

NEVADA TEST SITE

2008 DATA REPORT:
GROUNDWATER MONITORING PROGRAM
AREA 5 RADIOACTIVE WASTE MANAGEMENT SITE

January 2009

Prepared for:

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

Prepared by:

National Security Technologies, LLC
Las Vegas, Nevada

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LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|--------------------------------|--|
| AMSL | above mean sea level |
| BN | Bechtel Nevada |
| °C | degrees Celsius |
| Ca | calcium |
| CFR | Code of Federal Regulations |
| Cl | chloride |
| cm | centimeter |
| cm/yr | centimeter per year |
| DOE | U.S. Department of Energy |
| E | Easting |
| °F | degrees Fahrenheit |
| F | fluoride |
| Fe | iron |
| ft | feet |
| GW | groundwater |
| HCO ₃ | bicarbonate |
| IL | investigation level |
| in. | inch |
| in./year | inch per year |
| K | potassium |
| L | liter |
| LCA | lower carbonate aquifer |
| m | meter |
| m/m | meter change in water level elevation per meter change in gradient direction |
| m ³ /m ³ | void space volume (cubic meter) per total aquifer volume (cubic meter) |
| MDC | minimum detectable concentration |
| MDL | method detection limit |
| Mg | magnesium |
| mg/L | milligram per liter |
| mmhos/cm | millimhos per centimeter |
| Mn | manganese |
| N | Northing |
| Na | sodium |
| NDEP | Nevada Division of Environmental Protection |
| NSTec | National Security Technologies, LLC |
| NTS | Nevada Test Site |
| pCi/L | picoCurie per liter |
| RCRA | Resource Conservation and Recovery Act |
| REECo | Reynolds Electrical and Engineering Company, Inc. |
| RWMS | Radioactive Waste Management Site |
| SC | specific conductance |
| SiO ₂ | silicate |
| SO ₄ | sulfate |
| TOC | total organic carbon |
| TOX | total organic halides |
| µg/L | microgram per liter |

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EXECUTIVE SUMMARY

This report is a compilation of the groundwater sampling results from the Area 5 Radioactive Waste Management Site (RWMS) including calendar year 2008 results. Each of the three Pilot Wells was sampled on March 11, 2008, and September 10, 2008. These wells were sampled for the following indicators of contamination: pH, specific conductance, total organic carbon, total organic halides, and tritium. Indicators of general water chemistry (cations and anions) were also monitored. Results from all samples collected in 2008 were within the limits established by agreement with the Nevada Division of Environmental Protection for each analyte. These data indicate that there has been no measurable impact to the uppermost aquifer from the Area 5 RWMS.

There were no significant changes in measured groundwater parameters compared to previous years.

Other information in the report includes an updated Cumulative Chronology for the Area 5 RWMS Groundwater Monitoring Program and a brief description of the site hydrogeology.

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1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

This report is a compilation of the groundwater sampling results from three monitoring wells located near the Area 5 Radioactive Waste Management Site (RWMS) at the Nevada Test Site (NTS), Nye County, Nevada, for calendar year 2008. The NTS is an approximately 3,561 square kilometer (1,375 square mile) restricted-access federal installation located approximately 105 kilometers (65 miles) northwest of Las Vegas, Nevada (Figure 1-1). Pilot wells UE5PW-1, UE5PW-2, and UE5PW-3 are used to monitor the groundwater at the Area 5 RWMS (Figure 1-2). In addition to groundwater monitoring results, this report includes information regarding site hydrogeology, well construction, sample collection, and meteorological data measured at the Area 5 RWMS.

The disposal of low-level radioactive waste and mixed low-level radioactive waste at the Area 5 RWMS is regulated by U.S. Department of Energy (DOE) Order 435.1, "Radioactive Waste Management" (DOE, 2001). The disposal of mixed low-level radioactive waste is also regulated by the State of Nevada under the Resource Conservation and Recovery Act (RCRA) regulation Title 40 Code of Federal Regulations (CFR) Part 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities" (CFR, 1999). 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 have been modified slightly since that date to provide additional information and to facilitate the readability of the document. The objective of this report is to satisfy any Area 5 RWMS reporting agreements between DOE and NDEP.

1.2 SITE HYDROGEOLOGY

The Area 5 RWMS is located in northern Frenchman Flat in the southeast portion of the NTS. Frenchman Flat is a topographically closed basin. Erosion of surrounding mountains has resulted in accumulation of thick, unsaturated, alluvial deposits above volcanic rocks within the basin (Bright et al., 2001). Alluvial and volcanic aquifers are present beneath the Area 5 RWMS and are believed to extend throughout much of the Frenchman Flat basin (Bechtel Nevada [BN], 2005). In this south-central portion of the NTS, a moderately thick volcanic confining unit, consisting of altered volcanic rocks, separates the shallow alluvial and volcanic aquifers from the underlying regional lower carbonate aquifer (LCA) (BN, 2005; Lacznik et al., 1996).

Sodium-bicarbonate type water comes from the three monitoring wells (UE5PW-1, UE5PW-2, and UE5PW-3). This type of water is common in the upper aquifers in Frenchman Flat. UE5PW-1 and UE5PW-2 are completed in the alluvial aquifer and UE5PW-3 is completed in the volcanic aquifer. Similar groundwater chemistry and water-table elevations in UE5PW-1, UE5PW-2, and UE5PW-3 indicate that the alluvial and volcanic aquifers are locally connected near the Area 5 RWMS.

Groundwater Monitoring Program
Area 5 Radioactive Waste Management Site

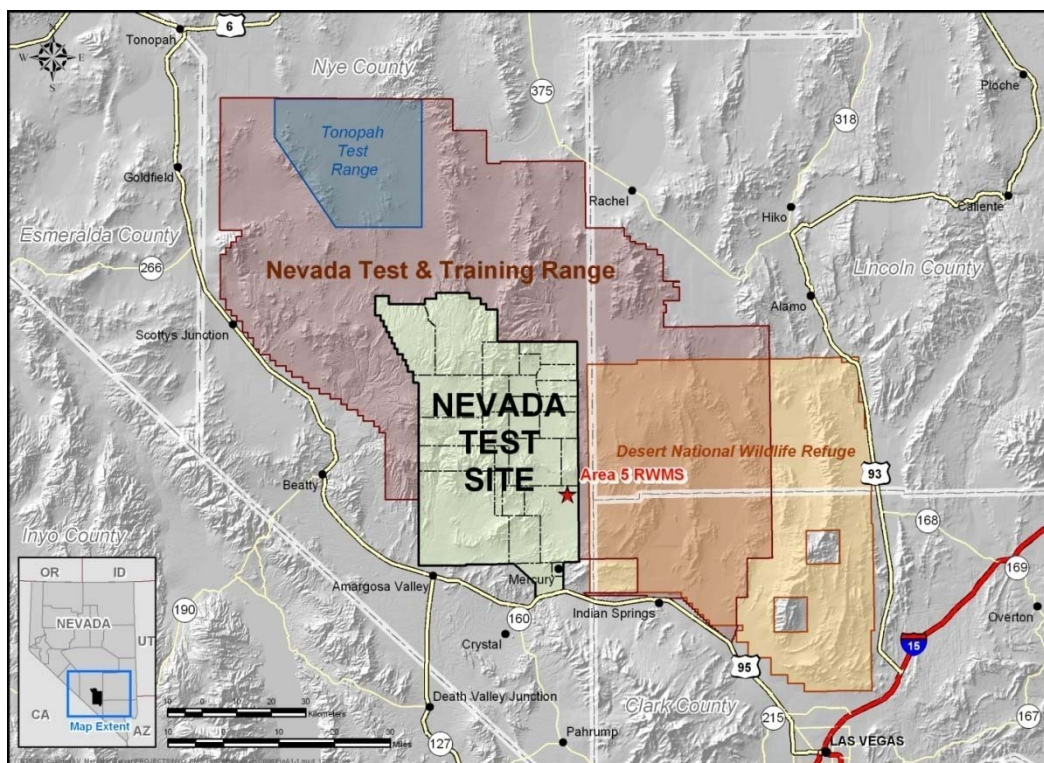


Figure 1-1 Location of the Area 5 RWMS and Nevada Test Site within Nevada

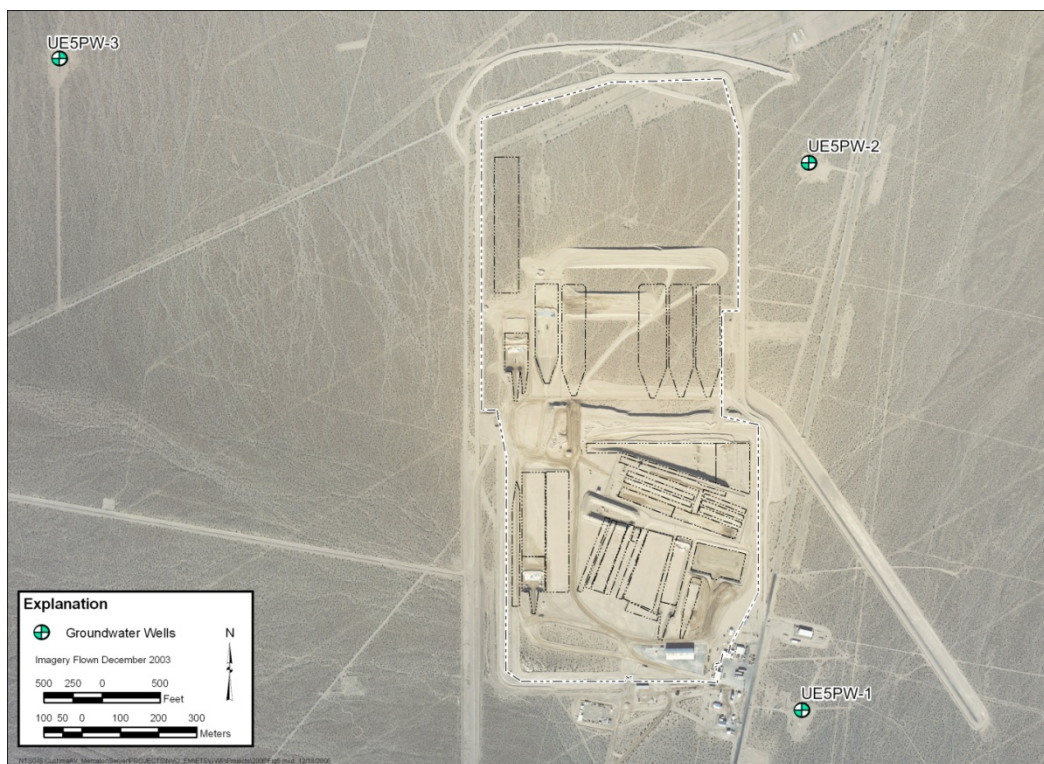


Figure 1-2 Location of Pilot Wells at the Area 5 RWMS

Some vertical groundwater flow is thought to occur between the uppermost aquifers in Frenchman Flat and the underlying regional LCA, and is being studied by the Underground Test Area Sub-Project (Stoller-Navarro, 2006). Based on measured groundwater elevations above mean sea level (AMSL) (Figure 1-3), the lateral hydraulic gradient in the upper Frenchman Flat aquifer is very low. Lateral groundwater movement beneath Frenchman Flat primarily occurs within the deep carbonate aquifer and is generally from the northeast to southwest. It eventually discharges in Amargosa Valley and Ash Meadows in southwest Nevada and Death Valley in California (Figure 1-4) (Laczniak et al., 1996).

For more detailed descriptions of Area 5 RWMS site characteristics, refer to the report *Revised Area 5 Radioactive Waste Management Site Outline of a Comprehensive Groundwater Monitoring Program* (BN, 1998).

1.3 MONITORING WELL DESCRIPTIONS

Pilot wells UE5PW-1, UE5PW-2, and UE5PW-3 were drilled between March and November 1992, and the groundwater has been monitored since 1993. Each well is completed with a centralized 6.35-centimeter (cm) (2.50-inch [in.]) diameter stainless steel casing with an 18.3-meter (m) (60-feet [ft]) dual-screen filter pack attached to the bottom of the casing. The borehole annulus below and around the screen is filled with 6/12 coarse mesh sand (Reynolds Electrical and Engineering Company, Inc. [REECo], 1994).

UE5PW-1 is 255.7 m (839 ft) deep from top of casing and is screened from 232.3 m (762 ft) to 250.5 m (822 ft). UE5PW-1 is completed in alluvium. During 2008, the average water table depth below the top of the well casing was 235.77 m (773.51 ft), and the average water table elevation was 733.61 m (2,406.84 ft) AMSL.

UE5PW-2 is 280.3 m (919.5 ft) deep from top of casing and is screened from 253.0 m (830 ft) to 271.3 m (890 ft). UE5PW-2 is completed in alluvium. During 2008, the average water table depth below the top of the well casing was 256.37 m (841.11 ft), and the average water table elevation was 733.75 m (2,407.32 ft) AMSL.

UE5PW-3 is 291.1 m (955 ft) deep from top of casing and is screened from 267.6 m (878 ft) to 282.9 m (928 ft). UE5PW-3 is completed in volcanic rock. The alluvium volcanic rock contact is 188 m (617 ft) deep at UE5PW-3 (REECo, 1994). During 2008, the average water table depth below the top of the well casing was 271.50 m (890.76 ft), and the average water table elevation was 733.72 m (2,407.21 ft) AMSL.

**Groundwater Monitoring Program
Area 5 Radioactive Waste Management Site**

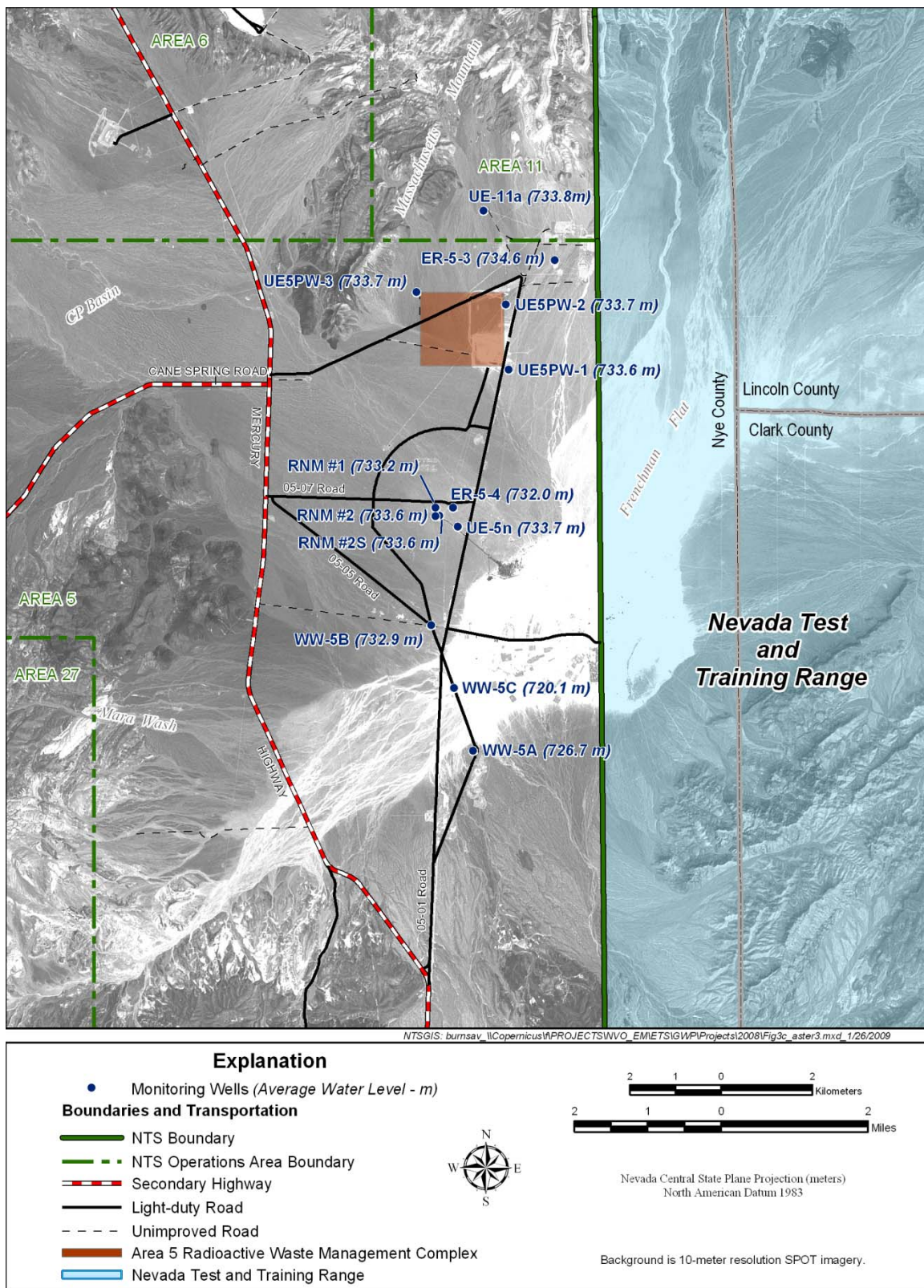


Figure 1-3 Average Water Level Elevations at Groundwater Monitoring Wells in the Vicinity of Area 5 RWMS (U.S. Geological Survey, 2008)

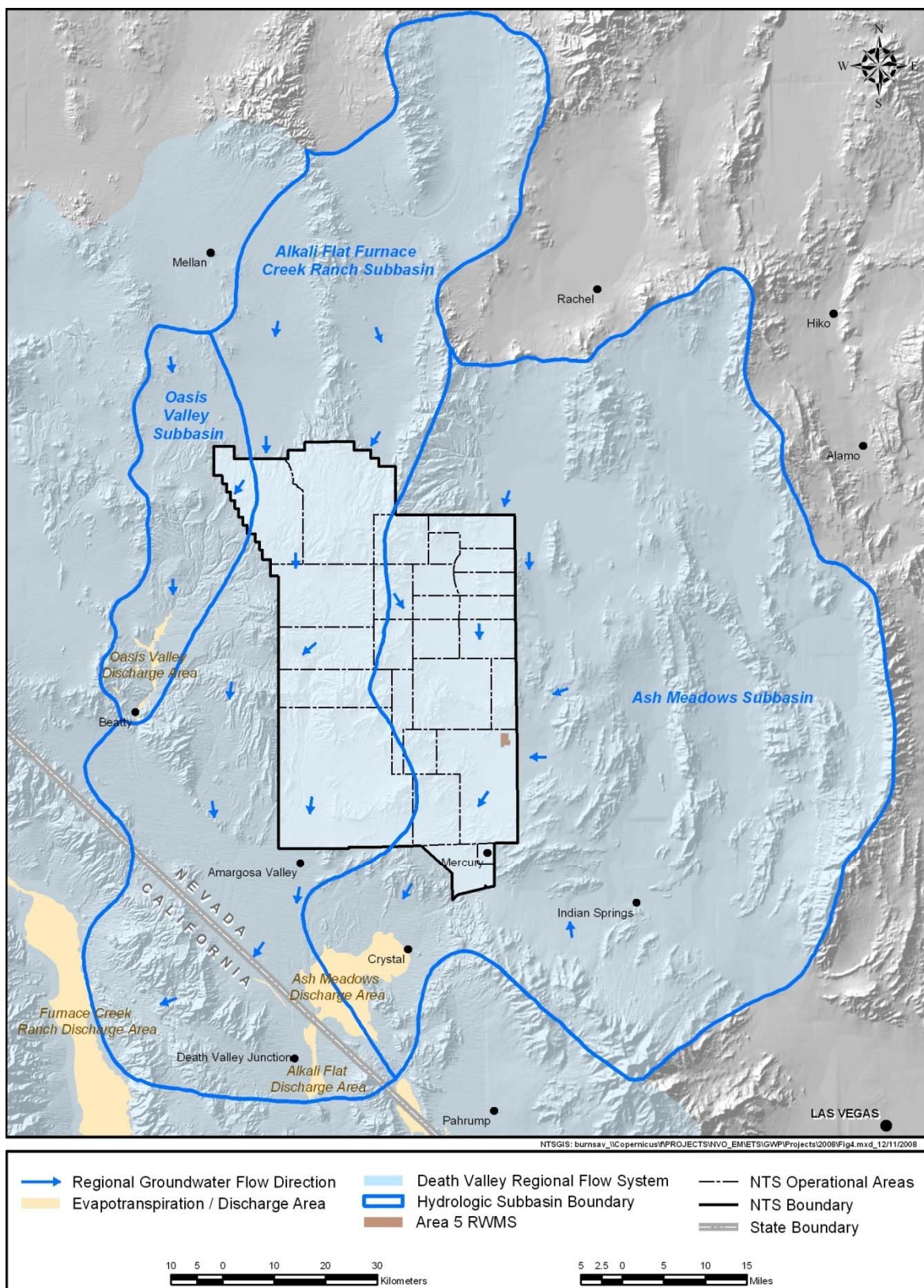


Figure 1-4 Groundwater Subbasins and Flow Directions in the Vicinity of the Area 5 RWMS

1.4 SITE METEOROLOGY

Meteorological data are measured at the Area 5 RWMS. These data include temperature, relative humidity, barometric pressure, wind speed and direction, and precipitation. During 2008 the average daily temperature at 3 m height was 16.2 degrees Celsius (°C) [61.2 degrees Fahrenheit (°F)]. The maximum observed temperature at 3 m height was 43.0°C (109.4°F) on July 9, 2008, and the minimum observed temperature at 3 m was -12.1°C (10.2°F) on December 20, 2008. The maximum observed wind gust at 3 m was 20.0 meters/second (44.7 miles per hour) on February 13, 2008. The average annual precipitation measured at the Area 5 RWMS from 1994 through 2008 was 12.4 cm per year (cm/yr) (4.88 in./yr). There was 6.1 cm (2.40 in.) of precipitation at the Area 5 RWMS during 2008. There were 27 days of measurable precipitation in 2008 at the Area 5 RWMS. The wettest month is February, which gets approximately 20 percent of the annual precipitation. Monthly precipitation at the Area 5 RWMS from January 1994 through December 2008 is provided in Figure 1-5.

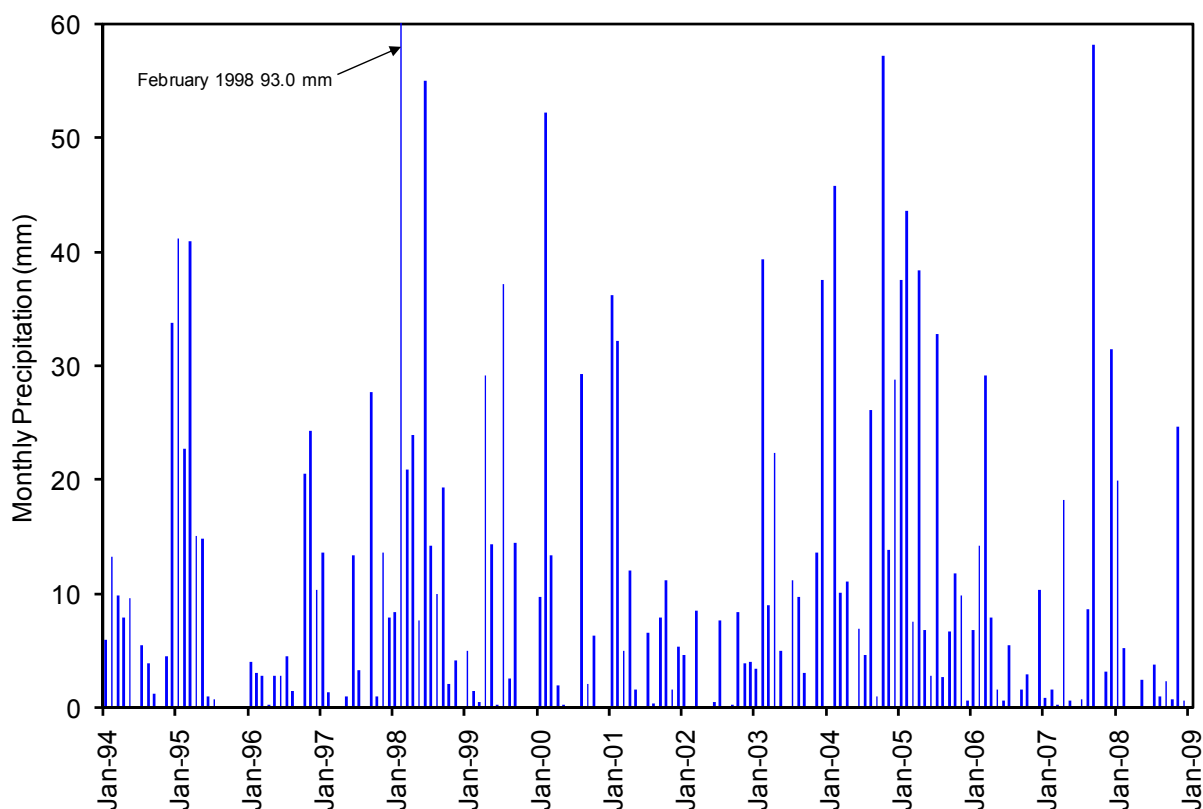


Figure 1-5 Monthly Precipitation at the Area 5 RWMS

2.0 MONITORING METHODS AND RESULTS

The Area 5 RWMS pilot wells have been monitored since 1993 (see Appendix A). The groundwater monitoring program has transitioned from monitoring all parameters required by 40 CFR 265 to a program that monitors parameters applicable to the Area 5 RWMS. The current monitoring program is modeled after the 40 CFR 265 detection-monitoring program.

2.1 METHODS

Samples are tested semiannually for the analytes listed below, which are divided into groups representing indicators of contamination and general water chemistry parameters:

Indicators of contamination:

- pH
- Specific conductance (SC)
- Total organic carbon (TOC)
- Total organic halides (TOX)
- Tritium

General water chemistry parameters:

- Cations: calcium (Ca), iron (Fe), magnesium (Mg), manganese (Mn), potassium (K), sodium (Na)
- Anions: bicarbonate (HCO_3), sulfate (SO_4), chloride (Cl), fluoride (F)
- Silicate (SiO_2)

Investigation levels (ILs) for each analyte identified as an indicator of contamination were established by DOE and NDEP in 1998 (Table 2-1). Further groundwater analyses are required if an analyte's IL is exceeded. The intent of ILs is to replace the need for rigorous statistical analyses to identify contamination. Statistical analyses are not presented in this report, as agreed upon by NDEP in a letter dated April 17, 2000 (Liebendorfer, 2000). The ILs for pH and SC are based on the distributions of data collected from 1993 through 1996. Historic analyses for TOC, TOX, and tritium typically have concentration levels less than the method detection limit (MDL) or the minimum detectable concentration (MDC), so the ILs for TOC and TOX are set slightly above their MDLs or MDCs. The tritium IL is set at 2,000 picoCuries per liter (pCi/L), which is 10 percent of the National Primary Drinking Water Standard of 20,000 pCi/L.

Wells UE5PW-1, UE5PW-2, and UE5PW-3 were sampled on March 11, 2008, and again on September 10, 2008. The current groundwater sampling procedure (National Security Technologies, LLC [NSTec], 2006) was followed. Tritium samples were enriched prior to shipment to a contract laboratory for analysis. Analyses for tritium were conducted by General Engineering Laboratory, and nonradiological analyses were conducted by Lionville Laboratory Incorporated.

Table 2-1 Investigation Levels of Indicator Parameters

| Parameter | Investigation Level (IL) |
|-----------|-----------------------------|
| pH | <7.6 or >9.2 |
| SC | 0.440 mmhos/cm ^a |
| TOC | 1 mg/L ^b |
| TOX | 50 µg/L ^c |
| Tritium | 2,000 pCi/L |

(a) mmhos/cm = millimhos per centimeter

(b) mg/L = milligrams per liter

(c) µg/L = micrograms per liter

For TOC and TOX analysis, three replicate water samples were collected consecutively from each well for each analyte. This provides sufficient sample backups in case any sample result is above the analyte's IL. Well resampling would be required if all three replicate water samples are above the analyte's IL. False detections of these analytes above their ILs and subsequent resampling of the wells have occurred in the past. No resampling was required in 2008.

2.2 RESULTS

This section lists the results for each of the five indicators of contamination, the general water chemistry parameters, and the groundwater elevation.

2.2.1 pH

The measured pH at each well remained within the ILs of 7.6 and 9.2 during 2008 (Table 2-2). The 2008 pH values ranged from 8.00 to 8.17 and represent the stable pH reading obtained from each well just prior to sampling for other analytes. Measured pH has remained relatively stable throughout the entire monitoring period (Figure 2-1). No groundwater contamination is indicated by the pH monitoring results.

Table 2-2 Area 5 RWMS pH Values

| UE5PW-1 | | UE5PW-2 | | UE5PW-3 | |
|------------|------|------------|------|------------|------|
| Date | pH | Date | pH | Date | pH |
| 03/31/1993 | 8.17 | 03/24/1993 | 7.99 | 04/14/1993 | 8.24 |
| 07/06/1993 | 8.30 | 06/22/1993 | 8.24 | 06/02/1993 | 8.68 |
| 09/01/1993 | 8.25 | 11/15/1993 | 8.40 | 10/12/1993 | 8.69 |
| 12/07/1993 | 7.91 | 01/19/1994 | 8.79 | 12/20/1993 | 8.60 |
| 06/15/1994 | 8.45 | No sample | | 05/24/1994 | 8.87 |
| 08/01/1994 | 8.28 | 06/07/1994 | 8.81 | 08/08/1994 | 8.77 |
| No sample | | 11/29/1994 | 8.79 | 01/18/1995 | 8.58 |
| 04/04/1995 | 8.25 | 04/04/1995 | 8.58 | 04/05/1995 | 8.28 |
| 11/09/1995 | 8.35 | 11/09/1995 | 8.08 | 11/09/1995 | 8.43 |
| 01/18/1996 | 8.41 | 01/25/1996 | 8.63 | 01/18/1996 | 8.55 |
| 04/16/1996 | 8.22 | 04/23/1996 | 8.21 | 04/23/1996 | 8.23 |
| No sample | | 04/30/1996 | 8.15 | 04/30/1996 | 8.15 |
| 10/02/1996 | 8.18 | 10/02/1996 | 8.28 | 10/02/1996 | 8.18 |
| 11/20/1996 | 8.25 | 11/20/1996 | 8.16 | 11/20/1996 | 8.13 |

| UE5PW-1 | | UE5PW-2 | | UE5PW-3 | |
|------------|------|------------|------|------------|------|
| 04/16/1997 | 8.33 | 04/16/1997 | 8.40 | 04/16/1997 | 8.25 |
| 11/05/1997 | 8.30 | 11/05/1997 | 8.17 | 11/05/1997 | 8.22 |
| 05/13/1998 | 8.31 | 05/13/1998 | 8.37 | 05/13/1998 | 8.34 |
| 07/29/1998 | 8.63 | No sample | | No sample | |
| 10/28/1998 | 8.34 | 10/28/1998 | 8.32 | 10/28/1998 | 8.14 |
| 05/19/1999 | 8.50 | 05/19/1999 | 8.49 | 05/19/1999 | 8.47 |
| 10/27/1999 | 8.49 | 10/27/1999 | 8.52 | 10/27/1999 | 8.34 |
| 04/26/2000 | 8.50 | 04/26/2000 | 8.39 | 04/26/2000 | 8.24 |
| 08/09/2000 | 8.26 | 08/09/2000 | 8.14 | 08/09/2000 | 8.23 |
| 05/29/2001 | 8.46 | 05/29/2001 | 8.25 | 05/29/2001 | 8.27 |
| 10/03/2001 | 8.39 | 10/03/2001 | 8.22 | 10/03/2001 | 8.13 |
| 05/15/2002 | 8.46 | 05/15/2002 | 8.30 | 05/15/2002 | 8.32 |
| 10/22/2002 | 8.43 | 10/22/2002 | 8.23 | 10/22/2002 | 8.24 |
| 04/15/2003 | 8.54 | 04/15/2003 | 8.38 | 04/15/2003 | 8.42 |
| 10/22/2003 | 8.37 | 10/22/2003 | 8.24 | 10/21/2003 | 8.16 |
| 05/04/2004 | 8.50 | 05/04/2004 | 8.25 | 05/04/2004 | 8.26 |
| 10/19/2004 | 8.30 | 10/19/2004 | 8.32 | 10/20/2004 | 8.24 |
| 04/19/2005 | 8.48 | 04/19/2005 | 8.30 | 04/19/2005 | 8.33 |
| 10/11/2005 | 8.47 | 10/11/2005 | 8.27 | 10/11/2005 | 8.31 |
| 04/26/2006 | 8.34 | 04/26/2006 | 8.12 | 04/26/2006 | 8.17 |
| 10/10/2006 | 8.11 | 10/10/2006 | 8.03 | 10/10/2006 | 8.07 |
| 03/19/2007 | 8.37 | 03/19/2007 | 8.13 | 03/19/2007 | 8.44 |
| 08/29/2007 | 8.29 | 08/29/2007 | 8.09 | 09/05/2007 | 8.10 |
| 03/11/2008 | 8.08 | 03/11/2008 | 8.00 | 03/11/2008 | 8.03 |
| 09/10/2008 | 8.17 | 09/10/2008 | 8.08 | 09/10/2008 | 8.14 |

Values before 05/19/1999 are means of multiple measurements, and values from 05/19/1999 to present are the stable pH value measured just prior to sampling.

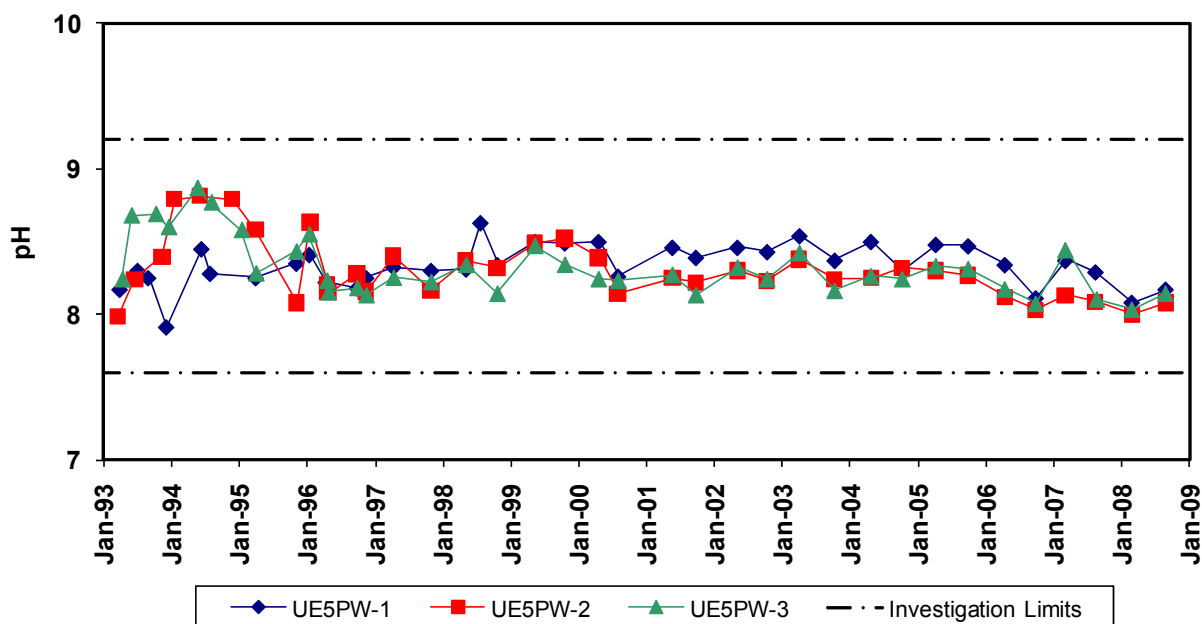


Figure 2-1 Area 5 RWMS Time Series Plot of pH

2.2.2 Specific Conductance

The 2008 measured SC of water samples from each well remained below the IL of 0.440 mmhos/cm and ranged from 0.360 to 0.386 mmhos/cm (Table 2-3). SC values from each well have remained relatively stable throughout the entire monitoring period (Figure 2-2). No groundwater contamination is indicated by the SC monitoring results.

Table 2-3 Area 5 RWMS SC Values in mmhos/cm

| UE5PW-1 | | UE5PW-2 | | UE5PW-3 | |
|------------|-------|------------|-------|------------|-------|
| Date | SC | Date | SC | Date | SC |
| 03/31/1993 | 0.401 | 03/24/1993 | 0.371 | 04/14/1993 | 0.383 |
| 06/06/1993 | 0.391 | 06/22/1993 | 0.411 | 06/02/1993 | 0.382 |
| 09/01/1993 | 0.391 | 11/15/1993 | 0.384 | 10/12/1993 | 0.376 |
| 12/07/1993 | 0.383 | 01/19/1994 | 0.371 | 12/20/1993 | 0.359 |
| 06/15/1994 | 0.383 | 06/07/1994 | 0.363 | 05/24/1994 | 0.363 |
| 08/01/1994 | 0.380 | No Sample | | 08/08/1994 | 0.367 |
| No Sample | | 11/29/1994 | 0.325 | 01/18/1995 | 0.338 |
| 04/04/1995 | 0.320 | 04/04/1995 | 0.336 | 04/05/1995 | 0.347 |
| 11/09/1995 | 0.366 | 11/09/1995 | 0.348 | 11/09/1995 | 0.352 |
| 01/18/1996 | 0.360 | 01/25/1996 | 0.343 | 01/18/1996 | 0.355 |
| 04/16/1996 | 0.363 | 04/23/1996 | 0.355 | 04/23/1996 | 0.363 |
| No Sample | | 04/30/1996 | 0.356 | 04/30/1996 | 0.379 |
| 10/02/1996 | 0.383 | 10/02/1996 | 0.363 | 10/02/1996 | 0.376 |
| 11/20/1996 | 0.374 | 11/20/1996 | 0.365 | 11/20/1996 | 0.378 |

| UE5PW-1 | | UE5PW-2 | | UE5PW-3 | |
|------------|-------|------------|-------|------------|-------|
| 04/16/1997 | 0.385 | 04/16/1997 | 0.364 | 04/16/1997 | 0.376 |
| 11/05/1997 | 0.377 | 11/05/1997 | 0.358 | 11/05/1997 | 0.361 |
| 05/13/1998 | 0.377 | 05/13/1998 | 0.356 | 05/13/1998 | 0.370 |
| 07/29/1998 | 0.373 | No Sample | | No Sample | |
| 10/28/1998 | 0.380 | 10/28/1998 | 0.358 | 10/28/1998 | 0.370 |
| 05/19/1999 | 0.379 | 05/19/1999 | 0.351 | 05/19/1999 | 0.369 |
| 10/27/1999 | 0.370 | 10/27/1999 | 0.355 | 10/27/1999 | 0.370 |
| 04/26/2000 | 0.378 | 04/26/2000 | 0.355 | 04/26/2000 | 0.369 |
| 08/09/2000 | 0.378 | 08/09/2000 | 0.357 | 08/09/2000 | 0.370 |
| 05/29/2001 | 0.377 | 05/29/2001 | 0.358 | 05/29/2001 | 0.371 |
| 10/03/2001 | 0.376 | 10/03/2001 | 0.358 | 10/03/2001 | 0.371 |
| 05/15/2002 | 0.386 | 05/15/2002 | 0.374 | 05/15/2002 | 0.384 |
| 10/22/2002 | 0.374 | 10/22/2002 | 0.368 | 10/22/2002 | 0.368 |
| 04/15/2003 | 0.372 | 04/15/2003 | 0.355 | 04/15/2003 | 0.369 |
| 10/22/2003 | 0.376 | 10/22/2003 | 0.357 | 10/21/2003 | 0.373 |
| 05/04/2004 | 0.378 | 05/04/2004 | 0.361 | 05/04/2004 | 0.353 |
| 10/19/2004 | 0.372 | 10/19/2004 | 0.352 | 10/20/2004 | 0.365 |
| 04/19/2005 | 0.377 | 04/19/2005 | 0.359 | 04/19/2005 | 0.369 |
| 10/11/2005 | 0.368 | 10/11/2005 | 0.352 | 10/11/2005 | 0.364 |
| 04/26/2006 | 0.361 | 04/26/2006 | 0.341 | 04/26/2006 | 0.357 |
| 10/10/2006 | 0.384 | 10/10/2006 | 0.363 | 10/10/2006 | 0.376 |
| 03/19/2007 | 0.390 | 03/19/2007 | 0.330 | 03/19/2007 | 0.332 |
| 08/29/2007 | 0.385 | 08/29/2007 | 0.359 | 09/05/2007 | 0.378 |
| 03/11/2008 | 0.386 | 03/11/2008 | 0.371 | 03/11/2008 | 0.386 |
| 09/10/2008 | 0.378 | 09/10/2008 | 0.360 | 09/10/2008 | 0.375 |

Values before 05/19/1999 are means of multiple measurements, and values from 05/19/1999 to present are the stable SC value measured just prior to sampling.

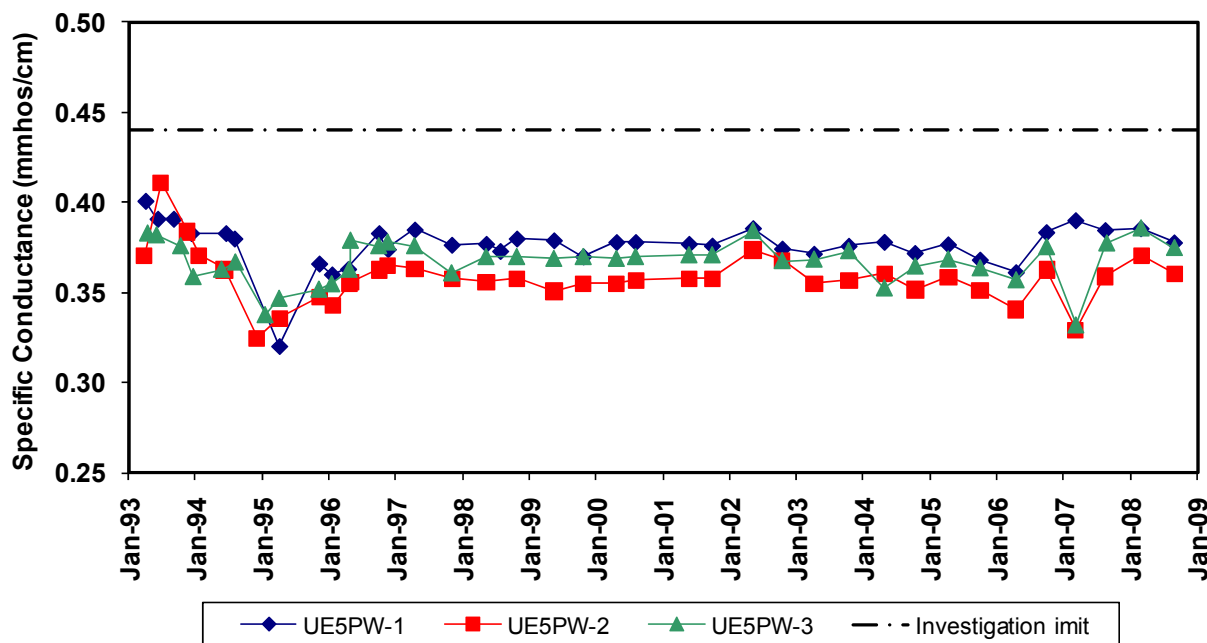


Figure 2-2 Area 5 RWMS Time Series Plot of SC

2.2.3 Total Organic Carbon

In 2008, three samples were collected consecutively from each well on both sample dates, and the averages of the three sample measurements are reported in Table 2-4. When sample TOC values fell below the sample's MDL of 0.5 mg/L, then 0.5 mg/L was the value used in calculating the reported average. Values shown as <0.5 mg/L indicate that all three sample results were less than the MDL. Samples collected from Well UE5PW-1 on September 10, 2008, had TOC results of <0.5 mg/L, <0.5 mg/L, and 0.61 mg/L; samples collected from Well UE5PW-2 on September 10, 2008, had TOC results of <0.5 mg/L, 0.53 mg/L, and 0.65 mg/L. All other TOC results from 2008 were <0.5 mg/L. All six TOC average values for 2008 are below the IL of 1 mg/L.

TOC values have remained relatively low and stable throughout the monitoring period (Figure 2-3). Most variation in TOC values is the result of variation in the MDL. No groundwater contamination is indicated by the TOC monitoring results.

Table 2-4 Area 5 RWMS TOC Values in mg/L

| UE5PW-1 | | UE5PW-2 | | UE5PW-3 | |
|------------|------|------------|------|------------|------|
| Date | TOC | Date | TOC | Date | TOC |
| 03/31/1993 | <1.0 | 03/24/1993 | <1.0 | 04/14/1993 | <1.0 |
| 07/06/1993 | <1.0 | 06/22/1993 | <1.0 | 06/02/1993 | <1.0 |
| 09/01/1993 | <1.0 | 11/15/1993 | <1.0 | 10/12/1993 | <1.0 |
| 12/07/1993 | <1.0 | 01/19/1994 | <1.0 | 12/20/1993 | <1.0 |
| No Sample | | 06/07/1994 | <1.0 | No Sample | |
| 08/01/1994 | 1.7 | 11/29/1994 | <1.0 | 08/08/1994 | <1.0 |

| UE5PW-1 | | UE5PW-2 | | UE5PW-3 | |
|------------|-------------------|------------|-------------------|------------|-------------------|
| 01/18/1995 | 0.20 | 01/18/1995 | 0.50 | 01/18/1995 | 0.23 |
| 04/04/1995 | <1.0 | 04/04/1995 | <1.0 | 04/05/1995 | <1.0 |
| 11/09/1995 | <1.0 | 11/20/1995 | <1.0 | 11/09/1995 | <1.0 |
| 04/16/1996 | <0.3 | 04/30/1996 | <0.3 | 04/30/1996 | <0.3 |
| 10/02/1996 | <0.3 | 10/02/1996 | <0.3 | 10/02/1996 | <0.3 |
| 11/20/1996 | <0.3 | 11/20/1996 | <0.3 | 11/20/1996 | <0.3 |
| 04/16/1997 | <0.3 | 04/16/1997 | <0.3 | 04/16/1997 | <0.3 |
| 11/05/1997 | <0.3 | 11/05/1997 | <0.3 | 11/05/1997 | <0.3 |
| 05/13/1998 | <1.0 | 05/13/1998 | <1.0 | 05/13/1998 | <1.0 |
| 10/28/1998 | <1.0 | 10/28/1998 | <1.0 | 10/28/1998 | <1.0 |
| 05/19/1999 | <1.0 | 05/19/1999 | <1.0 | 05/19/1999 | <1.0 |
| 10/27/1999 | <1.0 | 10/27/1999 | 1.3 ^a | 10/27/1999 | <1.0 |
| No Sample | | 12/13/1999 | <0.5 | No Sample | |
| 04/26/2000 | 0.98 ^a | 04/26/2000 | 0.60 ^a | 04/26/2000 | 1.3 ^a |
| 08/09/2000 | <0.5 ^b | 08/09/2000 | <0.5 ^b | 04/26/2000 | <0.5 ^b |
| 05/29/2001 | 0.51 ^b | 05/29/2001 | <0.5 ^b | 05/29/2001 | 0.53 ^b |
| 10/03/2001 | <0.5 | 10/03/2001 | <0.5 | 10/03/2001 | <0.5 |
| 05/15/2002 | <0.5 | 05/15/2002 | <0.5 | 05/15/2002 | <0.5 |
| 10/22/2002 | <0.5 | 10/22/2002 | 0.55 | 10/22/2002 | 0.58 |
| 04/15/2003 | 0.51 | 04/15/2003 | 0.58 | 04/15/2003 | 0.52 |
| 10/22/2003 | 0.64 | 10/22/2003 | 0.68 | 10/21/2003 | 0.62 |
| 05/04/2004 | 0.55 | 05/04/2004 | <0.5 | 05/04/2004 | 0.58 |
| 10/19/2004 | 0.58 | 10/19/2004 | 0.90 | 10/20/2004 | 0.83 |
| 04/19/2005 | 0.65 | 04/19/2005 | 0.62 | 04/19/2005 | 0.50 |
| 10/11/2005 | 0.60 | 10/11/2005 | 0.53 | 10/11/2005 | <0.5 |
| 04/26/2006 | <0.5 | 04/26/2006 | 0.97 | 04/26/2006 | 0.51 |
| 10/10/2006 | 0.80 | 10/10/2006 | 1.12 | 10/10/2006 | 0.52 |
| 03/19/2007 | 0.62 | 03/19/2007 | 0.54 | 03/19/2007 | <0.5 |
| 08/29/2007 | <0.5 | 08/29/2007 | <0.5 | 09/05/2007 | <0.5 |
| 03/11/2008 | <0.5 | 03/11/2008 | <0.5 | 03/11/2008 | <0.5 |
| 09/10/2008 | 0.54 | 09/10/2008 | 0.56 | 09/10/2008 | <0.5 |

(a) Determined to be a false positive through resampling

(b) Multiple laboratories used; this value is the average of the Lionville Laboratory only

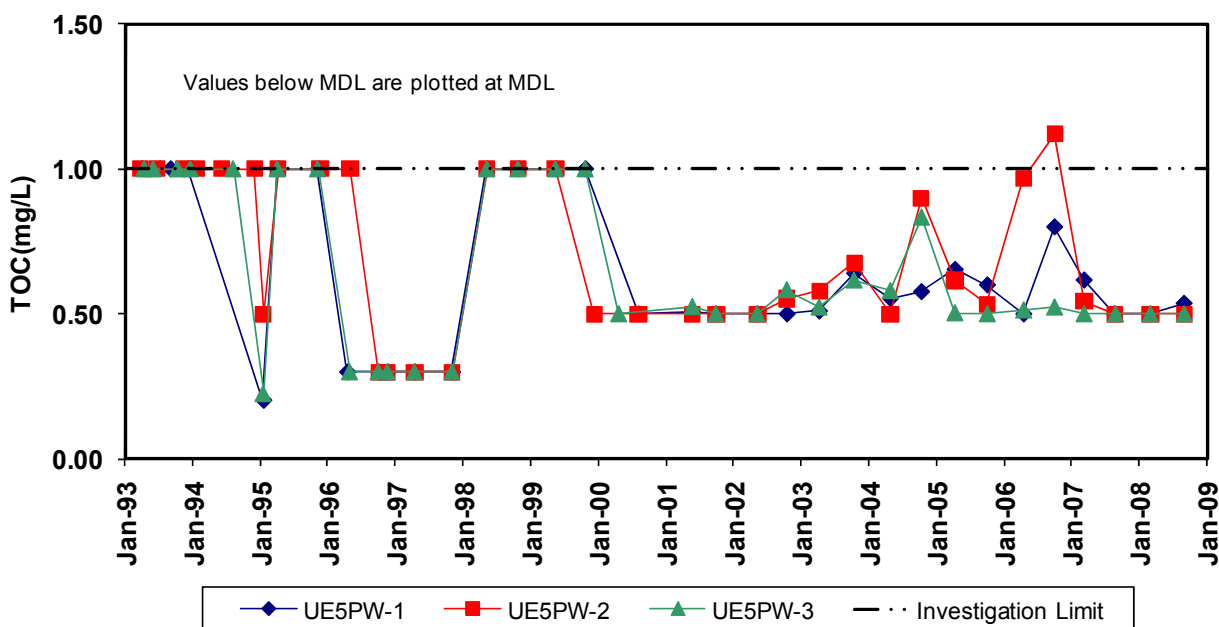


Figure 2-3 Area 5 RWMS Time Series Plot of TOC

2.2.4 Total Organic Halides

All 2008 TOX results are below the IL of 50 µg/L (Table 2-5). In 2008, three samples were collected from each well on each sample date, and the averages of the three sample results are reported in Table 2-5. When sample TOX values fell below the sample's MDL of 5.2 µg/L, then 5.2 µg/L was the value used in calculating the reported average. Values in Table 2-5 preceded by a less than symbol (<) indicate that all three samples were less than the MDL. Samples collected from Well UE5PW-2 on September 10, 2008, had TOX results of 6.0 µg/L, 6.4 µg/L, and <5.2 µg/L; samples collected from Well UE5PW-3 on September 10, 2008, had TOX results of <5.2 µg/L, 16.2 µg/L, and <5.2 µg/L. All other TOX results from 2008 were <5.2 µg/L.

TOX values have remained relatively stable and below the IL throughout the monitoring period (Figure 2-4). No groundwater contamination is indicated by the TOX results.

Table 2-5 Area 5 RWMS TOX Values in µg/L

| UE5PW-1 | | UE5PW-2 | | UE5PW-3 | |
|------------|-----|------------|-----|------------|-----|
| Date | TOX | Date | TOX | Date | TOX |
| 03/31/1993 | 17 | 03/24/1993 | 23 | 04/14/1993 | <10 |
| 07/06/1993 | <10 | 06/22/1993 | <10 | 06/02/1993 | 13 |
| 09/01/1993 | 13 | 11/15/1993 | <10 | 10/12/1993 | <10 |
| 12/07/1993 | <10 | 01/19/1994 | <10 | 12/20/1993 | <10 |
| 06/15/1994 | <10 | 06/07/1994 | <10 | No Sample | |
| 08/01/1994 | 11 | 11/29/1994 | 13 | 08/08/1994 | <10 |

| UE5PW-1 | | UE5PW-2 | | UE5PW-3 | |
|------------|--------------------|------------|-------------------|------------|-------------------|
| 01/18/1995 | <10 | 01/18/1995 | <10 | 01/18/1995 | <10 |
| 04/04/1995 | <10 | 04/04/1995 | <10 | 04/05/1995 | <10 |
| 11/09/1995 | <40 | 11/09/1995 | <40 | 11/09/1995 | <40 |
| 04/16/1996 | <40 | 04/30/1996 | <40 | 04/30/1996 | <40 |
| No Sample | | 10/02/1996 | <20 | 10/02/1996 | <20 |
| 11/20/1996 | <20 | 11/20/1996 | <20 | 11/20/1996 | <20 |
| 04/16/1997 | <20 | 04/16/1997 | <20 | 04/16/1997 | <20 |
| 11/05/1997 | <20 | 11/05/1997 | <20 | 11/05/1997 | <20 |
| 05/13/1998 | 391 ^a | 05/13/1998 | 843 ^a | 05/13/1998 | 1000 ^a |
| 07/29/1998 | <5 | No Sample | | No Sample | |
| 10/28/1998 | <5 | 10/29/1998 | <5 | 10/29/1998 | <5 |
| 05/19/1999 | <5 | 05/19/1999 | <5 | 05/19/1999 | <5 |
| 10/27/1999 | <5 | 10/27/1999 | <5 | 10/27/1999 | 7 |
| 04/26/2000 | 72 ^a | 04/26/2000 | 59 ^a | 04/26/2000 | 57 ^a |
| 08/09/2000 | 92 ^{a,b} | 08/09/2000 | 73 ^{a,b} | 08/09/2000 | 83 ^{a,b} |
| 05/29/2001 | <12.7 ^b | 05/29/2001 | <12 ^b | 05/29/2001 | <12 ^b |
| 10/03/2001 | <6.1 | 10/03/2001 | <5.8 | 10/03/2001 | <5.2 |
| 05/15/2002 | <5.2 | 05/15/2002 | 5.4 | 05/15/2002 | <5.2 |
| 10/22/2002 | <5.2 | 10/22/2002 | <5.2 | 10/22/2002 | <5.2 |
| 04/15/2003 | <5.2 | 04/15/2003 | <5.2 | 04/15/2003 | <5.2 |
| 10/22/2003 | <5.2 | 10/22/2003 | 5.5 | 10/21/2003 | <5.2 |
| 05/04/2004 | <5.2 | 05/04/2004 | <5.2 | 05/04/2004 | <5.2 |
| 10/19/2004 | <5.2 | 10/19/2004 | <5.2 | 10/20/2004 | <5.2 |
| 04/19/2005 | <5 | 04/19/2005 | <5 | 04/19/2005 | <5 |
| 10/11/2005 | 5.2 | 10/11/2005 | 6.5 | 10/11/2005 | <5 |
| 04/26/2006 | 7.3 | 04/26/2006 | 5.8 | 04/26/2006 | 7.4 |
| 10/10/2006 | <5.1 | 10/10/2006 | <5 | 10/10/2006 | <5 |
| 03/19/2007 | <5.2 | 03/19/2007 | <5.2 | 03/19/2007 | <5.2 |
| 08/29/2007 | <5.2 | 08/29/2007 | <5.2 | 09/05/2007 | <5.2 |
| 03/11/2008 | <5.2 | 03/11/2008 | <5.2 | 03/11/2008 | <5.2 |
| 09/10/2008 | <5.2 | 09/10/2008 | 5.9 | 09/10/2008 | 8.9 |

(a) Determined to be a false positive through resampling

(b) Multiple laboratories used; this value is the average of the Lionville Laboratory only

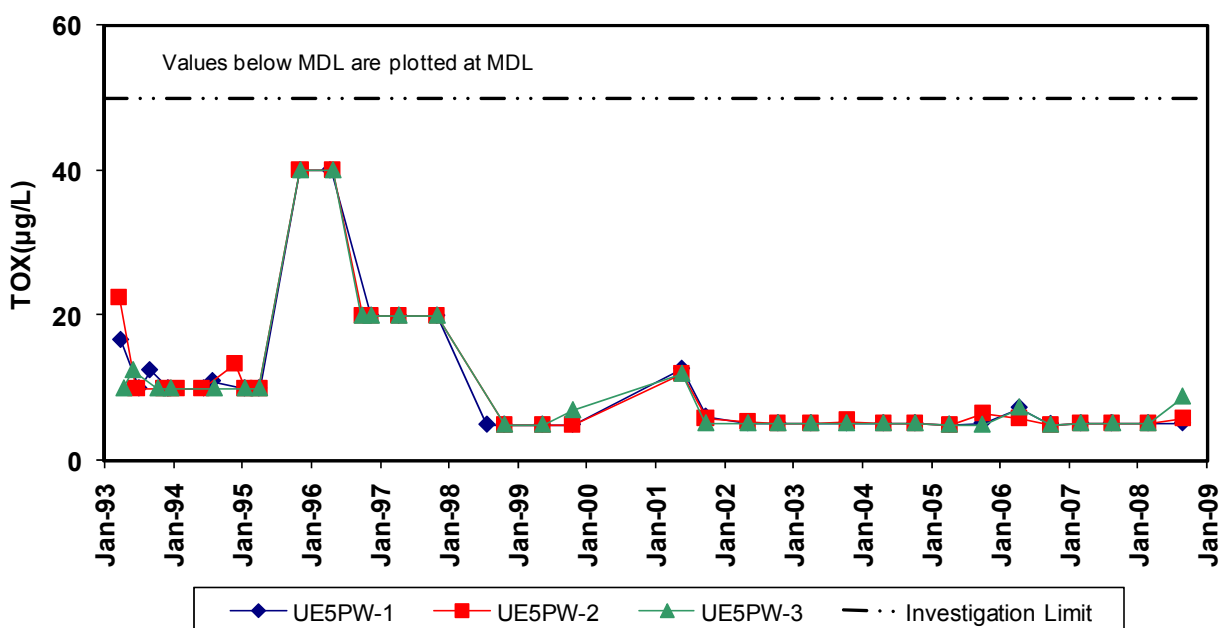


Figure 2-4 Area 5 RWMS Time Series Plot of TOX

2.2.5 Tritium

All tritium results from 2008 water samples were below the IL of 2,000 pCi/L and below the laboratory MDC of approximately 20 pCi/L (Table 2-6). In 2008, duplicate samples were collected from each well on each sample date. Table 2-6 reports the average of these two results.

Tritium values have remained relatively stable and below the IL and MDC throughout the monitoring period (Figure 2-5). No groundwater contamination is indicated by the tritium results.

Table 2-6 Area 5 RWMS Tritium Values in pCi/L

| UE5PW-1 | | UE5PW-2 | | UE5PW-3 | |
|------------|---------|------------|---------|------------|---------|
| Date | Tritium | Date | Tritium | Date | Tritium |
| 03/31/1993 | 0.442 | 03/24/1993 | -4.28 | 04/14/1993 | 1.96 |
| 12/07/1993 | -1.58 | 11/15/1993 | 32.2 | 06/02/1993 | -2.74 |
| No Sample | | 01/19/1994 | 3.69 | 12/20/1993 | -0.459 |
| 06/15/1994 | -2.04 | 06/07/1994 | 1.29 | 05/24/1994 | 1.13 |
| 08/01/1994 | 1.86 | 11/29/1994 | 0.015 | 08/08/1994 | 1.04 |
| 04/04/1995 | 2.80 | 04/04/1995 | -0.920 | 04/05/1995 | 1.50 |
| 04/16/1996 | -1.72 | 04/30/1996 | -1.91 | 04/30/1996 | -2.29 |
| 04/16/1997 | 3.15 | 04/16/1997 | 0.189 | 04/16/1997 | 3.69 |
| 05/13/1998 | -2.35 | 05/13/1998 | -1.95 | 05/13/1998 | -4.71 |
| 10/28/1998 | -1.09 | 10/28/1998 | -1.85 | 10/28/1998 | -8.25 |
| 05/19/1999 | 5.17 | 05/19/1999 | 4.24 | 05/19/1999 | 4.60 |

| UE5PW-1 | | UE5PW-2 | | UE5PW-3 | |
|------------|--------|------------|-------|------------|--------|
| 10/27/1999 | -1.36 | 10/27/1999 | -3.37 | 10/27/1999 | 1.08 |
| 04/26/2000 | -2.56 | 04/26/2000 | 1.17 | 04/26/2000 | -0.080 |
| 08/09/2000 | -1.48 | 08/09/2000 | 6.97 | 08/09/2000 | 4.35 |
| 05/29/2001 | -1.90 | 05/29/2001 | -11.5 | 05/29/2001 | -12.4 |
| 10/03/2001 | -2.93 | 10/03/2001 | -2.82 | 10/03/2001 | 2.46 |
| 05/15/2002 | -2.82 | 05/15/2002 | 0.150 | 05/15/2002 | -3.26 |
| 10/22/2002 | -4.15 | 10/22/2002 | 0.113 | 10/22/2002 | -1.17 |
| 04/15/2003 | -1.13 | 04/15/2003 | -5.22 | 04/15/2003 | 1.62 |
| 10/22/2003 | 0.952 | 10/22/2003 | 11.4 | 10/21/2003 | 0.405 |
| 05/04/2004 | -2.69 | 05/04/2004 | -6.17 | 05/04/2004 | -6.04 |
| 10/19/2004 | -1.50 | 10/19/2004 | -10.0 | 10/20/2004 | -6.39 |
| 04/19/2005 | 3.67 | 04/19/2005 | 3.76 | 04/19/2005 | 3.56 |
| 10/11/2005 | 8.83 | 10/11/2005 | 5.24 | 10/11/2005 | -4.78 |
| 04/26/2006 | 0.480 | 04/26/2006 | -2.70 | 04/26/2006 | -6.71 |
| 10/10/2006 | 7.42 | 10/10/2006 | 9.35 | 10/10/2006 | 13.75 |
| 03/19/2007 | -10.33 | 03/19/2007 | -7.96 | 03/19/2007 | -4.15 |
| 08/29/2007 | -7.25 | 08/29/2007 | -5.61 | 09/05/2007 | -5.60 |
| 03/11/2008 | 5.33 | 03/11/2008 | 7.63 | 03/11/2008 | -1.41 |
| 9/10/2008 | 4.53 | 9/10/2008 | -2.03 | 9/10/2008 | -4.98 |

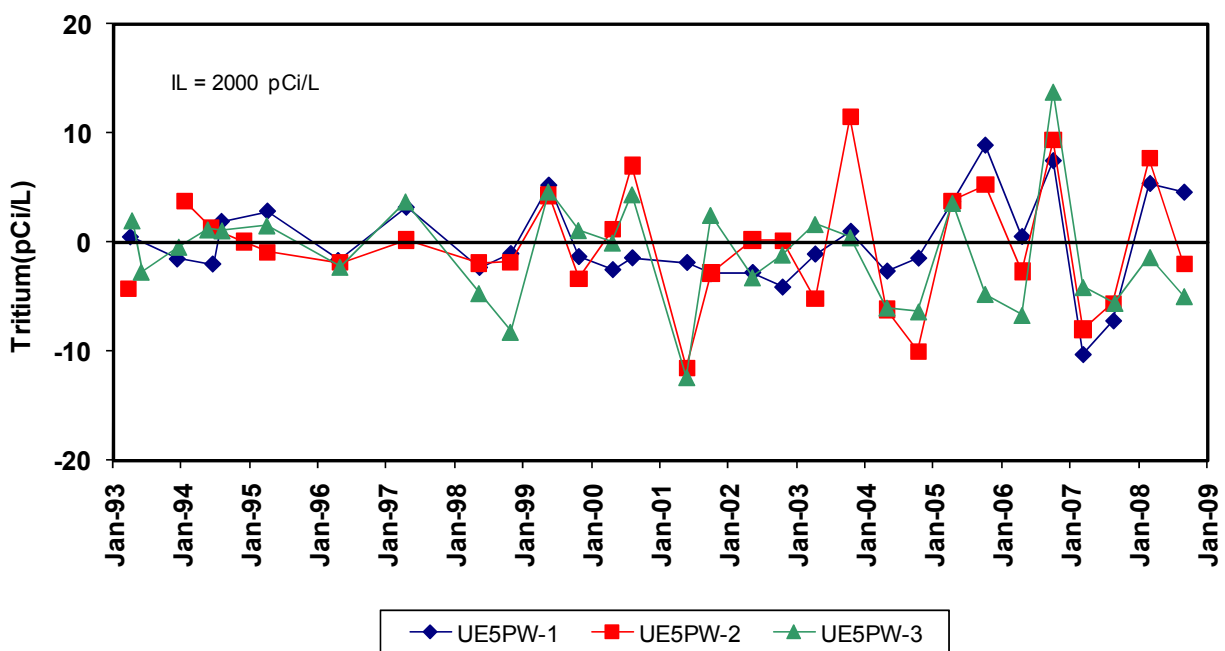


Figure 2-5 Area 5 RWMS Time Series Plot of Tritium

2.2.6 General Water Chemistry Parameters

General water chemistry analyses during 2008 for cations (Ca, Mg, Na, K, Fe), anions (Cl, F, SO₄, HCO₃), and SiO₂ indicate similar groundwater in all three wells and no changes in groundwater chemistry (Table 2-7, Table 2-8, and Table 2-9).

Groundwater temperatures measured in March 2008 ranged from 17.0 to 18.8°C (66.6 to 65.8°F) and in September 2008 ranged from 21.3 to 21.4°C (70.3 to 70.5°F). Temperature measurements are collected at the ground surface and are influenced by the ambient air temperature.

Stiff plots for 2007 and 2008 indicate similar groundwater chemistry for all three wells and no changes in the groundwater chemistry (Figure 2-6). A piper diagram for the same water chemistry data indicates that the groundwater is a sodium-bicarbonate type (Figure 2-7).

Table 2-7 UE5PW-1 General Water Chemistry Values in mg/L

| Date | Ca | Mg | K | Na | Mn | Fe | SiO ₂ | SO ₄ | HCO ₃ | Cl | FI |
|------------|-------------|-------------|-------------|------|-------------|---------|------------------|-----------------|------------------|-------------|-------------|
| 3/31/1993 | No analysis | No analysis | No analysis | 48.0 | <0.006 | 0.013 | No analysis | 32 | 167 | 9.2 | 1.2 |
| 6/6/1993 | No analysis | No analysis | No analysis | 58.0 | <0.001 | 0.059 | No analysis | 37 | 161 | 9.7 | 1.4 |
| 9/1/1993 | No analysis | No analysis | No analysis | 56.0 | 0.0066 | 0.027 | No analysis | No analysis | 192 | 8.4 | 5.7 |
| 12/7/1993 | No analysis | No analysis | No analysis | 57.0 | <0.0012 | 0.012 | No analysis | 36 | 183 | 9.9 | 1.5 |
| 6/15/1994 | No analysis | No analysis | No analysis | 61.0 | <0.004 | 0.01 | No analysis | No analysis | No analysis | No analysis | No analysis |
| 8/1/1994 | No analysis | No analysis | No analysis | 53.0 | <0.0012 | 0.021 | No analysis | 36 | No analysis | 10.0 | No analysis |
| 4/4/1995 | No analysis | No analysis | No analysis | 58.0 | <0.01 | <0.05 | No analysis | 34 | No analysis | 9.9 | No analysis |
| 4/16/1996 | No analysis | No analysis | No analysis | 61.0 | <0.001 | 0.02 | No analysis | 34 | No analysis | 9.9 | No analysis |
| 4/16/1997 | 15.1 | 5.3 | 5.9 | 54.5 | <0.001 | 0.012 | No analysis | 32.2 | 156 | 9.3 | 1.3 |
| 11/5/1997 | 15.5 | 5.6 | 6.4 | 57.8 | No analysis | 0.012 | No analysis | 35.2 | 151 | 10.2 | 1.2 |
| 5/13/1998 | 14.0 | 5.4 | 5.2 | 55.8 | 0.0015 | 0.034 | 54.2 | 34.6 | 151 | 9.6 | 1.1 |
| 10/28/1998 | 14.9 | 5.6 | 6.9 | 57.6 | 0.0015 | 0.024 | 60.5 | 34.0 | 160 | 9.7 | 1.1 |
| 5/19/1999 | 12.5 | 5.3 | 6.9 | 61.0 | <0.0025 | <0.05 | 68.5 | 34.0 | 146 | 10.0 | 1.0 |
| 10/27/1999 | 14.5 | 6.0 | 6.6 | 63.5 | <0.008 | <0.009 | 62.0 | 35.0 | 159 | 8.8 | 1.1 |
| 4/26/2000 | 12.8 | 4.8 | 6.7 | 53.7 | 0.001 | 0.0326 | 58.4 | 35.7 | 165 | 10.0 | 1.0 |
| 8/9/2000 | 15.0 | 4.9 | 6.6 | 52.0 | 0.00045 | <0.0164 | 59.9 | 37.1 | 146 | 10.4 | 1.1 |
| 5/29/2001 | 14.4 | 4.9 | 6.0 | 59.0 | <0.025 | 0.01215 | 61.7 | No analysis | 143 | No analysis | No analysis |
| 10/3/2001 | 13.7 | 4.8 | 6.7 | 51.0 | 0.00020 | <0.0156 | 58.3 | 36.0 | 151 | 10.2 | 1.0 |
| 5/15/2002 | 14.3 | 5.1 | 7.0 | 54.5 | 0.00053 | 0.02845 | 60.9 | 35.9 | 155 | 10.7 | 1.0 |
| 10/22/2002 | 14.6 | 5.2 | 6.4 | 50.0 | 0.0002 | 0.0181 | 60.7 | 35.6 | 143 | 10.1 | 1.0 |
| 4/15/2003 | 13.7 | 5.0 | 6.2 | 58.0 | <0.0005 | 0.011 | 59.2 | 32.9 | 150 | 12.3 | 1.0 |
| 10/22/2003 | 14.0 | 5.0 | 6.0 | 58.1 | <0.0156 | 0.0141 | 61.2 | 36.6 | No analysis | 9.5 | 1.1 |
| 5/4/2004 | 12.9 | 4.6 | 6.4 | 55.3 | 0.0027 | 0.0374 | 54.4 | 34.4 | 154 | 9.8 | 1.1 |
| 10/19/2004 | 13.1 | 5.2 | 6.0 | 56.2 | <0.028 | 0.0279 | 59.9 | 37.3 | 168 | 10.1 | 1.0 |
| 4/19/2005 | 13.8 | 4.8 | 6.6 | 55.1 | <0.0006 | 0.007 | 58.6 | 39.6 | 149 | 10.5 | 1.0 |
| 10/11/2005 | 13.4 | 5.0 | 6.1 | 50.5 | <0.0002 | <0.0026 | 61.2 | 35.7 | 156 | 9.7 | 1.0 |
| 4/26/2006 | 14.6 | 5.3 | 6.3 | 60.4 | <0.0032 | <0.0054 | 63.3 | 35.4 | 149 | 10.7 | 1.2 |
| 10/10/2006 | 14.0 | 5.2 | 5.9 | 58.8 | 0.0007 | <0.0048 | 61.4 | 33.8 | 148 | 9.9 | 0.9 |
| 3/19/2007 | 15.7 | 5.4 | 6.0 | 57.4 | <0.0036 | 0.0124 | 64.0 | 37.7 | 151 | 10.5 | 1.0 |
| 8/29/2007 | 15.4 | 5.4 | 6.2 | 59.0 | 0.00046 | 0.0058 | 64.6 | 35.9 | 148 | 10.0 | 1.2 |
| 3/11/2008 | 14.0 | 5.4 | 6.3 | 60.4 | <0.00045 | 0.0066 | 63.1 | 37.4 | 149 | 11.1 | 1.2 |
| 9/10/2008 | 14.3 | 5.5 | 6.4 | 59.1 | <0.0009 | <0.045 | 62.5 | 34.7 | 155 | 11.0 | 1.2 |

Data source: Data before 10/27/1999 from BN, 2001.

Groundwater Monitoring Program
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Table 2-8 UE5PW-2 General Water Chemistry Values in mg/L

| Date | Ca | Mg | K | Na | Mn | Fe | SiO ₂ | SO ₄ | HCO ₃ | Cl | FI |
|------------|-------------|-------------|-------------|-------------|-------------|-------------|------------------|-----------------|------------------|-------------|-------------|
| 3/24/1993 | No analysis | No analysis | No analysis | 46 | 0.11 | 0.062 | No analysis | 28 | 159 | 8.4 | 1.0 |
| 6/22/1993 | No analysis | No analysis | No analysis | 54 | 0.032 | 0.25 | No analysis | 30 | 183 | 9.7 | 1.1 |
| 11/15/1993 | No analysis | No analysis | No analysis | 51 | <0.004 | 0.180 | No analysis | 31 | 171 | 9.4 | 1.3 |
| 1/19/1994 | No analysis | No analysis | No analysis | 45 | <0.0012 | 0.074 | No analysis | 29 | 159 | No analysis | 1.2 |
| 6/7/1994 | No analysis | No analysis | No analysis | 55 | <0.004 | 0.14 | No analysis | 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 | 8.0 | No analysis |
| 4/4/1995 | No analysis | No analysis | No analysis | 50 | <0.01 | <0.05 | No analysis | 28 | No analysis | 8.5 | No analysis |
| 4/30/1996 | No analysis | No analysis | No analysis | 51 | <0.001 | 0.013 | No analysis | 29 | No analysis | 8.3 | No analysis |
| 4/16/1997 | 15.9 | 6.0 | 5.0 | 47.6 | <0.001 | 0.012 | No analysis | 26.4 | 149 | 7.9 | 1.2 |
| 11/5/1997 | 17.4 | 6.8 | 4.9 | 50.6 | No analysis | 0.018 | No analysis | 28.9 | 140 | 8.6 | 0.9 |
| 5/13/1998 | 14.8 | 5.7 | 3.8 | 45.2 | <0.0011 | 0.066 | 50.8 | 28.4 | 151 | 8.2 | 1.0 |
| 10/28/1998 | 15.8 | 6.2 | 5.6 | 47.4 | 0.0009 | 0.015 | 55.9 | 28.4 | 157 | 8.3 | 1.0 |
| 5/19/1999 | 15.0 | 6.3 | 6.2 | 52.0 | <0.0025 | <0.05 | 62.0 | 27.5 | 134 | 8.7 | 0.9 |
| 10/27/1999 | 16.0 | 6.7 | 5.7 | 52.0 | <0.0008 | <0.009 | 55.6 | 28.0 | 152 | 7.4 | 1.0 |
| 4/26/2000 | 15.3 | 6.5 | 5.6 | 45.6 | 0.0007 | 0.0288 | 55.8 | 29.1 | 177 | 8.6 | 0.8 |
| 8/9/2000 | 17.0 | 6.6 | 5.3 | 44.5 | <0.0002 | <0.0164 | 59.2 | 28.8 | 155 | 9.3 | 0.9 |
| 5/29/2001 | 16.6 | 6.6 | 4.8 | 48.8 | <0.0088 | <0.0107 | 60.4 | No analysis | 152 | No analysis | No analysis |
| 10/3/2001 | 16.0 | 6.7 | 5.5 | 44.7 | 0.00017 | 0.0214 | 58.8 | 28.4 | 152 | 8.7 | 1.0 |
| 5/15/2002 | 16.5 | 6.8 | 5.6 | 46.1 | 0.00059 | 0.0603 | 60.1 | 28.7 | 155 | 9.3 | 0.9 |
| 10/22/2002 | 17.6 | 7.1 | 5.3 | 44.4 | 0.0031 | <0.0156 | 63.0 | 28.7 | 149 | 8.7 | 0.8 |
| 4/15/2003 | 16.3 | 6.6 | 5.3 | 50.8 | <0.0005 | <0.0101 | 60.3 | 26.7 | 157 | 9.8 | 0.8 |
| 10/22/2003 | 16.1 | 6.6 | 5.2 | 49.6 | <0.0016 | 0.0618 | 60.5 | 29.5 | 141 | 8.8 | 0.9 |
| 5/4/2004 | 16.0 | 6.3 | 5.4 | 47.2 | <0.0007 | 0.0397 | 58.2 | 28.1 | 159 | 8.2 | 0.9 |
| 10/19/2004 | 15.7 | 6.7 | 5.1 | 48.6 | <0.0003 | <0.0279 | 59.7 | 29.6 | 169 | 8.9 | 0.9 |
| 4/19/2005 | 16.3 | 6.3 | 5.2 | 44.9 | <0.0006 | 0.0115 | 58.6 | 31.3 | 133 | 8.4 | 0.9 |
| 10/11/2005 | 16.0 | 6.8 | 5.0 | 44.0 | <0.0002 | 0.0270 | 62.2 | 29.0 | 167 | 8.1 | 0.9 |
| 4/26/2006 | 16.6 | 6.7 | 5.4 | 51.2 | <0.0032 | 0.0612 | 62.5 | 28.1 | 152 | 8.8 | 1.1 |
| 10/10/2006 | 16.5 | 6.5 | 5.2 | 48.0 | <0.0007 | 0.0170 | 61.2 | 27.2 | 156 | 8.6 | 1.1 |
| 3/19/2007 | 16.8 | 6.6 | 5.4 | 49.8 | <0.0036 | 0.0387 | 62.9 | 42.2 | 149 | 11.3 | 0.9 |
| 8/29/2007 | 16.9 | 6.7 | 5.2 | 50.5 | <0.00045 | 0.0098 | 63.7 | 27.9 | 151 | 9.0 | 1.1 |
| 3/11/2008 | 16.7 | 6.7 | 5.2 | 50.5 | <0.00045 | 0.0159 | 60.3 | 30.7 | 149 | 10.0 | 1.0 |
| 9/10/2008 | 16.8 | 7.0 | 5.7 | 52.7 | 0.0020 | <0.045 | 60.3 | 28.7 | 152 | 9.2 | 1.0 |

Data source: Data before 10/27/1999 from BN, 2001.

Table 2-9 UE5PW-3 General Water Chemistry Values mg/L

| Date | Ca | Mg | K | Na | Mn | Fe | SiO ₂ | SO ₄ | HCO ₃ | Cl | Fl |
|------------|-------------|-------------|-------------|------|-------------|---------|------------------|-----------------|------------------|-------------|-------------|
| 04/14/93 | No analysis | No analysis | No analysis | 46 | 0.042 | 0.024 | No analysis | 31 | 157 | 8.5 | 1.3 |
| 06/02/93 | No analysis | No analysis | No analysis | 53 | 0.009 | 0.014 | No analysis | 31 | 162 | 9.1 | 1.2 |
| 10/12/93 | No analysis | No analysis | No analysis | 57 | <0.006 | 0.11 | No analysis | 30 | 156 | 7.9 | 1.2 |
| 12/20/93 | No analysis | No analysis | No analysis | 48 | <0.0012 | 0.1 | No analysis | 33 | 156 | 8.7 | 1.3 |
| 05/24/94 | No analysis | No analysis | No analysis | 56 | <0.0012 | 0.02 | No analysis | No analysis | No analysis | No analysis | No analysis |
| 08/08/94 | No analysis | No analysis | No analysis | 51 | <0.0012 | <0.009 | No analysis | 33 | No analysis | 8.9 | No analysis |
| 04/05/95 | No analysis | No analysis | No analysis | 55 | <0.01 | <0.05 | No analysis | 31 | No analysis | 8.8 | No analysis |
| 04/30/96 | No analysis | No analysis | No analysis | 57 | <0.001 | 0.0088 | No analysis | 32 | No analysis | 8.7 | No analysis |
| 04/16/97 | 15.8 | 5.7 | 4.0 | 54.2 | <0.001 | <0.006 | No analysis | 29 | 155 | 8.4 | 1.3 |
| 11/05/97 | 16.8 | 6.1 | 4.3 | 55.5 | No analysis | 0.0133 | No analysis | 32.1 | 140 | 9.2 | 1.1 |
| 05/13/98 | 15.8 | 5.8 | 3.3 | 53.8 | <0.0011 | 0.035 | 56.6 | 31.0 | 151 | 8.6 | 1.0 |
| 10/28/98 | 15.6 | 5.7 | 4.2 | 53.7 | 0.0009 | 0.009 | 57.1 | 31.4 | 156 | 8.7 | 1.0 |
| 05/19/99 | 15.0 | 5.8 | 4.8 | 56.0 | <0.0025 | <0.05 | 66.3 | 30.5 | 146 | 9.2 | 0.9 |
| 10/27/1999 | 16.0 | 6.4 | 5.0 | 58.5 | <0.0008 | <0.009 | 59.9 | 31.0 | 159 | 7.7 | 0.9 |
| 4/26/2000 | 15.3 | 5.9 | 4.5 | 49.8 | 0.00033 | 0.0178 | 58.5 | 32.0 | 169 | 9.1 | 0.9 |
| 8/9/2000 | 16.0 | 5.8 | 4.3 | 48.3 | <0.0002 | <0.0164 | 57.8 | 32.6 | 162 | 9.9 | 1.0 |
| 5/29/2001 | 16.4 | 5.9 | 4.0 | 54.8 | 0.0018 | <0.0107 | 60.5 | No analysis | 151 | No analysis | No analysis |
| 10/3/2001 | 15.6 | 6.0 | 4.5 | 48.4 | 0.00022 | 0.0237 | 57.9 | 31.5 | 154 | 8.9 | 1.0 |
| 5/15/2002 | 15.7 | 6.0 | 4.5 | 49.3 | 0.00027 | 0.0249 | 57.9 | 33.0 | 151 | 9.8 | 0.9 |
| 10/22/2002 | 17.2 | 6.2 | 4.3 | 47.6 | <0.0002 | <0.0181 | 60.5 | 32.2 | 143 | 9.3 | 0.9 |
| 4/15/2003 | 16.0 | 5.9 | 4.5 | 54.7 | 0.00083 | 0.0195 | 58.4 | 29.3 | 144 | 11.8 | 0.8 |
| 10/21/2003 | 16.3 | 5.8 | 4.1 | 54.4 | <0.0016 | 0.0212 | 59.5 | 32.5 | 160 | 9.2 | 1.0 |
| 5/4/2004 | 16.1 | 5.6 | 4.7 | 52.2 | 0.0019 | 0.0453 | 58.2 | 31.1 | 155 | 8.7 | 1.0 |
| 10/20/2004 | 15.6 | 5.9 | 4.0 | 52.3 | <0.0003 | <0.0279 | 58.4 | 32.0 | 166 | 9.4 | 0.8 |
| 4/19/2005 | 16.2 | 5.6 | 4.5 | 50.9 | <0.0006 | 0.0319 | 57.8 | 34.4 | 148 | 8.8 | 0.9 |
| 10/11/2005 | 16.1 | 6.1 | 4.3 | 48.5 | <0.0002 | <0.026 | 61.4 | 32.5 | 156 | 8.5 | 0.9 |
| 4/26/2006 | 16.6 | 6.1 | 4.2 | 58.1 | <0.0032 | 0.0057 | 61.6 | 31.6 | 159 | 9.4 | 1.2 |
| 10/10/2006 | 15.9 | 5.5 | 4.0 | 49.7 | 0.0007 | 0.0114 | 57.3 | 30.1 | 152 | 9.0 | 1.0 |
| 3/19/2007 | 16.8 | 6.1 | 4.0 | 55.5 | <0.0036 | 0.0921 | 61.2 | 19.9 | 149 | 9.3 | 0.8 |
| 9/5/2007 | 16.5 | 5.9 | 4.3 | 54.7 | 0.0012 | 0.0041 | 60.1 | 32.5 | 149 | 9.8 | 1.1 |
| 3/11/2008 | 16.7 | 6.1 | 4.2 | 57.2 | <0.00045 | 0.0045 | 58.8 | 32.1 | 144 | 9.9 | 1.0 |
| 9/10/2008 | 16.4 | 6.1 | 4.5 | 56.4 | <0.0009 | <0.045 | 58.8 | 35.9 | 165 | 9.5 | 1.0 |

Data source: Data before 10/27/1999 from BN, 2001.

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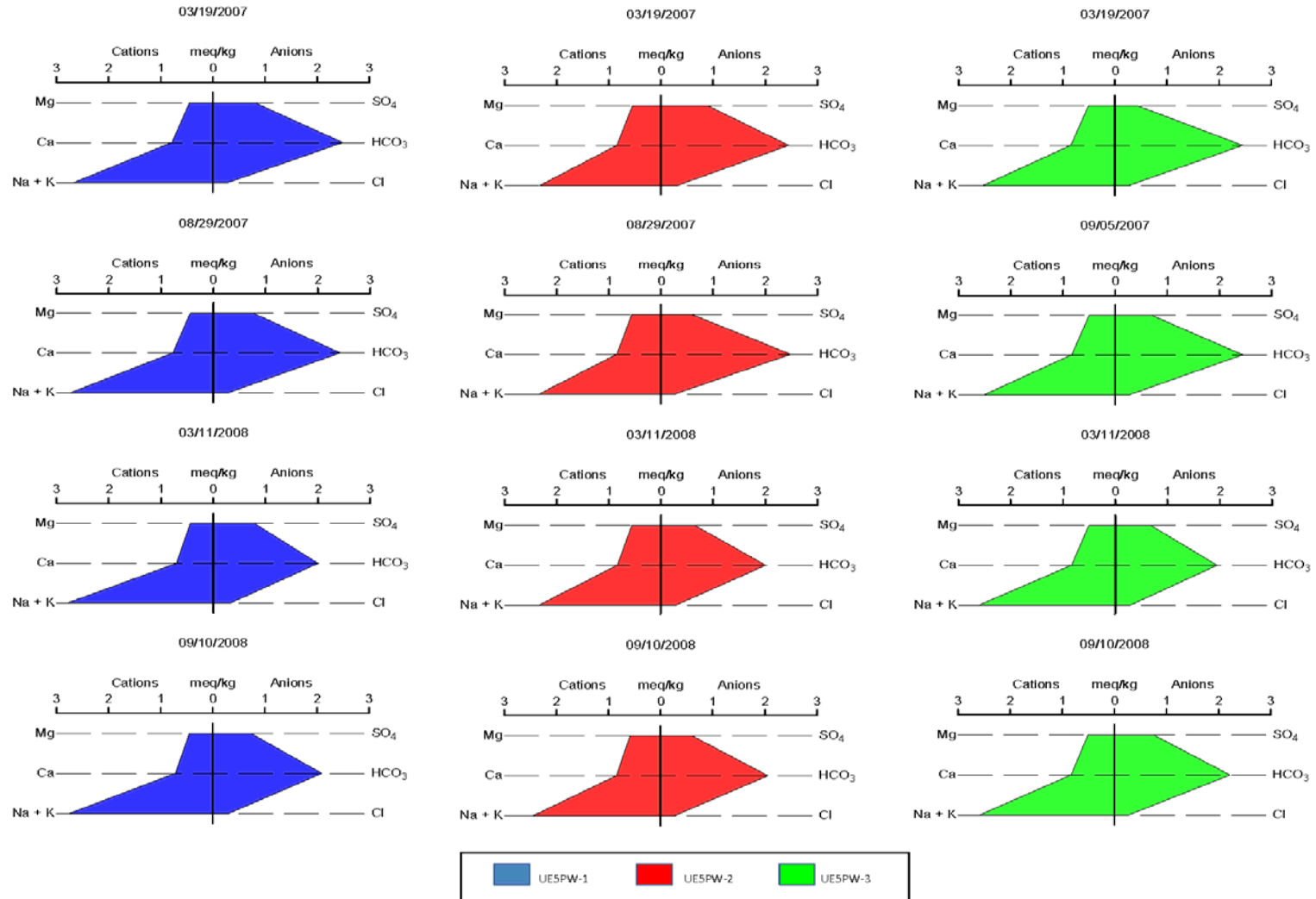


Figure 2-6 Area 5 RWMS Stiff Diagrams for 2007 and 2008

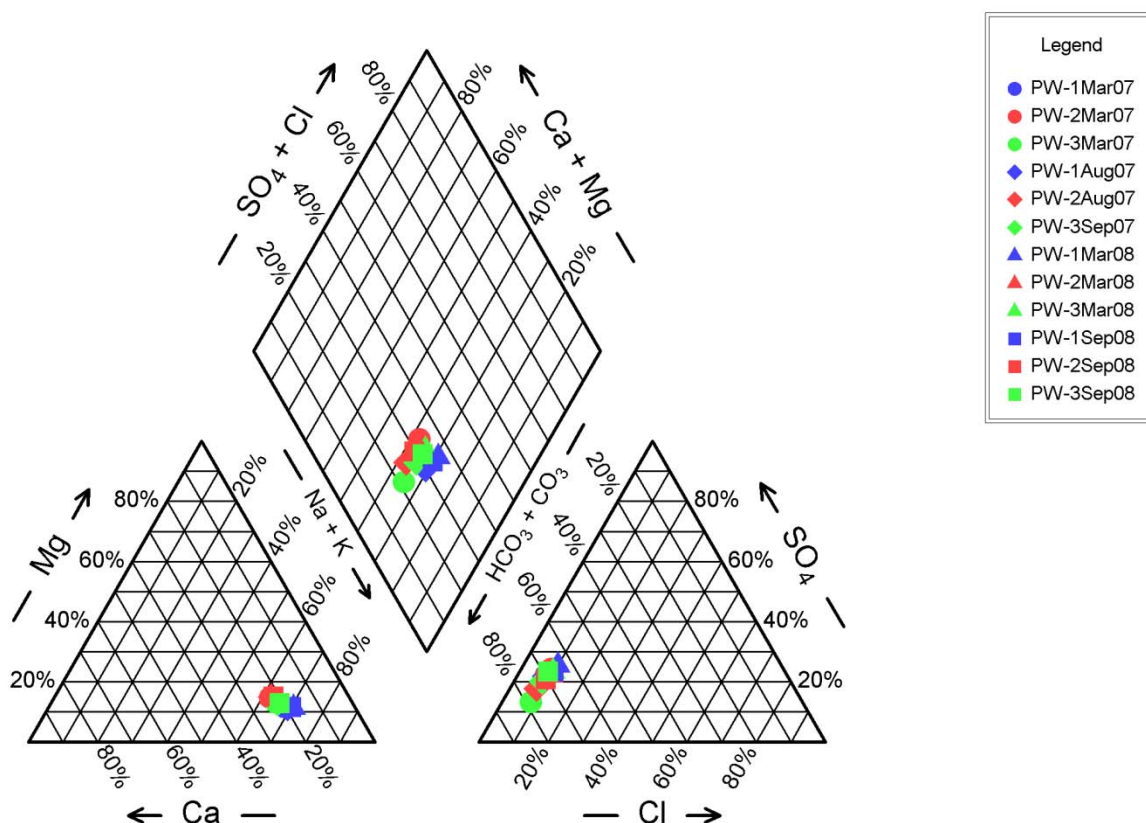


Figure 2-7 Area 5 RWMS Two-Year Piper Diagram

2.2.7 Groundwater Elevation

Groundwater elevations in UE5PW-1, UE5PW-2, and UE5PW-3 are measured quarterly using an electronic water-level tape (Table 2-10; Figure 2-8). The 2008 average depths to water from top of casing are 235.77 m (773.51 ft), 256.37 m (841.11 ft), and 271.50 m (890.76 ft) for UE5PW-1, UE5PW-2, and UE5PW-3, respectively. These measurements are corrected for borehole deviation (REEC_o, 1994).

The 2008 average groundwater elevations are 733.61 m (2,406.84 ft) AMSL, 733.75 m (2,407.32 ft) AMSL, and 733.72 m (2,407.21 ft) AMSL for UE5PW-1, UE5PW-2, and UE5PW-3, respectively. These measurements are corrected for borehole deviation (REEC_o, 1994). Based on the similar groundwater elevations, the groundwater table is essentially flat with little or no flow. Groundwater gradient, velocity, and flow direction are calculated from the groundwater elevations, borehole locations, and aquifer hydraulic properties (Table 2-11; Appendix B). The very low calculated flow velocities and the fluctuating flow directions indicate little or no groundwater flow.

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Table 2-10 Area 5 RWMS Groundwater Elevation Data

| Well Characteristics^a | UE5PW-1 | | UE5PW-2 | | UE5PW-3 | |
|---|--|---------------------------|--|---------------------------|--|---------------------------|
| Northing ^b (m) | 233,386.48 | | 234,817.13 | | 235,089.93 | |
| Easting ^b (m) | 216,357.08 | | 216,376.00 | | 214,415.04 | |
| Well Casing Elevation ^c (m) | 969.37 | | 990.12 | | 1,005.22 | |
| Casing Stickup Height ^d (m) | 0.72 | | 0.68 | | 0.76 | |
| Land Surface Elevation (m) | 968.73 | | 989.54 | | 1,004.50 | |
| Borehole Deviation Correction (m) | 0.08 | | 0.21 | | 0.02 | |
| Date | Depth to Water (m below Top of Casing) | Water Table Elevation (m) | Depth to Water (m below Top of Casing) | Water Table Elevation (m) | Depth to Water (m below Top of Casing) | Water Table Elevation (m) |
| 03/22/1993 | 235.55 | 733.82 | 256.38 | 733.74 | 271.69 | 733.53 |
| 03/23/1993 | 235.53 | 733.84 | 256.48 | 733.64 | 271.68 | 733.54 |
| 03/24/1993 | 235.53 | 733.84 | 256.36 | 733.76 | 271.69 | 733.53 |
| 03/25/1993 | 235.53 | 733.84 | 256.35 | 733.77 | 271.69 | 733.53 |
| 03/29/1993 | 235.59 | 733.78 | 256.38 | 733.74 | 271.73 | 733.49 |
| 03/30/1993 | 235.62 | 733.75 | 256.43 | 733.69 | 271.75 | 733.47 |
| 03/31/1993 | 235.62 | 733.75 | 256.44 | 733.68 | 271.74 | 733.48 |
| 04/01/1993 | 235.54 | 733.83 | 256.37 | 733.75 | 271.69 | 733.53 |
| 04/05/1993 | 235.51 | 733.86 | 256.35 | 733.77 | 271.67 | 733.55 |
| 04/06/1993 | 235.59 | 733.78 | 256.40 | 733.72 | 271.75 | 733.47 |
| 05/10/1993 | 235.64 | 733.73 | 256.46 | 733.66 | 271.76 | 733.46 |
| 05/11/1993 | 235.56 | 733.81 | 256.42 | 733.70 | 271.70 | 733.52 |
| 05/12/1993 | 235.54 | 733.83 | 256.40 | 733.72 | 271.72 | 733.50 |
| 05/13/1993 | 235.61 | 733.76 | 256.45 | 733.67 | 271.75 | 733.47 |
| 05/17/1993 | 235.61 | 733.76 | 256.45 | 733.67 | 271.74 | 733.48 |
| 05/18/1993 | 235.59 | 733.78 | 256.45 | 733.67 | 271.74 | 733.48 |
| 05/19/1993 | 235.59 | 733.78 | 256.44 | 733.68 | 271.73 | 733.49 |
| 05/20/1993 | 235.54 | 733.83 | 256.39 | 733.73 | 271.70 | 733.52 |
| 05/24/1993 | 235.60 | 733.77 | 256.43 | 733.69 | 271.74 | 733.48 |
| 05/25/1993 | 235.61 | 733.76 | 256.45 | 733.67 | 271.74 | 733.48 |
| 06/01/1993 | 235.58 | 733.79 | 256.43 | 733.69 | 271.73 | 733.49 |
| 06/07/1993 | 235.64 | 733.73 | 256.46 | 733.66 | 271.76 | 733.46 |
| 06/14/1993 | 235.61 | 733.76 | 256.46 | 733.66 | 271.74 | 733.48 |
| 06/21/1993 | 235.58 | 733.79 | 256.43 | 733.69 | 271.73 | 733.49 |
| 07/26/1993 | 235.59 | 733.78 | 256.45 | 733.67 | 271.74 | 733.48 |
| 08/03/1993 | 235.54 | 733.83 | 256.42 | 733.70 | 271.70 | 733.52 |
| 08/09/1993 | 235.62 | 733.75 | 256.46 | 733.66 | 271.75 | 733.47 |
| 08/16/1993 | 235.59 | 733.78 | 256.42 | 733.70 | 271.73 | 733.49 |
| 08/30/1993 | 235.58 | 733.79 | 256.43 | 733.69 | 271.72 | 733.50 |
| 12/28/1993 | 235.59 | 733.78 | 256.47 | 733.65 | 271.74 | 733.48 |
| 01/03/1994 | 235.57 | 733.80 | 256.44 | 733.68 | 271.70 | 733.52 |
| 02/02/1994 | 235.53 | 733.84 | 256.44 | 733.68 | 271.66 | 733.56 |
| 02/22/1994 | 235.60 | 733.77 | 256.43 | 733.69 | 271.71 | 733.51 |

| | | | | | | |
|------------|--------|--------|--------|--------|--------|--------|
| 02/28/1994 | 235.60 | 733.77 | 256.45 | 733.67 | 271.70 | 733.52 |
| 03/07/1994 | 235.54 | 733.83 | 256.38 | 733.74 | 271.66 | 733.56 |
| 03/14/1994 | 235.55 | 733.82 | 256.45 | 733.67 | 271.67 | 733.55 |
| 03/21/1994 | 235.56 | 733.81 | 256.38 | 733.74 | 271.68 | 733.54 |
| 03/28/1994 | 235.63 | 733.74 | 256.47 | 733.65 | 271.70 | 733.52 |
| 04/04/1994 | 235.53 | 733.84 | 256.40 | 733.72 | 271.66 | 733.56 |
| 04/13/1994 | 235.55 | 733.82 | 256.43 | 733.69 | 271.65 | 733.57 |
| 04/20/1994 | 235.51 | 733.86 | 256.38 | 733.74 | 271.64 | 733.58 |
| 04/26/1994 | 235.55 | 733.82 | 256.35 | 733.77 | 271.65 | 733.57 |
| 01/18/1995 | 235.63 | 733.74 | 256.45 | 733.67 | 271.62 | 733.60 |
| 04/03/1995 | 235.57 | 733.80 | 256.39 | 733.73 | 271.61 | 733.61 |
| 01/16/1996 | 235.36 | 734.01 | 256.13 | 733.99 | 271.35 | 733.87 |
| 04/15/1996 | 235.56 | 733.81 | 256.30 | 733.82 | 271.43 | 733.79 |
| 10/01/1996 | 235.54 | 733.83 | 256.32 | 733.80 | 271.51 | 733.71 |
| 11/19/1996 | 235.59 | 733.78 | 256.33 | 733.79 | 271.52 | 733.70 |
| 03/03/1997 | 235.54 | 733.83 | 256.30 | 733.82 | 271.41 | 733.81 |
| 04/15/1997 | 235.63 | 733.74 | 256.40 | 733.72 | 271.54 | 733.68 |
| 06/18/1997 | 235.61 | 733.76 | 256.40 | 733.72 | 271.52 | 733.70 |
| 07/28/1997 | 235.60 | 733.77 | 256.37 | 733.75 | 271.51 | 733.71 |
| 08/20/1997 | 235.52 | 733.85 | 256.29 | 733.83 | 271.44 | 733.78 |
| 09/25/1997 | 235.59 | 733.78 | 256.35 | 733.77 | 271.49 | 733.73 |
| 10/27/1997 | 235.57 | 733.80 | 256.34 | 733.78 | 271.48 | 733.74 |
| 11/03/1997 | 235.65 | 733.72 | 256.40 | 733.72 | 271.55 | 733.67 |
| 11/06/1997 | 235.57 | 733.80 | 256.36 | 733.76 | 271.48 | 733.74 |
| 11/12/1997 | 235.66 | 733.71 | 256.45 | 733.67 | 271.54 | 733.68 |
| 11/13/1997 | 235.60 | 733.77 | 256.29 | 733.83 | 271.49 | 733.73 |
| 11/19/1997 | 235.63 | 733.74 | 256.42 | 733.70 | 271.55 | 733.67 |
| 11/20/1997 | 235.65 | 733.72 | 256.43 | 733.69 | 271.57 | 733.65 |
| 11/25/1997 | 235.64 | 733.73 | 256.39 | 733.73 | 271.54 | 733.68 |
| 11/26/1997 | 235.50 | 733.87 | 256.27 | 733.85 | 271.45 | 733.77 |
| 12/03/1997 | 235.71 | 733.66 | 256.43 | 733.69 | 271.60 | 733.62 |
| 01/26/1998 | 235.72 | 733.65 | 256.47 | 733.65 | 271.60 | 733.62 |
| 05/12/1998 | 235.60 | 733.77 | 256.32 | 733.80 | 271.52 | 733.70 |
| 10/27/1998 | 235.52 | 733.85 | 256.21 | 733.91 | 271.36 | 733.86 |
| 12/22/1998 | 235.54 | 733.83 | 256.20 | 733.92 | 271.35 | 733.87 |
| 02/02/1999 | 235.61 | 733.76 | 256.34 | 733.78 | 271.42 | 733.80 |
| 05/18/1999 | 235.56 | 733.81 | 256.26 | 733.86 | 271.35 | 733.87 |
| 08/25/1999 | 235.56 | 733.81 | 256.26 | 733.86 | 271.38 | 733.84 |
| 10/26/1999 | 235.57 | 733.80 | 256.26 | 733.86 | 271.34 | 733.88 |
| 04/24/2000 | 235.64 | 733.73 | 256.34 | 733.78 | 271.52 | 733.70 |
| 08/07/2000 | 235.59 | 733.78 | 256.30 | 733.82 | 271.47 | 733.75 |
| 11/13/2000 | 235.66 | 733.71 | 256.34 | 733.78 | 271.45 | 733.77 |
| 02/22/2001 | 235.57 | 733.80 | 256.26 | 733.86 | 271.38 | 733.84 |
| 05/21/2001 | 235.67 | 733.70 | 256.35 | 733.77 | 271.49 | 733.73 |
| 08/01/2001 | 235.66 | 733.71 | 256.36 | 733.76 | 271.48 | 733.74 |
| 10/01/2001 | 235.66 | 733.71 | 256.35 | 733.77 | 271.45 | 733.77 |
| 02/26/2002 | 235.76 | 733.61 | 256.43 | 733.69 | 271.52 | 733.70 |
| 05/13/2002 | 235.65 | 733.72 | 256.39 | 733.73 | 271.44 | 733.78 |
| 08/19/2002 | 235.61 | 733.76 | 256.28 | 733.84 | 271.42 | 733.80 |
| 10/21/2002 | 235.61 | 733.76 | 256.31 | 733.81 | 271.44 | 733.78 |
| 02/26/2003 | 235.65 | 733.72 | 256.28 | 733.84 | 271.43 | 733.79 |
| 04/10/2003 | 235.61 | 733.76 | 256.30 | 733.82 | 271.41 | 733.81 |
| 09/10/2003 | 235.74 | 733.63 | 256.35 | 733.77 | 271.50 | 733.72 |
| 10/20/2003 | 235.73 | 733.64 | 256.42 | 733.70 | 271.53 | 733.69 |
| 02/25/2004 | 235.78 | 733.59 | 256.36 | 733.76 | 271.52 | 733.70 |

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| | | | | | | |
|------------|--------|--------|--------|--------|--------|--------|
| 04/27/2004 | 235.72 | 733.65 | 256.43 | 733.69 | 271.52 | 733.70 |
| 08/18/2004 | 235.72 | 733.65 | 256.38 | 733.74 | 271.48 | 733.74 |
| 10/18/2004 | 235.71 | 733.66 | 256.29 | 733.83 | 271.47 | 733.75 |
| 01/26/2005 | 235.67 | 733.70 | 256.45 | 733.67 | 271.46 | 733.76 |
| 04/18/2005 | 235.66 | 733.71 | 256.33 | 733.79 | 271.44 | 733.78 |
| 07/27/2005 | 235.75 | 733.62 | 256.42 | 733.70 | 271.51 | 733.71 |
| 10/10/2005 | 235.77 | 733.60 | 256.44 | 733.68 | 271.54 | 733.68 |
| 03/08/2006 | 235.74 | 733.63 | 256.39 | 733.73 | 271.50 | 733.72 |
| 05/03/2006 | 235.69 | 733.68 | 256.41 | 733.71 | 271.62 | 733.60 |
| 08/23/2006 | 235.76 | 733.61 | 256.43 | 733.69 | 271.50 | 733.72 |
| 10/09/2006 | 235.69 | 733.68 | 256.38 | 733.74 | 271.44 | 733.78 |
| 02/28/2007 | 235.74 | 733.63 | 256.29 | 733.83 | 271.49 | 733.73 |
| 07/11/2007 | 235.77 | 733.60 | 256.41 | 733.71 | 271.50 | 733.72 |
| 08/28/2007 | 235.78 | 733.59 | 256.42 | 733.70 | 271.47 | 733.75 |
| 10/15/2007 | 235.76 | 733.61 | 256.40 | 733.72 | 271.49 | 733.73 |
| 01/22/2008 | 235.79 | 733.58 | 256.39 | 733.73 | 271.53 | 733.69 |
| 03/03/2008 | 235.80 | 733.57 | 256.38 | 733.74 | 271.53 | 733.69 |
| 06/16/2008 | 235.74 | 733.63 | 256.32 | 733.80 | 271.48 | 733.74 |
| 09/09/2008 | 235.73 | 733.64 | 256.39 | 733.73 | 271.47 | 733.75 |

^a Source for northings, eastings, well casing elevations, and deviation corrections: REECO, 1994

^b Coordinate System: Nevada (Central) State Plane NAD27

^c Measured from top of well casing

^d Measured from top of well casing to land surface

Note: All elevations are m above mean sea level

Table 2-11 2008 Area 5 RWMS Groundwater Flow Calculations

| Hydraulic Conductivity = 1.12E-03 cm/s (3.67E-05 ft/s) ^a | | | |
|---|--------------------------|-----------------|--|
| Effective Porosity = 0.38 ^a | | | |
| Date | Hydraulic Gradient (m/m) | Velocity (m/yr) | Flow direction (degrees East of North) |
| 01/22/08 | 1.10E-04 | 0.10 | 198 |
| 03/03/08 | 1.25E-04 | 0.12 | 200 |
| 06/16/08 | 1.27E-04 | 0.12 | 202 |
| 09/09/08 | 6.29E-05 | 0.06 | 179 |

^a Source: REECO, 1994

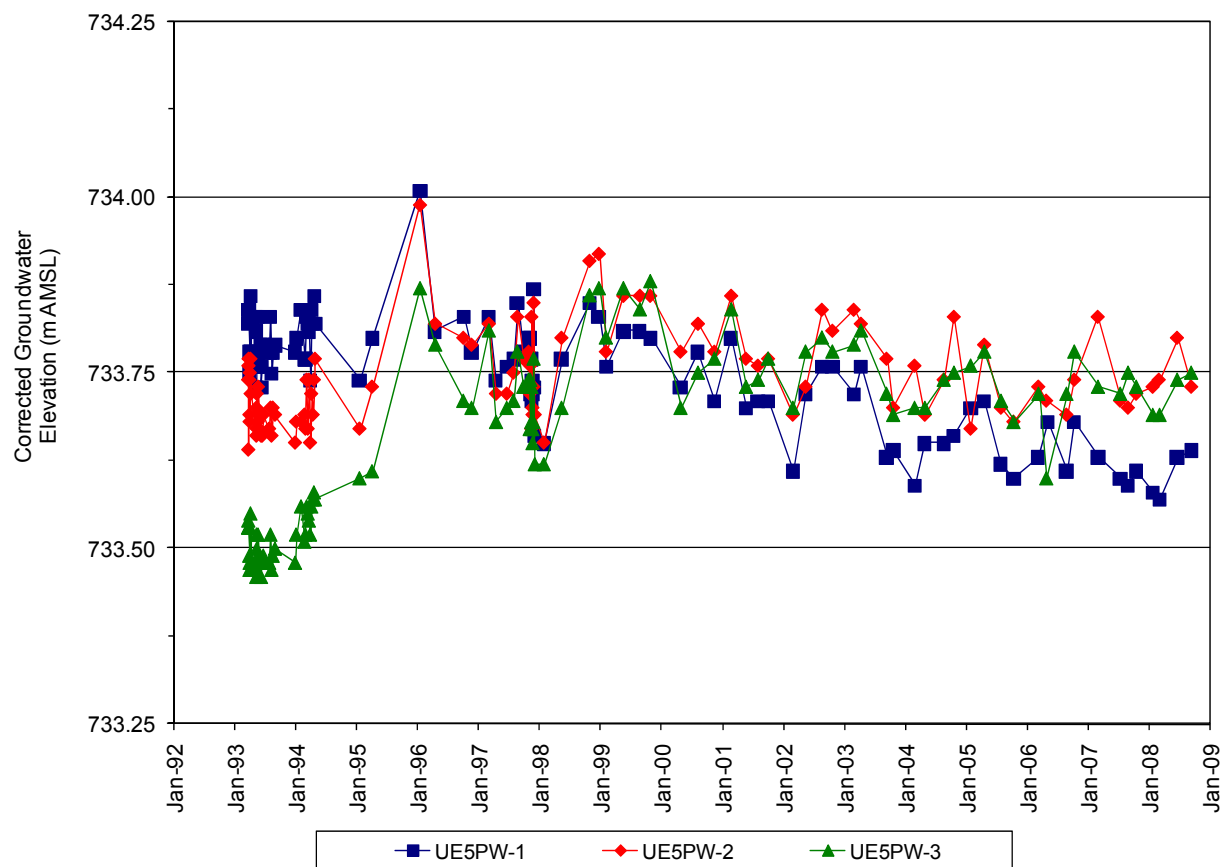


Figure 2-8 Area 5 RWMS Time Series Plot of Groundwater Elevations

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3.0 SUMMARY

The hydrologic conditions in the uppermost aquifer beneath the Area 5 RWMS remain stable. Groundwater flow in this uppermost aquifer is negligible. No significant changes were detected in the water chemistry, and all indicator parameters remain within the established ILs.

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4.0 CONCLUSION

There is no measurable impact to the uppermost aquifer from the Area 5 RWMS.

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**Appendix A – Cumulative Chronology for the Area 5 Radioactive
Waste Management Site Groundwater Monitoring Program**

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| Cumulative Chronology for Area 5 RWMS Groundwater (GW) 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 | | | | |
| 06/16/1992 | Drilling ends | 06/18/1992 | Drilling begins | | |
| 09/11/1992 | Well Developed | 09/04/1992 | Drilling ends | | |
| | | | | 09/16/1992 | Drilling begins |
| | | | | 11/09/1992 | Drilling ends |
| | | 03/24/1993 | GW Sampling | | |
| 03/31/1993 | GW Sampling | 03/30/1993 | Well Developed | 04/04/1993 | Well Developed |
| | | | | 04/14/1993 | GW Sampling |
| 06/06/1993 | GW Sampling | 06/22/1993 | GW Sampling | 06/02/1993 | GW Sampling |
| 09/01/1993 | GW Sampling | | | 10/12/1993 | GW Sampling |
| 12/07/1993 | GW Sampling | 11/15/1993 | GW Sampling | 12/20/1993 | GW Sampling |
| 12/17/1993 | DOE letter to Nevada Department of Environmental Protection (NDEP) requesting to establish Pilot Wells located near the Area 5 as Resource Conservation and Recovery Act (RCRA) groundwater monitoring wells. | | | | |
| 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 | | | 08/08/1994 | GW Sampling |
| | | 11/29/1994 | GW Sampling | | |
| 09/30/1994 | DOE submits 1993 groundwater-monitoring results from quarterly sampling effort. | | | | |
| 01/18/1995 | UE5PW-3 GW resampling for 08/01/1994 total organic carbon (TOC) hit. | | | | |
| 02/23/1995 | DOE transmits to NDEP Groundwater Monitoring Program Outline. | | | | |
| 03/01/1995 | 1994 GW Monitoring Report submitted to NDEP. | | | | |
| 04/04/1995 | GW Sampling | | | | |
| 11/09/1995 | GW Sampling | | | | |
| 11/09/1995 | UE5PW-1 pump snagged in hole, resulting in a bent shaft on the reel. | | | | |
| 01/18/1996 | GW Sampling | 01/25/1996 | GW Sampling | 01/18/1996 | GW Sampling |
| 01/22/1996 | Bennett pump seals replaced at all three wells. | | | | |

Groundwater Monitoring Program
Area 5 Radioactive Waste Management Site

| Cumulative Chronology for Area 5 RWMS Groundwater (GW) Monitoring Program | | | | | |
|--|--|-------------|----------------|-------------|----------------|
| Date | UE5PW-1 | Date | UE5PW-2 | Date | UE5PW-3 |
| 03/01/1996 | DOE submits to NDEP the 1995 GW Monitoring Report. | | | | |
| 04/16/1996 | GW Sampling | 04/23/1996 | GW Sampling | | |
| | | 04/30/1996 | GW Sampling | | |
| 10/02/1996 | GW Sampling | | | | |
| 10/25/1996 | NDEP requests clarifications/changes in the GW Monitoring Report. | | | | |
| 11/20/1996 | 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 | Total organic halides (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. | | | | |

| Cumulative Chronology for Area 5 RWMS Groundwater (GW) Monitoring Program | | | | | |
|---|--|------|---------|------------|----------------|
| Date | UE5PW-1 | Date | UE5PW-2 | Date | UE5PW-3 |
| 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. | | | | |
| 02/25/2000 | DOE submits to NDEP 1999 Groundwater Monitoring Report. | | | | |
| 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 | | | | |
| 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. | | | | |
| 02/21/2001 | DOE submits to NDEP 2000 Groundwater Monitoring Report | | | | |
| 03/14/2001 | Letter from NDEP stating that the 2000 GW Monitoring report was received in a timely manner and contains all the data required by Title 40 Code of Federal Regulations Part 265.94. Letter also requests information regarding data in Appendix A of the 2000 GW Monitoring Report (Bechtel Nevada, 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 | | | | |
| 03/01/2002 | DOE submits to NDEP 2001 Groundwater Monitoring Report. | | | | |
| 05/15/2002 | GW Sampling | | | | |
| 10/22/2002 | GW Sampling | | | | |
| 03/01/2003 | DOE submits to NDEP 2002 GW Monitoring Report. | | | | |
| 04/15/2003 | GW Sampling | | | | |
| 10/22/2003 | GW Sampling | | | 10/21/2003 | GW Sampling |

Groundwater Monitoring Program
Area 5 Radioactive Waste Management Site

| Cumulative Chronology for Area 5 RWMS Groundwater (GW) Monitoring Program | | | | | |
|--|--|-------------|----------------|-------------|----------------|
| Date | UE5PW-1 | Date | UE5PW-2 | Date | UE5PW-3 |
| 03/01/2004 | DOE submits to NDEP 2003 GW Monitoring Report. | | | | |
| 05/04/2004 | GW Sampling | | | | |
| 10/19/2004 | GW Sampling | | | 10/20/2003 | GW Sampling |
| 02/25/2005 | DOE submits to NDEP 2004 GW Monitoring Report. | | | | |
| 04/19/2005 | GW Sampling | | | | |
| 10/11/2005 | GW Sampling | | | | |
| 03/01/2006 | DOE submits to NDEP 2005 GW Monitoring Report. | | | | |
| 04/26/2006 | GW Sampling | | | | |
| 10/10/2006 | GW Sampling | | | | |
| 03/01/2007 | DOE submits to NDEP 2006 GW Monitoring Report. | | | | |
| 03/19/2007 | GW Sampling | | | | |
| 08/29/2007 | GW Sampling | | | 09/05/2007 | GW Sampling |
| 03/01/2008 | DOE submits to NDEP 2007 GW Monitoring Report | | | | |
| 03/11/2008 | GW Sampling | | | | |
| 09/10/2008 | GW Sampling | | | | |

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 near the Area 5 Radioactive Waste Management Site (UE5PW-1, UE5PW-2, and UE5PW-3) are used to calculate the magnitude and direction of the aquifer hydraulic gradient.

The locations of the three wells are given in Nevada State Central Zone coordinates in meters as Northing (N) and Easting (E) values. The coordinates of each of the three water elevation points define a plane that contains the water level points. The coordinates of the water elevation points are (E_i , N_i , e_i) where:

E_i is the East Coordinate of the i^{th} well (m)
 N_i is the North Coordinate of the i^{th} well (m)
 e_i is the water level elevation of the i^{th} well (m)

Assuming $i=1$ for UE5PW-1, $i=2$ for UE5PW-2, and $i=3$ for UE5PW-3, the vector **a** connecting the water level at UE5PW-1 to the water level at UE5PW-2 and the vector **b** connecting the water level at UE5PW-1 to the water level at UE5PW-3 are defined by:

$$\mathbf{a} = (E_2 - E_1)\mathbf{i} + (N_2 - N_1)\mathbf{j} + (e_2 - e_1)\mathbf{k}$$

$$\mathbf{b} = (E_3 - E_1)\mathbf{i} + (N_3 - N_1)\mathbf{j} + (e_3 - e_1)\mathbf{k}$$

The aquifer hydraulic gradient is the cross product $\mathbf{a} \times \mathbf{b}$.

$$\begin{aligned} \mathbf{a} \times \mathbf{b} &= \text{DET} \begin{bmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ E_2 - E_1 & N_2 - N_1 & e_2 - e_1 \\ E_3 - E_1 & N_3 - N_1 & e_3 - e_1 \end{bmatrix} \\ &= [(N_2 - N_1)(e_3 - e_1) - (e_2 - e_1)(N_3 - N_1)]\mathbf{i} + \\ &\quad [(e_2 - e_1)(E_3 - E_1) - (E_2 - E_1)(e_3 - e_1)]\mathbf{j} + \\ &\quad [(E_2 - E_1)(N_3 - N_1) - (N_2 - N_1)(E_3 - E_1)]\mathbf{k} \\ &= A\mathbf{i} + B\mathbf{j} + C\mathbf{k} \end{aligned}$$

Where: $A = (N_2 - N_1)(e_3 - e_1) - (e_2 - e_1)(N_3 - N_1)$
 $B = (e_2 - e_1)(E_3 - E_1) - (E_2 - E_1)(e_3 - e_1)$
 $C = (E_2 - E_1)(N_3 - N_1) - (N_2 - N_1)(E_3 - E_1)$

Dividing hydraulic gradient by C gives the magnitude of the gradient in Easting (**i**) and Northing (**j**) for a unit change in elevation (**k**)

$$(\mathbf{a} \times \mathbf{b})/C = A/C\mathbf{i} + B/C\mathbf{j} + \mathbf{k}$$

The magnitude of the gradient is:

$$\sqrt{A/C^2 + B/C^2}$$

The direction of the gradient from north (θ) is calculated using the magnitudes of easting (E) and northing (N).

If $B > 0$, then $\theta = \arctan (a/b)$
If $B < 0$, then $\theta = 180^\circ + \arctan (a/b)$
If $B = 0$ and $A > 0$, then $\theta = 90^\circ$
If $B = 0$ and $A < 0$, then $\theta = 270^\circ$
If $B = 0$ and $A = 0$, then the flow is straight down.

Calculation of Mean Groundwater Velocity

Groundwater flux is from calculated from Darcy's Law:

$$J = -K \left(\frac{\Delta e}{C} \right)$$

Where: J is groundwater flux (m/s)
K is saturated hydraulic conductivity (m/s)
 $\frac{\Delta e}{C}$ is the hydraulic gradient (m/m)

The mean groundwater velocity is calculated from the flux:

$$v = J / \phi$$

Where: V is mean groundwater velocity (m/s)
J is the groundwater flux (m/s)
 Φ is porosity (m^3/m^3)

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