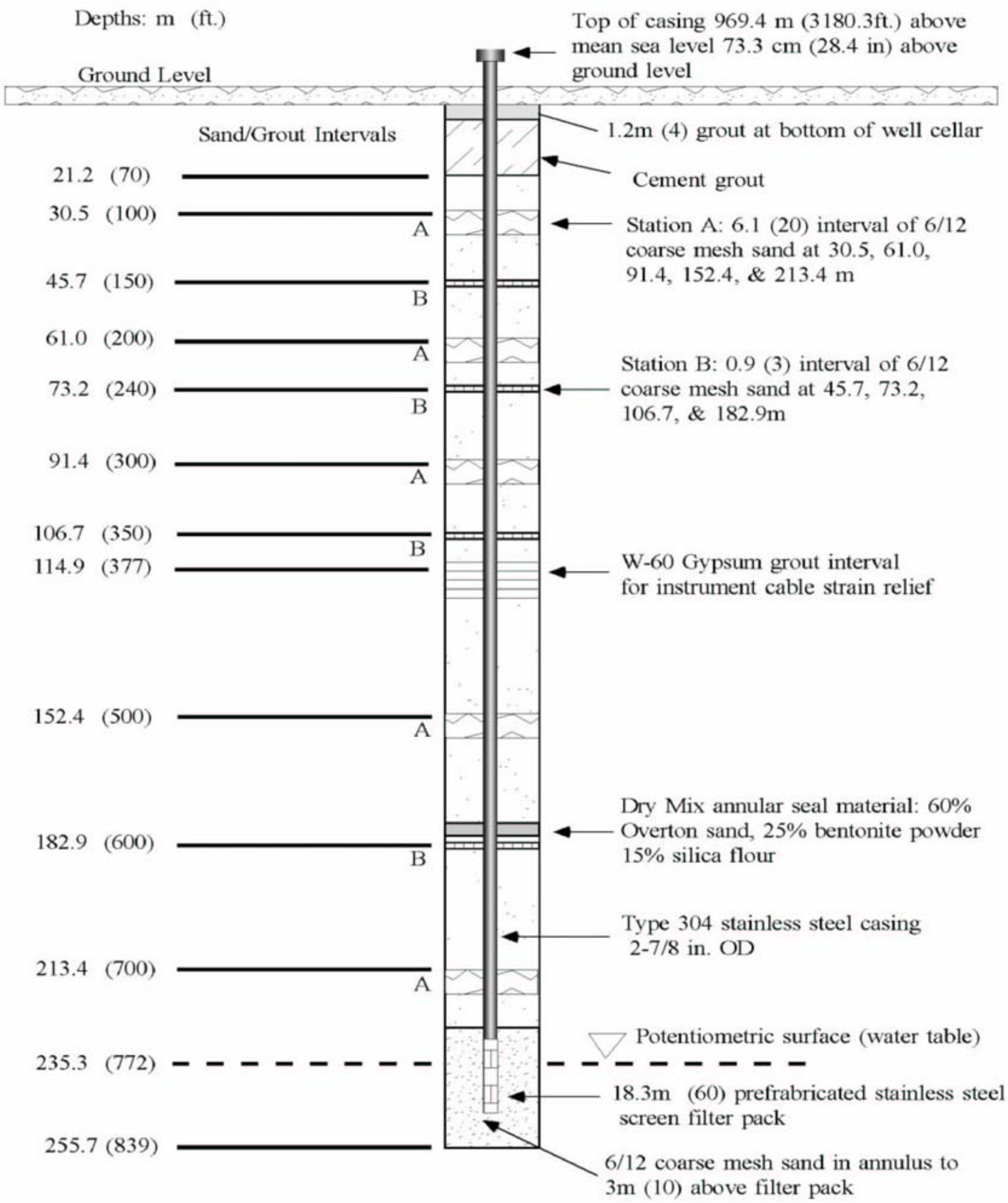

Figure 6 Completion Detail for Ue5PW-1 (Note: Well Screened in Alluvium)

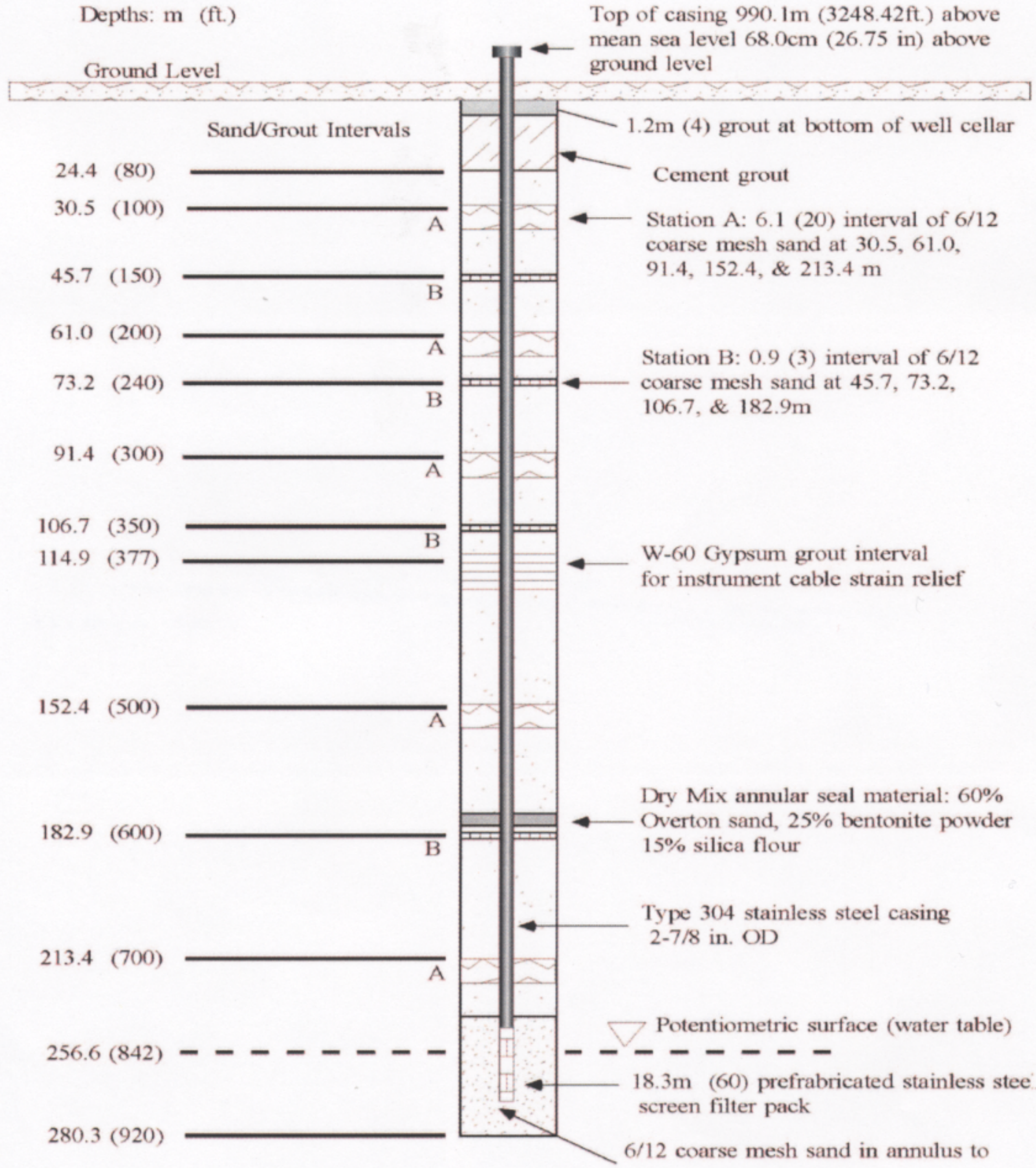

Figure 7 Completion Detail for Ue5PW-2 (Note: Well Screened in Alluvium)

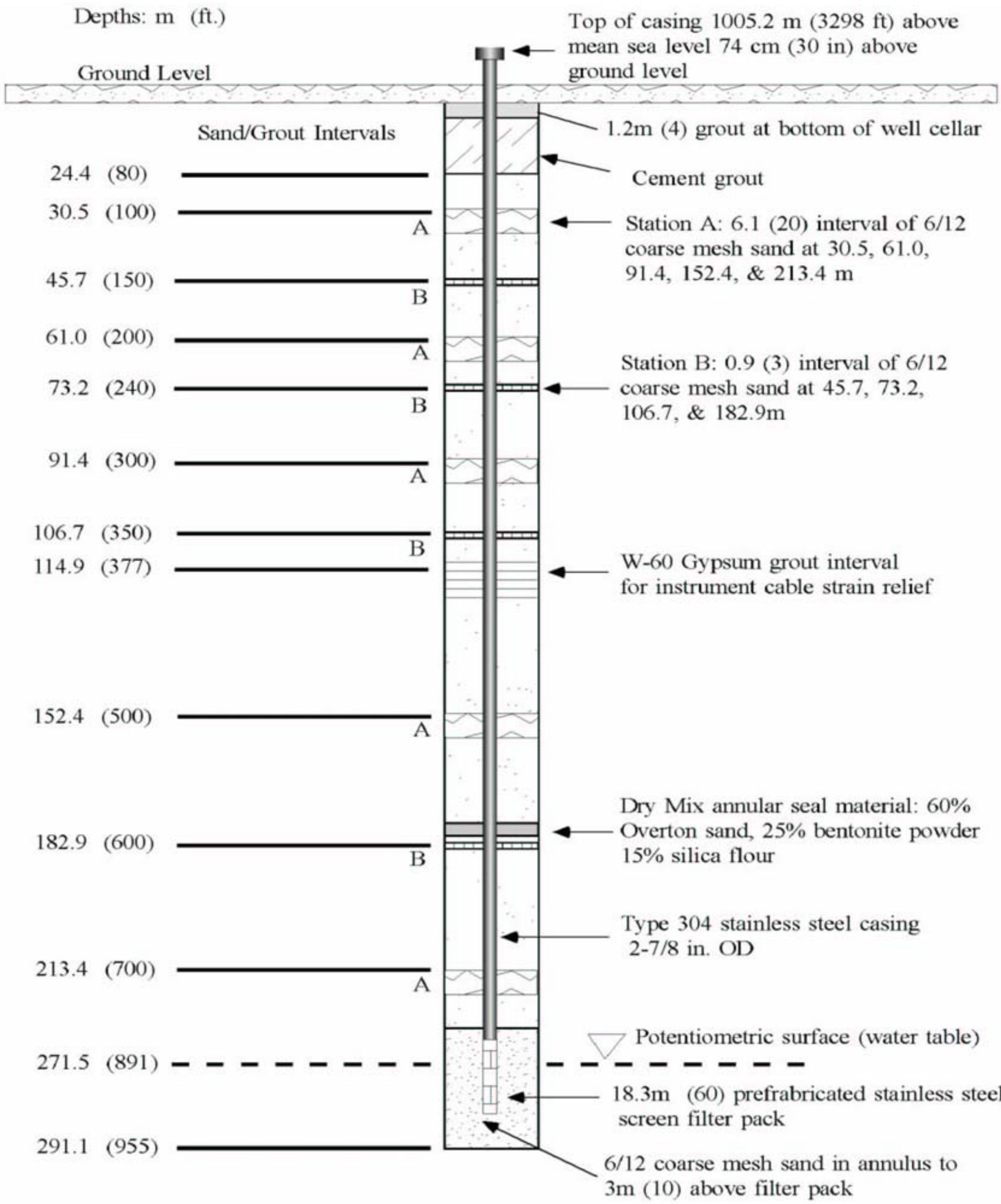

Figure 8 Completion Detail for Ue5PW-3 (Note: Well Screened in Timber Mountain Tuff)

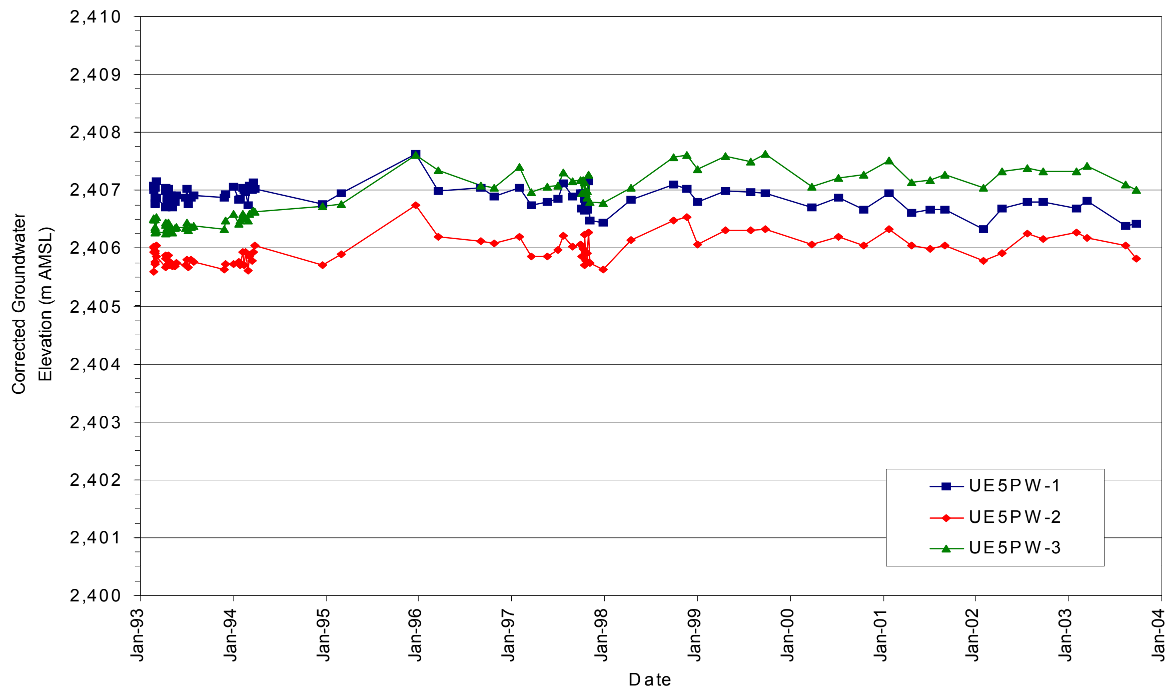

Figure 9 Area 5 RWMS Time-Series Plot of Groundwater Elevations

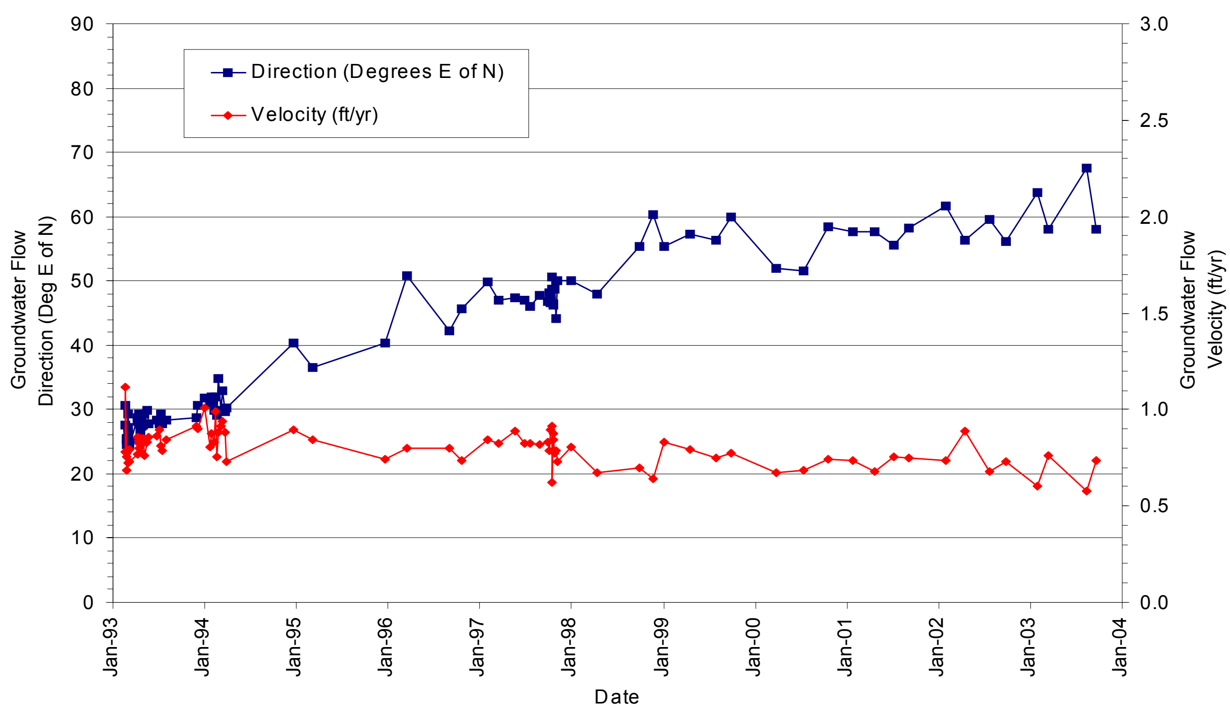

Figure 10 Area 5 RWMS Time-Series Plot of Groundwater Velocity and Flow Direction

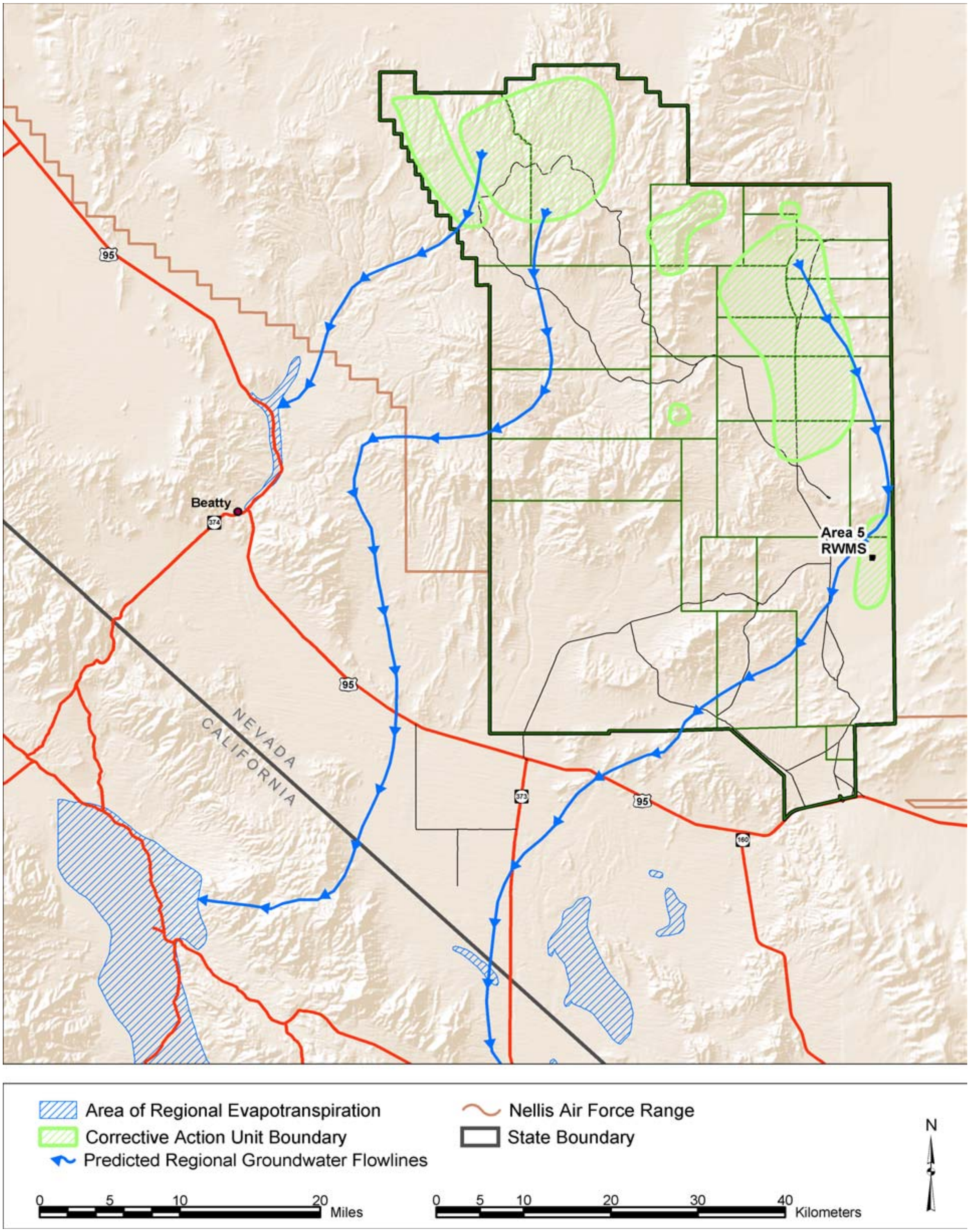

Figure 11 Nevada Test Site Predicted Regional Groundwater Flow Paths (Rehfeldt, 2001; written Communication)

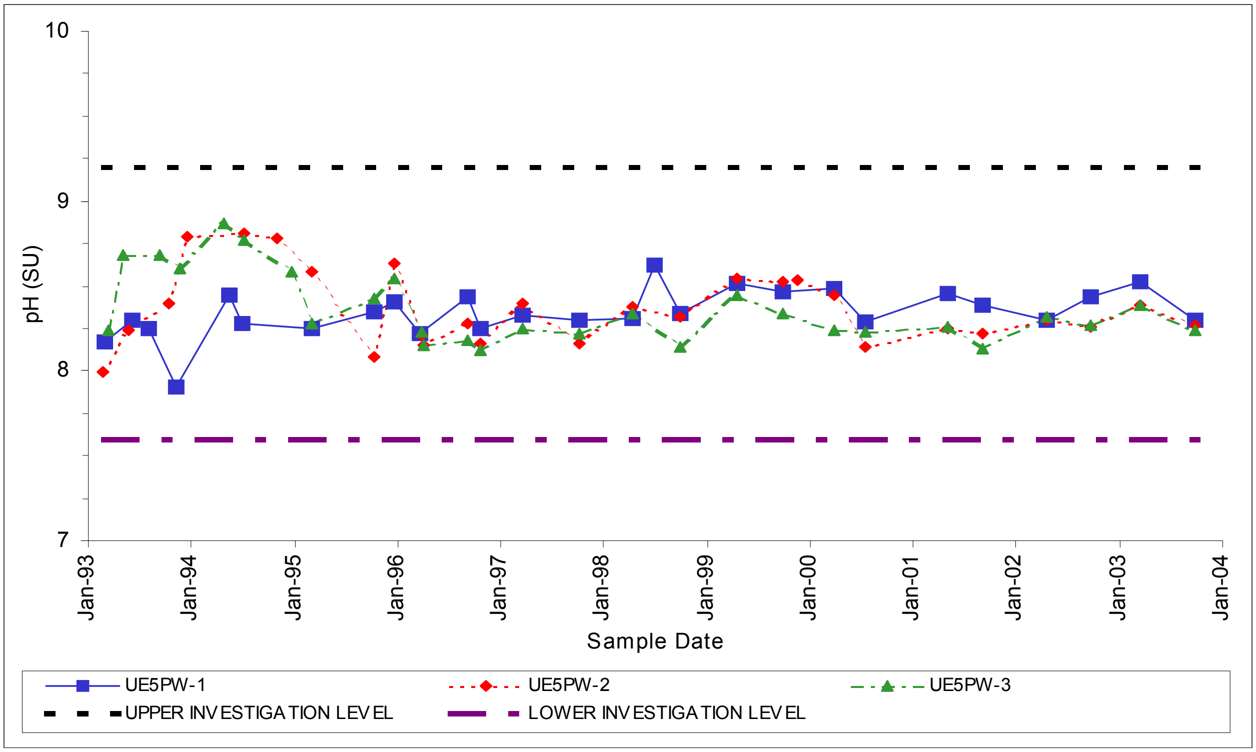

Figure 12 Area 5 RWMS Time-Series Plot of pH

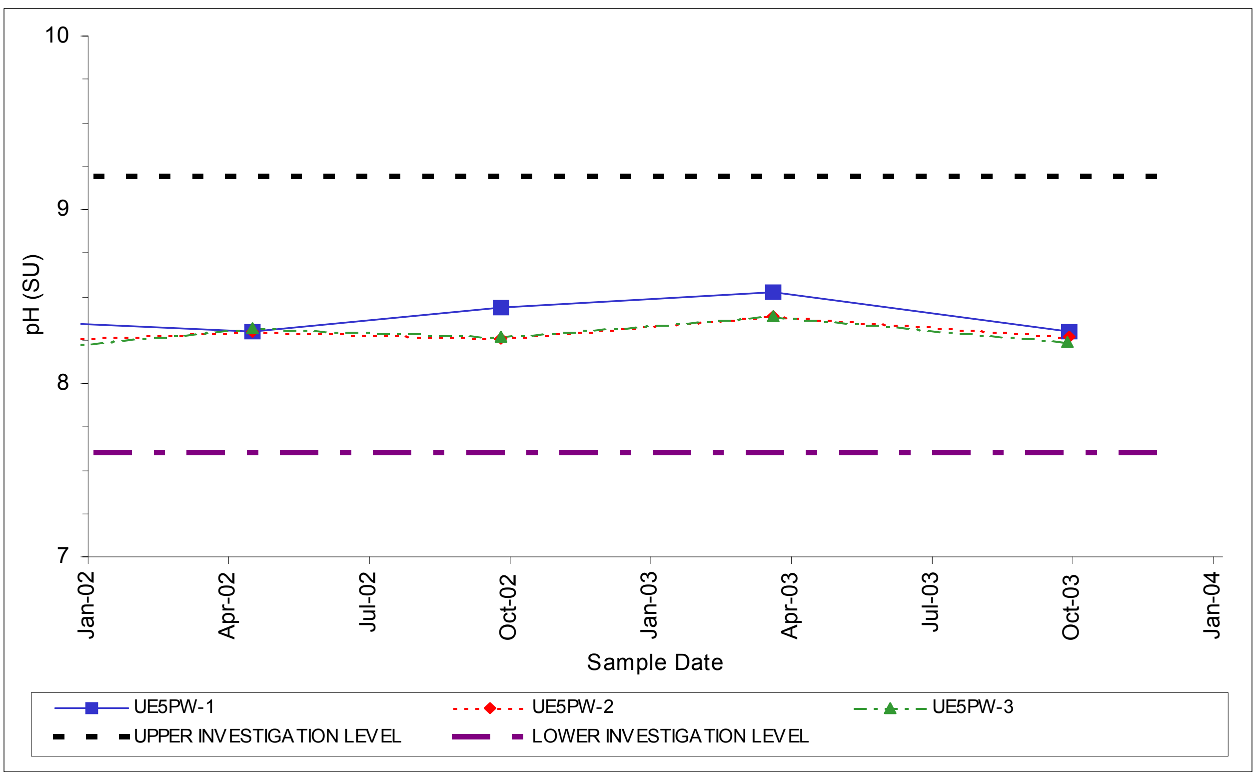

Figure 13 Area 5 RWMS Two-Year Plot of pH

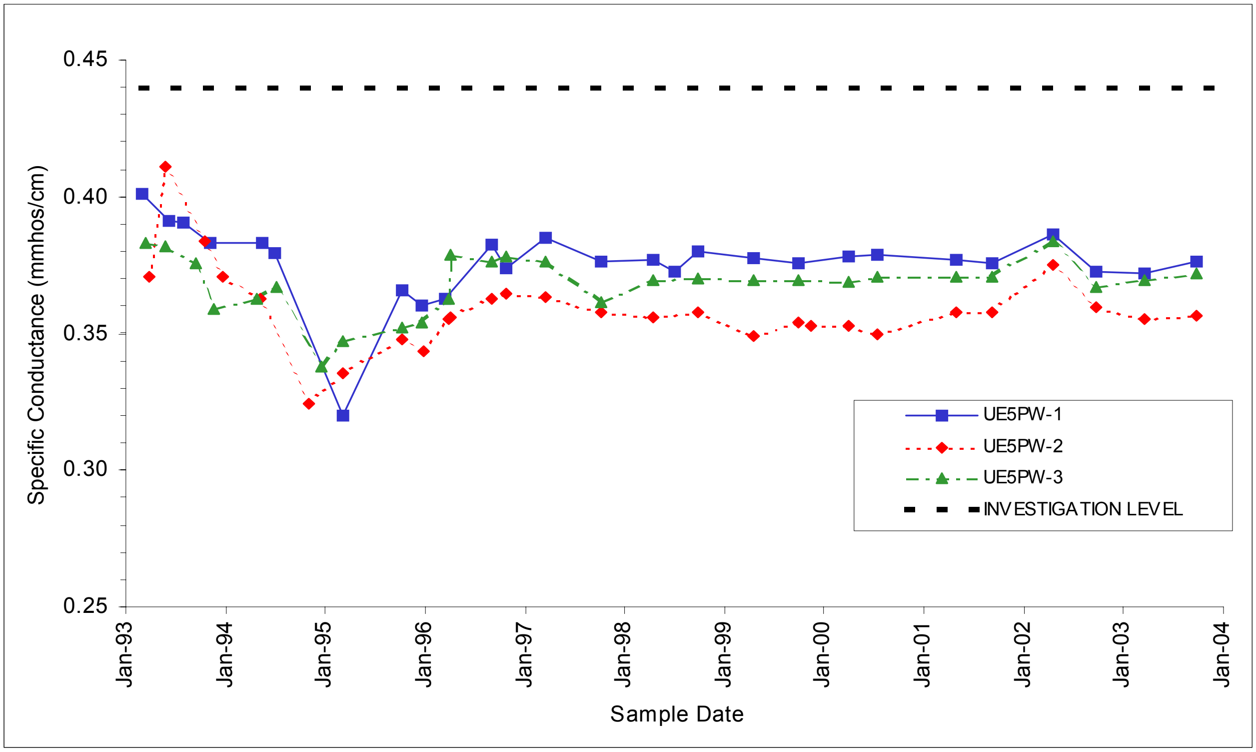

Figure 14 Area 5 RWMS Time-Series Plot of Specific Conductance

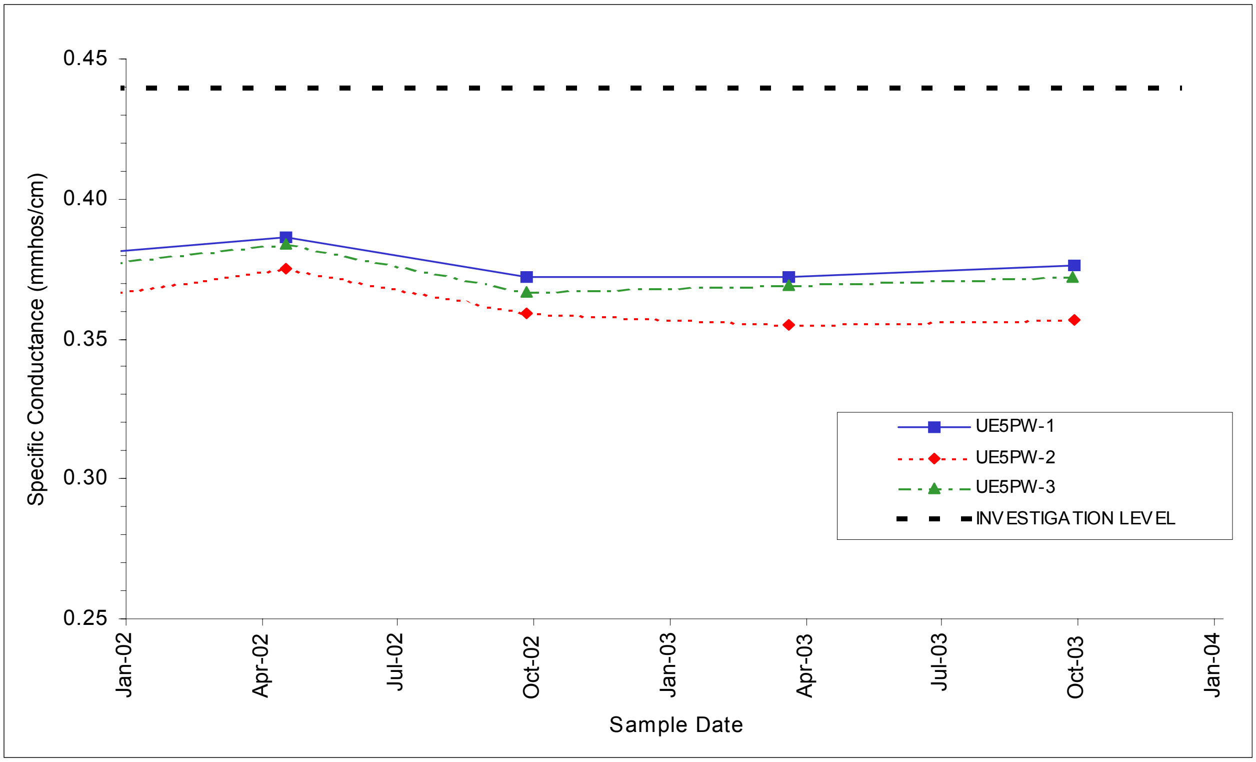

Figure 15 Area 5 RWMS Two-Year Plot of Specific Conductance

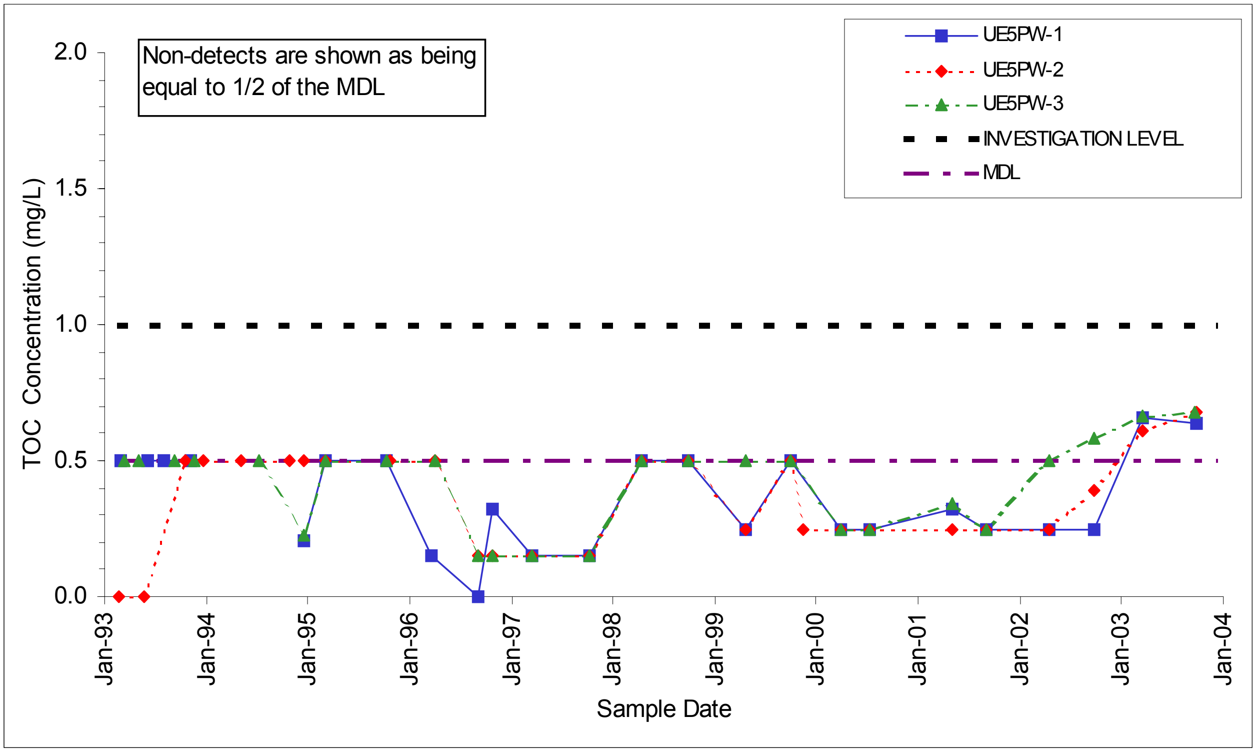

Figure 16 Area 5 RWMS Time-Series Plot of Total Organic Carbon

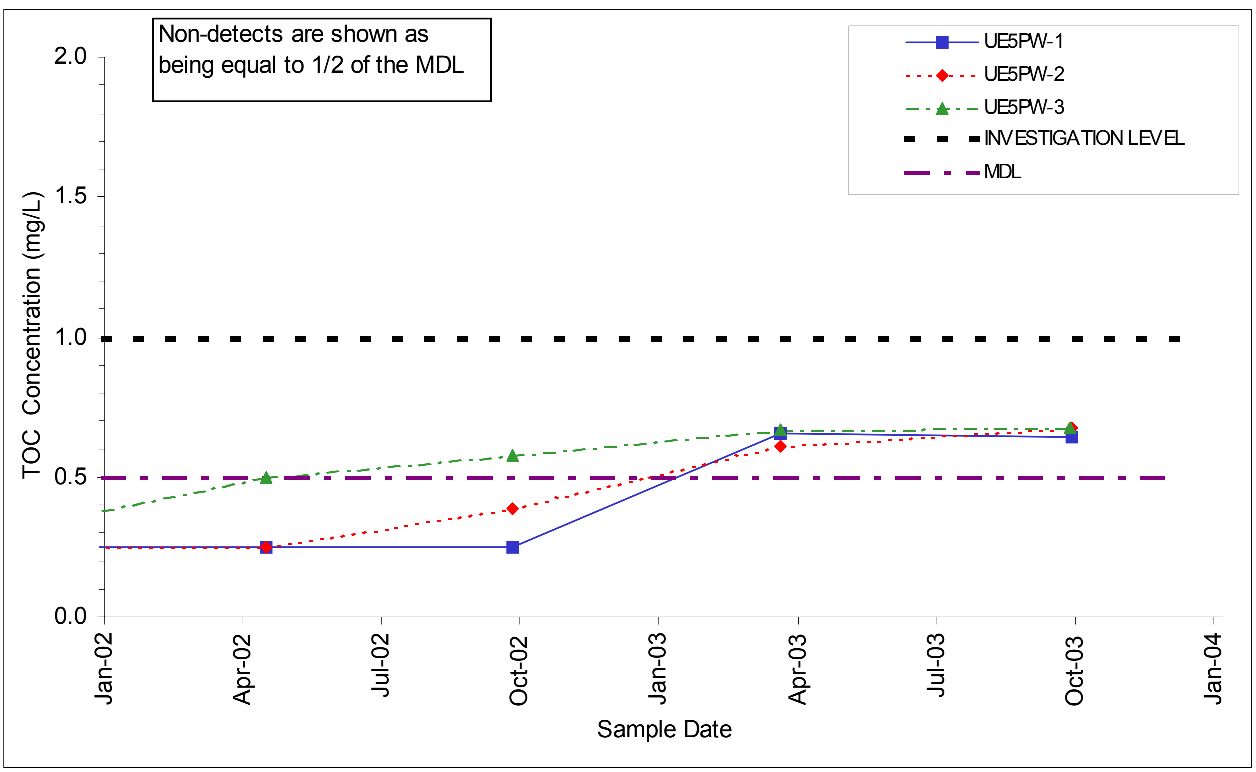

Figure 17 Area 5 RWMS Two-Year Plot of Total Organic Carbon

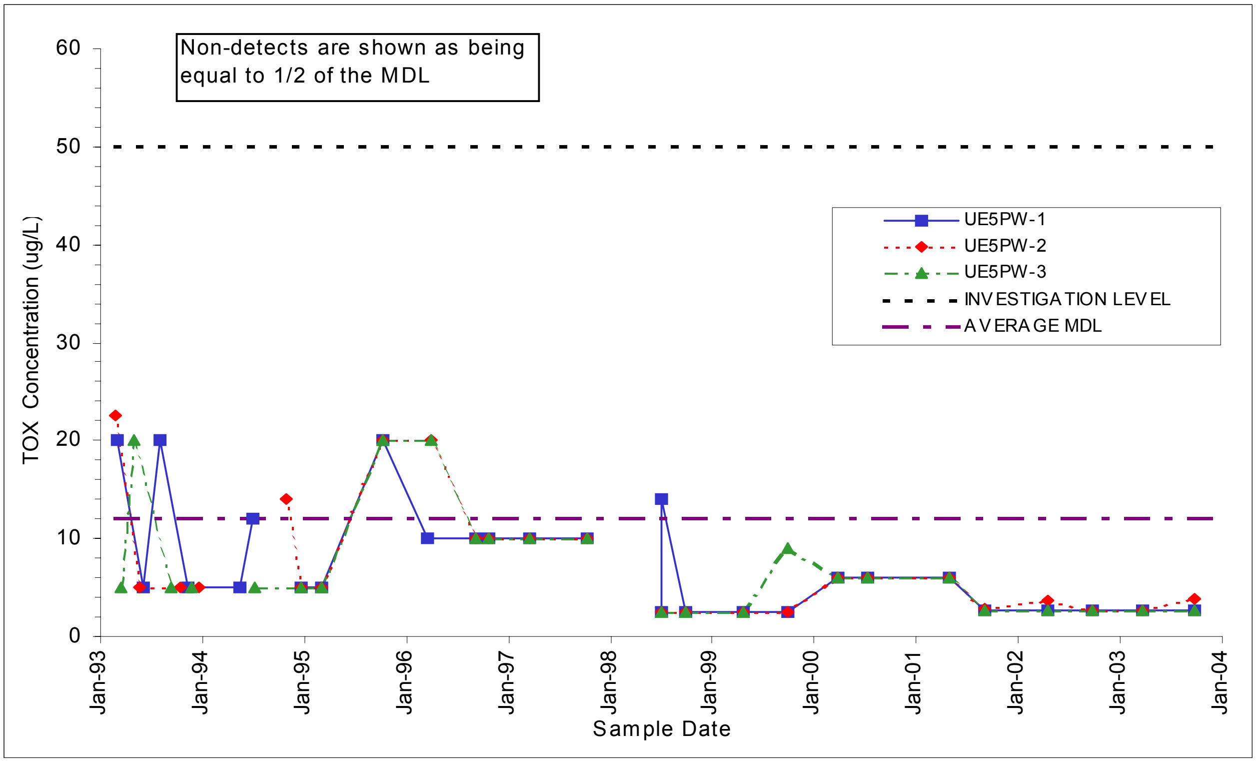

Figure 18 Area 5 RWMS Time-Series Plot of Total Organic Halides

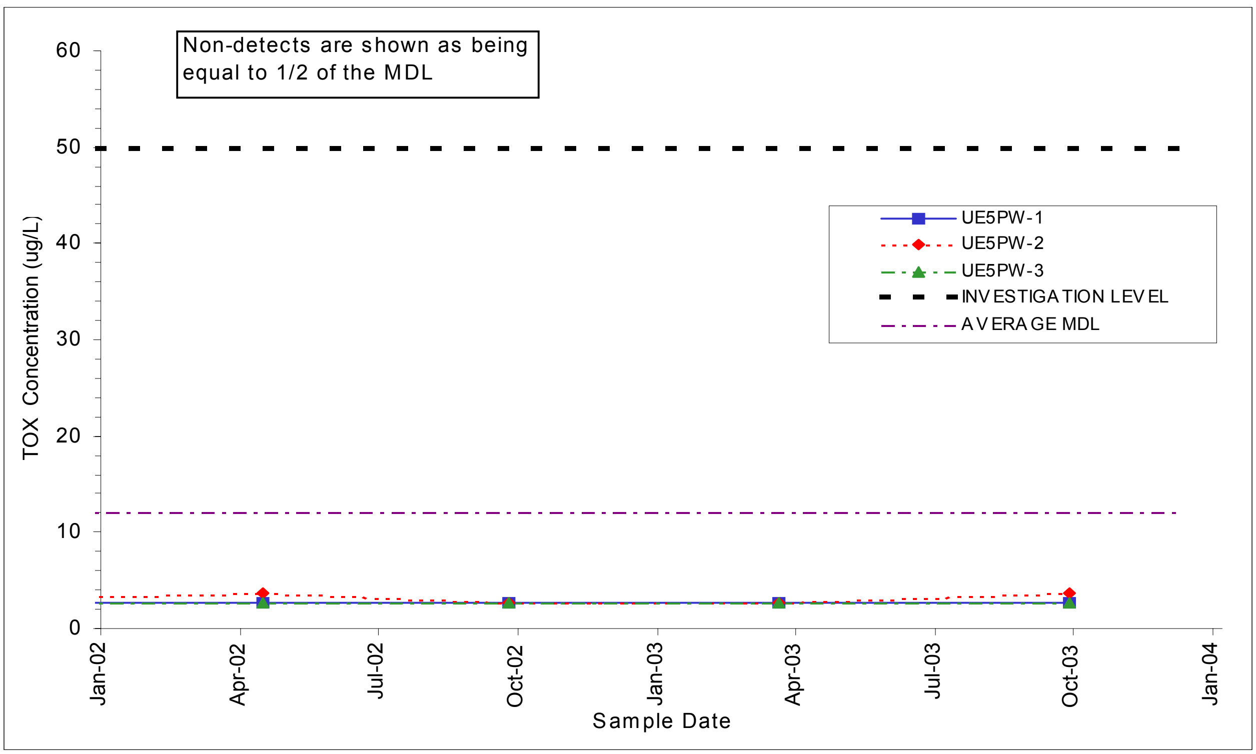

Figure 19 Area 5 RWMS Two-Year Plot of Total Organic Halides

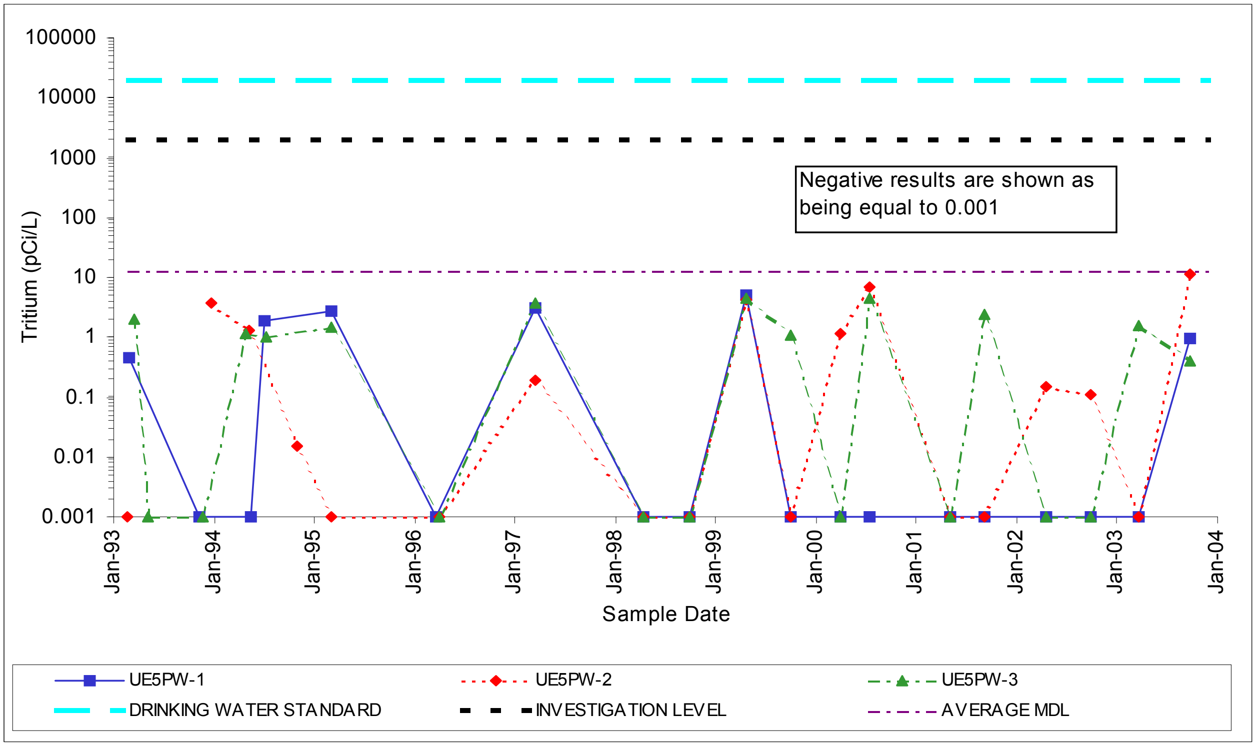

Figure 20 Area 5 RWMS Time-Series Plot of Tritium

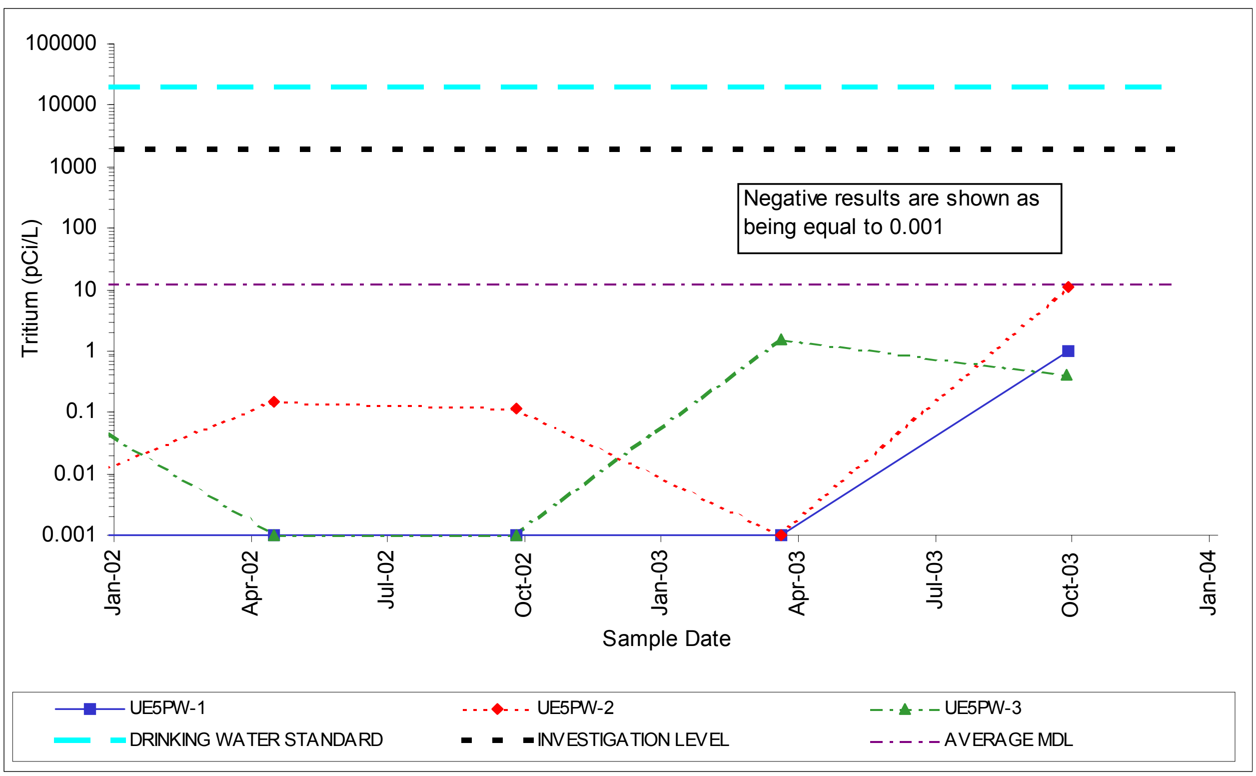

Figure 21 Area 5 RWMS Two-Year Plot of Tritium

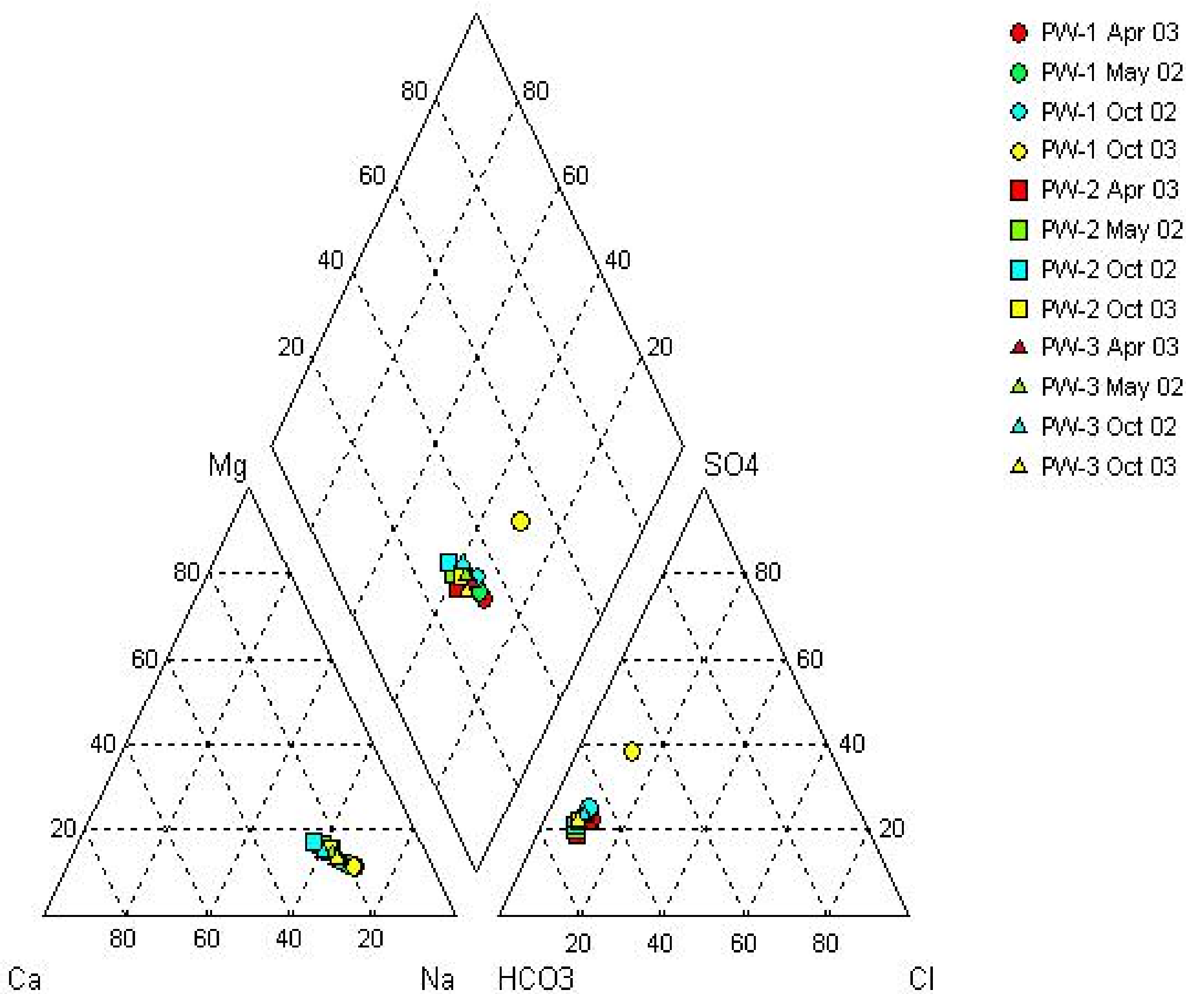

Figure 22 Area 5 RWMS Two-Year Piper Diagram

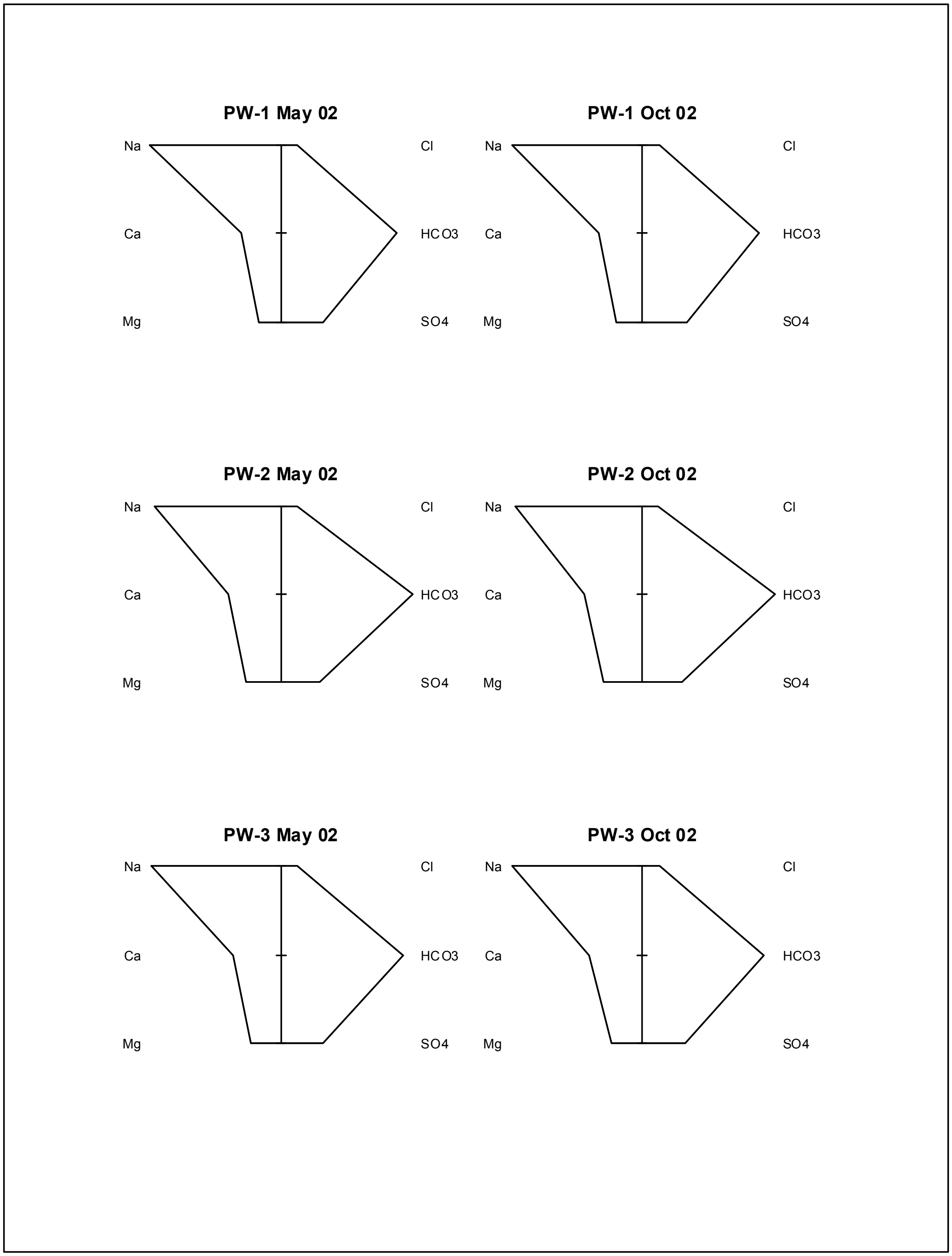

Figure 23 Area 5 RWMS Stiff Plots - 2002

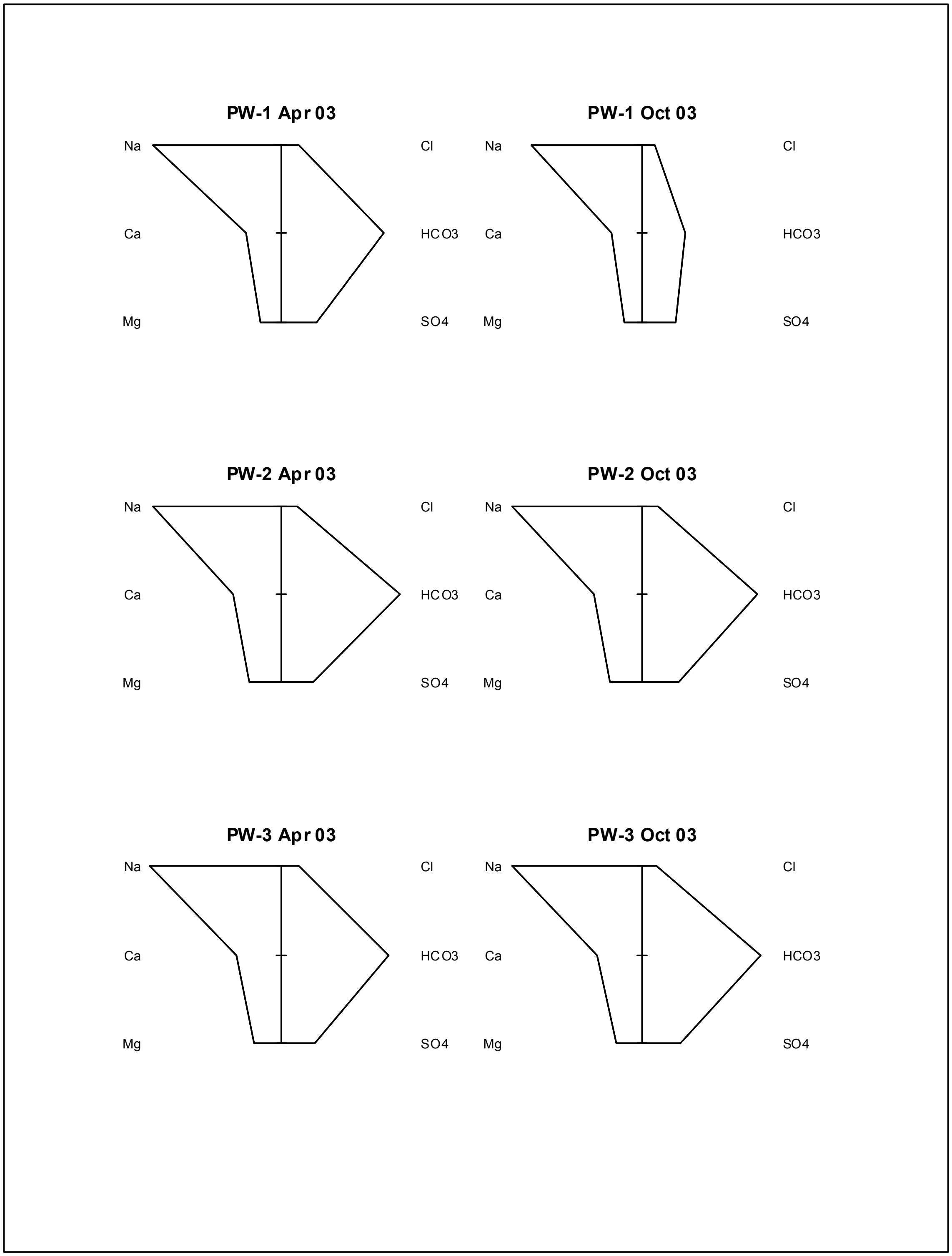

Figure 24 Area 5 RWMS Stiff Plots - 2003

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Tables

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Table 1 Area 5 RWMS Hydraulic Parameters				
Hydraulic Conductivity	**Effective Porosity**	**Mean Hydraulic Gradient**	**Mean Velocity**	**Mean Flow Direction**
1.12e-3 cm/s[a] (3.67e-5 ft/s)	0.38[a]	0.25 m/km (1.35 ft/mi)	0.24 m/yr (0.8 ft/yr)	40° E of N

[a] REECO 1994

Table 2 Investigation Levels for Indicator Parameters	
Parameter	**Investigation Level (IL)**
TOX	50 ug/L
TOC	1 mg/L
pH	Less than 7.6 SU and greater than 9.2 SU
Specific Conductance	0.440 mmhos/cm
Tritium	2,000 pCi/L

Table 3 Area 5 RWMS pH Values in SU			
Date Sampled	**Ue5PW-1**	**Ue5PW-2**	**Ue5PW-3**
March 1993 [a]	8.17	7.99	8.24
July 1993 [a]	8.30	8.24	8.68
September 1993 [a]	8.25	8.40	8.68
December 1993 [a]	7.90	8.79	8.6
June 1994 [a]	8.45	8.81	8.87
August 1994 [a]	8.28	8.78	8.77
November 1994 [a]	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
May 2001	8.46	8.25	8.26
October 2001	8.39	8.22	8.13
May 2002	8.30	8.30	8.32
October 2002	8.44	8.26	8.27
April 2003	8.53	8.38	8.39
October 2003	8.30	8.27	8.24
Mean	**8.34**	**8.37**	**8.36**
Standard Deviation	**0.14**	**0.22**	**0.21**

(a) Dates are approximated in 1993 and 1994 to make graphs consistent.

Table 4 Area 5 RWMS Specific Conductance Values in mmhos/cm			
Date Sampled	**Ue5PW-1**	**Ue5PW-2**	**Ue5PW-3**
March 1993 [a]	0.401	0.371	0.383
July 1993 [a]	0.391	0.411	0.382
September 1993 [a]	0.391	0.384	0.376
December 1993 [a]	0.383	0.371	0.359
June 1994 [a]	0.383	0.363	0.363
August 1994 [a]	0.378	0.324	0.367
November 1994 [a]	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
May 2001	0.377	0.358	0.371
October 2001	0.376	0.358	0.371
May 2002	0.386	0.375	0.384
October 2002	0.372	0.359	0.367
April 2003	0.372	0.355	0.369
October 2003	0.376	0.357	0.372
Mean	**0.376**	**0.359**	**0.368**
Standard Deviation	**0.014**	**0.015**	**0.011**

(a) Dates are approximated in 1993 and 1994 to make graphs consistent.

Table 5 Area 5 RWMS TOC Values in mg/L			
Date Sampled	**Ue5PW-1**	**Ue5PW-2**	**Ue5PW-3**
March 1993 [a]	<1.0	<1.0	<1.0
July 1993 [a]	<1.0	<1.0	<1.0
September 1993 [a]	<1.0	No sample	<1.0
December 1993 [a]	<1.0	<1.0	<1.0
June 1994 [a]	No sample	<1.0	No sample
August 1994 [a]	1.7[b]	<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[c]
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[b,c]	<1.0
December 1999	No sample	<0.5	No sample
April 2000	0.98[b]	0.48[b]	1.31[b]
August 2000	<0.54[d]	<0.5[d]	<0.5[d]
May 2001	.32[d,e]	<0.5[d]	0.34[d,e]
October 2001	<0.5	<0.5	<0.5
May 2002	<0.5	<0.5	<0.5
October 2002	<0.5	0.39[e]	0.42[e]
April 2003	0.658	0.610	0.668
October 2003	0.640	0.677	0.677

(a) Dates are approximated in 1993 and 1994 to make graphs consistent.
(b) Determined to be a false positive through resampling.
(c) Duplicate sample results were <1.0.
(d) Multiple laboratories used, this value represents RECRA laboratory result only.
(e) Multiple replicates analyzed, assumes non-detects are equal to one-half the MDL.

Table 6 Area 5 RWMS TOX Values in μg/L

Date Sampled	Ue5PW-1	Ue5PW-2	Ue5PW-3
March 1993 [a]	20	23	<10
July 1993 [a]	<10	<10	20[c]
September 1993 [a]	20[c]	<10	<10
December 1993 [a]	<10	<10	<10
June 1994 [a]	<10	No sample	No sample
August 1994 [a]	12[c]	No sample	<10
November 1994 [a]	No sample	14[c]	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[b]	842[b]	1000[b]
July 1998	<5	No sample	No sample
October 1998	<5	<5	<5
May 1999	<5	<5	<5
October 1999	<5	<5	9[c]
April 2000	71.7[b]	59.3[b]	56.5[b]
August 2000	91.8[b,d]	73.0[b,d]	82.8[b,d]
May 2001	<12.6[d]	<12[d]	<12[d]
October 2001	<6.1	<5.8	<5.2
May 2002	<5.2	3.7[e]	<5.2
October 2002	<5.2	<5.2	<5.2
April 2003	<5.2	<5.2	<5.2
October 2003	<5.2	3.8[e]	<5.2

(a) Dates are approximated in 1993 and 1994 to make graphs consistent.
(b) Determined to be false positive through resapling.
(c) Duplicate sample results were less than MDL.
(d) Multiple laboratories used, this value represents RECRA laboratory result only.
(e) Multiple replicates analyzed, assumes non-detects are equal to one-half the MDL.

Table 7 Area 5 RWMS Tritium Values in pCi/L			
Date Sampled	**Ue5PW-1**	**Ue5PW-2**	**Ue5PW-3**
March 1993 [a]	0.442	-4.28	1.96
December 1993 [a]	-1.58	32.2[b]	-2.74
January 1994 [a]	No sample	3.69	-0.46
June 1994 [a]	-2.04	1.29	1.13
August 1994 [a]	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
May 2001	-1.9	-11.5	-12.4
October 2001	-2.93	-2.82	2.45
May 2002	-2.8	0.15	-3.26
October 2002	-4.3	0.11	-1.17
April 2003	-1.15	-5.19	1.58
October 2003	0.97	11.21	0.40

(a) Dates are approximated in 1993 and 1994 to make graphs consistent.
(b) Standard analysis performed, not enriched.

Table 8 Ue5PW-1 General Water Chemistry Values in mg/L											
Date	**Ca**	**Fe**	**Mg**	**Mn**	**K**	**Si**	**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
07-06-1993	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	25.4	55.8	34.6	123.5	9.6	1.1
10-28-1998	14.9	0.024	5.58	0.0015	6.87	28.3	57.6	34	131	9.7	1.1
05-19-1999	12.5	<0.05	5.30	<0.0025	6.85	32	61	34	120	10	1
10-27-1999	14.5	<0.1	6.0	<0.005	6.6	29	63.5	35	130	8.8	1.1
04-26-2000	12.8	0.032	4.80	0.001	6.69	27.2	53.7	35.6	135	10	1.0
08-09-2000	15.0	<0.0164	4.90	0.00045	6.6	28	52.0	37.1	120	10.4	1.1
05-29-2001	14.4	0.009	4.9	<0.0018	6.0	28.9	59.0	No analysis[a]	117	No analysis[a]	No analysis[a]
10-03-2001	13.6	0.008	4.8	0.0002	6.6	27.2	51	36.0	123.5	10.1	1.0
05-15-2002	14.25	0.0285	5.08	0.000525	6.96	28.45	54.5	35.9	127	10.65	0.99
10-22-2002	14.55	0.018	5.17	0.0002	6.43	28.4	50	35.6	117.5	10.1	0.99
04-15-2003	13.70	0.011	4.98	<0.0005	6.24	27.70	58.0	32.9	123	12.3	0.95
10-22-2003	14.00	0.0152	5.04	<0.0016	5.97	28.50	58.0	36.5	58.2[c]	9.4	1
Mean	**14.20**	**NA[b]**	**5.20**	**NA[b]**	**6.38**	**28.25**	**56.29**	**34.93**	**125.21**	**9.87**	**1.39**
Standard Deviation	**0.85**	**NA[b]**	**0.35**	**NA[b]**	**0.48**	**1.53**	**3.91**	**1.50**	**19.84**	**0.78**	**1.12**

(a) No analysis due to laboratory erroneously acidifying sample.
(b) Not applicable.
(c) Result rejected.

Table 9 Ue5PW-2 General Water Chemistry Values in mg/L

Date	Ca	Fe	Mg	Mn	K	Si	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	23.8	45.2	28.4	123.5	8.2	1.0
10-28-1998	15.8	0.015	6.18	0.0009	5.56	26.2	47.4	28.4	128.5	8.3	0.98
05-19-1999	15.0	<0.05	6.3	<0.0025	6.2	29	52	27.5	110	8.7	0.92
10-27-1999	16.0	<0.1	6.7	<0.005	5.7	26	52	28	125	7.4	0.96
04-26-2000	15.2	0.029	6.53	0.0007	5.6	26.1	45.6	29.1	145	8.6	0.84
08-09-2000	17.0	<0.0164	6.59	<0.0002	5.3	27.7	44.4	28.7	127	9.26	0.94
05-29-2001	16.6	<10.7	6.6	<0.0018	4.8	28.2	48.8	No analysis[a]	124.5	No analysis[a]	No analysis[a]
10-03-2001	16	0.017	6.7	0.0002	5.4	27.5	44.6	28.4	125	8.65	.95
05-15-2002	16.5	0.074	6.85	0.00059	5.59	28.1	46.05	28.7	127	9.3	0.87
10-22-2002	17.55	0.33	7.1	0.0031	5.29	29.45	44.35	28.7	122	8.65	0.845
04-15-2003	16.40	<0.0101	6.69	<0.0005	5.23	28.40	51.10	26.7	126	9.9	0.81
10-22-2003	16.10	0.0618	6.62	<0.0016	5.18	28.3	49.60	29.5	116	8.8	0.88
Mean	**16.16**	**NA[b]**	**6.53**	**NA[b]**	**5.26**	**27.40**	**48.63**	**28.52**	**127.03**	**8.66**	**0.98**
Standard Deviation	**0.83**	**NA[b]**	**0.37**	**NA[b]**	**0.55**	**1.59**	**3.31**	**1.03**	**9.92**	**0.63**	**0.14**

(a) No analysis due to laboratory erroneously acidifying sample.
(b) Not applicable.

Table 10 Ue5PW-3 General Water Chemistry Values in mg/L

Date	Ca	Fe	Mg	Mn	K	Si	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	26.4	53.8	31	124	8.6	1
10-28-1998	15.6	0.009	5.7	0.0009	4.16	26.7	53.7	31.4	128	8.7	1
05-19-1999	15.0	<0.05	5.8	<0.0025	4.8	31.0	56.0	30.5	120	9.2	0.88
10-27-1999	16.0	<0.1	6.4	<0.005	3.75	28.0	58.5	31	130	7.6	0.94
04-26-2000	15.2	0.014	5.89	0.0003	4.5	27.4	49.8	32	138.5	9.1	0.86
08-09-2000	16.0	<0.016	5.78	<0.0002	4.3	27.0	48.2	32.6	133	9.85	0.96
05-29-2001	16.4	<10.7	5.9	<0.0018	2.4	28.3	54.8	No analysis[a]	123.5	No analysis[a]	No analysis[a]
10-03-2001	15.6	0.02	6.0	0.0002	4.5	27.0	48.4	31.5	126	8.8	<1.0
05-15-2002	15.7	0.025	5.98	0.00027	4.48	27.05	49.3	33	124	9.8	0.885
10-22-2002	17.1	0.018	6.1	0.0002	4.27	28.3	47.6	32.2	117	9.3	0.85
04-15-2003	16.0	0.0195	5.87	0.00083	4.53	27.3	54.7	29.3	118	11.8	0.82
10-21-2003	16.3	0.0212	5.79	<0.0016	4.12	27.8	54.4	32.5	131	9.2	0.96
Mean	**15.95**	**NA[b]**	**5.91**	**NA[b]**	**4.10**	**27.69**	**52.81**	**31.46**	**126.31**	**9.00**	**1.03**
Standard Deviation	**0.57**	**NA[b]**	**0.19**	**NA[b]**	**0.61**	**1.21**	**3.62**	**1.17**	**6.10**	**0.85**	**0.17**

(a) No analysis due to laboratory erroneously acidifying sample.
(b) Not applicable.

Table 11 Area 5 RWMS Groundwater Elevation Data

Nevada State Central Zone Coordinates			Top of Casing Elevation (ft)	Top of Casing to Land Surface (ft)	Land Surface Elevation (ft)	Deviation Correction (ft)
Borehole	North (m)	East (m)				
Ue5PW-1	233,386.48	216,357.08	3180.35	2.37	3177.98	-0.27
Ue5PW-2	234,817.13	216,376.00	3248.42	2.23	3246.19	-0.67
Ue5PW-3	235,089.93	214,415.04	3297.97	2.50	3295.47	-0.05

	Ue5PW-1 Water Level Measurements			Ue5PW-2 Water Level Measurements			Ue5PW-3 Water Level Measurements		
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 for 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

Table 11 Area 5 RWMS Groundwater Elevation Data (Continued)									
	Ue5PW-1 Water Level Measurements			Ue5PW-2 Water Level Measurements			Ue5PW-3 Water Level Measurements		
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 for Deviation (ft)
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
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
02/22/2001	773.14	2407.21	2406.94	841.43	2406.99	2406.32	890.40	2407.57	2407.52
05/21/2001	773.47	2406.88	2406.61	841.71	2406.71	2406.04	890.78	2407.19	2407.14
08/01/2001	773.42	2406.93	2406.66	841.76	2406.66	2405.99	890.74	2407.23	2407.18
10/01/2001	773.42	2406.93	2406.66	841.71	2406.71	2406.04	890.65	2407.32	2407.27
02/26/2002	773.75	2406.60	2406.33	841.97	2406.45	2405.78	890.88	2407.09	2407.04

Table 11 Area 5 RWMS Groundwater Elevation Data (Continued)

	Ue5PW-1 Water Level Measurements			Ue5PW-2 Water Level Measurements			Ue5PW-3 Water Level Measurements		
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 for Deviation (ft)
05/13/2002	773.40	2406.95	2406.68	841.84	2406.58	2405.91	890.6	2407.37	2407.32
08/19/2002	773.28	2407.07	2406.80	841.49	2406.93	2406.26	890.53	2407.44	2407.39
10/21/2002	773.28	2407.07	2406.80	841.59	2406.83	2406.16	890.6	2407.37	2407.32
02/26/2003	773.39	2406.96	2406.69	841.48	2406.94	2406.27	890.59	2407.38	2407.33
04/10/2003	773.27	2407.08	2406.81	841.57	2406.85	2406.18	890.50	2407.47	2407.42
09/10/2003	773.69	2406.66	2406.39	841.71	2406.71	2406.04	890.82	2407.15	2407.10
10/20/2003	773.66	2406.69	2406.42	841.94	2406.48	2405.81	890.91	2407.06	2407.01

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Appendix A

Instructions for Area 5 RWMS Groundwater Well Preparation and Groundwater Sampling

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Bechtel Nevada

ORGANIZATION INSTRUCTION	
Title: **Instructions for Area 5 RWMS Groundwater Well Preparation and Groundwater Sampling**	**Page 1 of 22**
Document Number: **OI-2154.108** Revision Number: **0** **Effective Date: 6/16/03**	Change Notice History: Reviewed By: Date:
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Responsible Organization: **Environmental Operations**	
Instructions: This instruction replaces OP-2151.214, "Instructions for Area 5 RWMS Groundwater well Preparation and Groundwater Sampling" Revision 0, dated August 23, 1999. Recycle the superseded document."	
Revision Control:	

Signature Approval:	
Original signed by: D. M. Van Etten	June 16, 2003
Environmental Operations Manager	Date

1.0 PURPOSE

1.1 This instruction establishes procedures for sampling groundwater wells 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 435.1, "Radioactive Waste Management."

2.0 SCOPE

2.1 This instruction applies to Environmental Technical Services (ETS) personnel who collect groundwater samples for detection monitoring at the Area 5 RWMS. The Area 5 RWMS is an interim status Treatment, Storage, and Disposal Facility (TSDF).

ORGANIZATION INSTRUCTION	
Title: **Instructions for Area 5 RWMS Groundwater Well Preparation ad Groundwater Sampling**	**Page 2 of 22**
Document Number: **OI-2154.108** Revision Number: **1**	Change Notice History:

3.0 ROLES AND RESPONSIBILITIES

3.1 The following entities have responsibilities in this procedure:

- **RWMS Manager**
- **ETS Manager**
- **Environmental Activity Manager**
- **Task Lead**
- **Field Supervisor**
- **Samplers**
- **ETS Sample Management Personnel**
- **Data Management Personnel**
- **Quality Assurance Officer**

3.2 The **RWMS Manager** shall establish, develop, and ensure adherence to the RWMS Work Controls

3.3 The **ETS Manager** shall:

[1] Ensure that the groundwater monitoring program is in full compliance with this instruction and the Routine Radiological Environmental Monitoring Program (RREMP).

[2] Ensure that all work conducted follows applicable safety standards.

[3] Determine groundwater analytes of interest.

3.4 The **Environmental Activity Manager** shall:

[1] Ensure that required monitoring and sampling are conducted according to the RREMP and this instruction.

[2] Verify that the staff meets training and certification requirements.

[3] Verify that work is conducted according to all requirements, instructions, and safety standards of the RREMP.

3.5 The **Task Lead** shall:

ORGANIZATION INSTRUCTION	
Title: **Instructions for Area 5 RWMS Groundwater Well Preparation ad Groundwater Sampling**	**Page 3 of 22**
Document Number: **OI-2154.108** Revision Number: **1**	Change Notice History:

[1] Act as the point of contact (POC) for issues regarding groundwater sampling procedures, operations, technical questions, and problem reporting.

[2] Evaluate and maintain field and analytical data, and coordinate with the ETS Manager to determine sampling parameters.

3.6 The **Field Supervisor** shall:

[1] Schedule the wells to be sampled.

[2] Obtain well information.

[3] Direct staff to what the preferred sampling zone should be (may be adjusted as field conditions dictate).

[4] Establish the required analytes to be sampled.

[5] Provide field oversight, including:

- Ensuring Field Sampler adherence to this instruction and applicable standard practices.
- Evaluating and maintaining field data.
- Reviewing, assessing, and meeting requirements, procedures, and safety standards.

[6] Coordinate and maintain field staff training.

[7] Conduct safety inspections and briefings before sampling.

[8] Provide Radiological Work Permit If necessary, and coordinate any additional support (i.e., Radiological Control Technician (RCT), other).

3.7 The **Samplers** shall:

[1] Prepare monitoring wells for sampling.

[2] Order and control supplies for groundwater sampling.

[3] Perform field measurements of water-quality parameters.

ORGANIZATION INSTRUCTION	
Title: **Instructions for Area 5 RWMS Groundwater Well Preparation ad Groundwater Sampling**	**Page 4 of 22**
Document Number: **OI-2154.108** Revision Number: **1**	Change Notice History:

[4] Collect, preserve, and transport groundwater samples and ensure Radiation Surveys are completed for the shipment of samples.

[5] Provide requested quality control trip blanks.

[6] 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.

[7] 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.

[8] Ensure accuracy and completeness of the Chain-of-Custody form for samples taken.

[9] Conduct all work in accordance with work controls as defined in the Sample Package.

3.8 **ETS Sample Management Personnel** shall:

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

[2] Provide laboratory analyses of samples for inorganic, organic, or radiological constituents.

[3] Provide laboratory quality control tests and maintain a laboratory quality assurance program.

[4] Review and report data results, as required.

[5] Maintain complete data analysis packages.

3.9 **Data Management Personnel** shall prepare a Sample Package and coordinate approval with the Task Lead and Environmental Monitoring Activity Manager.

3.10 **Quality Assurance Officer** shall:

[1] Ensure Sample Packages are complete.

[2] Ensure that all personnel follow the RREMP, this instruction, and other applicable procedures and regulations when sampling for groundwater.

ORGANIZATION INSTRUCTION	
Title: **Instructions for Area 5 RWMS Groundwater Well Preparation ad Groundwater Sampling**	**Page 5 of 22**
Document Number: **OI-2154.108** Revision Number: **1**	Change Notice History:

4.0 PROCESS

4.1 Equipment and Prefield Preparations

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

- Wear gloves, safety glasses, and other personal protective equipment (PPE) as necessary.
- Clean up spills and other sampling material immediately.
- Inspect and clean all equipment prior to entering the sampling well.
- Record all readings in the Groundwater Sample Package.

4.2 Prior to Groundwater Sampling

4.2.1 The **Sampler** shall:

[1] Complete dust suppression before sampling, if appropriate.

[2] Note weather conditions and wind direction to minimize potential contamination in the sampling area.

[3] Locate vehicles from the sampling area (downwind) to minimize contamination (e.g., exhaust).

[4] Gather the necessary sample collection containers, preservatives, coolers, and other items as the job requires.

[5] Inspect the area around the wellhead for cleanliness and possible contamination.

[6] Loosen the wellhead cap to allow borehole pressure to equilibrate.

Note: Pumps that are dedicated to a well do not require decontamination unless they have been contaminated in some fashion at the surface or have been removed from the well (e.g., shipped to the manufacturer for maintenance).

[7] Decontaminate/clean any nondedicated equipment (e.g., water-quality instruments, bailers, and pumps) used in the purging and sampling of a well.

ORGANIZATION INSTRUCTION	
Title: **Instructions for Area 5 RWMS Groundwater Well Preparation ad Groundwater Sampling**	**Page 6 of 22**
Document Number: **OI-2154.108** Revision Number: **1**	Change Notice History:

The following method shall be used prior to sampling and between sampling wells:

- Wash with mild detergent solution
- Triple rinse with tap water
- Triple rinse with deionized or distilled water
- Thoroughly dry all sampling equipment before use

4.3 Check and Purge Retrievable Sampling Pumps (Bennett™ Pumps)

4.3.1 The **Sampler** shall:

[1] Place the pump in a spare purge container.

[2] Turn on the water level sensor.

[3] Add enough tap water to cover the top of pump and listen for audible sound.

[4] Remove the pump and dry using lint-free towels.

[5] Check connectors and fittings on the pump head.

[6] Place the pump in its dedicated purge container.

[7] Add 11 gallons of distilled water.

[8] Pump water through the pump until approximately 6 inches of water remains and water is flowing out of the pump.

4.4 Measure Static Water Level

[1] Test the probe's electronic signal (audible or visual) in tap water.

[2] Attach the bell cap and clean the probe and measuring tape with distilled water and dry with lint-free towels while lowering the probe and measuring tape down the borehole.

[3] Lower the probe down the borehole until the electronic signal activates.

[4] Remove bell cap and hold the measuring tape next to the marked rim of the casing to take the measurement. Measure to the nearest 0.01 foot (ft).

ORGANIZATION INSTRUCTION	
Title: **Instructions for Area 5 RWMS Groundwater Well Preparation ad Groundwater Sampling**	**Page 7 of 22**
Document Number: **OI-2154.108** Revision Number: **1**	Change Notice History:

[5] Repeat measurements until two consecutive measurements are within 0.02 ft.

[6] Record the sampler's name taking the measurement, the well ID, the date and time (use 24-hour military clock), and the depth-to-water from the rim of the casing in the Sample Package on the Field Log form.

[7] Retrieve the probe, cleaning the tape and probe with distilled water and dry with lint-free towels as it is being wound onto the reel.

Note: Measuring tapes shall be calibrated annually by a qualified vendor at a known location. Calibration of measuring tapes shall be noted in the Groundwater Sampling Logbook.

4.5 Install a Pump

4.5.1 The **Sampler** shall:

[1] Place the hose bundle through the pulley.

[2] Inspect the tubing and, measuring tape around the bundle and replace the measuring tape as required.

[3] Rinse and wipe the unreeled hose using distilled water and dry with lint-free towels.

[4] Attach a bell cap.

[5] Lower the pump into the well until the water sensor sounds.

[6] Place measuring tape on the tubing bundle to indicate a water depth of 5 ft.

[7] Lower the pump to 5 ft below the water surface.

[8] Seal the wellhead using plastic.

4.6 Set Up The Water-Quality Monitoring Instrument

4.6.1 The **Sampler** shall:

[1] Set up the instrument without connecting it to the pump lines.

ORGANIZATION INSTRUCTION	
Title: **Instructions for Area 5 RWMS Groundwater Well Preparation ad Groundwater Sampling**	**Page 8 of 22**
Document Number: **OI-2154.108** Revision Number: **1**	Change Notice History:

[2] Calibrate the instrument per the manufacturer's instructions; document the calibration in the Sample Package.

[3] Connect to pump plumbing.

[4] Conduct a post-operational check at the end of the sampling period to assess drift.

Note: The temperature probe shall be checked quarterly or prior to use against a certified, calibrated kerosene-filled thermometer (readings must be within ± 0.5°C of the certified thermometer). If not, then the meter shall be tagged out and segregated to prevent use.

4.7 Purge a Well

4.7.1 The **Sampler** shall:

[1] Purge the well of at least three well volumes (150 liters or 40 gallons) at a flow rate comparable to the expected sampling rate.

[2] During the purging process, measure pH, specific conductance, and temperature (at a minimum) and enter measurements in the Sample Package.

[3] Purging is considered complete when either (or both) three well volumes are removed or the water-quality parameters remain stable (e.g., pH ± 0.1 SU, specific conductance ± 3%, and temperature ± 0.5°C over three successive measurements (see EPA, 1995 and 1996, and DOE ERD-05-304).

4.8 Sample Collection

Samplers shall collect groundwater samples in order of volatility (most volatile first and least volatile last). For the RWMS wells, this typically occurs as volatile organic compounds (VOCs), total organic halides (TOX), total organic carbon (TOC), semi-volatile organic compounds (SVOCs), metals, major cations and anions, and radionuclides. The following shall be recorded in the Sample Package.

- Name of Sampler
- Type of sampling (detection/assessment)
- Date and time (use 24-hour clock) of sampling

<table>
<tr><td colspan="2">ORGANIZATION INSTRUCTION</td></tr>
<tr><td colspan="2">Title: Instructions for Area 5 RWMS Groundwater Well Preparation ad Groundwater Sampling — Page 9 of 22</td></tr>
<tr><td>Document Number: OI-2154.108
Revision Number: 1</td><td>Change Notice History:</td></tr>
</table>

- Well information (identification, depth, and static water level)
- Water-quality parameters measured
- Flow information (purging rate, total volume purged, and sampling flow rate)
- Chronology of sampling activities
- Sample information (identification; container type/volume/Lot #, preservative type/volume/Lot #).
- Field observations (sample conditions such as suspended sediment and odors)
- Weather conditions (air temperature, wind, dust) and preservative volumes and types.

4.8.1 Organic Samples Collection

[1] The **Sampler** shall:

[a] Collect the correct number of samples using appropriate containers for the labile organic analytes (TOX and TOC) listed in Appendix A.

[b] Partially fill and rinse the container with the sample. Place the rinsate in the waste storage container.

[c] Fill the container 95% full by tilting the container slightly and slowly pouring water down the container walls to minimize turbulence.

[d] Add the appropriate preservative (see Appendix A), pour a small volume of sample over a pH strip to check the pH.

[e] If the pH checks fine, complete the slow filling of the container until the meniscus touches the lip of the bottle and cap. If the pH does not check correctly, then continue taking pH readings to insure it stabilizes.

[f] Do not allow any plastic material such as gloves to contact the sample during collection.

[g] Attach the pre-printed label.

ORGANIZATION INSTRUCTION	
Title: **Instructions for Area 5 RWMS Groundwater Well Preparation ad Groundwater Sampling**	**Page 10 of 22**
Document Number: **OI-2154.108** Revision Number: **1**	Change Notice History:

[h] Cap and gently invert the bottle. If any air bubbles are observed rising to the top of the container, repeat the collection process.

[i] Attach the custody seal (initialed and dated) over the top of the bottle cap.

[j] Place samples in sealable plastic bags and place the bags in an iced insulated cooler in a timely manner to expedite sample cooling.

[k] Update the Chain-of-Custody form and the Sample Package.

4.8.2 Collecting Total Metal and Anion Samples

[1] The **Sampler** shall:

[a] Collect the correct number of samples using appropriate containers for the total metals and anions listed in Appendix A.

[b] Partially fill and rinse the container with sample. Place the rinsate in the waste storage drum.

[c] Fill the container slowly with a minimum of turbulence until the meniscus touches the lip of the bottle.

[d] Add the appropriate preservative as needed (Appendix A), remove a small volume, and check the pH with a pH strip.

[e] If the pH checks fine, cap the bottle and attach the pre-printed sample label. If the pH does not check correctly, then resample using a new bottle and recheck pH.

[f] Attach a custody seal (initialed and dated) over the bottle cap and place the sample in plastic bag.

[g] Place the sample in an iced insulated cooler to expedite the cooling of the sample.

[h] Update the Chain-of-Custody form and the Sample Package (e.g., sampling sequence, sample IDs, container volumes and types, and preservative volumes and types).

4.8.3 Collecting Dissolved Metal Samples

<table>
<tr><td colspan="2">ORGANIZATION INSTRUCTION</td></tr>
<tr><td colspan="2">Title: Instructions for Area 5 RWMS Groundwater Well Preparation ad Groundwater Sampling   Page 11 of 22</td></tr>
<tr><td>Document Number: OI-2154.108
Revision Number: 1</td><td>Change Notice History:</td></tr>
</table>

[1] The **Sampler** shall:

[a] Collect the correct number of samples using appropriate containers for the dissolved metals provided in Appendix A.

[b] If necessary, attach a 0.45 μm in-line filter canister to the pump outlet (this determination will be made by the field supervisor).

[c] Pump approximately 100 ml of sample water through the filter and discard.

[d] Partially fill and rinse the container with the sample. Place the rinse in the waste storage drum.

[e] Fill the container slowly with a minimum of turbulence until the meniscus touches the lip of the bottle.

[f] Add the appropriate preservative.

[g] If a pH value is specified in Appendix A, remove a small sample and check the pH with pH paper.

[h] Cap the bottle and attach the pre-printed sample label.

[i] Attach a custody seal (initialed and dated) to the bottle cap.

[j] Update the Chain-of-Custody form and Sample Package.

4.8.4 Collecting Tritium Samples

[1] The **Sampler** shall:

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

[b] Attach the pre-printed Bechtel Environmental Integrated Data Management System sample label.

[c] Attach a custody seal (initialed and dated) to the bottle and fill out the Chain-of-Custody form.

[d] Record the sequence whereby the samples were collected, sample identification, sample container volume and type, and the amount and type of preservative added in the sample package.

ORGANIZATION INSTRUCTION	
Title: **Instructions for Area 5 RWMS Groundwater Well Preparation ad Groundwater Sampling**	**Page 12 of 22**
Document Number: **OI-2154.108** Revision Number: **1**	Change Notice History:

4.9 Completion of Sampling Activities

4.9.1 The **Sampler** shall:

[1] Remeasure the water-quality parameters to determine if the groundwater quality has remained constant during the sampling event.

[2] Retrieve the pump (Bennett™) from downhole and place in its dedicated purge container. Add 11 gallons of distilled water.

[3] Pump water through the pump until approximately 6 inches of water remains in the purge container and water is flowing out of the pump.

[4] Remove the sample input screen from the pump and connect a source of nitrogen gas (regulated tank) to the inlet.

[5] Purge the pump of water by passing nitrogen at 20 to 40 psi through the pump.

[6] Replace the input screen.

[7] Remove the pump from the purge container and dry using lint-free towels.

[8] Check all connectors and fittings on the pump head.

[9] Dismantle and store the equipment and probes per the manufacturer's instructions.

[10] Cap and lock the wellhead.

4.10 Field Quality Control

4.10.1 The **Sampler** shall:

[1] Collect and process field blanks and field duplicates for each analyte. Constituents which are analyzed by the same method do not require individual blanks and duplicates. Quality Control samples are obtained at a frequency that is the greater of once each week when sampling or once every 20 samples. A trip blank shall be prepared if volatile organics or tritium are target analytes. The trip blank shall be prepared once per sampling event for each sampling trip.

ORGANIZATION INSTRUCTION	
Title: **Instructions for Area 5 RWMS Groundwater Well Preparation ad Groundwater Sampling**	**Page 13 of 22**
Document Number: **OI-2154.108** Revision Number: **1**	Change Notice History:

[2] 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.

[3] Prepare field blanks by filling a sample container with laboratory pure water in the field, near the same location where field samples are collected. The blank shall use the same type container and preservative as the groundwater sample.

[4] Prepare equipment blanks by passing distilled water (~10 gallons) through the pump or other sampling apparatus. The blank shall use the same type container and preservative as the groundwater sample.

[5] Prepare a field duplicate by collecting two groundwater samples in sequence, keeping the sample collection as close in space and time as possible. The field duplicate is used to assess sampling and analysis precision.

4.11 Transport of Samples

4.11.1 The **Sampler** shall:

[1] Measure and record in the Sample Package the temperature inside each cooler at the conclusion of each sampling day. Add ice as needed to maintain a temperature of approximately 4°C.

[2] Document the transfer (persons relinquishing and receiving samples) on the Chain-of-Custody form whenever control of the samples is passed from one individual to another,. The first person relinquishing the samples must be a member of the sampling team.

Note: 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 environment.

[3] Have a radiological survey of the samples completed (if required) before submitting the samples to Sample Management or removing the samples from the NTS.

4.10 Review of Data Quality

4.12.1 The **Task Lead** shall enter the Project ID, Well ID, sampling date, reviewer's signature, analytical parameters, and field identification numbers. For all steps of the review, mark the "Complete" and/or "Acceptable" column of the pertinent row with

ORGANIZATION INSTRUCTION	
Title: **Instructions for Area 5 RWMS Groundwater Well Preparation ad Groundwater Sampling**	**Page 14 of 22**
Document Number: **OI-2154.108** Revision Number: **1**	Change Notice History:

"Y" (Yes) or "N" (No), as appropriate. The items and elements of the data to be reviewed include:

- Verifying that the analytical methods have been reported and are the methods requested.
- Verifying that the analysis date has been reported for organic parameters.
- Calculating/verifying the analysis holding times for the sample group. If semivolatile organics are a target analyte, calculating the preparation holding time (Method 8270). Recording the calculated holding times.
- Verifying that the concentration and units have been reported for each sample.
- Verifying that the uncertainty and number of standard deviations have been reported for radiological parameters for each sample.
- Verifying that the detection limit has been reported for each sample.
- Comparing the reported detection limit with the data quality objectives (DQOs).
- Verifying that the laboratory has analyzed and reported method and/or project-required QC samples. Verifying that the laboratory has analyzed and reported blank and surrogate spike results for organic parameters.
- Comparing the matrix spike percent recovery with the DQOs.
- Verifying that the Chain-of-Custody form is present.
- Verifying that laboratory management has reviewed and signed the data package.
- Calculating the relative percent difference (RPD) of the field duplicates or co-located samples for any analyte detected in both samples. If the analyte is not detected in both samples, enter N/A. Otherwise, record the relative percent difference.

  $$RPD = ((A-B)/((A+B)/2))*100$$

- Reviewing the field blank and the trip blank for the presence of volatile organics, if volatile organics are a target analyte.

ORGANIZATION INSTRUCTION	
Title: **Instructions for Area 5 RWMS Groundwater Well Preparation ad Groundwater Sampling**	**Page 15 of 22**
Document Number: **OI-2154.108** Revision Number: **1**	Change Notice History:

Note: If all blanks in the Complete/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.

- Marking 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 See Appendix B for the Groundwater Sampling Qualification and Training History documentation.

6.0 FORMS

6.1 Chain-of-Custody

7.0 RECORDS MANAGEMENT

7.1 This instruction generates the following records:

Record	Disposition Authority	Disposition Instructions	Office of Record

ORGANIZATION INSTRUCTION	
Title: **Instructions for Area 5 RWMS Groundwater Well Preparation ad Groundwater Sampling**	**Page 16 of 22**
Document Number: **OI-2154.108** Revision Number: **1**	Change Notice History:

Record	Disposition Authority	Disposition Instructions	Office of Record
Chain of Custody records	Unscheduled - Do Not Destroy	Retain until can be dispositioned by a NARA approved schedule.	Environment Operations
Sample Package	Unscheduled - Do Not Destroy	Retain until can be dispositioned by a NARA approved schedule.	Environment Operations

8.0 DRIVERS

8.1 DOE Order 435.1, "Radioactive Waste Management," 1988.

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

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

9.0 REFERENCES

9.1 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."

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

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

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

9.5 Nevada Administrative Code, Public Water Supplies, State of Nevada, Chapter 445.

9.6 *Radiological Control Manual*, DOE N 5480.6, 1999.

9.7 Bechtel Nevada Company Policy PY-3200.002, "Integrated Safety Management System".

ORGANIZATION INSTRUCTION	
Title: **Instructions for Area 5 RWMS Groundwater Well Preparation ad Groundwater Sampling**	**Page 17 of 22**
Document Number: **OI-2154.108** Revision Number: **1**	Change Notice History:

9.8 Bechtel Nevada Company Directive CD-0444.001, "General Safety Rules."

9.9 Bechtel Nevada Company Directive CD-0444.003, "Safety Meetings."

9.10 Bechtel Nevada Company Directive CD-0444.006, "Formal Workplace Inspection Program (FWIP)."

9.11 Bechtel Nevada Company Directive CD-0444.014, "Selecting, Using, and Storing Chemicals."

9.12 Bechtel Nevada Company Directive CD-0444.015, "Hazard Communication."

9.13 Bechtel Nevada Company Directive CD-0444.050, "Housekeeping and Fire Protection."

9.14 Bechtel Nevada Company Directive CD-0444.060, "Personal Protective Equipment."

10.0 DEFINITIONS

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

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

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

10.4 **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.

10.5 **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.

10.6 **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.

ORGANIZATION INSTRUCTION	
Title: **Instructions for Area 5 RWMS Groundwater Well Preparation ad Groundwater Sampling**	**Page 18 of 22**
Document Number: **OI-2154.108** Revision Number: **1**	Change Notice History:

10.7 **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.

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

10.9 **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.

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

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

10.12 **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.

11.0 APPENDICES

11.1 Appendix A: Sample Containers and Preservation.

11.2 Appendix B: Groundwater Sampling Qualification and Training History.

11.3 Appendix C: Sample Data Quality Summary.

11.4 Appendix D: Approximate Depth-to-Water

ORGANIZATION INSTRUCTION	
Title: **Instructions for Area 5 RWMS Groundwater Well Preparation ad Groundwater Sampling**	**Page 19 of 22**
Document Number: **OI-2154.108** Revision Number: **1**	Change Notice History:

APPENDIX A
Sample Containers and Preservation

[1]Parameter (Method)	# per Sample	Volume	Container	Preservation	Holding Time
TOX (EPA 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.	28 days
TOC (EPA 415.2)	1	250 ml	Amber glass bottle with Teflon™-lined cap	Acidify to pH < 2 with concentrated H_2SO_4; cool to 4 C. No headspace.	28 days
Cl, SO_4, F (EPA 300)	1	250 ml	Polyethylene bottle	None required per method.	28 days
HCO_3 and H_2CO_3 (SM 2320B)	1	250 ml	Polyethylene bottle	None required per method.	14 days
Na, Ca, Mg, Mn, K, Fe, SiO_2 (EPA 200.7)	1	500 ml	Polyethylene bottle	Acidify to pH < 2 with HNO_3.	180 days
Tritium Enrichment (OI-2154.364) Analysis (EPA 906.0)	1	1 liter	Glass bottle	None	6 months

(1) Use the method listed, or equivalent approved method.

ORGANIZATION INSTRUCTION	
Title: **Instructions for Area 5 RWMS Groundwater Well Preparation ad Groundwater Sampling**	**Page 20 of 22**
Document Number: **OI-2154.108** Revision Number: **1**	Change Notice History:

APPENDIX B
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			

ORGANIZATION INSTRUCTION	
Title: **Instructions for Area 5 RWMS Groundwater Well Preparation ad Groundwater Sampling**	**Page 21 of 22**
Document Number: **OI-2154.108** Revision Number: **1**	Change Notice History:

APPENDIX C
Sample Data Quality Summary

WELL IDENTIFICATION SAMPLE COLLECTION DATE:	Ue5PW-1 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					

ORGANIZATION INSTRUCTION	
Title: **Instructions for Area 5 RWMS Groundwater Well Preparation ad Groundwater Sampling**	**Page 22 of 22**
Document Number: **OI-2154.108** Revision Number: **1**	Change Notice History:

APPENDIX D
Approximate Depth-to-Water

Well Identification	Approximate Depth-to-Water
Ue5PW-1	773 feet
Ue5PW-2	842 feet
Ue5PW-3	891 feet

Appendix B

Gradient/Velocity Calculations

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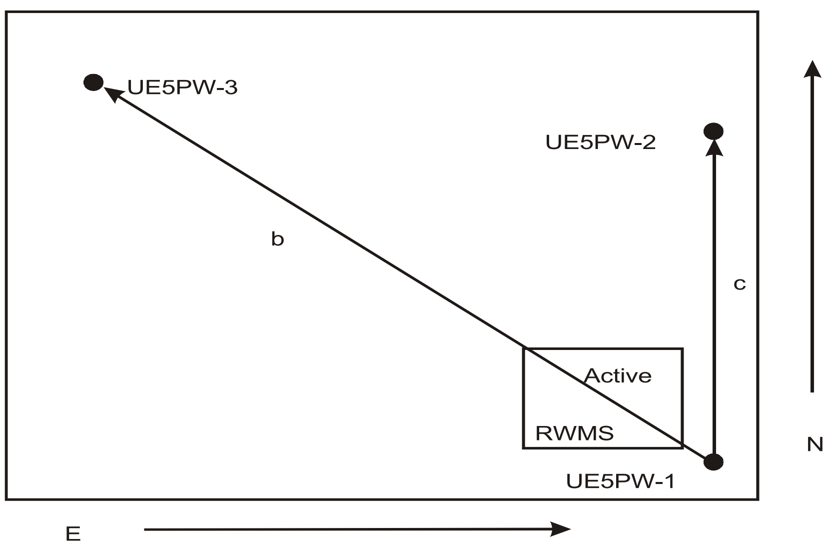
CALCULATION OF MAGNITUDE AND DIRECTION OF AREA 5 ALLUVIAL AQUIFER GRADIENT

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 Northing (N) and Easting (E) values (see 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 13 is given by $(E_3\text{-}E_1)\mathbf{I} + (N_3\text{-}N_1)\mathbf{j} + (e_3\text{-}e_1)\mathbf{k}$. 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**.

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

Expanding the determinant gives,

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

This gives the representation for the plane as,

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

Where:

$A = [N_2-N_1] [e_3-e_1] - [N_3-N_1] [e_2-e_1]$

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

$C = [E_2-E_1] [N_3-N_1] - [E_3-E_1] [N_2-N_1]$.

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,

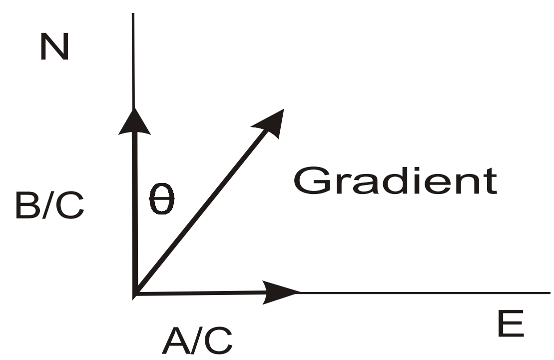
$\nabla e = -A/C\ \mathbf{I} + B/C\ \mathbf{j}$.

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

$$V = q/\Phi$$

Where:

q equals the specific discharge or Darcian flux

K is the saturated hydraulic conductivity (length/time)

i is the hydraulic gradient (dimensionless)

Φ is the effective porosity (dimensionless)

V is the mean groundwater velocity (length/time)

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