DATA AND ANALYSIS

This section provides analysis of water quality (through July 2006) and water level data (through January 2007) for the Bernalillo County regional monitoring wells. The discussion for each of the five hydrogeologic areas starts with water level and water quality information provided by other agencies, primarily CABQ and USGS. This overview places the subsequent Bernalillo County monitoring well specific discussions within an area-wide context. Following the area overview, the report provides a brief description of the geologic setting for each well followed by water level and water quality data and analysis for each of the Bernalillo County monitoring wells

Wells and nested piezometers in the East Mountains, Far Northeast Heights, South Valley, and West Mesas are included as part of the Bernalillo County regional groundwater monitoring system. (Bernalillo County does not maintain regional monitoring wells in the North Valley or in Paradise Hills). Bernalillo County measures water levels in each of the wells at least annually during water quality sampling events. Recently, the County has implemented quarterly measurements and has begun installing pressure transducers to provide for continuous water level monitoring in wells not monitored by the USGS. Bernalillo County is responsible for monitoring water levels in the Cedar Hill and San Raphael wells in the Far Northeast Heights, and the Paradise Boulevard and Nine-Mile Hill monitoring wells on the West Mesa. Water levels in other Bernalillo County monitoring wells are monitored by the USGS and are periodically measured by Bernalillo County to provide confirmation of the USGS measurements. Water-quality samples are collected at least annually for all wells in the County's regional monitoring program.

The USGS continues to collect water levels from wells drilled under Bernalillo County/USGS cooperative agreements. The USGS collects quarterly hand measurements from the Paradise Road monitoring well and uses dataloggers to provide for continuous monitoring of the Rio Bravo Park and Isleta nested piezometers. The USGS also provides for continuous water level monitoring in the four monitoring wells located in the East Mountains. The USGS monitors other nested piezometers throughout Bernalillo County to evaluate the long-term impact of municipal pumping by the ABCWUA. Hydrographs for some of those wells are discussed in later sections of this report.

Additional information on regional water levels can be found on the USGS homepage: (http://nm.water.usgs.gov/water_data_QL.htm).

1.5 ***East Mountain Area Monitoring Wells***

The East Mountain Area encompasses approximately 318 square miles. The four Bernalillo County monitoring wells are concentrated in the northern portion of the area along a three-mile stretch and within one-mile either side of NM Hwy 14. The USGS has previously monitored water levels and water quality in additional wells along Frost Road, along NM Hwy 14 and NM Hwy 337, and along I-40 from Tijeras Canyon to the eastern county line.

As seen in Figure 3.1, the four Bernalillo County monitoring wells represent a very limited geographic portion of the East Mountain Area. Two of the wells are located in the Sandia Park area and the other two wells are located to the south adjacent to State Hwy. 14. At best, the four monitoring wells represent approximately 1.5 square miles, or less than 0.5 percent, of the East Mountain Area. The four ground-water-monitoring wells (Sandia Park Wells 1and 2, Pinon Ridge Well, and Sierra Vista Well) were drilled in 1998 to assess the effects of septic systems in fractured bedrock aquifers, primarily sandstone and shale units (Thomson et al. 2000). The wells are located in a geologically complex area because of intense faulting and fracturing that influences ground-water flow. Because of the fractured nature of the aquifers, ground-water quality and flow characteristics can be highly complex, conditions may vary significantly over short distances, and water levels may be subject to significant fluctuations over short periods. Consequently, the threat of contaminant migration is increased along with the difficulty in understanding groundwater flow.

1.5.1 *USGS East Mountain Area Monitoring Wells*

The location of the USGS monitoring wells, the four Bernalillo County monitoring wells, the Carlito Springs Open Space well and spring, and approximate location of domestic and public supply wells is shown in Figures 3.1 and 3.2.

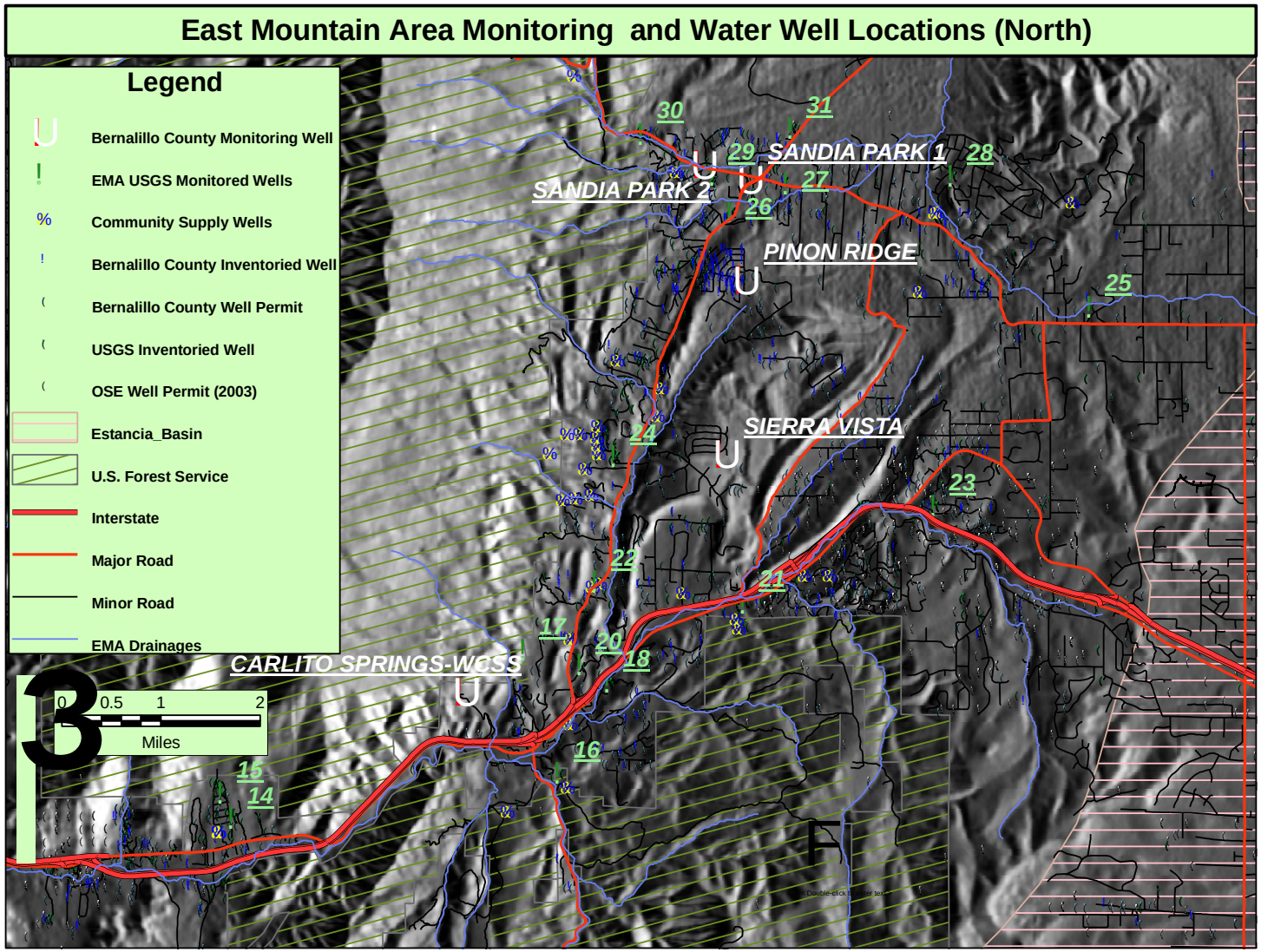


Figure 3.1 EMA Monitoring Wells (North Portion)

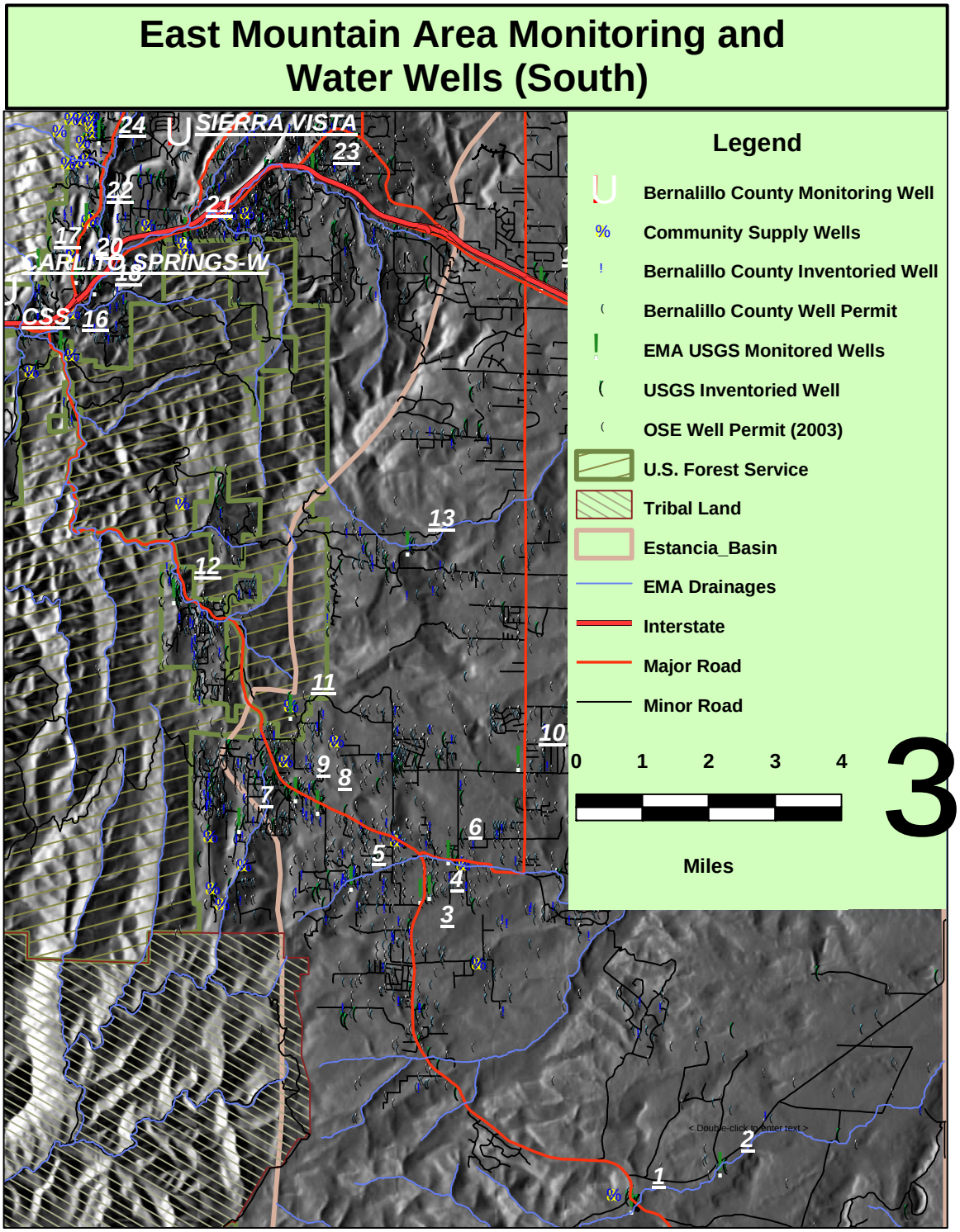


Figure 3.2 EMA Monitoring Wells (South Portion)

Table 3.1 provides a cross-correlation for the various well numbering systems used by the USGS for the water levels and water quality data in the 31 currently monitored East Mountain Area wells. Rankin (2000) initially presented a list of 74 wells and Blanchard (2003) reduced the list to 31 wells. Of these 31, only 17 of the wells are currently monitored for water level.

Table 3.1 USGS Monitoring Well Cross-Identification

USGS Site Identification (Based on Lat / Long)	Blanchard 2003	Rankin 2000	Blanchard and Kues (1999)	Kues and Garcia (1995)	Date of Latest Water Level Measurement	Data in USGS On-Line Water Level
345319 1061351 01	1	11	7	7	04/18/05	
345348 1061226 01	2	N/A			04/18/05	
345723 1061713 01	3	N/A			04/18/05	
345726 1061704 01	4	72			09/05/07	
345733 1061819 01	5	71			11/05/98	
345754 1061646 01	6	33			06/02/95	
345819 1062006 01	7	85			12/21/98	
345833 1061851 01	8	9		14	05/03/02	
345843 1061912 01	9	N/A			05/13/02	
345908 1061539 01	10	N/A			04/18/05	
345948 1061917 01	11	48			03/31/95	
350119 1062109 01	12	10	17	17	04/18/05	
350157 1061725 01	13	67			04/18/05	
350410 1062626 01	14	8	13		04/19/05	YES
350423 1062633 01	15	2	9		04/02/04	YES
350434 1062257 01	16	32			06/01/95	YES
350449 1062319 01	17	1	18	18	04/19/05	
350522 1062225 01	18	19	6	6	04/24/95	
350525 1061517 01	19	20	19	19	04/18/05	YES
350531 1062243 01	20	15	1	1	04/19/05	YES
350604 1062058 01	21	3	8	8	04/19/05	
350615 1062233 01	22	13	5	5	11/04/98	YES
350655 1061856 01	23	18	12	12	05/23/02	
350721 1062221 01	24	16	16	16	04/19/05	
350840 1061716 01	25	25			04/18/05	
350930 1062107 01	26	5	20	20	04/18/05	YES
350945 1062031 01	27	17			04/19/05	
350949 1061845 01	28		15	15	04/19/05	
350949 1062118 01	29	14	2	2	04/19/05	
351011 1062204 01	30	6	11	11	05/10/05	
351014 1062028 01	31	4	10	10	5/20/02	

In both the north and south portions of the EMA, the USGS locations are typically domestic wells monitored under informal agreement between the USGS and the private homeowner. These wells are subject to withdrawal from the monitoring program at the sole discretion of the homeowner with no assured right to monitor by either the USGS or the County. Figure 3.2 reflects that there are no Bernalillo County monitored wells south of I-40, and only a few USGS wells located either east or west of NM Hwy. 337.

1.5.1.1 EMA Water Levels

On-going series of water level measurements are available only for 17 of the 31 USGS monitored wells. There is a gap in available data from 1997 to 2002 and measurements taken since 1997 are generally absent from the on-line USGS database. In many cases, electronic data was not available prior to 2001. Water levels for the 17 wells for dates preceding 2001 were taken, where necessary, from hydrographs in USGS report OFR 03-81 (Blanchard, 2003).

In general, hydrographs for the USGS monitored wells indicated that declines in wells since 1990 may be occurring, but the decline has totaled less than 15 feet. The rate of decline has increased slightly since 1996 and, more noticeably, since 2001 when rounds of water level measurements were resumed by the USGS. This increase in decline rate coincides with the onset of drought conditions.

Eight (8) of the 17 measured wells exhibit increased rate of decline since 2001 and may represent a five- to seven-year delay in aquifer response to significant changes in precipitation (see Appendix A). Some wells may exhibit essentially instantaneous response to large precipitation events. The same eight (8) wells show a rise in water levels beginning in 2004.

Notable exceptions to these general trends occur in areas with a high density of community system pumping or densely spaced private domestic well use. In these areas, the fluctuations in water level due to pumping exceed the more subtle regional trends and drought-induced declines. Widespread regional decline in water levels appears to be about 0.5 to 1 foot per year, and is not the likely cause for well failures that occur in the EMA. Rather, inadequate well construction may be at fault. Inadequate construction occurs when the total depth of the well is too shallow to provide a reserve

for drought conditions and to compensate for additional drawdown from nearby pumping. Ideally, a private domestic well should be constructed such that on-going water use utilizes no more than 50 percent of the available water column in the well.

Figures 3.3 through 3.6 provide graphs of available water level data for USGS monitored domestic wells. The wells are completed in a variety of aquifers. Due to complexities of the geologic setting, no attempt is made to differentiate by aquifer. Moving eastward from Sandia Crest, faulting brings the eastward-sloping Madera Group units into contact with the younger Permian and Triassic-aged units, which outcrop west of NM Hwy 14. This complexity allows for cross-flow across the various units. Thus, precipitation events and periods of extended drought are seen as pulses in water levels, although these may be obscured by pumping near some of the measured wells. East of the Gutierrez Fault, the younger geologic units are absent and the Madera Group aquifer again outcrops in the southeastern third of Bernalillo County. The Madera Group aquifer and overlying alluvium is the principal aquifer in the EMA south of I-40 and for the northeastern portion of the EMA.

Based on water level data from 2001 to current, the hydrographs provided in Figure 3.3 through 3.6 can be separated into two groups, those showing a low in 2003-2004 followed by increased water levels in subsequent years, and those that show continuing decline or minimal change. Those wells showing a minimal change or continued decrease in water levels include Wells No. 3, 10, 13, 19, 25, and 28. With the exception of Well 28, these wells are all located to the southeast of the Gutierrez fault. Most of the wells located east of the Gutierrez Fault and south of I-40 are completed in the Madera Group aquifer.

Figure 3.3 provides hydrographs for the USGS monitored wells located near Sandia Park. The graphs show that the range of rise and decline is historically about 10 to 20 feet over a period of 5 to 10 years. Rises and declines of 10 to 20 feet are exhibited in Wells 29 and 30. Blanchard and Kues (1999) call out a six-foot rise in water levels in Well 30 between June and July 1991 and attribute the peak to intense rainfall in the preceding month. Between 1994 and 2004, water levels declined approximately 10 feet in Well 29 and approximately 5 feet in Well 30. These wells are located on the western boundary of Sandia Park. Given minimal rates of development in the immediate area, the declines are thought to be due to lack of precipitation from 1996 onward. Measurements made in

late 2004 and 2005 indicate a return to water levels last evidenced in the early 1990s - a rise of approximately 10 feet over two years. A similar rapid rise can be seen in 1983 in USGS well 350946406203301 and is seen in nearby Bernalillo County monitoring wells as will be discussed later.

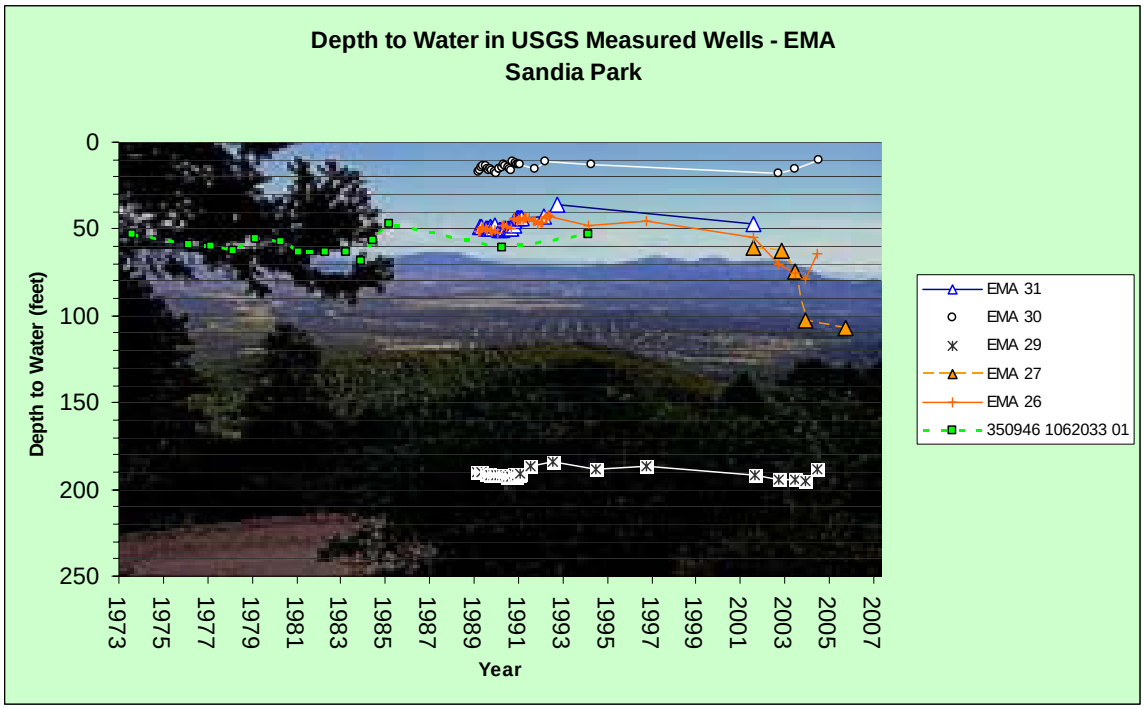


Figure 3.3 Water Levels near Sandia Park

Water levels in Well 26 demonstrated a trend similar to those in Wells 29 and 30 until 1997, after which water levels decline precipitously by 30 feet between 1997 and 2004. Approximately 20 feet of that decline was observed between 2001 and 2004 Measurements in 2004 indicated a slight rise, consistent with the rise seen in 2004 and 2005 in Wells 29 and 30. Well 31 demonstrates a similar trend. At least some portion of the decline since 1997 is related to lack of precipitation and is likely on the same scale as that exhibited in Wells 29 and 30. The increased rate of decline beginning in 2001 is thought to have resulted from increased pumping in the Sandia Triangle. The increased pumping in this geologically complex area has also affected Well 27, located at Bernalillo County Fire Station #6. From 2003 to 2004, the water level decreased over 30 feet. The well is inoperable due to an insufficient saturated thickness. Other nearby wells of others have been deepened to compensate for the decline.

The northeastern portion of the EMA (Figure 3.4) includes the Monte Largo horst and the eastward transition to the Madera Group aquifer and the Estancia Basin.

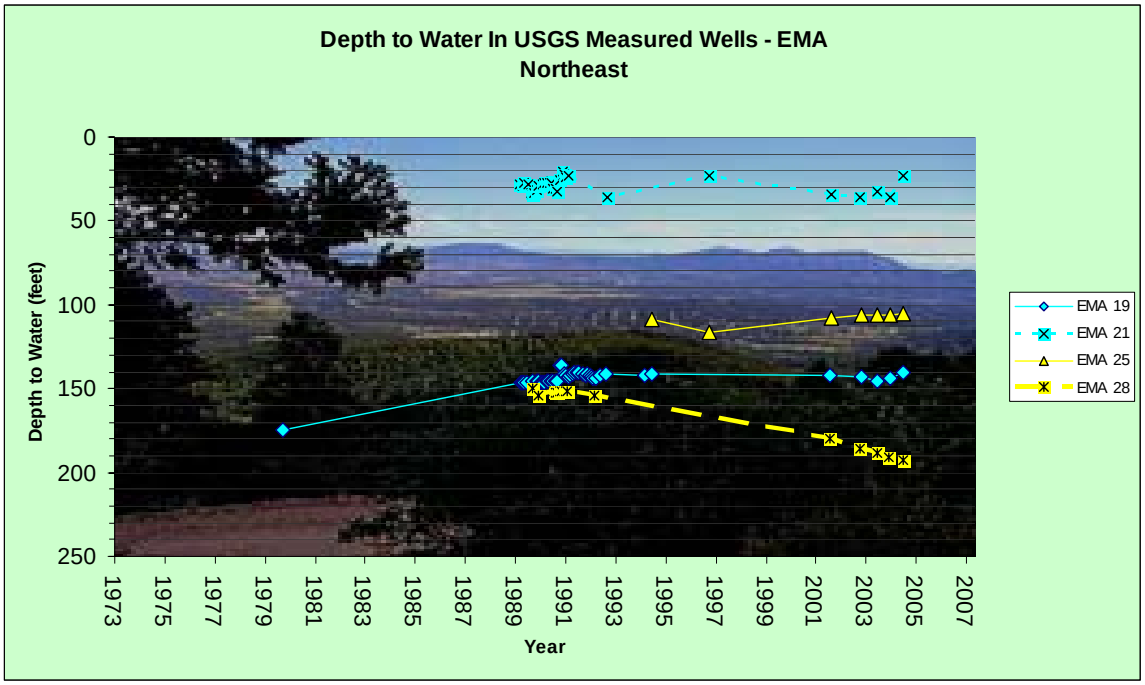


Figure 3.4 Water Levels in Northeastern Bernalillo County

Well 28 is located within the Monte Largo horst and is reportedly completed in the Pre-Cambrian formations. There is a nearby community supply well that services approximately 360 connections and pumps a reported 107 acre-feet per year. Due to the community well pumping, Well 28 shows a water level decline of approximately 40 feet between 1991 and 2004, or an average rate of decline of 3 feet per year. In contrast, Well 25 is located east of the horst and is completed within the Madera Group aquifer. Well 25 reflects minimal water fluctuation and there does not appear to be any decline in water levels since 1997. A one (1) foot rise in water levels was observed in 2005. Well 25 is located in an area of minimal development, so minimal water level change is expected.

Wells 21 and 19 are located near I-40, as shown in Figure 3.2, and both are apparently completed in the Madera Group aquifer. Well 21 is located on the eastern end of Tijeras Canyon and near the southern terminus of the Gutierrez Fault. Water levels in the well have shown rise and declines of approximately 20 feet over the period of record. Water levels in 2004-2005 were similar to those measured in 1990. Well 19 is located near the eastern boundary of Bernalillo County along I-40.

Since 1990, the water levels in the well have fluctuated by less than 1 foot from year-to-year. Of particular exception is a 6-foot peak in water levels in Well 21 and a 10-foot jump in water levels in June and July 1991. Blanchard and Kues (1999) indicate that the 1991 rise is due to unusually high precipitation in the preceding months. They also discuss a similar peak in Wells 15 and Well 30.

Figure 3.5 provides hydrographs for monitored wells within Tijeras Canyon and north along NM 14 to just south of Sandia Park.

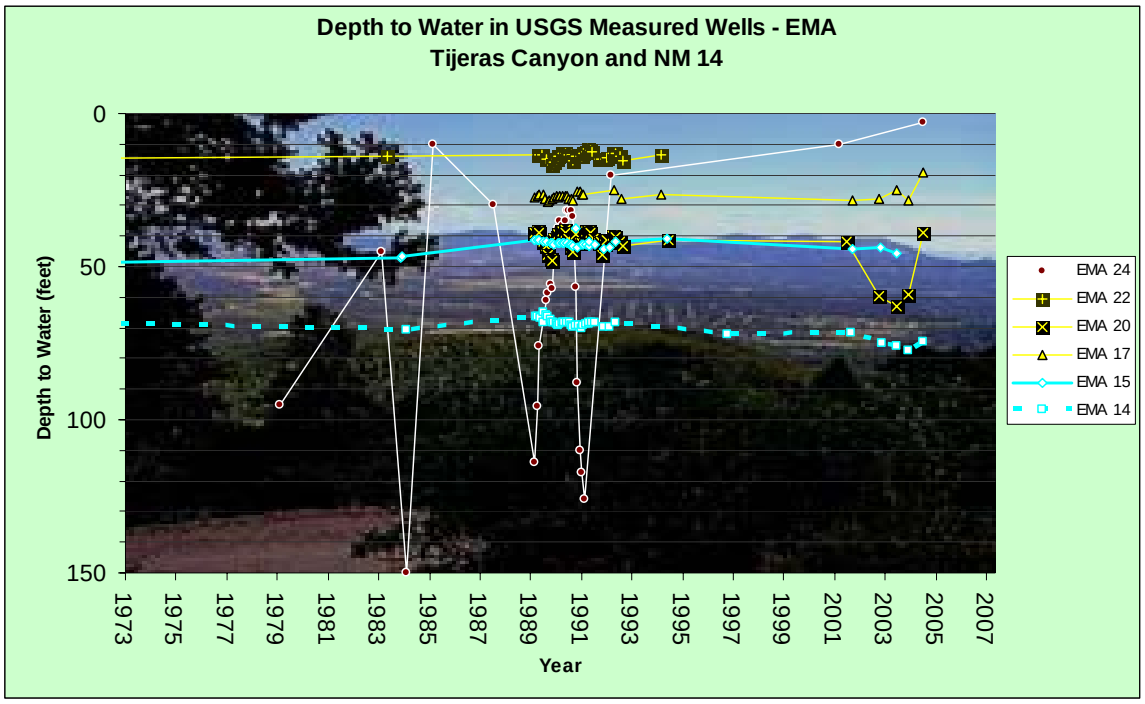


Figure 3.5 Water Levels in Tijeras Canyon and along NM 14

Wells 14 and 15 are located in the Carnuel community and are completed in Pre-Cambrian deposits and associated alluvial deposits. Water levels in Well 14 have been gradually declining since 1989 and at a rate of approximately 0.75-foot per year from 1990 through 1997. From 1997 to 2004, the rate of decrease increased to 0.9 feet per year. The increase in decline is presumed to be related to decreased precipitation during that period rather than increasing development. Water levels in Well 15 show a net decrease of only 3 feet between 1990 and 2004, suggesting an average rate of decline of only 0.2 feet per year. However, between 1995 and 2004, water levels dropped 0.5-foot per year, likely due to decreased precipitation over that period.

Wells 17, 20, and 22 are located north of Tijeras along NM 14. Well 17 is located in Tijeras southwest of the juncture of the Tijeras and Gutierrez faults, Well 20 is located near the juncture of the two features. Water levels in Well 17 rarely show greater than a two-foot fluctuation in water levels, suggesting the Tijeras overlies a key groundwater discharge point into the Tijeras arroyo. Between 2004 and 2005, there is an approximately 9-foot rise in water level, returning water levels to pre-1990 conditions. Well 20, by contrast, shows more marked fluctuations. Water levels in Well 20 can vary seasonally by 5 to 7 feet, with the lows occurring in the late summer and early fall. Well 20 also demonstrates a six (6)- foot peak in July-August 1991, consistent with peaks in other wells that have been attributed to significant precipitation in the preceding months. More recently, water levels from 2002 to 2004 decreased more than 18 feet over a two-year period. This sudden decline is presumably due to a change in well operations for the Village of Tijeras, including replacement of a failed well.

Well 22 is located approximately two (2) miles north of the Village of Tijeras and the last recorded measurement was taken in 1995. From 1991 to 1995, water levels did not fluctuate by more then two (2) feet, and the 1995 level was within 0.2 feet of the measurement taken in 1991. Well 22 is located near a perennial spring-fed stream and associated acequia, which presumably provided ample recharge for the well.

Well 24 provides a marked contrast to the wells just described. Water levels in Well 24 exhibit annual swings on the order of 100 feet. Perhaps the most noticeable is the decrease of 90 feet, which occurred during the summer of 1991 followed by a nearly full recovery to pre-1990 water levels in January 1993. Other wells exhibited 10-foot jumps during that same period, as previously described. As shown in Figure 3.2, Well 24 is located near at least 11 community supply wells. Undoubtedly, the fluctuation in water levels and the magnitude of that fluctuation is influenced by operation of those production wells, which provide service to over 500 East Mountain residents. Additionally, there are at least 20 domestic wells within a ½ mile radius of Well 20.

South of I-40, wells are completed in the Madera Group aquifer and/or the overlying alluvium, which fills many of the valley areas along the eastern and southeastern boundary of Bernalillo

County. Figure 3.6 provides the hydrographs for USGS monitored wells located in the southern portion of the County.

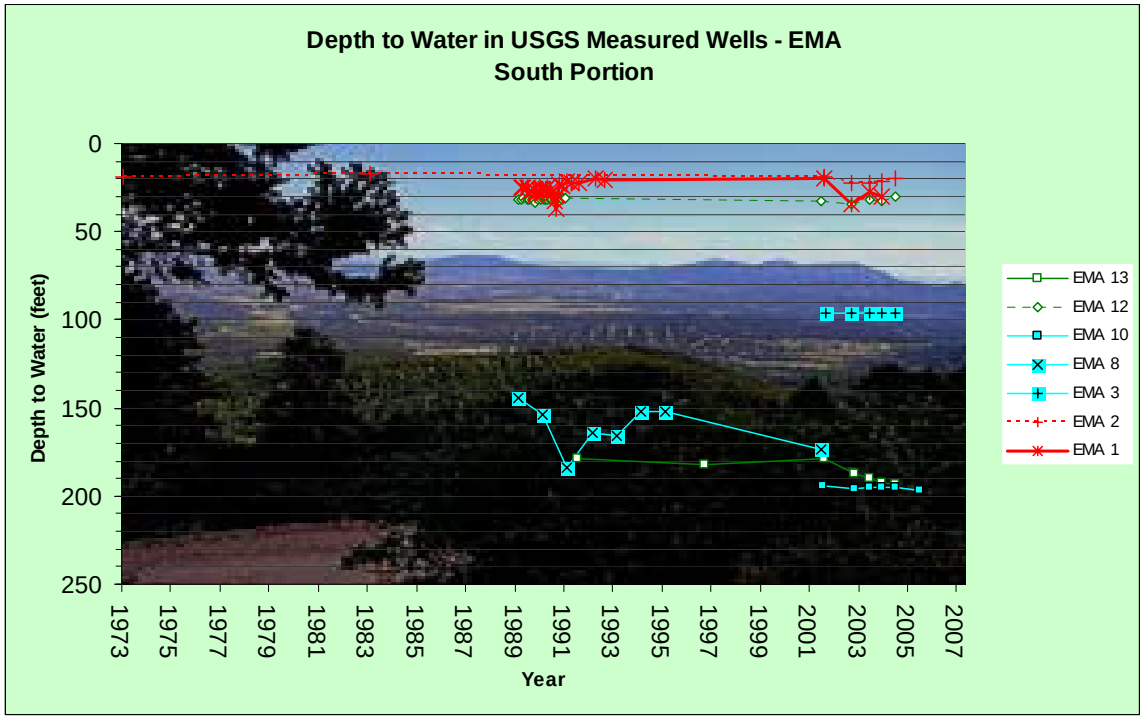


Figure 3.6 Water Levels in the South Portion of the EMA

Wells 1 and 2 are located near the community of Chilili. The hydrograph indicates that fluctuations on the order of 10 feet have occurred, but there does not appear to be any long-term decline in water levels in excess of that degree of fluctuation. Similarly, Well 2 shows fluctuations of approximately 3 feet or less, but no long-term decline is discernible.

Well 3 is located near Yrisarri. Available data only dates to 2002. Fluctuations in water levels in this well based on annual measurements are limited to a few tenths of a foot. There are no hydrographs for other nearby wells with which to compare. There is a perennial spring discharge area located approximately two (2) miles west, suggesting that water levels may not vary significantly.

Well 8 is located two (2) miles northwest of Yrisarri and exhibits a very different character than Well 3. Available measurements show an initial decline of 40 feet from 1990 to 1992, followed by a period of recovering water levels through 1996. The most recent measurement was taken in 2002,

and indicates decline of nearly 20 feet during that period, or an average rate of decline of four (4) feet per year. The cause of these rapid rates of decline is not clear. Community wells are located two (2) miles to the west and supply water for over 600 nearby residents. However, the distance is too great to be entirely reflective of competitive pumping. Other nearby domestic wells could potentially be affecting the measurements in the well. Alternately, Kues (1990) identifies this as an area of recharge, which may account for the wide fluctuation in water levels over relatively short durations. If so, water levels are likely precipitation dependent and more detailed water level and precipitation data are needed to verify that assumption.

Well 10 is located along NM Hwy 217 and approximately 1 ½ miles north of the intersection with NM Hwy 337. Water levels have been measured annually since 2002 and have declined about two (2) feet over that duration, or an average rate of decline of 0.5 feet per year. The well is located at a remote fire department substation, so pumping of the well is infrequent. Given the lack of pumping and the general lack of wells in the surrounding area, the decline is likely the effect of drought conditions.

As shown in Figure 3.2, Well 12 is located along NM Hwy 337 and just south of Juan Tomas Rd. Well 13 is located approximately mid-way from NM Hwy 337 and NM Hwy 217. Water levels in Well 12 have fluctuated less than 1 foot since 1990 and there is no discernible trend in the measurements. Water levels in Well 13 varied by approximately 4 feet from 1997 to 2003. However, in 2004 and 2005, water levels were measured as deep as 193 feet, suggesting the onset of a declining trend at a rate of 2.9 feet per year. The cause of the decline is not known. However, the well is located approximately ½ mile east of a groundwater divide, and like Well 8, may be in an area of recharge with water levels subject to significant fluctuations. Additional water level and precipitation data from this area are needed to determine the cause of the fluctuation.

In summary, the difference in water level response across the EMA is the result of several factors. In general, areas to the west of the Tijeras Fault are at increased elevation (i.e. greater than 7,500 feet) and, consequently, in area of increased precipitation. This increases the potential for direct recharge due to precipitation and snowfall events in the higher elevations.

Intense precipitation events may show an almost immediate response in some wells. Blanchard and Kues (1999) discuss water level response to a major precipitation event in July 1991 and indicate that in some local wells, water level rise may occur within a period of days or weeks of a significant recharge event (this response was noted by Blanchard and Kues for Wells 15, 30, 19). However, the water level response is more typically delayed several years from the precipitation event. Kues (1989, WRIR 89-4127) estimated a 2 to 3 year delay, but more recent data suggests an average groundwater age on the order of 10 to 20 years (USGS 2002, SIR 2004-5189). Appendix A provides a discussion on water levels for the Sandia Park wells and suggests a comparable delay in response - though the analysis is far from conclusive.

As previously mentioned, wells showing a minimal change or continued decrease in water levels after 2004 include Wells No. 3, 10, 13, 19, 25, and 28. Well 19, however, did demonstrate a jump in water levels in response to the 1991 precipitation event. With the exception of Well 28, these wells are all located to the southeast of the Gutierrez fault. The USGS (USGS 2004, p. 5) indicates that the Gutierrez fault coincides with a groundwater divide in the northeastern part of the County and with a north-south trending fault system south of I-40. In that vicinity, the groundwater gradients shifts from eastward to westward as one crosses the faults. This suggests that the direction of the groundwater gradients may be fault controlled or at least fault influenced, which would be consistent with a fracture-dominated groundwater flow system.

These multiple lines of evidence strongly suggest that recharge events occurring west of the Gutierrez fault and the north-south trending faults south of I-40 and along NM Hwy 337 do not significantly affect water levels in the southeastern third of the EMA. Rather, recharge to the Madera Group aquifer in south of I-40 and east of NM Hwy 337 is dependent on precipitation and snowfall events directly to the overlying ground surface, with subsequent infiltration through fractures, joints, and dissolution channels and migration to the west. Precipitation and snowfall events in the higher elevations to the north and east appear to have little or no impact east of the Gutierrez fault system.

This leads to the conclusion that recharge within the EMA is both geologically and geographically dependent. Geography, chiefly expressed as elevation, controls the amount of available

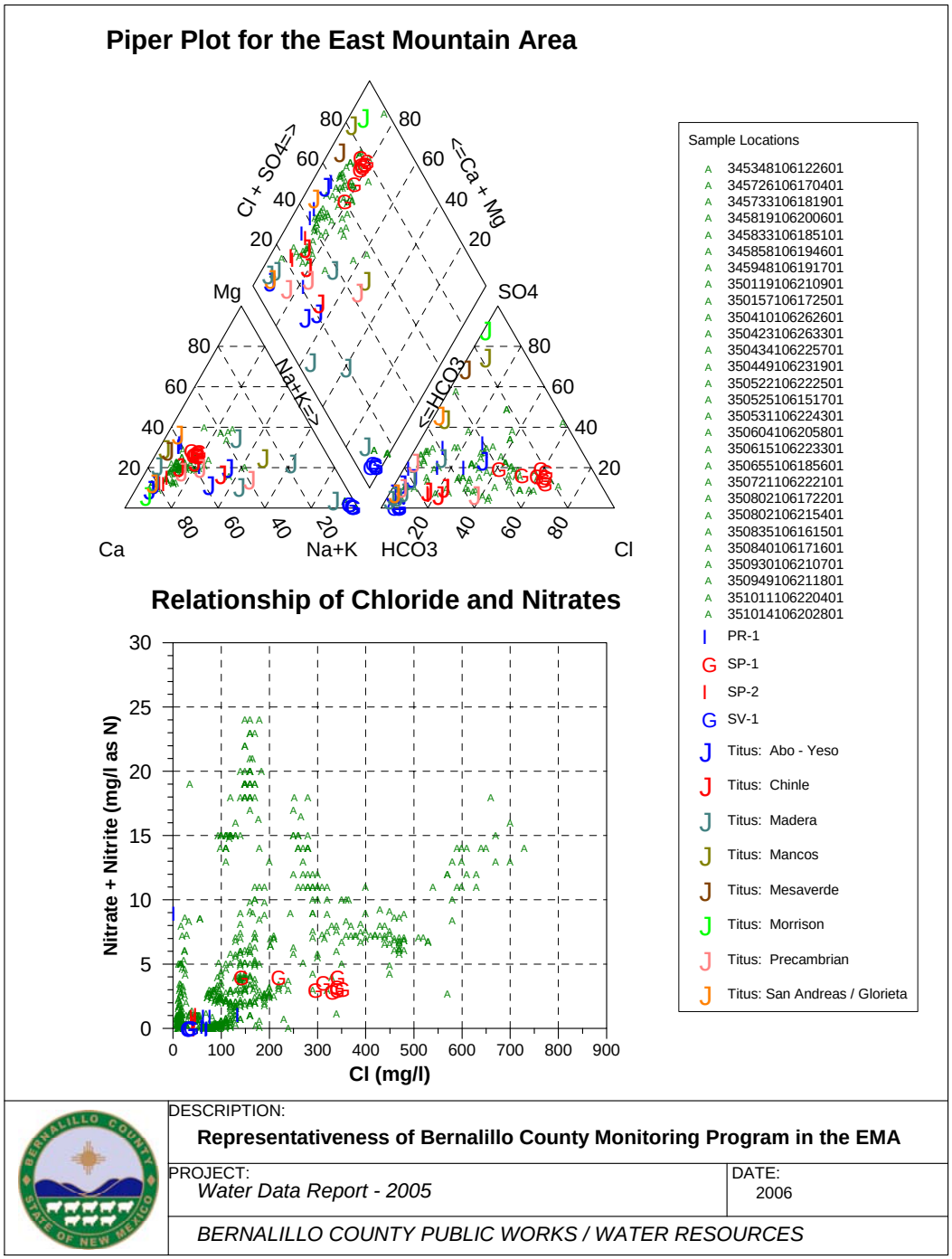
precipitation, which varies across the EMA, and differing geologic conditions control the capacity for infiltration and direction of flow. Consequently, land use planning as it pertains to water availability needs to consider the wide diversity in geologic settings in the East Mountain Area and may need to adjust lot sizes to provide for sustainable water supplies. Additional monitoring sites and targeted hydrogeologic studies are needed in the southeast portions of the EMA to establish the recharge potential and subsequent groundwater flow patterns. The monitoring data and study results should be used as a basis for determining sustainable development patterns.

1.5.1.2 EMA Water Quality

Figure 3.7 provides a Piper plot for all readily available anion-cation analyses for wells in the East Mountain area (i.e., all results were plotted regardless of accuracy in the calculated anion-cation balance). A description of the use of Piper Plots is provided in Section 2. Each sample from the USGS and Bernalillo County database is represented, with multiple samples potentially having been taken from any given well. In addition to the readily available analyses, plots of samples reported by Titus (1980) are provided for comparison.

In general, anions and cations in the EMA groundwaters consist of a predominance of calcium with little or no sodium and potassium. Generally, the anions consist of a predominance of bicarbonate and chloride. As a result, the analyses for EMA water typically plot to the upper left side of the middle Piper diamond. With respect to the relative percentage of anion and cations, three of the four Bernalillo County monitoring wells (PR-1, SP-1, and SP-2) produce water typical of the EMA.

The fourth monitoring well (SV-1) plots at the lower point of the Piper diagram and is unlike any other water analysis plotted for the EMA with the exception of USGS Well No. 24 (350721106222101). Well 24 is located due immediately west of SV-1. The predominance of sodium bicarbonate in these two wells is atypical for the East Mountain area. The USGS (in OFR 00-476 and designated as Well 16 therein) designated this well as producing from the Chinle aquifer. Monitoring well SV-1 appears to have been completed in the Mancos Shale. Faulting in the area of USGS Well No. 24 brings the Mancos into contact with the Cretaceous age sediments (Kues 1989, WRIR 89-4127, 1989). This contact, and inter-flow between the units, may account for the atypical composition in USGS Well. No. 24 - that is, groundwater in Well 24 may be a blend of compositions from the Chinle and the Mancos Shale.



DESCRIPTION:
Representativeness of Bernalillo County Monitoring Program in the EMA

PROJECT: *Water Data Report - 2005*

DATE: 2006

BERNALILLO COUNTY PUBLIC WORKS / WATER RESOURCES

Figure 3.7 Water Quality in the East Mountain Area

Of the 31 USGS wells, the most recent analyses from these wells indicate two with nitrate concentrations greater than 10 mg/L. These two wells (USGS No. 14 and 26) are located in Carnuel and in Sandia Park, respectively. Each of the wells have other wells in close proximity, (USGS Wells No. 15 and Wells No. 29 and 30 respectively), which showed only minor concentrations (<1.0 mg/L) of nitrate during the last sampling event in 2001-2002. An additional seven USGS well locations yielded nitrate concentrations in excess of 5 mg/L, and a further five wells yield nitrate concentrations in excess of 1.0 mg/L. In short, of the 31 USGS monitored wells, 14 of the wells (approximately half) yielded nitrate suggestive of septic tank contamination.

As a secondary indicator, the scatter plot indicates that while samples with elevated nitrate concentrations may exhibit either normal or elevated concentrations of chloride (i.e. chloride concentrations are greater than 200 mg/L in about ½ the samples where nitrate concentrations are above 2 mg/L), elevated chloride concentrations are consistently associated with elevated nitrate concentrations. However, there is not a linear relationship in concentrations, so chloride concentration is not a surrogate measure of the magnitude of the associated nitrate contamination. This also suggests that elevated chloride concentrations is indicative of septic tank contamination and is unlikely to be attributable to other sources such as deicing salt use. Alternately, discharge of water- softener brines through or near the septic system disposal field may be indicated.

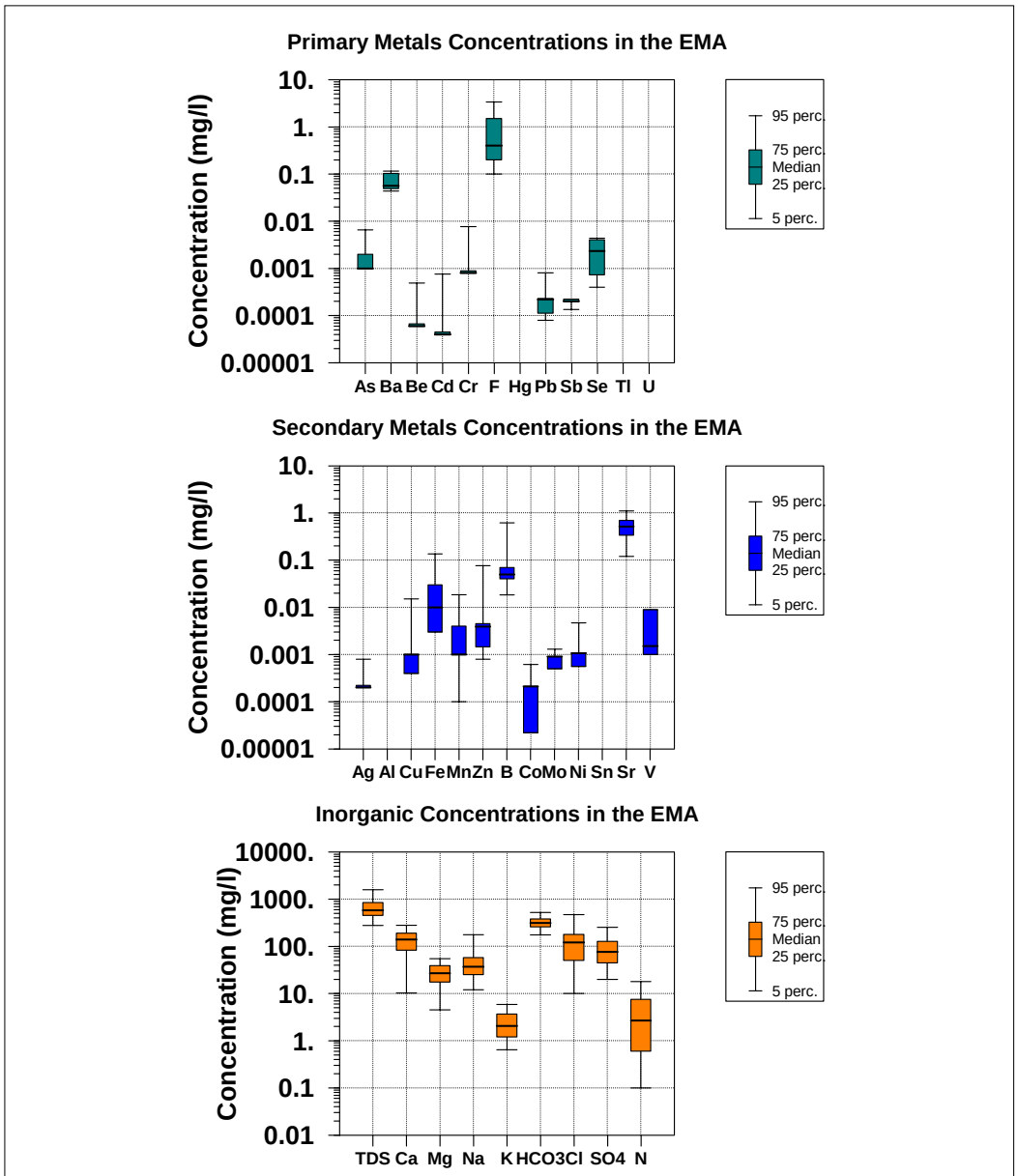
The scatter plot in Figure 3.7 comparing nitrate + nitrate concentrations to chloride concentrations indicates that while the Bernalillo County Monitoring wells may fall within the range of anion-cation concentrations present in the EMA, they are not representative with respect to monitoring nitrate contamination from septic tanks. As shown on Figure 3.7, nitrate concentrations above the U.S. EPA drinking water standard (10 mg/L) are found throughout the EMA, as are wells with elevated concentrations (above 2 mg/L and below 10 mg/L). In the EMA, there are multiple areas, most notably Sandia Park, Tablazon, and the subdivisions north of Sedillo Hill Road with known or suspected nitrate contamination issues. The USGS analyses suggest that elevated nitrate concentrations exist in slightly less than 1/2 of the wells monitored. By contrast, only one of the Bernalillo County monitoring wells (SP-1) consistently yields nitrate concentrations in excess of 1 mg/L.

In large part, the difference in representativeness is due to USGS's sampling of domestic wells, which by their nature, are located adjacent or in close proximity to active septic tank disposal fields, (i.e. both are located within a 1 to 2-acre lot size) and the greater number of wells sampled. By contrast, while the four monitoring well locations were chosen based in part on density of septic tanks and age of subdivision, the monitoring wells were located in public right-of-ways or County-owned property. Such locations are typically not immediately adjacent to known septic tanks. Conceptually speaking, the USGS analyses are more representative of likely conditions to be encountered by an individual homeowner, while the four monitoring wells are reflective of the extent of the lateral spread of nitrate-contaminated groundwater.

In general, the samples reported by Titus and shown on the Piper diagram were from wells located south of the I-40 area and are more representative of groundwater from the northern portions of the Manzano Mts, rather than the Sandia Mts. – consistent with the intent and focus of the Titus report. This is particularly true of samples from the Abo-Yeso and many of the samples from the Madera. This highlights the difference in geologic subareas of the EMA, namely the change in geology and hydrogeology that occurs south of I-40.

The difference in hydrogeologic subareas on the opposing sides of the Gutierrez Fault engenders a question as to whether differences in water quality may also be occurring. Because the nature of the geologic materials is different, it is necessary to compare only analytical results from the Madera Group from either side of the fault to determine whether significant differences exist. A review of the Piper Plot presented above while considering the location of the Madera wells represented does not suggest any significant differences in the relative percentages of anions or cations except for the samples taken from Titus. However, fluctuations in water levels may affect individual concentrations with time but not affect the relative percentage of the anion-cation balance.

The constituent distributions shown in Figure 3.8 are based on available sampling data. In some cases, particularly for the various metals, the sample set is small (less than 10 samples), so reliability of the distribution may be questionable. Absence of a distribution indicates that the sample size was insufficient to allow calculation of the various percentiles.



	Bernalillo County Public Works / Water Resources	
	Project: Water Date Report - 2005	Date: August 2006
	Description: **Metals and Inorganic Concentrations in EMA Groundwaters**	

Figure 3.8 Metals and Inorganic Concentrations in the East Mountain Area

With respect to U.S. Primary Drinking Water Standards (Tables 2.2a and 2.2b), groundwater samples from wells in the EMA generally do not exceed primary drinking water standards with the exception of the maximum contaminant level (MCL) for nitrate in Wells No. 15 and 26 as previously discussed. There are individual instances of the MCL for arsenic being exceeded in Well No. 8 (near Yrisarri) and fluoride (4.0 mg/L) in a well near the intersection of Frost Road and State Hwy 217. These exceedances are the maximum reported values and their infrequency is reflected in the 95th percentile distributions for these contaminants plotting below the drinking water standard concentrations. Additionally, there are multiple exceedances of the secondary standards (which are based on taste, aesthetics, or other factors) for total dissolved solids, fluoride, chloride, iron and manganese. The respective standards and the percentage of samples exceeding the standards are shown in Table 3.2.

Table 3.2 Exceedances of EPA Drinking Water Standards – East Mountain Area

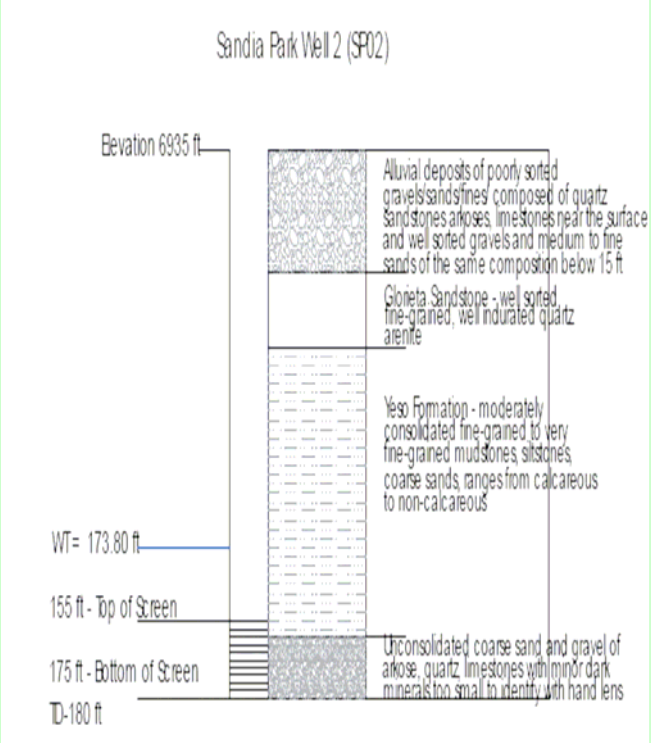
Parameter	Primary Standard	Secondary Standard	Total Number of Samples	Percent of Samples Exceeding Standard
Nitrate	10		733	13
Arsenic	0.010		71	3
Fluoride	4	2	77	6
Total Dissolved Solids		500	78	63
Chloride		250	770	18
Iron		0.3	550	2
Manganese		0.5	91	3

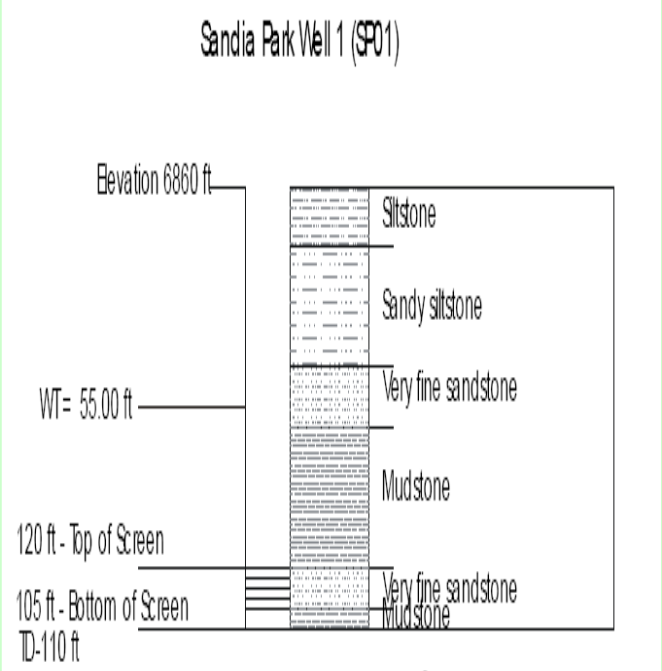
1.5.2 *Sandia Park Wells 1 and 2*

As previously shown on Figure 3.1, the Sandia Park wells are located near the Sandia Park triangle (Sandia Park Well 1) and just east (Sandia Park Well 2) of the intersection of State Hwy. 14 and the Sandia Crest Highway. These locations were originally selected to support a study focused on the evaluation of on-site wastewater treatment and disposal and were selected based on a combination of factors including residential septic system density, depth to groundwater, proximity to USGS-monitored domestic wells, and availability of County-owned properties (Thomson et al. 2000, p. 36-38). Well construction information is provided in Table 3.3 and Figure 3.9. Sandia Park Well 1 was completed in the sandstones of the Chinle Group (designated as Trc on the geologic map of Figure 3.10), while Sandia Park Well 2 was completed in the Abo-Yeso.

Table 3.3 Bernalillo County Regional Monitoring Well Network – Sandia Park Wells

Well	Well Type	Well / Hole Depth (ft)	Screen Settings (ft)
Sandia Park Well 1(SP1)	Single	110	95-105
Sandia Park Well 2 (SP2)	Single	180	155-175





(Both well diagrams taken from Thomson et al. 2000)
Errata: Top screen should be at 95 feet for Sandia Park Well 1.

Figure 3.9 Well Completion Logs for Sandia Park Wells 1and 2

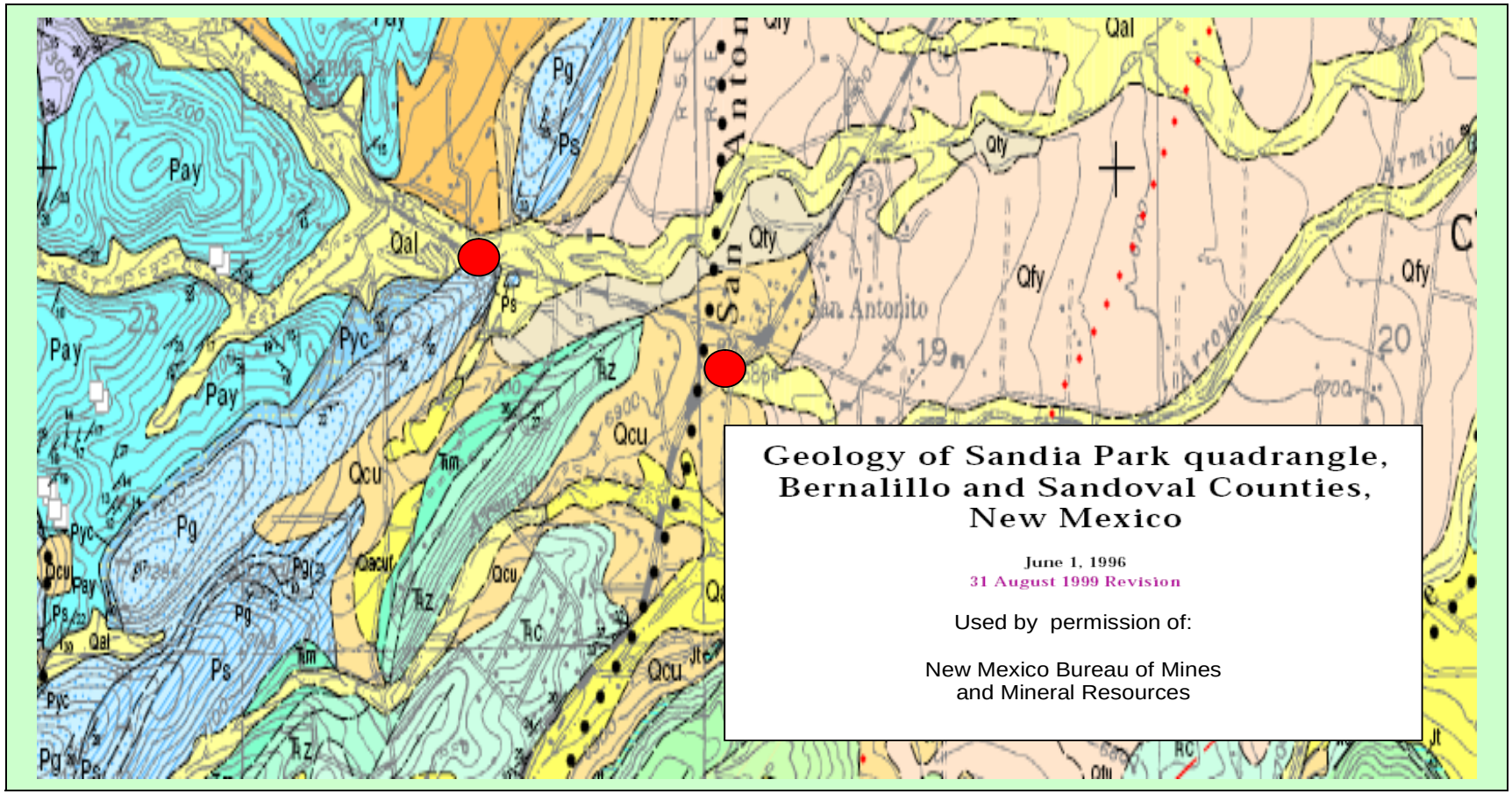


Figure 3.10a Geologic Setting of Sandia Park Wells 1 and 2

Surficial Units
Quaternary

Qal — **Valley alluvium (Holocene)**—Predominantly sand and silt and local gravely or clay-rich beds. Deposits underlie active floodplains and headwaters of low-order streams. As many as four upward-fining packages, separated by buried soils, are exposed locally in large incised drainages. Deposits derived from Permian bedrock are red; those derived from Pennsylvanian and Cretaceous bedrock are brown. Deposit locally incorporates debris-flow facies, derived from adjacent hillslopes, and spring and cienega carbonate- and organic-rich, fine-grained facies. From 3 to 20 ft (<1 to 6 m) thick.

Qcu — **Colluvium (Holocene and Pleistocene)**—Coarse-grained, poorly sorted, poorly stratified colluvial deposits. Deposit includes colluvium derived from a variety of mass-movement hillslope processes including debris flows, slumps, and landslides. Angular-clast, matrix-supported deposits are locally present as talus on the dip slope of the Sandia Mountains. Locally includes isolated exposures of bedrock. From 3 to 25 ft (<1 to 8 m) thick.

Qacu — **Alluvium and colluvium, undivided (Holocene to late Pleistocene)**—Poorly stratified, predominantly matrix supported colluvium that interfingers downslope with a valley-bottom alluvium. Deposits underlie toeslopes and valley bottoms of low-order streams and broad low-relief headwaters of Frost Creek and San Pedro Creek. From 3 to 25 ft (<1 to 8 m) thick.

Qacuc — Predominantly coarse grained, locally clast supported colluvium.

Qacuf — Predominantly fine grained colluvial deposits derived from shales, siltstones, and friable sandstones.

Qt — **Fluvial terraces (Pleistocene)**—Well-sorted, well-stratified, rounded fluvial gravels and sand and lesser amounts of silt and clay. Terrace deposits lie adjacent to major high-order drainages as predominantly thin inset alluvial fills that bury low-relief straths cut on bedrock. From 3 to 20 ft (<1 to 6 m) thick.

Qty — **Fluvial terraces (late Pleistocene)**—Straths typically 6 to 65 ft (2 to 20 m) above grade. Treads exhibit both intact and reworked characteristics. Soils developed in these terraces exhibit from stage I to II calcic horizon development.

Qto — **Fluvial terraces (middle Pleistocene)**—Straths typically 100 ft (30 m) above grade. Treads are significantly reworked, and soils developed in these terraces exhibit from stage II+ to III+ calcic horizons.

Qf — **Alluvial fans (Pleistocene)**—Moderately well sorted and stratified alluvial-fan sand, gravel, and boulders and lesser amounts of silt and clay. Fan facies reflect predominantly fluvial processes and to a lesser extent debris-flow and/or hyperconcentrated-flow processes. From 6 to 30 ft (2 to 10 m) thick.

Qfu — **Small alluvial fans, undivided (Holocene and late Pleistocene)**—These small fans are typically found at tributary mouths in alluvial valley bottoms and at the base of steep hillslope drainages.

Qfy — **Alluvial-fan deposits inset into the Qfo deposits (late Pleistocene)**— Younger fan deposits inset into Qfo. These deposits are composed of a heterolithic mix of carbonate and various Proterozoic rocks including quartzite. Fan surfaces exhibit modified bar and swale topography. Soils developed in these deposits exhibit from stage I to II+ calcic horizons.

Upper Triassic

TRc — **Chinle Group**—Dark-red, mostly medium bedded, trough and wedge-planar cross-stratified feldspathic sandstone and silty micaceous shale, about 1,300 ft (400 m) thick. Green reduction spots are common, as are limestone-pebble conglomeratic intervals, particularly near the base of the unit.

TRz — **Agua Zarca Formation**—The only subdivision of Chinle Group recognized during this study. It is a tan to light grayish-pink, resistant, thin- to medium-bedded quartz arenite and feldspathic arenite, about 350 ft (105 m) thick.

Middle and Lower Triassic

TRm — **Moenkopi Formation**—Recessive-weathering, dark-red micaceous shale, silty shale, and thin-bedded feldspathic sandstone, about 200 ft (60 m) thick.

Upper Permian

Psg — **San Andres–Glorieta Formations, undifferentiated**—The upper two lithostratigraphic units of the Permian have a combined thickness of about 400 ft (120 m), and are complexly interleaved. The lithotypes, which may not correlate strictly with formations of the same names, are gray limestone (San Andres) and white quartz arenite (Glorieta). These were differentiated where possible.

Ps — **San Andres Formation**—Light-gray and less commonly tan, medium- to thick-bedded limestone. The limestones are mostly micrites or skeletal wackestones, commonly with some component of quartz sand.

Pg — **Glorieta Formation**—White and pink (along contact with underlying Yeso Formation), massive or plane-bedded to low-angle planar cross-stratified quartz arenite. Locally, the sandstones are extensively bioturbated (*Macaronichnus*), and near the contact with Yeso Formation they are feldspathic. The sandstones are typically well sorted, but a thin, feldspathic quartz-pebble conglomerate occurs just below the base of the lowermost San Andres Formation limestone in the Arroyo Armijo area along the boundary between Sandia Park and Sandia Crest quadrangles.

Lower Permian

Pay — **Abo–Yeso Formations, undifferentiated**—The lower two lithostratigraphic units of the Permian represent a reddish, feldspathic to quartzose siliciclastic sequence that reaches 1,300 ft (400 m) in thickness, and was mapped as a single unit throughout most of the study area.

Py — **Yeso Formation, undifferentiated**—Reddish to pink or tan, medium- to thin-bedded feldspathic sandstone, shale, and silty shale interbedded with massive or laminated, micritic, gray or tan limestone near the top. The sandstones are typically cross-stratified and/or cross-laminated and virtually identical to those within the underlying Abo lithotype except that salt-hopper casts and molds are present

Pyc — **Yeso limestone**— Intervals, generally less than 5 m thick, of massive or algal/cryptalgal-laminated limestone. The limestones are typically micritic, fenestral fabrics are commonly preserved, and they contain abundant quartz sand

Pys — **Yeso sandstone**—Red to light-red and tan, medium- to fine-grained feldspathic sandstone and red siltstone or shale. Sandstones are typically thin to medium bedded and wedge planar to trough cross-stratified; ripple cross-laminations are common in the finer-grained intervals. Yeso lithotype siliciclastics are virtually indistinguishable from those of the Abo lithotype, and these sequences were usually mapped together. Yeso siliciclastics were differentiated only in areas directly adjacent to Yeso limestones or where salt-hopper casts/molds are abundant. Salt-hopper casts and molds are usually present in the upper part of the Abo–Yeso formation siliciclastic sequence, but because of the generally poor exposure and the small size of float material, the presence or absence of these structures was not considered a reliable criterion for picking the Abo–Yeso contact.

Pa — **Abo Formation**—Red and locally tan (particularly near the base), medium- and thin-bedded arkose and feldspathic sandstone interbedded with red micaceous siltstone and shale, commonly with green reduction spots. The lowermost arkoses are typically lighter colored and coarser grained than the younger feldspathic sandstones, and at least one of them is strongly bioturbated (*Macaronichnus*). The sandstones are cross-stratified (typically trough and wedge-planar geometries), and the finer-grained rocks are commonly ripple cross-laminated. In addition, mud-chip clasts and plant debris are common.

Pac — **Abo limestone**—Rare, less than 1-m-thick, thin- to medium-bedded, gray to tan limestones, typically containing abundant bivalve fragments and/or echinoid spines.

Figure 3.10b Geologic Setting of Sandia Park Wells 1and 2

1.5.2.1 Water Levels in Sandia Park Wells 1 and 2

Water levels have been monitored in Sandia Park Well 1 since July 1997, with levels being measured semi-annually through 2004 and at least annually thereafter. A hydrograph for Sandia Park Well 1 is provided as Figure 3.11. No Bernalillo County data are available for the period from November 2004 to October 2005.

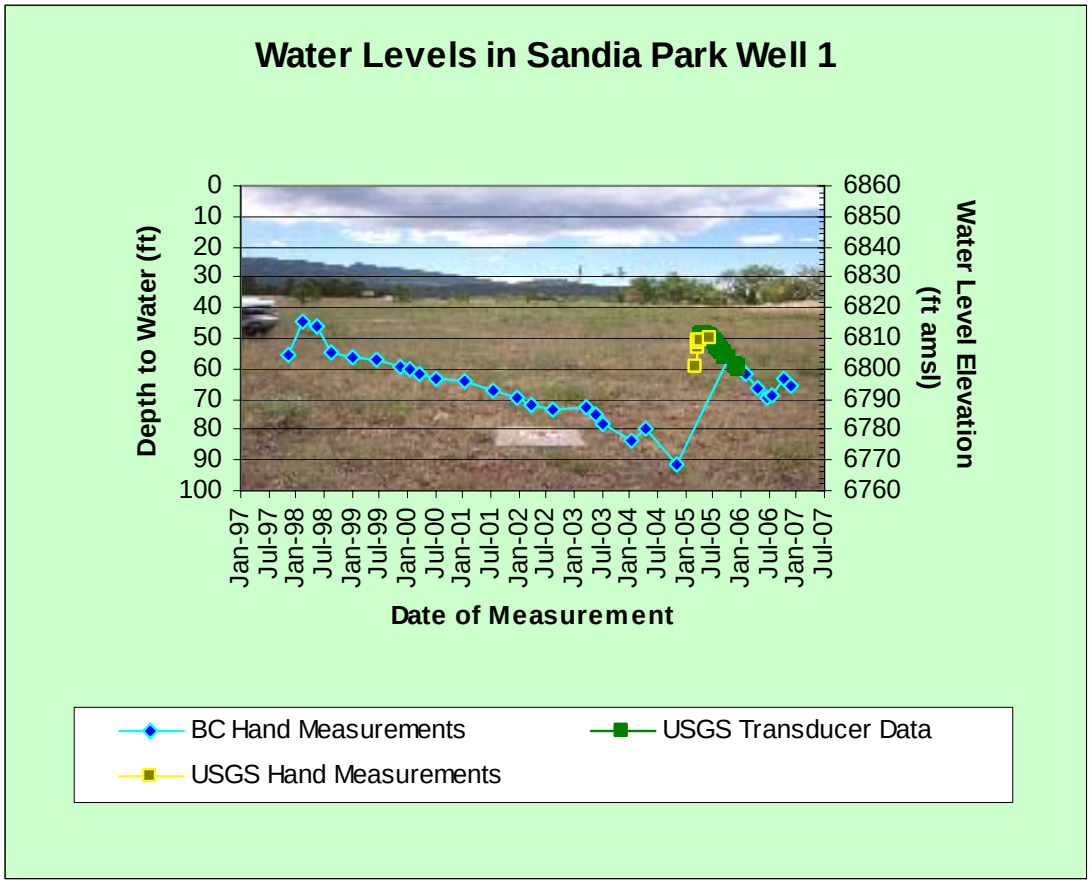


Figure 3.11 Water Levels in Sandia Park Well 1

The measurements shown in Figure 3.11 taken since July 1998 show a consistent decline in water levels through late 2005. Water levels have risen since the Fall 2005. In September 1998, the recorded measurement was at an elevation of 6805.23 ft, and the lowest measurement of 6768.49 ft amsl occurred in November 2004. The difference in measurements indicates a net decline of 36.74 feet over a 7 year and 2 month period, or an average decline of 5.9 feet per year.

The prolonged dramatic decline in the water level of this well is likely attributable to increased ground-water demands from private and commercial wells coupled with lower winter precipitation throughout this period. The amount of decline is also significant with respect to longevity of the monitoring well. The total well depth for Sandia Park Well 1 is 105 ft , while the November 2004 measurement was recorded as 91.51 feet below the top of the casing – a measurement that is within 13 feet of the bottom of the well. At an average decline of 5.9 feet per year, continuing drawdown could have rendered the well dry within an additional two-year period. As shown in Figure 3.11, a dramatic rise in water levels occurred between late 2004 and early 2005, returning water level conditions to near 1998 levels and extending the life of the monitoring well.

In early 2005, an automated water level measuring system (i.e., a pressure transducer and datalogger) was installed by the USGS, with additional hand measurements being taken to verify the automated measurements. The USGS hand-measured data has not been verified and is given here only to better identify the timing of the peak rise in water levels and to show confirmation of the reported transducer data. The transducer data, USGS hand-measured data and BC measured data all indicate the occurrence of the peak occurring in Sandia Park Wells 1 and 2 in June 2005.

Water levels have been monitored in Sandia Park Well 2 since early 1998 and monitoring has continued through the present (see Figure 3.12). Similar to Sandia Park Well 1, the measurements indicate a continual decline in water levels from 1998 through 2005. The highest water level elevation was the initial measurement made in March 1998 with the recorded water level elevation of 6802.2 ft above means sea level (amsl). The lowest measurement was recorded in November 2004 at an elevation of 6766.2 ft amsl. This represents a decline of 36 feet over a period of 5 years 8 month or an average decline of 6.4 ft per year. The rate of decline is slightly greater than that exhibited in Sandia Park Well 1. The lowest measurement corresponded to a depth of 168.8 ft below top of casing, while the total well depth is only 180 ft – a difference of only 12 feet or a continued longevity of two years.

As with Sandia Park Well 1, the dramatic decline in the water level in Sandia Park Well 2 between 1998 and 2004 is likely attributable to increased ground-water demands from private and commercial wells coupled with lower winter precipitation throughout this period.

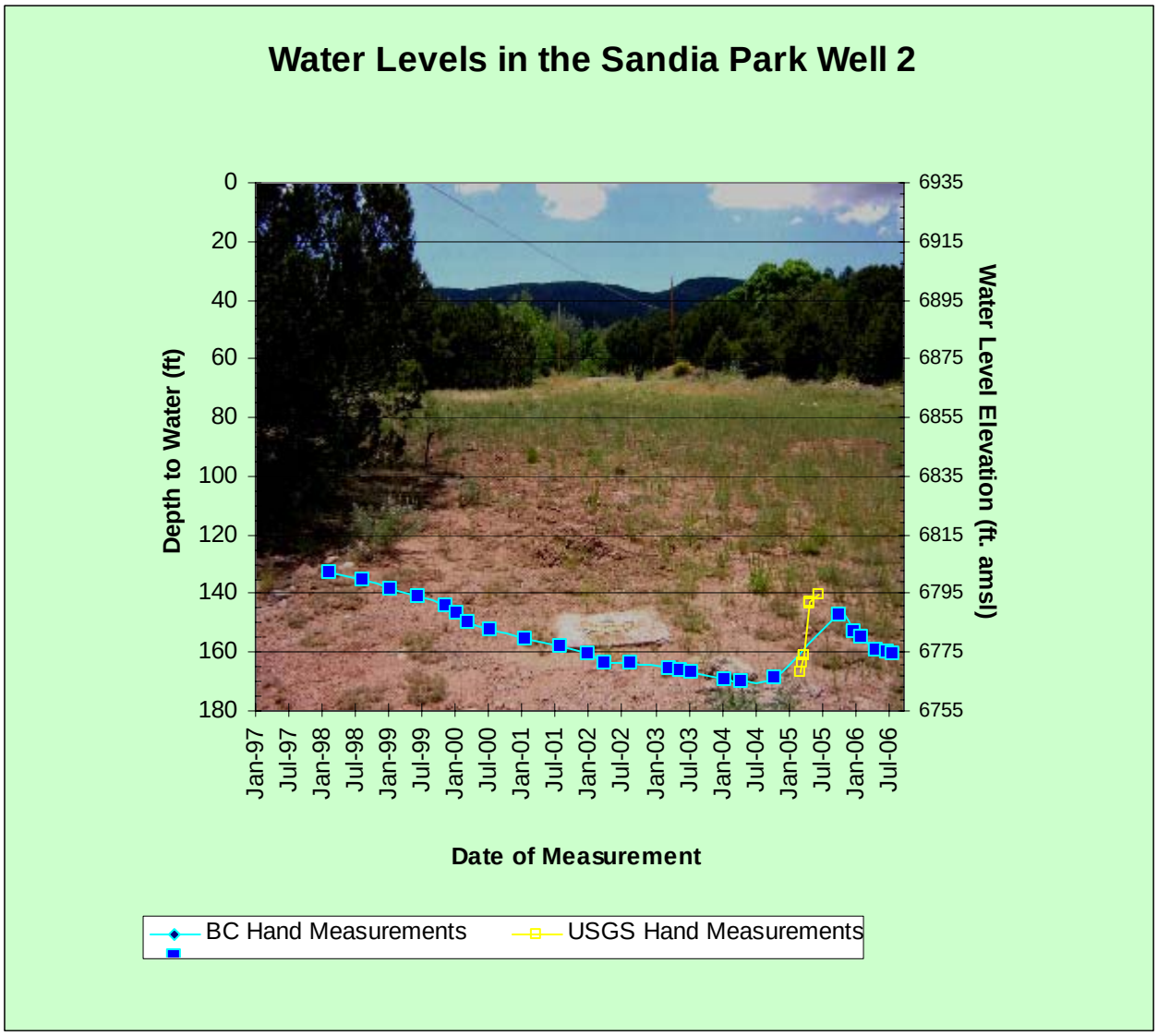


Figure 3.12 Water Levels in Sandia Park Well 2

A greater decline rate is evidenced in Sandia Park Well 2 than in Sandia Park Well 1. The greater decline rate is likely due to increased drawdown stemming from being in closer proximity to a nearby campground well (approximately 1,000 feet compared to 6,000 feet for Sandia Park 1). Additionally, Sandia Park Well 2 is located in an area with a greater density of nearby domestic wells (11 wells plotted within a 1,500 ft radius with the nearest well being within 500 feet) compared to that around Sandia Park Well 1 (six wells within a 1,500 ft radius and no wells plotted within 500 feet). The domestic well use upgradient of Sandia Park Well 2 results in increased capture of water flowing through the aquifer before the water flows past the monitoring well. This results in

decreased water levels near the monitoring well. Combined with geologic factors, differences in water level decline rates between the two Sandia Park wells are expected.

1.5.2.2 Water Quality in Sandia Park Wells 1 and 2

Water quality samples were initially collected in Sandia Park Wells 1 and 2 (SP- and SP-2, respectively) shortly after their construction in 1997 and 1998 respectively, and annual sampling has been conducted since that time.

One measure of water quality is comparison to the U.S. EPA Drinking Water Standards, previously discussed in Section 2. To date, none of the samples collected from Sandia Park Wells 1 or 2 have exceeded any of the Primary Drinking Water Standards (the health related standards) inclusive of the standards for organic compounds, trace metals, or inorganic compounds. However, "one-time" detections of minor concentrations of various organic compounds have occurred in both Sandia Park Wells 1 and 2. Each of the contaminants listed below was reported only for the 2003 annual sample, with the exception of the phthalate compound and 1,4-dioxane that were detected in the samples collected in 2001 and 2004 respectively. It should be emphasized that these compounds have not been detected at concentrations greater than the U.S. EPA drinking water standards and there has been no repetition of detection of these compounds.

Table 3.4 Organic Compounds Detected in Sandia Park Well 1

Compound	U.S. EPA Drinking Water Standard (ug/L)	Detected Concentration (ug/L)
Bis(2-Ethylhexyl)phthalate	No Standard	2
Total Trihalomethanes	100	7.2
Chloroform	No Standard	0.4
Dibromochloromethane	No Standard	2.9
Bromoform	No Standard	2.6
Bromodichloromethane	No Standard	1.3
1,4-Dioxane	No Standard	120

The phthalate compounds, particularly at low concentrations, are typically considered laboratory artifacts. The phthalate compounds are common plasticizers used in a wide variety of products including the tubing and bottles used in the laboratory process.

The presence of bromated compounds, coupled with the detection of trihalomethanes, in the sample for 2003 strongly suggests the presence of drinking water disinfection by-products. However, the samples were taken from a monitoring well, not from a community supply system. Consequently, the potential exists for some type of trace laboratory contamination, or cross-contamination of sampling equipment with treated drinking water, or possibly as a component of septic effluent – although most water in the area is taken from wells, not from a community supply well.

1,4-Dioxane is used as a solvent in many manufacturing processes. It is a component in PVC pipe cleaner and glue. In this case, its single detection is considered as an artifact of the well construction process rather than as a waste indicator. It was detected in the sample from 2004.

"One-time" detections of organic compounds have also occurred for Sandia Park Well 2. The compound 2-butanone (aka, methyl ethyl ketone) is a common laboratory contaminant and was detected in the sample collected in January 2004. As mentioned, 1,4-Dioxane is a component in PVC pipe cleaner and glue and its single detection is considered as an artifact of the well construction process rather than as a waste indicator. It was detected in the sample from November 2004. There have been no detections in subsequent sampling.

Table 3.5 Organic Compounds Detected in Sandia Park Well 2

Compound	U.S. EPA Drinking Water Standard (ug/L)	Detected Concentration (ug/L)
2-Butanone (MEK)	No Standard	3.9
1,4-Dioxane	No Standard	94

Shortly after construction, samples collected from Sandia Park Wells 1 and 2 were analyzed by the USGS for 66 organic compounds associated with domestic wastewater. Of this list of 66 compounds, detectable concentrations were reported for only five of the compounds. Four of the compounds (tribromomethane, d-limone, 2-methyl naphthalene, and an ethyl acetate compound) were found in Sandia Park Well 1 and only the compound tri (2-chloroethyl) phosphate was found in Sandia Park 2. Elevated nitrate concentrations in Sandia Park Well 1 coupled with the detection of these compounds is indicative of groundwater quality impact by septic tank effluent. The compound tri (2-chloroethy) phosphate is used as a fire retardant in association with flexible foam products and building insulation – the source area for this compound and the migration pathway to Sandia Park Well 2 for this compound is not known.

Secondary standards, those related to aesthetic qualities such as taste, odor, or discoloration, have been consistently exceeded for total dissolved solids and chloride in Sandia Park Well 1 (respectively, standards are 1,000 mg/L and 250 mg/L). Maximum reported concentrations were 1470 mg/L for total dissolved solids and 359 mg/L for chloride. Secondary standards for iron and manganese (respective limits of 0.3 mg/L and 0.05 mg/L) have been exceeded in Sandia Park Well 1, with maximum concentrations reported as 2.5 mg/L for iron and 0.09 mg/L for manganese. There have been no exceedances of drinking water standards for organic compounds or for nitrates in the wells, although nitrate concentrations in SP-1 appear to be elevated with respect to natural concentrations.

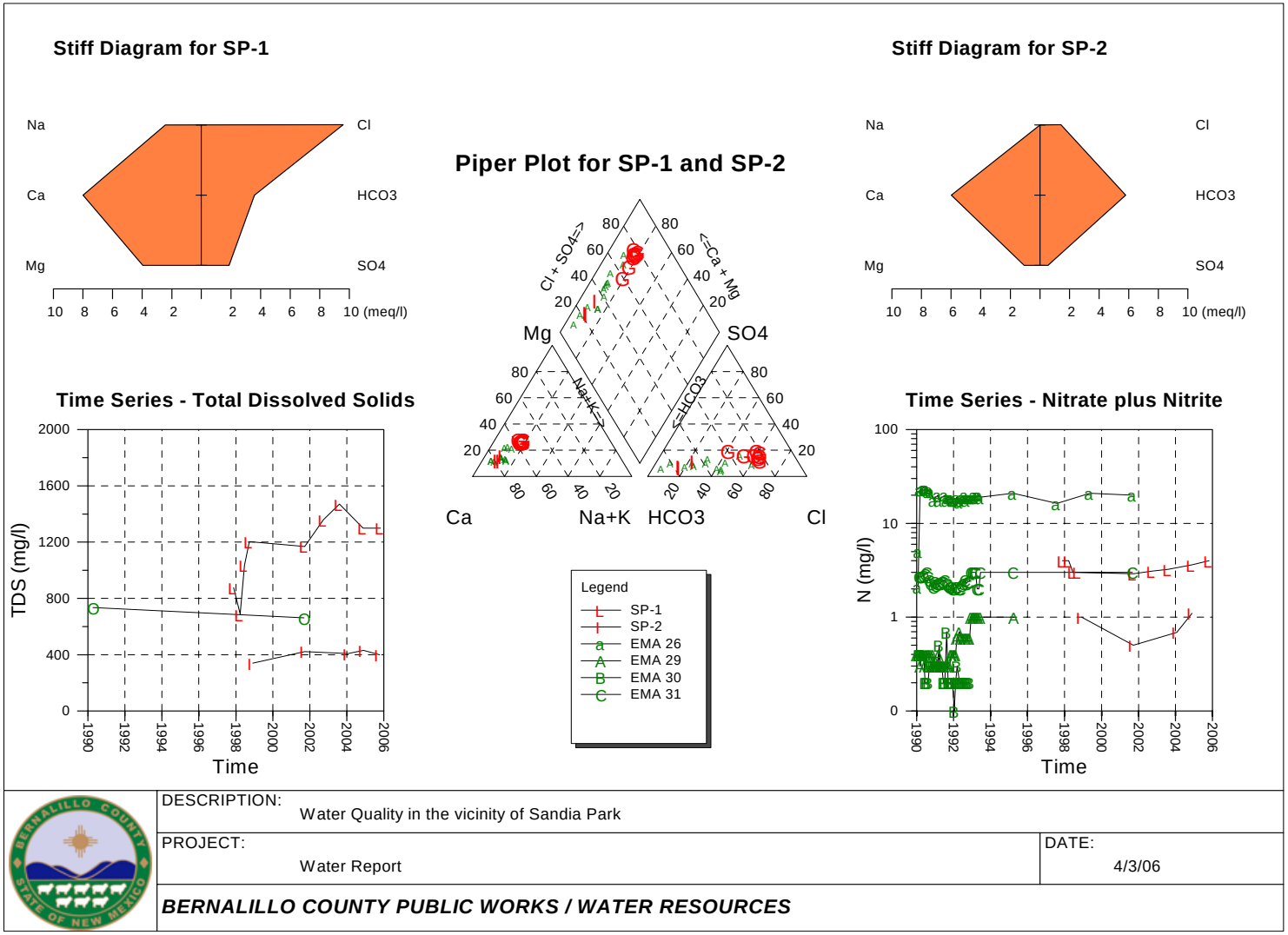
The upper right and upper left diagrams in Figure 3.13 provides a graphic depiction of the relative contribution of each of the major anions and cations for the latest sample from each of the wells. The predominance of magnesium, sodium and chloride in the groundwater composition for Sandia Park Well 1 relative to Sandia Park Well 2 is clearly discernible in the Stiff diagrams, while Sandia Park Well 2 shows a marked increase in bicarbonate (HCO_3) relative to Well 1. This difference in composition, primarily with respect to chloride and bicarbonate, causes the separation of the samples from Sandia Park Wells 1 and 2 as shown on the Piper diagram in the middle of the figure. The difference in composition is most likely due to the naturally occurring differences in geologic materials, as evidenced by the plots provided in Figure 3.14 and discussed below.

The lower left hand diagram in Figure 3.13 indicates the trend in total dissolved solids concentrations through time for Sandia Park Wells 1 and 2, and for USGS Well No. 26, a nearby well with elevated nitrate concentrations. This diagram indicates an overall rising trend in total dissolved concentrations in Sandia Park 1, but not in Sandia Park 2.

The lower right hand figure shows nitrate plus nitrite concentration through time for Sandia Park Wells 1 and 2 and for the surrounding nearby domestic wells. The nitrate plus nitrite diagram shows that USGS Well No. 26 exceeds the safe drinking water standard for nitrate (10 mg/L), and has done so for a number of years. Perhaps more alarming is the gradually increasing rise in nitrate concentrations in Sandia Park 1, with nitrate (as N) concentrations migrating upward from initial concentrations from 2.9 to 3.6 mg/L in recent years. Sandia Park Well 1 is located immediately hydraulically downgradient from Well 26. This suggests that water from a well contaminated by nitrates from a homeowner's individual septic system is migrating with time to areas outside the capture radius of the well. This suggests that neighborhood-scale nitrate contamination exists in certain areas. Sampling of domestic wells in this area may be warranted.

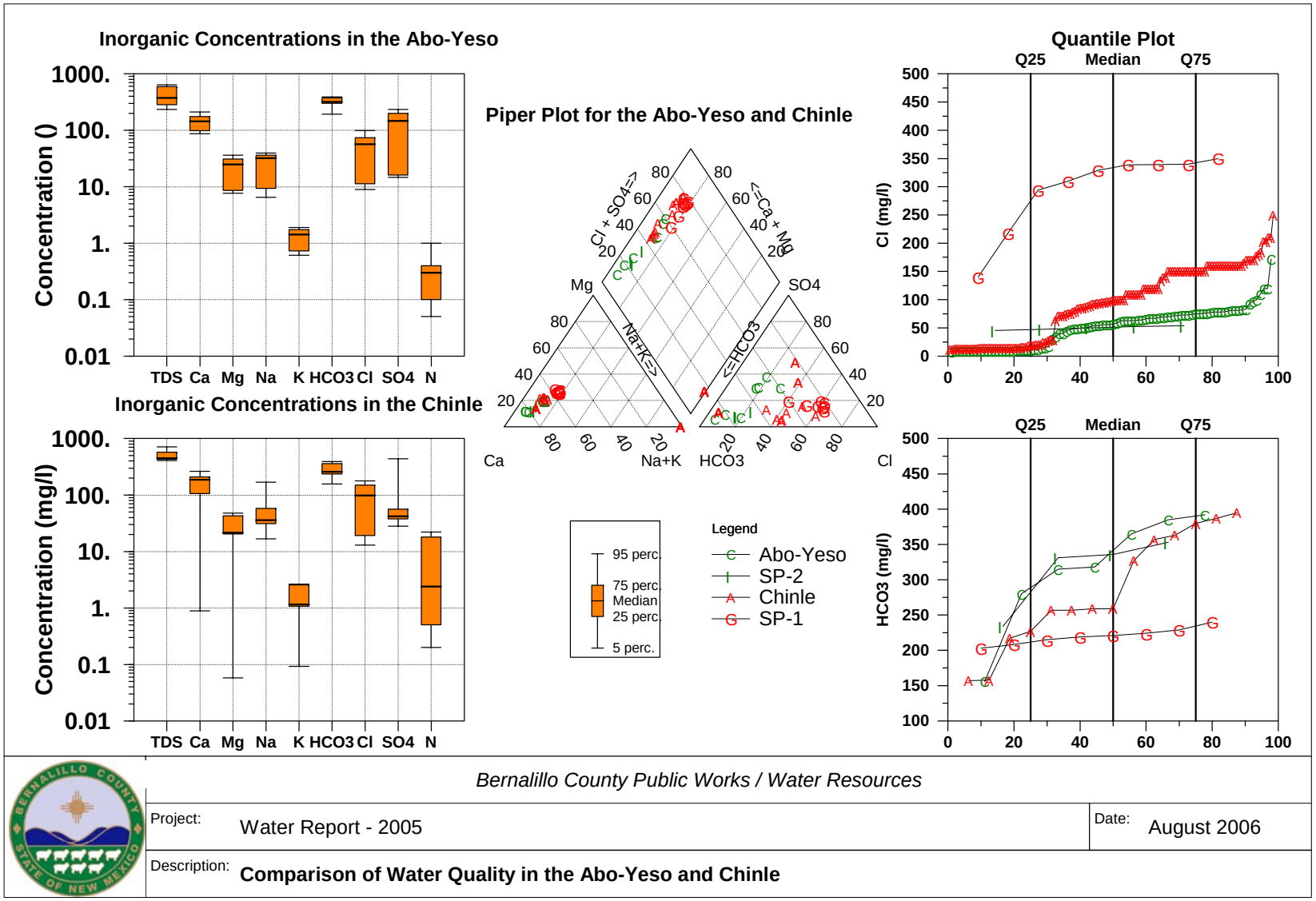
Figure 3.14 shows the range in inorganic concentrations (absent results for the monitoring wells) taken from nearby domestic wells for the respective formations for Sandia Park Well 1 (Chinle) and for Sandia Park Well 2 (Abo-Yeso). Naturally occurring differences in groundwater composition are primarily noted by the difference in the 75 percentile values for bicarbonates, chloride, and sulfate as presented in the Box and Whiskers diagrams on the left hand side of the Figure 3.14. The difference in nitrate concentrations shown in the Box and Whisker plots is due to likely septic contamination of one of the wells contained within the Chinle dataset.

The differences in water composition between Sandia Park Wells 1 and 2 are at least partially attributable to naturally occurring differences in bicarbonate and chloride concentrations. The Time Series plots on the right hand side of Figure 3.14 plot the compositions for the Chinle and Abo-Yeso formations exclusive of the monitoring wells and for SP-1 and SP-2.



DESCRIPTION:	Water Quality in the vicinity of Sandia Park
PROJECT: Water Report	DATE: 4/3/06
BERNALILLO COUNTY PUBLIC WORKS / WATER RESOURCES	

Figure 3.13 Piper Plot and Time Series Plots for Sandia Park Wells 1 and 2



Bernalillo County Public Works / Water Resources

Project:	Water Report - 2005	Date:	August 2006
Description:	**Comparison of Water Quality in the Abo-Yeso and Chinle**		

Figure 3.14 Comparison of Water Quality in the Abo-Yeso and the Chinle

The graphs show that the composition in samples from SP-2 are representative of the Abo-Yeso wells as a whole and that the relative differences in chloride and bicarbonate concentration in the two formations is reflected in the composition from the two monitoring wells. These relative relationships also appear to hold constant through time. However, it is also evident that the chloride concentrations in SP-1 are elevated with respect to the concentration in most Chinle wells. This is likely associated with the slightly elevated nitrate concentrations.

1.5.3 *Pinon Ridge Well 1*

The Pinon Ridge well is located in the Pinon Ridge subdivision, east of Highway 14 and south of Frost Road (Figure 2.3). The location was chosen based on a combination of factors including residential septic system density, depth to groundwater, proximity of USGS-monitored domestic wells, and availability of County-owned properties (Thomson et al. 2000, p. 36-38). The well is located at the downgradient edge of the Pinon Ridge subdivision and is located in public right of way.

The subdivision depends on water taken from individual wells. The original purpose of the monitoring well was to evaluate the potential impact of on-site wastewater and disposal systems. Two domestic wells and related septic systems are located within 500 feet north and south of the monitoring well location. There are approximately 15 domestic wells located within a 1,000-foot radius of the monitoring well. Land to the east is largely undeveloped.

In December 2002, Bernalillo County Environmental Health Department released a targeted environmental study: *Pinon Ridge Subdivision On-Site Wastewater Assessment of Affects on Groundwater Quality* (Garcia et al, 2002). The study was prompted by recurrent problems with on-site wastewater systems stemming from a lack of topsoil, small lot sites and the required private well setback distance. Groundwater was sampled from a subset of forty-five (45) volunteered locations of the approximately 143 homes within the subdivision. The study indicated that thirty-two (32) of the forty-five (45) wells (or 70 percent) yielded samples with detectable nitrate concentrations (<0.01 mg/L). However, the average nitrate concentration was 1.63 mg/L. Twelve (12) of the samples had nitrate concentrations greater than 2 mg/L (the threshold used in this report to be indicative of anthropogenic contamination) and the maximum reported concentration was 4.2 mg/L.

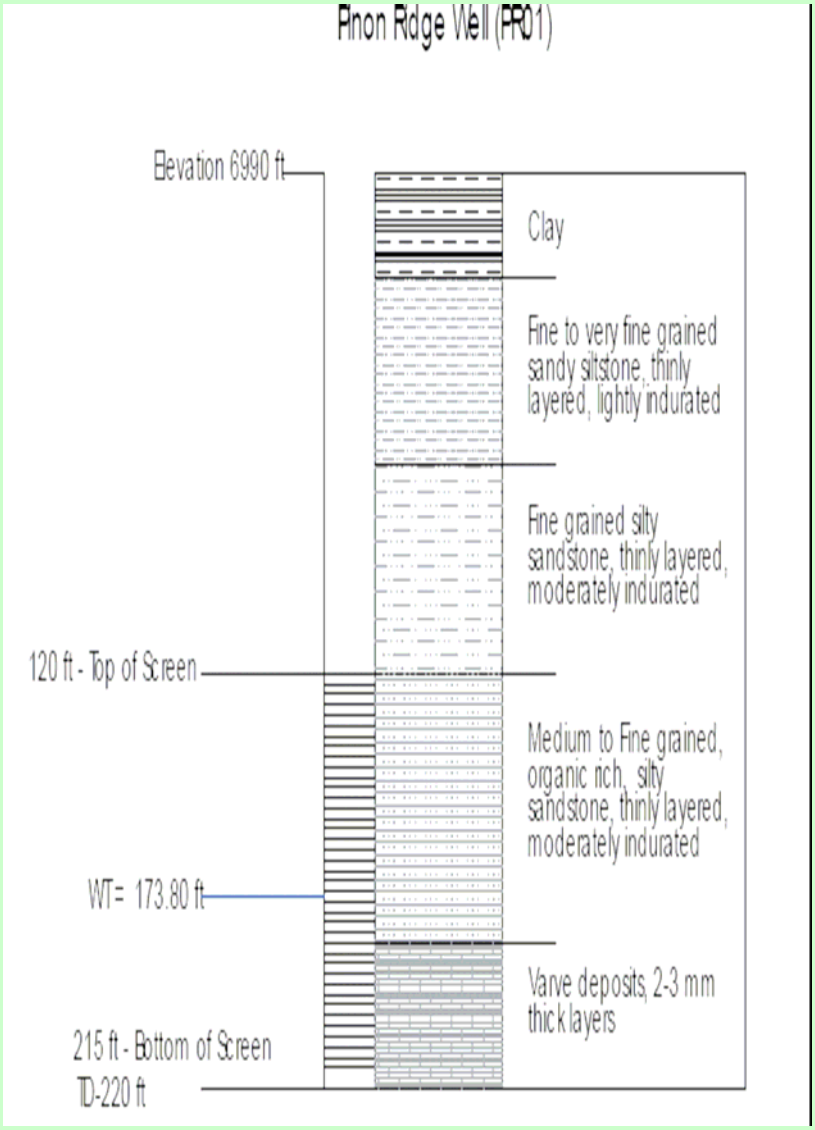
Wells with nitrate concentrations greater than 2 mg/L appeared to be concentrated in the northwest portion of the subdivision. The report also suggests the identification of six different types of water being present (pgs. 3 and 4) from wells within the subdivision, although three of the types are described as "did not have a distinct classification". No well depth, water level, or well completion information was provided in the report, so variance in the water quality could not be tied to geologic differences. The distribution of nitrate concentrations in this study suggests that nitrate contamination is of a site-scale or perhaps subdivision-scale concern. In this study, elevated concentrations are noted at the western edge of the subdivision, but within ½-mile to the southeast, there are numerous wells that are unaffected, including the regional monitoring well, which is sampled annually.

Two of the sampled wells are located in close proximity to the Pinon Ridge Well 1, which is used for regional monitoring purposes. The Pinon Ridge well is 250 feet deep. Well construction information is provided in Table 3.6 and Figure 3.15. Water quality from Pinon Ridge Well 1 matches that from the two nearest domestic wells as described by Garcia et al. (2002).

As indicated in Figure 3.16, the well originates at the surface in Quaternary alluvium deposits and is completed in the Cretaceous-aged Dakota Formation. This interpretation is based on mapped surface exposures near the well and measured dip of the formation in the immediate area (see Figure 3.16). This interpretation is contrary to that presented in Thomson et al. (2000, p. 54), who report the well as having been completed in the Mancos. Though not specifically stated in that report, the interpretation is presumably based on the "varved deposits" found in the bottom section of the well. However, the upper 150 feet penetrated by the well is described as various thin-bedded, and "slightly to moderately indurated" sandstones and silty sandstones, which more closely aligns with the description of the upper unit of the Dakota Formation and described as "thin to medium bedded slightly calcareous sandstone, siltstone, and silty shale" (Ferguson et al., 1999). By contrast, the sandstones of the Mancos Shale are typically only a few tens of feet (2 to 4 m) thick and the unit is predominantly shale rather than sandstone.

Table 3.6 Bernalillo County Regional Monitoring Well Network – Pinon Ridge Well 1

Well	Well Type	Well / Hole Depth (ft)	Screen Setting (ft)
Pinon Ridge (PR1)	Single	220	120-215



(Well Diagram taken from Thomson et al. 2000)

Figure 3.15 Well Completion Log for Pinon Ridge Well 1

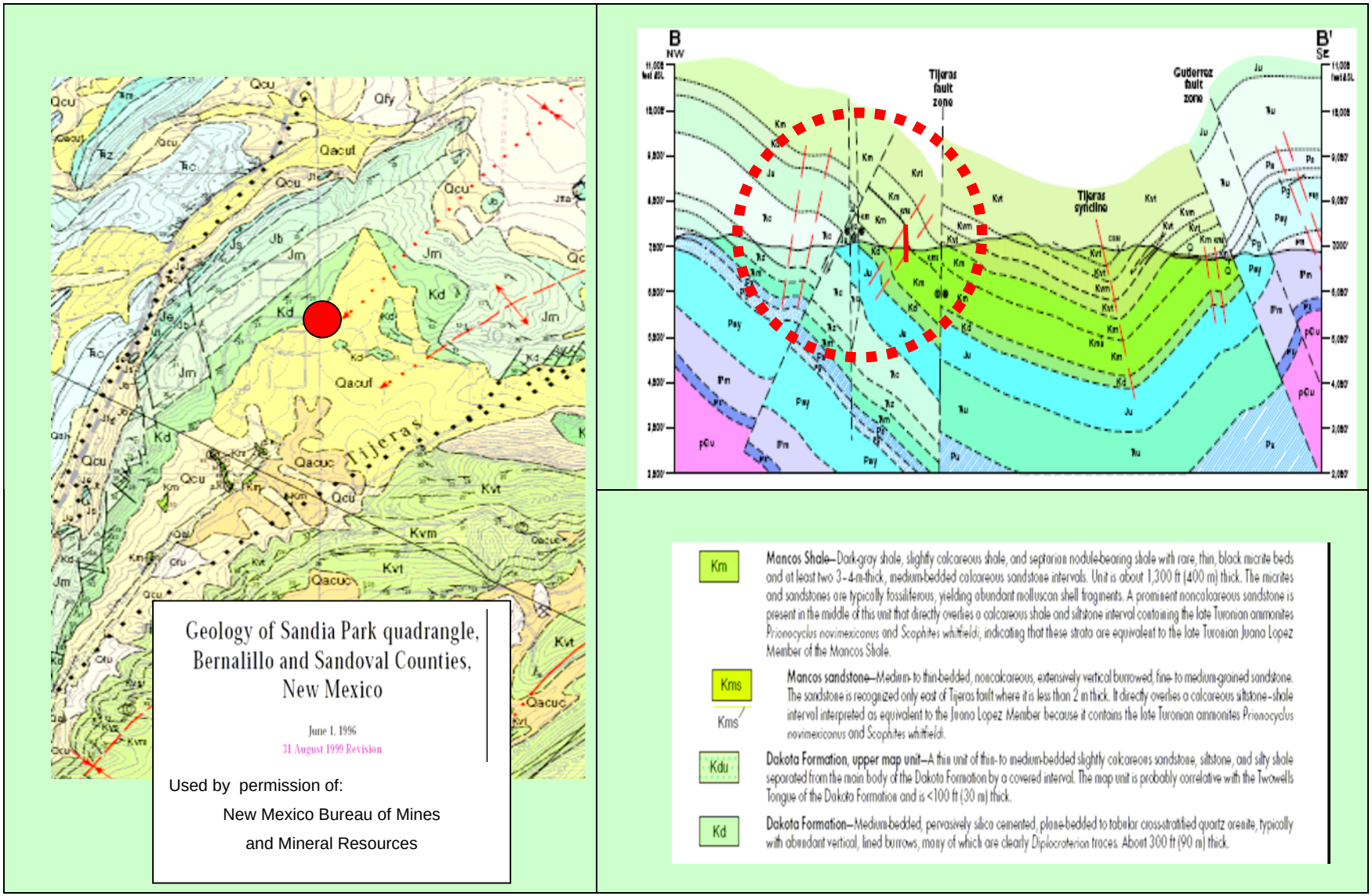


Figure 3.16 Geologic Setting of Pinon Ridge Well 1

Figure 3.16 illustrates the geologic setting of the Pinon Ridge well, both in map view and in a geologic cross-section taken south of the well location. As shown in the cross-section, the Pinon Ridge well is located along the axis of an inferred anticline (i.e. surrounding rock layers suggest that rock layers in the fold dip away from a centerline through the fold). The axial plane is inferred to have been tilted approximately 45 degrees past vertical toward the east. This anticline is bounded to the east by the San Antonio fault and to the west by the Tijeras fault.

1.5.3.1 Water Levels in Pinon Ridge Well 1

As indicated in Figure 3.17, water levels have been monitored in Pinon Ridge Well 1 (PR-1) since 1998. Water levels have been measured by hand from 1998 through 2005. In 2005, the USGS installed a transducer and datalogger to provide for nearly continuous water level monitoring. Between 1998 and 2005, the well has exhibited a persistent water level decline of approximately 1.4 feet/year. However, consistent with the dramatic rise seen in the Sandia Park Wells 1 and 2, a rise of approximately 2.5 feet was shown by hand measurements in late 2005. An overlay of the available transducer measurements suggests that the rise may have been as great as 5 feet and, for a short period, returned the water levels to 1999 levels.

It is not clear whether the rise in water levels is due to recharge or to reduced pumping on the neighboring properties. As mentioned in the initial description, Pinon Ridge Well 1 is located in close proximity to two domestic wells. During the 2005 site visit, the property to the south was listed for sale. Decreased well use can be presumed for at least some portion of the 2004-2005 timeframe.

However, there are no records on well pumping from the nearby domestic wells to confirm that presumption and there are no existing data on the hydrogeologic properties of the formation in the immediate area. Consequently, it is not clear whether the water level increase is due to recharge or to reduced pumping from the neighboring well.

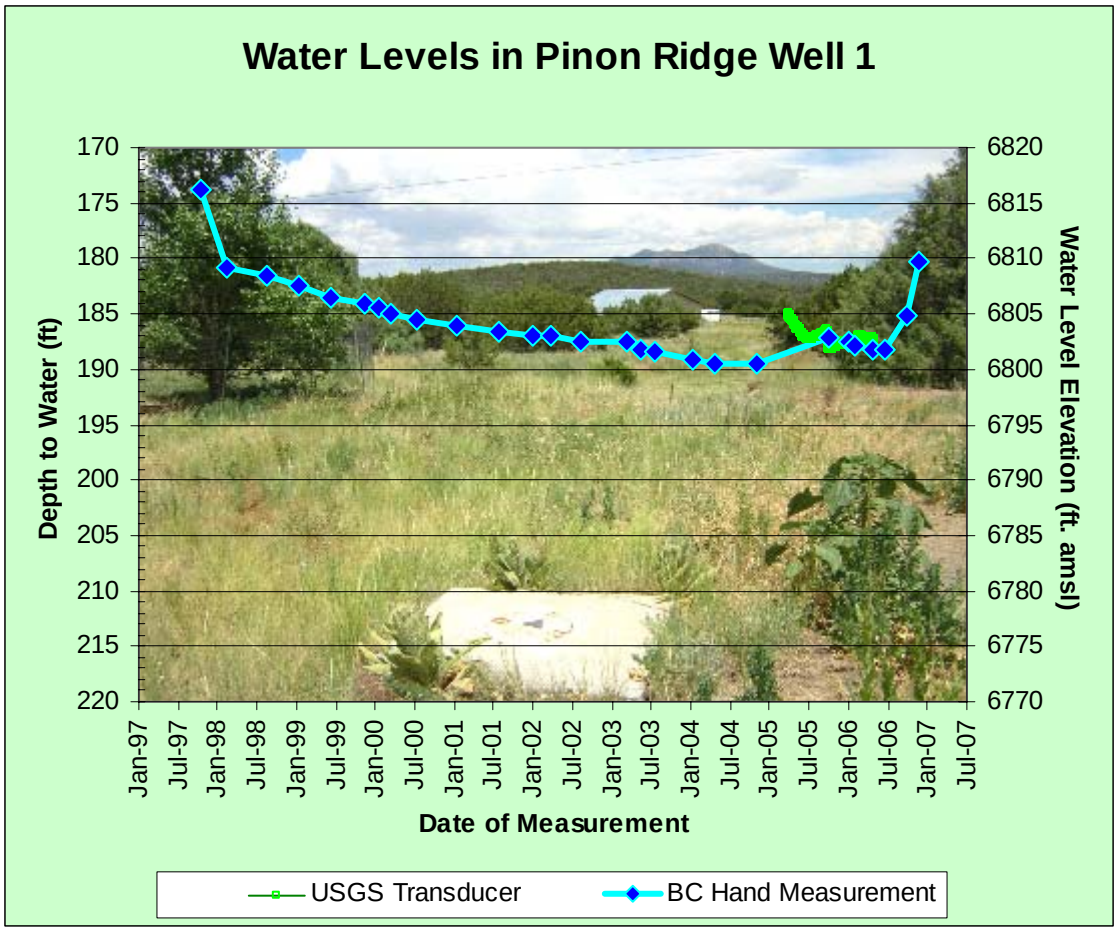


Figure 3.17 Water Levels in Pinon Ridge Well 1

If one assumes:

- an average pumping from the domestic well of 2 gpm for seven days,
- a distance to the wells of approximately 500 feet,
- a saturated thickness of 50 feet, and
- a hydraulic conductivity of 20 to 2 gpd/ft^2 (or transmissivity of 1000 to 100 gpd/ft or 130 to 13 ft^2/day);

Then the Thies equation predicts drawdown at the monitoring well location would be approximately 1 to 5 feet. Cessation of pumping would cause a similar rise in water levels. The parameters assumed above, however, are conservative and hydrogeologic properties could easily be a factor of 10 greater. If so, then the major part of the rebound is due to a recharge event rather than cessation of nearby pumping.

The fluctuation in water levels in the Pinon Ridge Well 1 is similar to the patterns shown in the published USGS data for wells located east of the San Antonio and Tijeras faults and previously discussed. Therefore, interpretation as a recharge event is slightly preferred over cessation of pumping.

This suggests that recharge to the aquifers may be occurring areally and/or that the San Antonio fault does not represent a significant hydrogeologic boundary in the vicinity of Sandia Park, San Antonio, and the Pinon Ridge subdivision. Blanchard (2004, Figure 3) indicates groundwater flow being eastward across NM Hwy 14 in this vicinity (i.e. across the San Antonio fault) with subsequent flow to north and south near the Pinon Ridge subdivision. Water level records for USGS Wells 26 and 27 (see Figure 3.3) do not show the rebound reported in the other wells in the immediate area, though this may be due to the lack of water level measurements in 2005 or that the rebound was insufficient to overcome progressively declining water levels.

Determining the nature of the flow across the faults would require a detailed inventory of existing wells in the area including:

- water level measurements during periods of low or minimal pumping,
- a pumping test with pumping taken from a large volume production well;
- monitoring wells located along and on both sides of the fault, and
- computer modeling to quantify hydrogeologic parameters associated with the test.

The nature of faulting is such that along a given fault the hydrogeolgic characteristics can be quite variable. The fault may be a recharge point along one portion, and a no flow or reduced-flow boundary along another, and the conditions may vary as one moves across the fault zone.

1.5.3.2 Water Quality in Pinon Ridge Well 1

Thomson et al. (2000) initially collected water samples from Pinon Ridge Well 1 shortly after its construction in 1997. Bernalillo County has conducted annual sampling since. To date, none of the samples collected from Pinon Ridge Well 1 have exceeded any of the Primary Drinking Water

Standards (i.e., the health related standards) inclusive of the standards for organic compounds, trace metals, or inorganic compounds. Only one organic compound was detected during routine sampling. A phthalate compound was detected at low concentration in the sample from 2001, consistent with its presence as a laboratory contaminant.

Shortly after construction in 1997, samples from Pinon Ridge Well 1 were analyzed by the USGS for 66 organic compounds associated with domestic wastewater. Of this list of 66 compounds, detectable concentrations were reported for ten of the compounds, including two suspected laboratory artifacts (plasticizers), detergent metabolites, and four polynuclear aromatic hydrocarbons (PAHs). These compounds included:

trephenyl phosphate -	plasticizer
bis (2-ethy hexyl) phthalate -	plasticizer
tribromomethane –	drinking water disinfection by-product
nonylphenol ethoxylate 1 and 2 –	non-ionic detergent metabolites
2,6-di-ter-para-benzoquione –	antioxidant
tri (2-chloroethyl) phosphate –	fire retardant
phenanthrene –	polynuclear aromatic hydrocarbon
flouranthene -	polynuclear aromatic hydrocarbon
pyrene -	polynuclear aromatic hydrocarbon
benzo (g,h,l) perylene -	polynuclear aromatic hydrocarbon

These detections are consistent with wastewater effluent. However, nitrate concentrations in subsequent samples have all been reported as being 1.1 mg/L or less. Thomson et al. (2000, p. 94) indicate that the well was purged and sampled at least twice prior to sampling for the USGS analysis. It is possible that some cross-contamination of the subsurface occurred during drilling of the well, with cuttings being circulated into the subsurface or possibly with wastewater effluent in the shallow portions of the boring cross-contaminating the circulating drilling fluid.

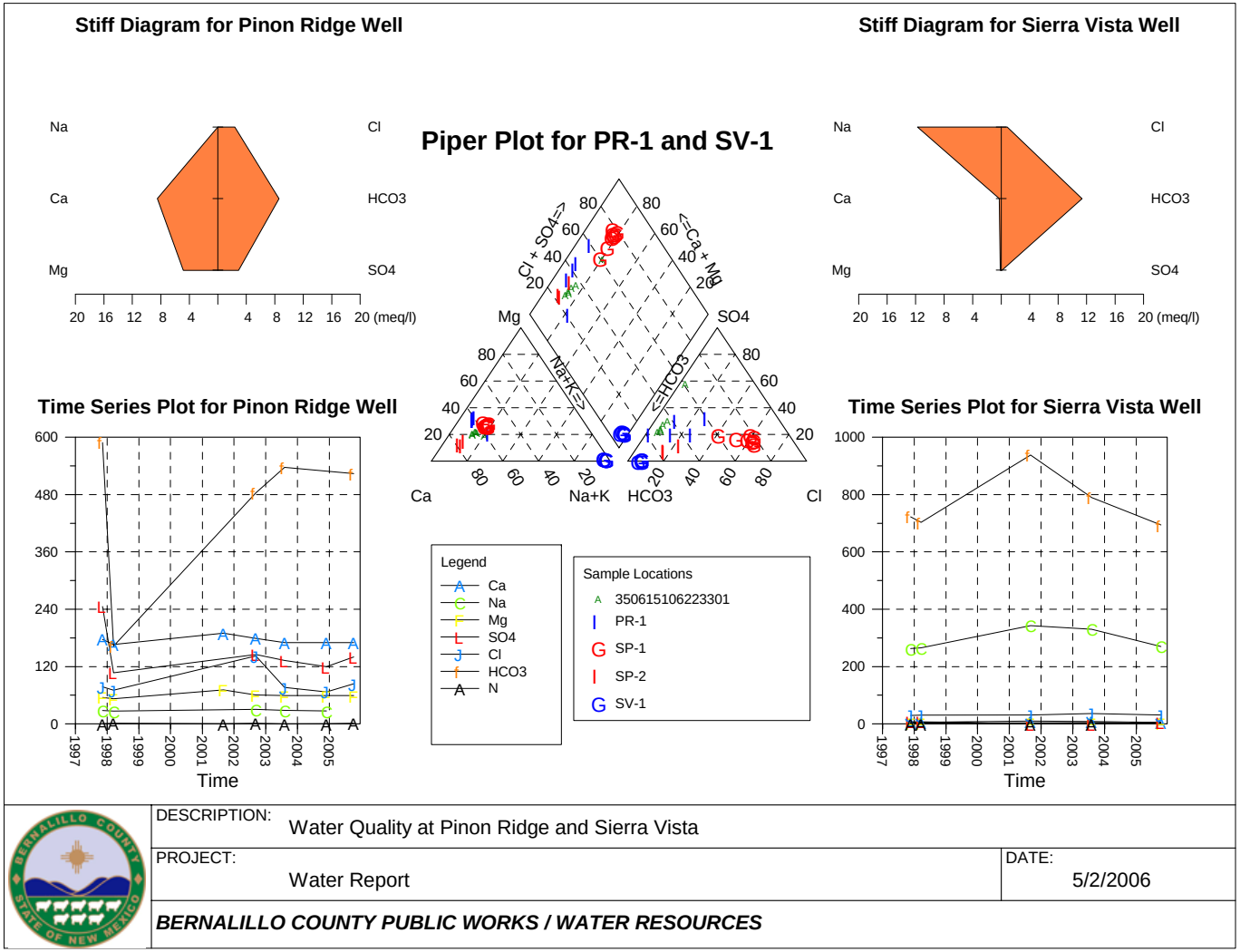
Secondary standards (i.e., those related to aesthetic qualities such as taste, odor, or discoloration) from time to time have been exceeded for total dissolved solids (standard of 500 mg/L), iron and

manganese (respective standards of 0.3 mg/L and 0.05 mg/L), and for aluminum (limit of 0.05 mg/L). These exceedances are likely naturally occurring given that the well is completed in materials described as "organic rich" and "varve deposits" and classified as silt to clay.

Figure 3.18 provides a summary of the inorganic water quality data for Pinon Ridge Well 1. Within the Piper Plot, the plots for Sandia Park Wells 1and 2 and for Sierra Vista Well 1 have been included for comparison. There is insufficient data to provide a statistical summary of water quality in the Dakota Sandstone, in which Pinon Ridge Well is completed.

The plot indicates that water quality in the Pinon Ridge well is similar to that in the Sandia Park Wells 1 and 2, though more similar to quality in Sandia Park Well 2 largely due to the minimal chloride concentrations. USGS Well 22 is located several miles south and west of St. Hwy 14 and the USGS identified Well 22 (350615106223301) as a Mancos Shale well, the reported formation for Pinon Ridge Well 1. Water quality from Well 22 is plotted for comparison. The plot shows that the water quality of the Mancos Shale well is different, with respect to anion contributions, from water quality in the Pinon Ridge Well 1.

Garcia et al. (2002) indicate that elevated nitrate concentrations (greater than 2 mg/L) exist within the Pinon Ridge Subdivision. The two domestic wells adjacent to the Pinon Ridge Well 1 site (37 and 38 Juniper Hill Lp) have reported nitrate concentrations of 0.1 and 3.2 mg/L respectively. The greatest verifiable nitrate concentration in Pinon Ridge Well 1 is 1.1. mg/L. The trilinear plot for the Pinon Ridge Well 1 indicates similar water quality to that taken from the two nearby domestic wells.



DESCRIPTION:	Water Quality at Pinon Ridge and Sierra Vista
PROJECT: Water Report	DATE: 5/2/2006
BERNALILLO COUNTY PUBLIC WORKS / WATER RESOURCES	

Figure 3.18 Water Quality at Pinon Ridge and Sierra Vista

1.5.4 *Sierra Vista Well 1*

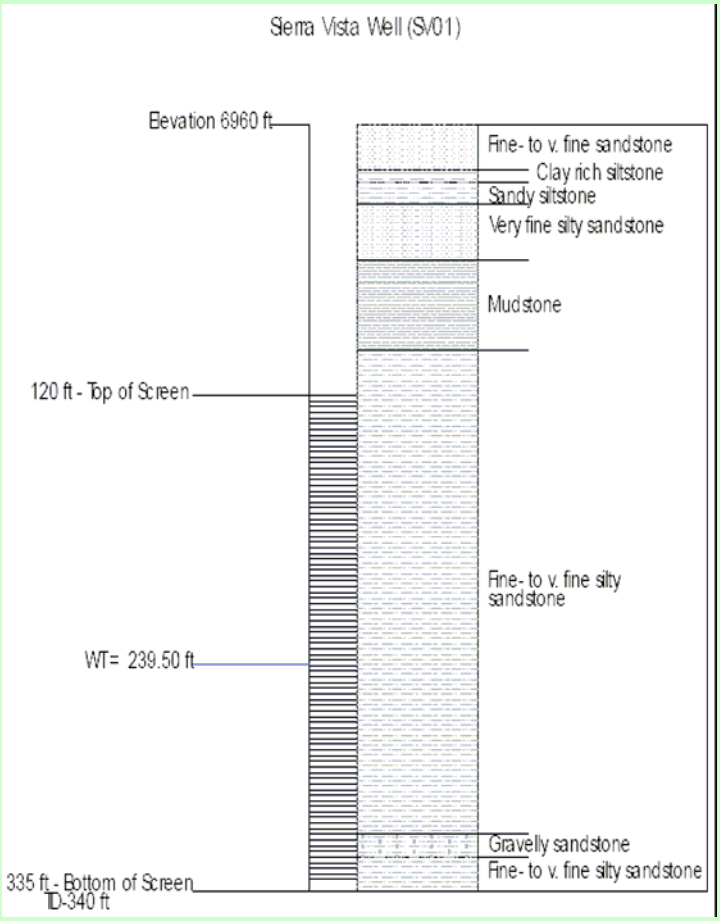
Sierra Vista Well 1 is located in the Sierra Vista subdivision, east of Highway 14 (see Figure 2.3). This location was selected to evaluate the effects of on-site wastewater treatment and disposal on water quality. It was chosen based on a combination of factors including residential septic system density, depth to groundwater, proximity of USGS-monitored domestic wells, and availability of County-owned properties (Thomson et al. 2000, p. 36-38). Because of the low productivity of the geologic formations, residences in the area are connected to a community supply system rather than depending on individual wells. Supply wells for the community system are located east of Hwy 14. No sewer service is available and individual septic systems are used.

Thomson et al. (2000) record the well as 340 ft, with the lower 220 feet being screened. Well completion is summarized in Table 3.7 and a well completion log is provided as Figure 3.19. Based on the location, reported depth, log descriptions, and surrounding geology, it appears that this well was completed within the Mesaverde Group sandstones. The presence of the siltstones and mudstone in the upper 100 feet of the boring suggest the marine lithofacies (Kvm). The well appears to be screened within the terrestrial lithofacies (Kvt), based primarily on the abundance of silty sandstone and particularly on the presence of gravelly sandstone. These types of deposit are consistent with distributary-channel facies deposits, which Ferguson et al. (1999) identify as belonging to the terrestrial lithofacies (i.e., a type or characteristic pattern of river sedimentation).

Geologically, the well is located east of the Tijeras Fault and west of the Gutierrez Fault within an area commonly referred to as the Tijeras syncline. The well is located west of the axis of the syncline. Formations are tilted downward to the east, and upward to the west and south. The geologic setting for this well is shown in Figure 3.20. The two cross-sections shown in the figure are located immediately to east of the well (section D-D' running southwest to northeast) and to the south of the well (section A-A' running northwest to southeast).

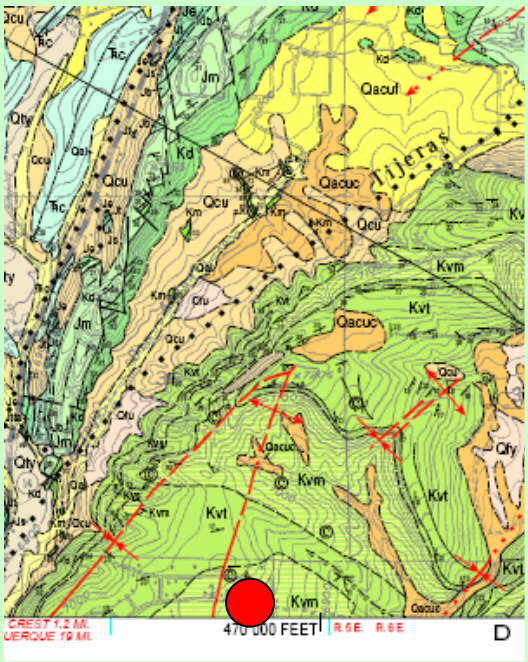
Table 3.7 Bernalillo County Regional Monitoring Well Network – Sierra Vista Well 1

Well	Well Type	Well / Hole Depth (ft)	Screen Settings ft)
Sierra Vista (SV1)	Single	340	120-335



(Well Diagram taken from Thomson et al. 2000)

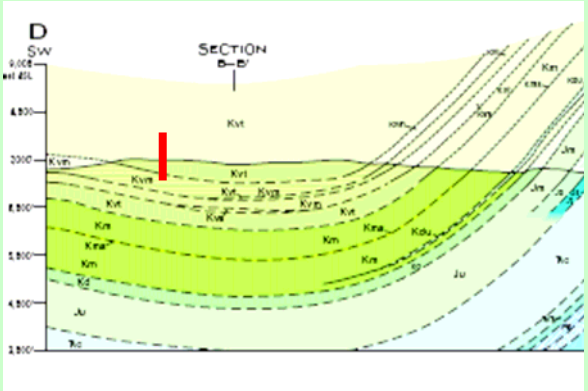
Figure 3.19 Well Completion Log for Sierra Vista Well 1

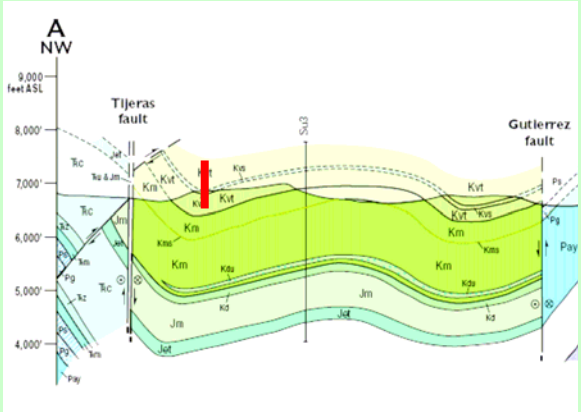


Geology of Sandia Park quadrangle, Bernalillo and Sandoval Counties, New Mexico

June 1, 1996
31 August 1999 Revision

Used by permission of:





(Section A-A' taken from the Sedillo quadrangle)

Kv — **Mesaverde Group, undifferentiated**—A complex unit of marine, marginal-marine, and fluvial sandstones, shales, and siltstones with at least two intervals of coal-bearing strata, up to 1,400 ft (430 m) thick. The sequence is divided into three mappable lithofacies, which have been given interpretive informal names: 1) marine sandstone and shale (Kvm); 2) fluvial and distributary-channel sandstones, which include the coal beds (Kvt); and 3) shoreface sandstones (Kvs). The sandstones of the Mesaverde Group range from feldspathic arenites to quartz arenites, and, locally, dark-colored chert grains are abundant.

Kvm — **Mesaverde Group marine sandstone and shale**—A map unit recognized only in areas where molluscan shell fragments (chiefly bivalves) are present. The unit is typically recessive weathering, and the sandstones are thin to medium bedded, dark brown to greenish, argillaceous, and variably calcareous. The unit along the west limb of the Tijeras syncline includes at least one medium-bedded calcareous sandstone containing septarian nodules and bivalve shell fragments.

Kvt — **Mesaverde Group terrestrial sandstones**—A map unit characterized by abundant woody debris and mud-chip intraclasts. It consists of two types of sandstones: 1) resistant, medium- to thick-bedded, trough and wedge-planar cross-stratified, light-colored sandstones and 2) recessive, massive or flaggy-weathering, argillaceous, greenish-brown sandstones and siltstones with abundant woody debris and mud-chip clasts. Three intervals of this map unit are recognized, each overlying marine sequences, and the upper two contain coal beds. The middle unit thins dramatically to the east, where it is represented by a 3 to 10 ft (1 to 3 m) thick, clean, cross-stratified sandstone along the east limb of the Tijeras synclinorium.

Kvs — **Mesaverde Group near shoreface sandstones**—A map unit recognized by a combination of at least two of the following features: 1) clean (nonargillaceous), well-sorted nature of the sandstone; 2) planar bedding or low-angle cross-stratification; 3) recognition of the upper-shoreface-environment restrictive trace fossil *Macaronichnus* (c.f., Mieras *et al.*, 1993). Molluscan shell fragments are also recognized, and at the top of the easternmost mapped outcrop, vertical, lined burrows are present. The combination of textural maturity, sedimentology, and ichnofauna are indicators of a high-energy near-shoreface environment. The map unit is discontinuous, appearing to grade laterally into marine or nonmarine sandstone units.

(Additional geologic description available on Figure 3.10b and 3.16)

Figure 3.20 Geologic Setting of the Sierra Vista Well 1

Low productivity has been confirmed during sampling events, suggesting that primary and secondary permeability are extremely limited. This is expected, as the well is located away from the fault zone and away from the central axis of the syncline. Consequently, the degree of fracturing and dissolution along fracture plains is limited. The folded nature of the formations is seen in the cross-sections included with the geologic map. Section D runs southwest to northeast and is located east of the well. Section A runs northwest to southeast and is located south of the well location.

1.5.4.1 Water Levels in Sierra Vista Well 1

Water levels have been monitored in Sierra Vista Well 1 (SV-1) since its installation in 1997. A hydrograph is provided as Figure 3.21. The well exhibited an initial rise in water levels through 1998, possibly in response to dewatering during drilling, well development and sampling activities occurring immediately after construction. Since about 1999, water levels in the well, while fluctuating, have varied over a limited range. Static water level measurements have ranged from 235.33 ft below top of casing (btoc) to 238.65 ft btoc, a difference of slightly over three feet. There are no domestic wells in the immediate area, so water level fluctuations likely represent response to naturally occurring events.

There are no significant trends in water level elevation in this well. The rise in water levels in 2005 exhibited in the Sandia Park Wells 1 and 2 and in Pinon Ridge Well 1 is not seen at this location. This suggests a lack of hydrogeologic connection to formations to the east and north, though deeper strata may exhibit such connections.

In the spring of 2005, under an agreement with Bernalillo County, the USGS installed a transducer and data recorder in the Sierra Vista well. The well was sampled by a Bernalillo County consultant in June 2005. Water levels were measured by hand prior to sampling, the transducer was removed, and the well was purged and sampled by bailing. The transducer was then reinstalled. As a result, the transducer was in place and recorded the recovery of water levels in the well over the period of a few months, mimicking the recovery that may have occurred shortly after construction in 1997. This event is shown on the right-hand side of the hydrograph (Figure 3.21).

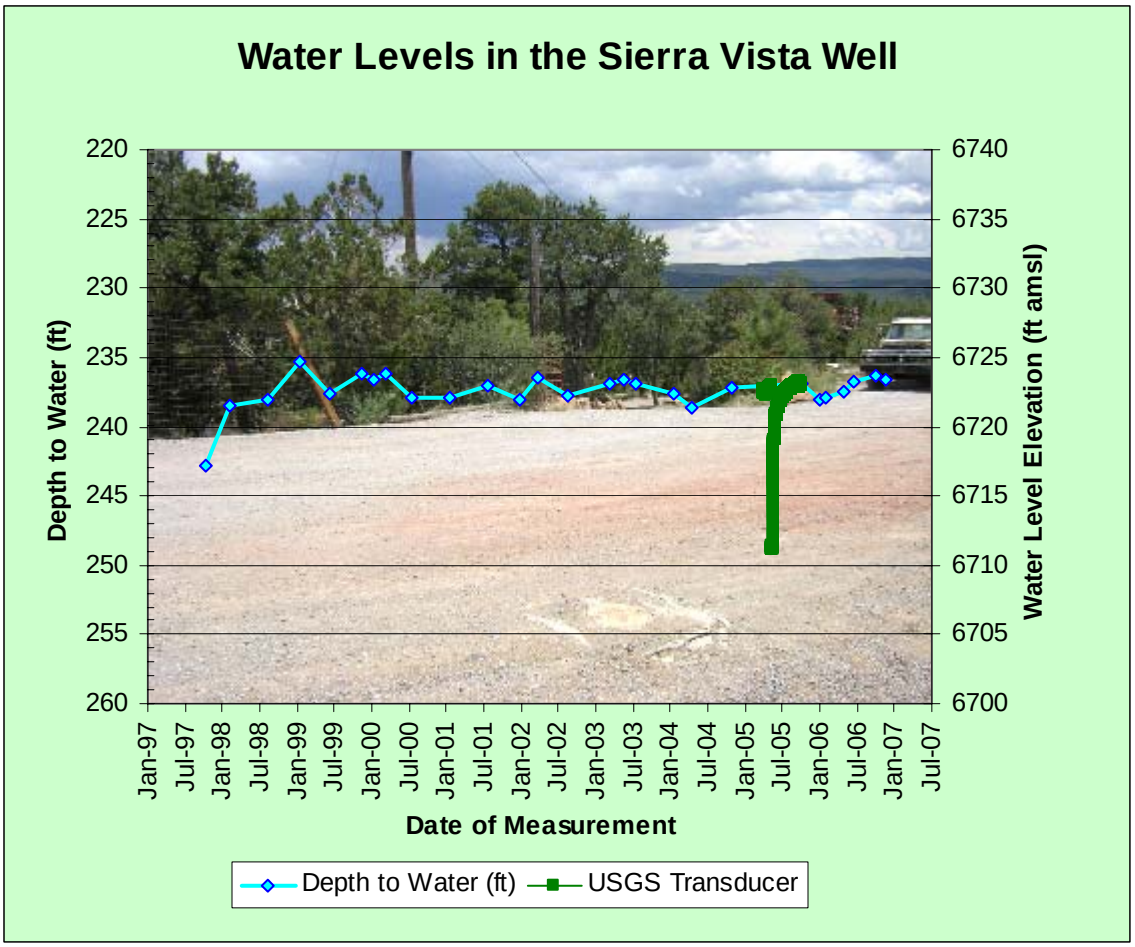


Figure 3.21 Water Levels in Sierra Vista Well 1

An analysis of the recovery curve is provided in Appendix B and indicates that the productivity of the formation is extremely limited, consistent with the absence of individual wells in the area.

1.5.4.2 Water Quality in Sierra Vista Well 1

Water quality samples were initially collected in Sierra Vista Well 1 shortly after its construction in 1997 and annual sampling has been conducted since. To date, none of the samples collected from the Sierra Vista well have exceeded any of the Primary Drinking Water Standards, the health related standards, inclusive of the standards for organic compounds, trace metals, or inorganic compounds.

Trace levels of various organic compounds (<2 ug/L) were reported for samples collected in 2001 and 2003. The compounds included typical gasoline components including benzene, toluene, ethylbenzene, and various xylene compounds as well as naphthalene. Contamination of groundwater

by petroleum compounds is not expected, as there are no service stations, garages, or shops in the immediate area of the monitoring well. Given the low reported concentrations and that detection of these compounds was not repeated in the 2004 samples, it is suspected that these detections are due to sample contamination.

This may have either occurred within the laboratory (a change in laboratories in 2003 resulted in virtual elimination of other known laboratory contaminants being reported for the sample), or could be a result of contamination of sampling equipment or of the sample directly. The monitoring well is located in a public thoroughfare and there is the potential for the sampling pump, sample bottles, or sample to have come in contact with waste or dripped fuels from the road surface. More likely, direct sample contamination occurred. The sampling pump is operated by a gasoline-powered air compressor and generator. Refueling and subsequent spills could easily result in intake of fuel vapors to the compressed air supply, or the sampling personnel could cross-contaminate the sample via spills to hands, gloves, or clothing.

Shortly after construction, samples collected from the Sierra Vista well were analyzed by the USGS for 66 organic compounds associated with domestic wastewater. Of this list of 66 compounds, detectable concentrations were reported for nine of the compounds:

D-limone -	component in fragrances
1,2,4-trimethylbenzene -	lab contaminant / component of gasoline
naphthalene -	polynuclear aromatic hydrocarbon
1-methyl napthalene -	polynuclear aromatic hydrocarbon
2-methyl naphthalene -	polynuclear aromatic hydrocarbon
fluorene -	polynuclear aromatic hydrocarbon
phenanthrene	polynuclear aromatic hydrocarbon
2(2-btxethxy)ethyl acetate -	solvent for nitrocelluose resins
2,6-di-tert-para-benzoquione –	antioxidant

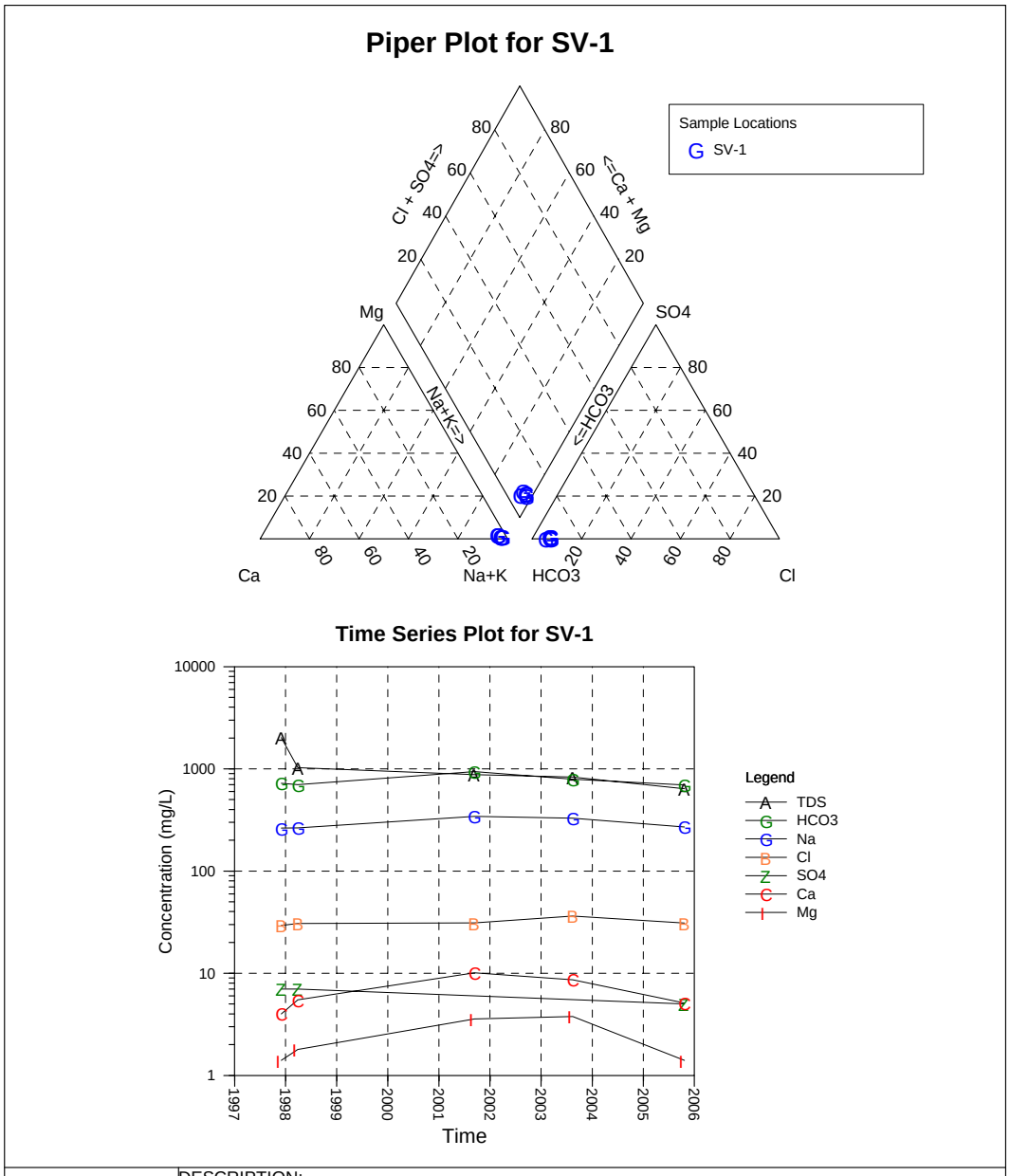
While the presence of these organic compounds is consistent with human wastewater components, it is unclear whether these compounds resulted from cross-contamination during drilling or are

representative of on-going groundwater conditions. What is clear is that nitrate and chloride concentrations typical for septic related contamination are not present in samples from this well. Nitrate concentrations are at or below detection limits (<0.1 mg/L) and chloride concentrations are typically less than 40 mg/L, as shown in Figure 3.22. Thus, there is no reason to suspect on-going groundwater contamination from wastewater in this vicinity. Additionally, the reported concentrations are extremely low and no organic compounds have been detected in recent samples.

Secondary standards (i.e., those related to aesthetic qualities such as taste, odor, or discoloration) have been exceeded for total dissolved solids (standard of 500 mg/L), iron and manganese (respective standards of 0.3 mg/L and 0.05 mg/L), and for aluminum (limit of 0.05 mg/L). Total dissolved solids have steadily decreased from 2,013 mg/L in 1998 to 640 mg/L in the 2005 sample, iron has ranged from 1 to 3 mg/L, and there is one instance of aluminum at a concentration of 1.6 mg/L.

Time-series plots for anions and cations in Sierra Vista Well 1 are provided in Figure 3.22. These plots show a gradual decrease in total dissolved solids with time. However, the initial decrease in total dissolved solids in accompanied by an increase in most constituents, then followed with decreases in the primary constituents of sodium and bicarbonate. This suggests that initial samples from the well may have been affected by well development activities. The continual decline in constituent concentrations is puzzling, as it represents a "freshening of the water". This could be reflective of infiltration of precipitation from the land surface, possible infiltration from septic system, infiltration from leakage / line loss from the community supply system, or is an effect of repeated purging and sampling of the well through time.

The water chemistry for samples from this well is unique both for the East Mountain Area and for groundwater samples as a whole. It is unusual for any groundwater sample to be at the extreme end-point of possible groundwater compositions and to plot at the corners of the Piper Diagram - even more so when waters from surrounding formations tend to plot to a different portion of range in groundwater chemistry.



DESCRIPTION:
Water Quality in SV-1

PROJECT: Water Report

DATE: 5/6/06

BERNALILLO COUNTY PUBLIC WORKS / WATER RESOURCES

Figure 3.22 Water Quality in Sierra Vista Well 1

As shown on Figure 3.22, however, samples from the Sierra Vista well have consistently plotted to the sodium bicarbonate endpoint of the Piper diagram. There are singular examples of wells in the East Mountains completed in the Madera limestone and in the Chinle exhibiting similar Piper plots. However, the geologic setting for Sierra Vista Well 1 is not conducive to migration of waters from those units. In short, the water chemistry data from Sierra Vista Well 1 is not representative of the East Mountain area as a whole.

1.6 ***Far Northeast Heights Monitoring Wells***

The Far Northeast Heights encompasses two major residential portions of the County: Sandia Heights and North Albuquerque Acres. Sandia Heights obtains its water supply from supply wells located to the southwest of the Sandia Heights community, while residents in North Albuquerque Acres depend on individual or shared domestic wells. In both cases, the water is pumped from the alluvial aquifer system that extends from the mountain front to the Rio Grande. This aquifer is prominent in the Albuquerque/Middle Rio Grande region and provides substantial amounts of groundwater as compared with the fractured aquifers in the East Mountain Area. The aquifer materials consist of gravel, sand, and silt deposited as floodplain deposits of the Rio Grande and the outwash from the breakdown of the Sandia Mountains and the associated granites. The ABCWUA also pumps from this aquifer, with wells located along the southern and eastern edge of the North Albuquerque Acres area, as do wells belonging to Sandia Utilities, Ventura Estates and the Oakland Heights Homeowners Association. The location of Bernalillo County monitoring wells, the nearest USGS piezometer, and nearby community supply wells are shown in Figure 3.23.

Both these areas utilize septic system disposal and have been the subject of studies sponsored in part by the Bernalillo County Environmental Health Department. Sandia Heights was the primary area of focus in *Evaluation of Onsite Wastewater Treatment and Disposal: Determination of Groundwater Contamination and Demonstration of Alternative Technologies* (Thomson et al. 2000). That study incorporated results of water levels and water sample analysis from four monitoring wells.

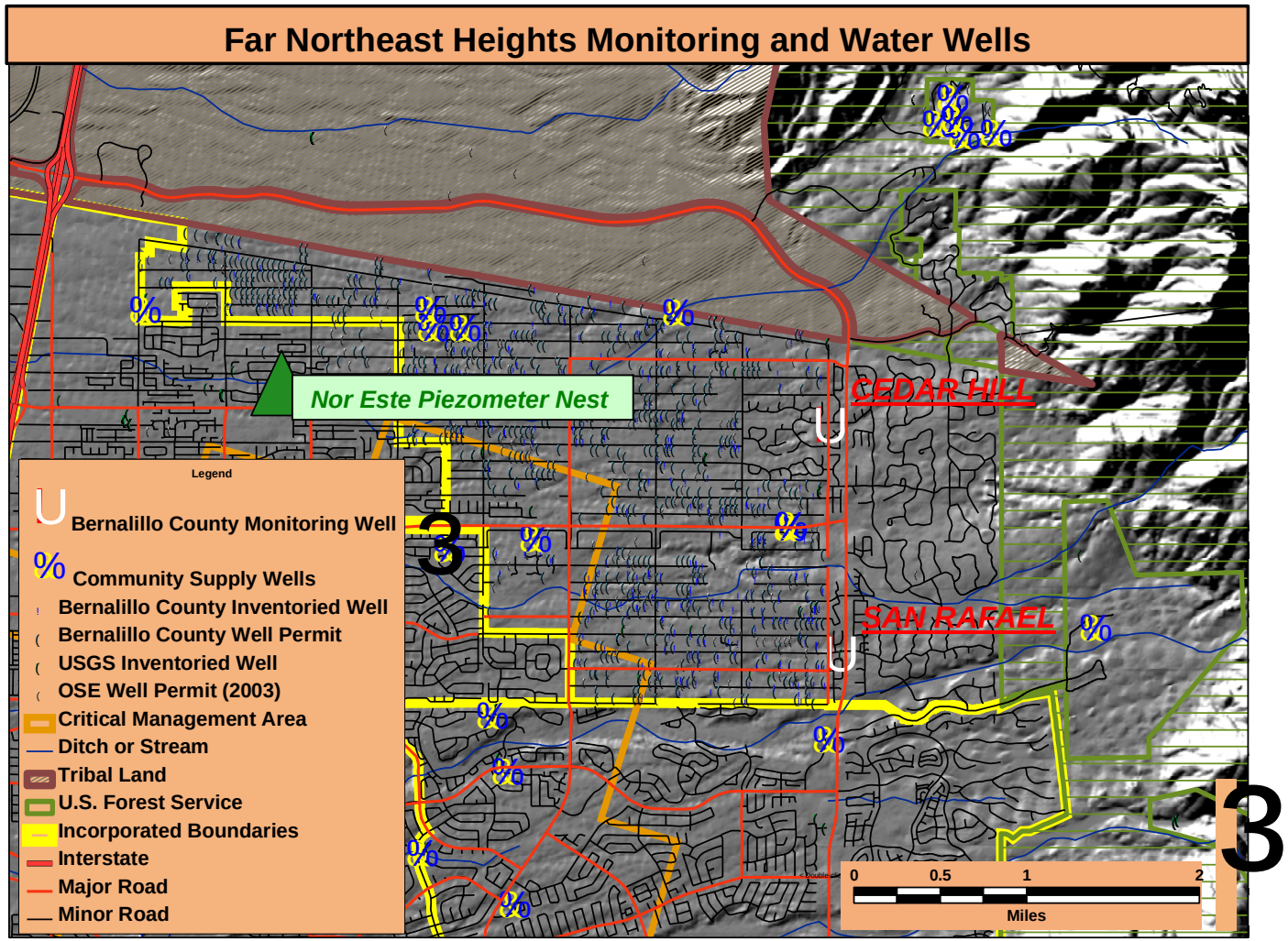


Figure 3.23 Far Northeast Heights Monitoring and Water Wells

Two of the wells were pre-existing at the time of the study (the Mhoon Well and the Elena Gallegos Well). Neither the USGS nor Bernalillo County actively monitor the wells. The City of Albuquerque monitors the Elena Gallegos well annually as a public water supply and analyzes for a minimal list of constituents (coliform, nitrate+nitrite). Nitrate levels are typically about 0.1 to 0.2 mg/L. Neither of the wells is monitored for water level. Two monitoring wells were installed as part of the study. The two wells, Cedar Hill and San Rafael, are actively monitored as part of the Bernalillo County monitoring program and are further discussed. Locations of the two wells are shown in Figure 3.23.

The Sandia Heights study resulted in the detection of nitrate concentrations of up to 3.5 mg/L in groundwater, while vadose zone sampling indicated decreasing nitrate and COD concentrations with depth and suggesting possible occurrence of denitrification in the soil column. Groundwater modeling for the study predicted a peak nitrate concentration of about 6 mg/L after 50 years of wastewater disposal through the on-site systems. The modeling results are dependent on the assumed septic tank density (7 systems / 246,330 $ft^2 \approx 1.2$ systems / acre) and on the nitrate source concentrations (34.1 grams per day per system) (Thomson et al. 2000 p. 119 and Figures 5-9 and 5-10). A doubling of either term results in a doubling of the modeled nitrate concentration in groundwater. McQuillan et al. (2004) cite to the report and calculate and groundwater impact of 2.5 mg/L (Table 1).

Results of a separate study based on samples from 23 individual domestic wells in North Albuquerque Acres are discussed in *North Albuquerque Acres Ground Water Quality and Septic System Impact Assessment* (CDM 2002). Based on the 25 samples, CDM concluded that none of the collected samples exceeded groundwater quality standards for any of the analytes and that most of the nitrate (from septic tanks) is being denitrified in the thick vadose zone or that the solute front had not reached the groundwater in most places. Of the 23 samples, only four samples were reported as not detected and only six samples exhibited nitrate concentrations greater than 1 mg/L. The maximum reported concentration was 2.3 mg/L. Four of the samples exceeded the now implemented EPA standard for arsenic of 10 mg/L.

A review of the USGS database indicates that 31 wells have been monitored by the USGS in the Far Northeast Heights. Most of these wells were monitored only prior to 1990 and active monitoring has been discontinued.

1.6.1 *USGS Far Northeast Heights Monitoring Wells*

The USGS previously monitored two municipal wells located along the southern boundary of the Far Northeast Heights area (Walker 1 and Walker 2), which are approximately 2 to 2.5 miles west of the Bernalillo County monitoring wells. The USGS currently maintains a piezometer nest for water level monitoring in Nor Este Park. The piezometer nest is 3 miles west of the monitoring wells. Sandia Peak Utilities pumps from two wells located mid-way between the two Bernalillo County monitoring wells. Pumping data and water level data for the two wells is not readily available. The respective well locations are shown in Figure 3.23.

1.6.1.1 Far Northeast Heights Water Levels

Water level data for the Walker 1 and Walker 2 wells are available only during the 1980's. The available data indicates a decline in water levels of approximately 6 feet in Walker 1, and approximately 20 feet in Walker 2 from 1982 to about 1987. This indicates a decline rate of 1 to 4 feet per year. This significant decline rate was partially responsible for the establishment of the OSE's critical management area outlined in Figure 3.23.

Figure 3.24 provides a hydrograph for water levels in the Nor Este piezometer nest. Water levels have been measured by the USGS since 1997, and readily available data extends through 2005 – a time period equivalent to the period of record for the Bernalillo County monitoring wells and a period of increasing population growth in the Far Northeast Heights. The data shown below was downloaded from the USGS website (USGS Ground Water for New Mexico: Water Levels and reformatted for this report.

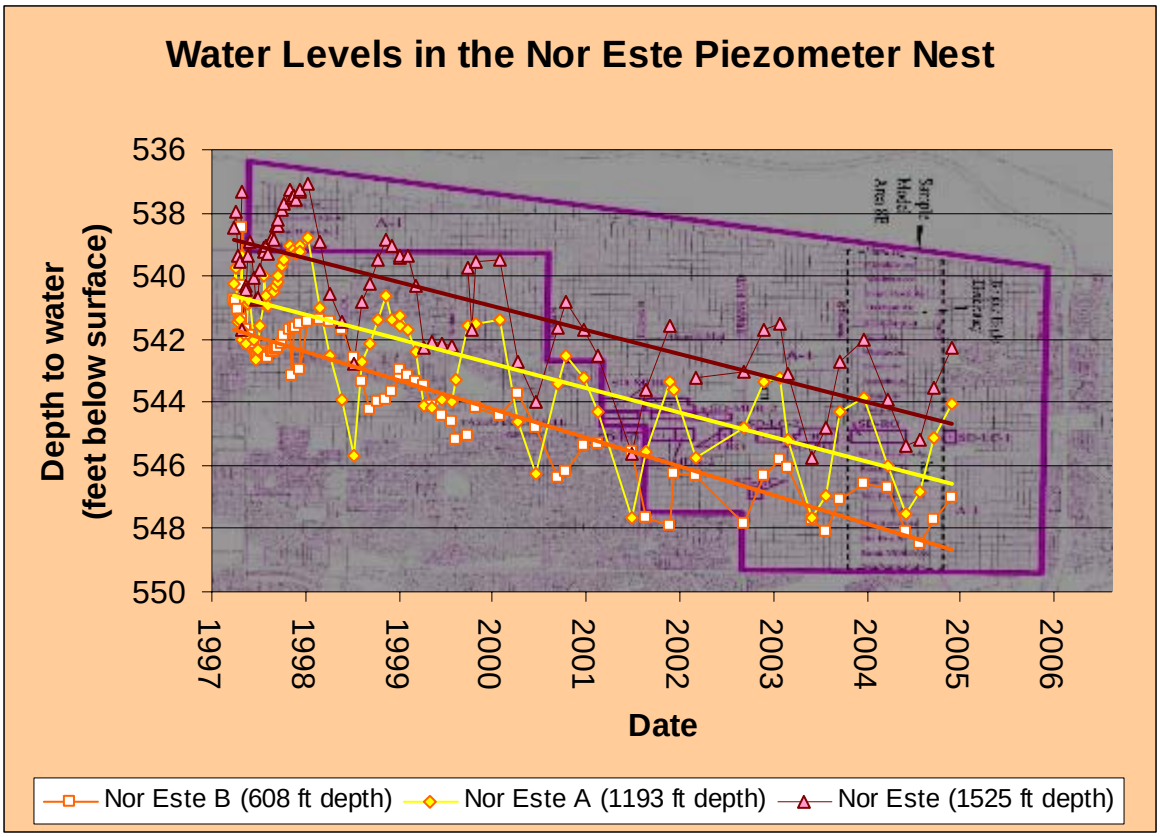


Figure 3.24 Water Levels in the Nor Este Nested Piezometer

Figure 3.24 indicates three pertinent trends in the water level data from the piezometer nest. First, the general trend in water levels is a decline of approximately 4 to 9 feet (depending on the zone monitored) from 1997 through 2005. This trend is shown by the linear trend fit (as shown above) or by visually inspecting the trend in the peak highs or peak lows. This indicates a decline in water levels of 0.5 to 1.1 feet per year regardless of the depth of the piezometer or seasonal fluctuation. The decline in water levels in the piezometer nest is likely reflective of the decline in water levels in individual domestic wells throughout the area. Secondly, the hydrographs clearly show a seasonal fluctuation. Peak water levels occur during the winter months when pumping from municipal and individual wells is at its minimum. This seasonal fluctuation can be as great as four feet in the shallow part of the aquifer. Lastly, the shallowest well (608 ft deep) shows the deepest water levels (i.e. the bottom graph in Figure 3.24) and the deepest well (1525 ft deep) shows the shallowest water levels (i.e. the top graph of Figure 3.24). This indicates a generally upward flow regime in the immediate vicinity of the piezometer. This is consistent with flow moving from recharge in the mountain to discharge at the Rio Grande. Pumping of intermediate or deep wells, however, can

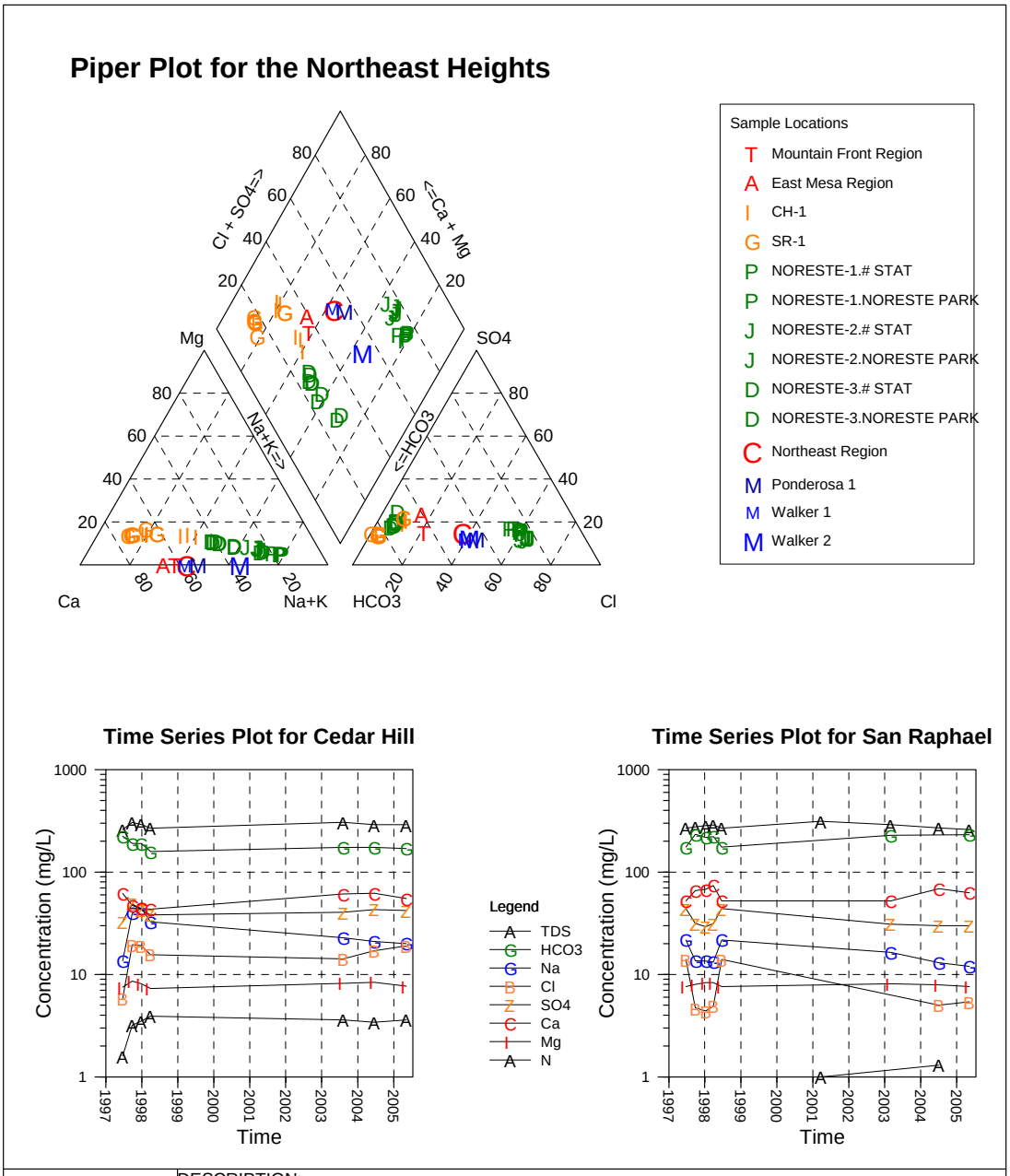
locally change the water flow dynamics, with all flow in the immediate area of the well being toward the screened portion of the well. Wells located greater distances from high volume domestic or community wells may show a decreased effect. Pumping effects are shown in Figure 3.24 when the middle graph crosses over the bottom graph, which occurs during the summer months of each year. This crossover indicates that pumping from the intermediate zone (i.e., the middle graph) is sufficient to lower water levels such that downward flow is induced from the upper zone (i.e. the lowest graph).

1.6.1.2 Far Northeast Heights Water Quality

Groundwater quality in the ABCWUA service area has been previously summarized by the USGS in *Spatial Patterns and Temporal Variability in Water Quality from City of Albuquerque Drinking-Water Supply Wells and Piezometer Nests, with Implications for the Ground-water Flow System* (USGS WRIR 01-4244, 2001). The Far Northeast Heights overlays portions of two of the five groundwater-quality regions identified in the report (i.e., the Northeast Region and Mountain Front Regions).

Representative samples for each of those groundwater-quality regions are plotted in Figure 3.25. The figure also includes the Piper plots for the Nor Este nested piezometer and for nearby municipal production wells. Collectively, the plots represent water quality in the Far Northeast Heights. Plots for the two monitoring wells, Cedar Hill Well 1 (CH-1) and San Rafael Well 1 (SR-1), are shown for comparison.

The Piper Plot clearly demonstrates the significant difference in groundwater quality characteristics in the Rio Grande valley area compared to the East Mountain area. The plots of the relative percentage of anions and cations for the valley area plot to the center portion of the diagram, while the samples for the East Mountain area plotted to the extreme upper left of the center diagram.



DESCRIPTION:

Water Quality in the Northeast Heights

PROJECT: *Water Data Report - 2005*

DATE: 5/16/06

BERNALILLO COUNTY PUBLIC WORKS / WATER RESOURCES

Figure 3.25 Water Quality in the Far Northeast Heights

This is due to the predominance of calcium bicarbonate in the East Mountain area and stems from the geologic setting. To a lesser degree, this is also reflected in the plots for Cedar Hill Well 1 and San Rafael Well 1. A progression to increased sodium composition with depth, is noted in samples from the Nor Este piezometer. The increase is due to interaction with the alluvial fill sediment during groundwater flow.

The diagram clearly illustrates that the water chemistry for the two monitoring wells differs from that of the production wells and the Nor Este Piezometer nest. The water chemistry in the two wells more closely resembles the representative chemistry of the Mountain Front Region, also shown on the plot. This is expected as the two shallow monitoring wells are located on the far eastern edge of the Northeast Region and reflect influence of mountain front recharge via the arroyos draining from the Sandia foothills. Of the samples shown, the chemistry of the two monitoring wells is more closely aligned to the water quality in the shallowest of the Nor Este piezometer nest. This is reasonable given the shallow depth of the wells and the minimal cation exchange that has occurred during groundwater flow.

The samples from the intermediate and deep Nor Este piezometers plot to the right mid-portion of the diagram and reflect a predominance of sodium over calcium and chloride over bicarbonate. This is reflective of the geochemical processes and effect of groundwater flow through the alluvial fill aquifer. Municipal wells demonstrate an intermediate chemistry and reflect the combined mixing of chemistry from shallow and deep zones and capture of water from both east and west, and match the "representative" chemistry for the Northeast groundwater quality region (as they should because they are part of the statistical basis of the "representative" sample.)

Figure 3.26 provides a statistical summary of the concentration distribution for trace metal and inorganics for the Far Northeast Heights as a whole. In some cases, particularly for the various metals, the sample set is small (less than 10 samples), so reliability of the distribution may be questionable. Absence of a distribution indicates that the sample size was insufficient to allow calculation of the various percentiles.

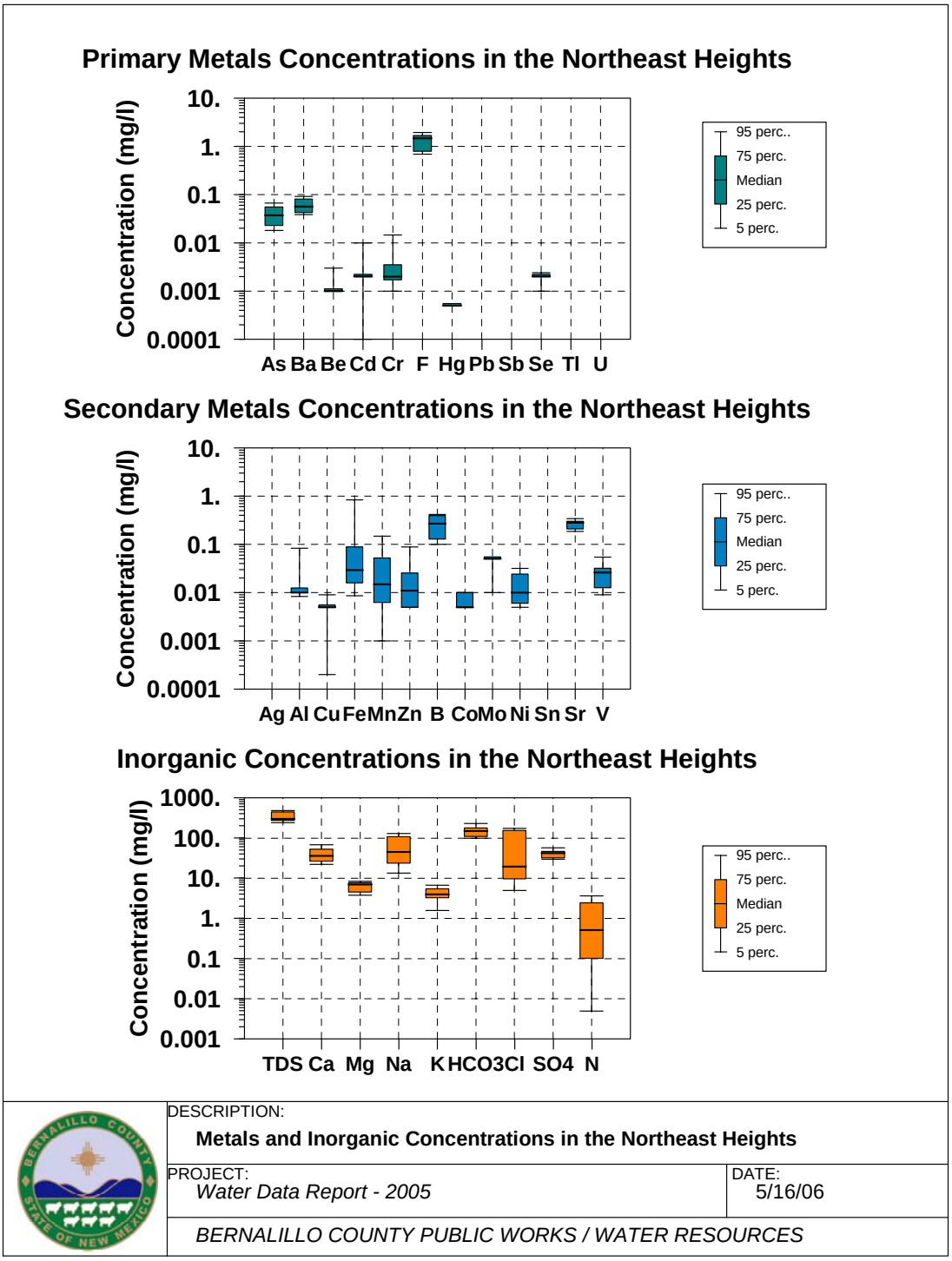


Figure 3.26 Trace Metal and Inorganic Concentrations in the Far Northeast Heights

Groundwater samples from wells in the Far Northeast Heights generally exceed the primary drinking water standard for arsenic and may at times exceed the standard for cadmium, but concentrations are consistent with natural occurrence of these elements. The secondary standards for iron and manganese are occasionally exceeded as noted by the 95th percentile exceeding the respective standards. This may be due to analysis of unfiltered vs. filtered samples, with inherent increases in concentrations due to oxides present on sediments and colloids present in unfiltered samples. The respective standards and the percentage of samples exceeding the standards are shown in Table 3.8 below.

Table 3.8 Exceedances of EPA Drinking Water Standards – Far Northeast Heights

Parameter	Primary Standard	Secondary Standard	Total Number of Samples	Percent of Samples Exceeding Standard
Arsenic	0.010		36	87
Cadmium	0.005		25	13
Iron		0.3	41	16
Manganese		0.5	40	24

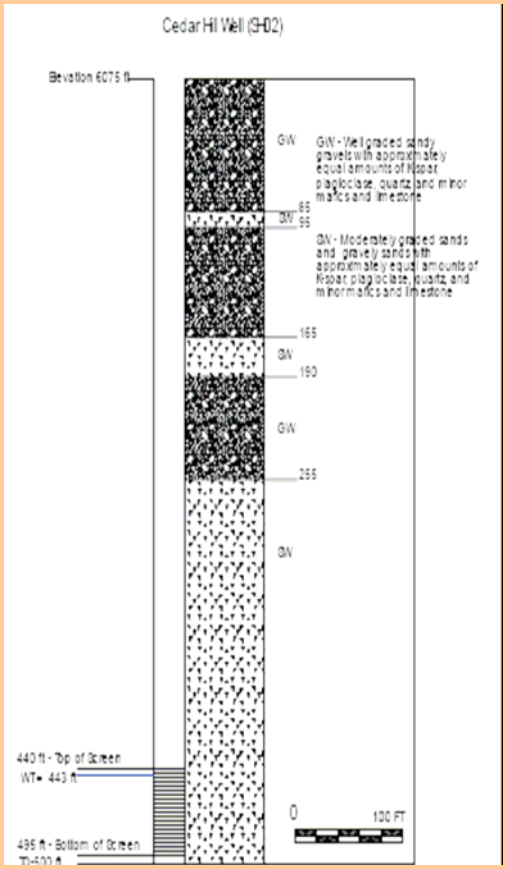
1.6.2 *Cedar Hill and San Rafael Wells*

Cedar Hill Well 1 and San Rafael Well 1 are located near Tramway Boulevard between North Albuquerque Acres and Sandia Heights (Figure 3.23). Similar to the East Mountain Area wells, these locations were originally selected to evaluate impacts of on-site wastewater treatment and disposal. The locations were selected based on a combination of factors including residential septic system density, depth to groundwater, proximity of USGS-monitored domestic wells, and availability of County-owned properties (Thomson et al. 2000, p. 36-38).

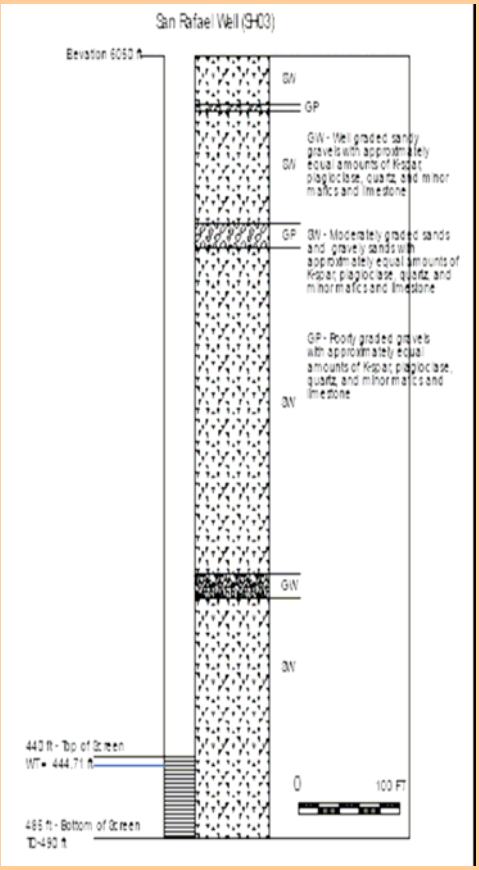
Both of the wells were completed in the Santa Fe Group alluvial aquifer, similar to most all wells in this area. The monitoring wells are completed in the shallowest portion of the aquifer at depths of 495 and 485 feet respectively as shown in Table 3.9 and Figure 3.27.

Table 3.9 Bernalillo County Regional Monitoring Well Network – Far Northeast Heights

Well	Well Type	Well / Hole Depth (ft)	Screen Settings (ft)
Cedar Hill (CH1)	Single	500	440-495
San Rafael (SR1)	Single	490	440-485



(Diagram from Thomson et al, 2000)



(Diagram from Thomson et al, 2000)

Figure 3.27 Cedar Hill and San Rafael Well Completion

The bottom 45 to 50 feet of the wells are screened and samples from these wells represent the uppermost conditions in the aquifer along the eastern side of the Far Northeast Heights. Well completion diagrams are provided in Figure 3.27. In general, domestic wells located near the monitoring wells are completed at depths in excess of 550 feet. Completion depths deepen to 600 to 800 feet or greater as once moves westward across the Embudo fault strands and to the northwest.

As shown in the geologic map and cross-section (Figure 3.28 and Figure 3.29), the monitoring wells are located east of the Sandia Fault – Tramway strand. The well locations are bounded to the west by the East and West Embudo strands. Based on geologic mapping, at least six fault strands transect the Far Northeast Heights area, with block movement consistently downward to the west. Available water level data suggests a marked increase in groundwater gradient moving westward between the East and West Embudo strands. This is highlighted in Figure 3.29. This structural control on gradient strongly suggests that the Embudo fault strands act as a partial hydraulic barrier.

1.6.2.1 Water Levels in Cedar Hill and San Rafael Wells

Water levels have been measured in the Cedar Hill and San Rafael wells since their installation in 1997. Figures 3.30 and 3.31 provide the hydrographs for the period of record. Water levels have been measured at least annually. A review of electronic data, however, indicates that identical depths to water were entered for all common dates for the two wells between 2000 and 2005, so accuracy and reliability of the data is suspect. Independent documentation is available for dates prior to 1999 and the author has taken the measurements since 2005. Based on comparison of the measurements from September1998 and February 2006, there has been an 11.4 feet decline in water levels in the Cedar Hill well, and 10.0 foot decline in the San Rafael well. The linearity of the trend between those dates is suspect due to the data irregularity mentioned. Regardless, the net decline between the two dates represents respective declines of 1.5 feet/year and 1.4 feet/year compared to 0.5 to 1.1 feet/year for the Nor Este piezometers.

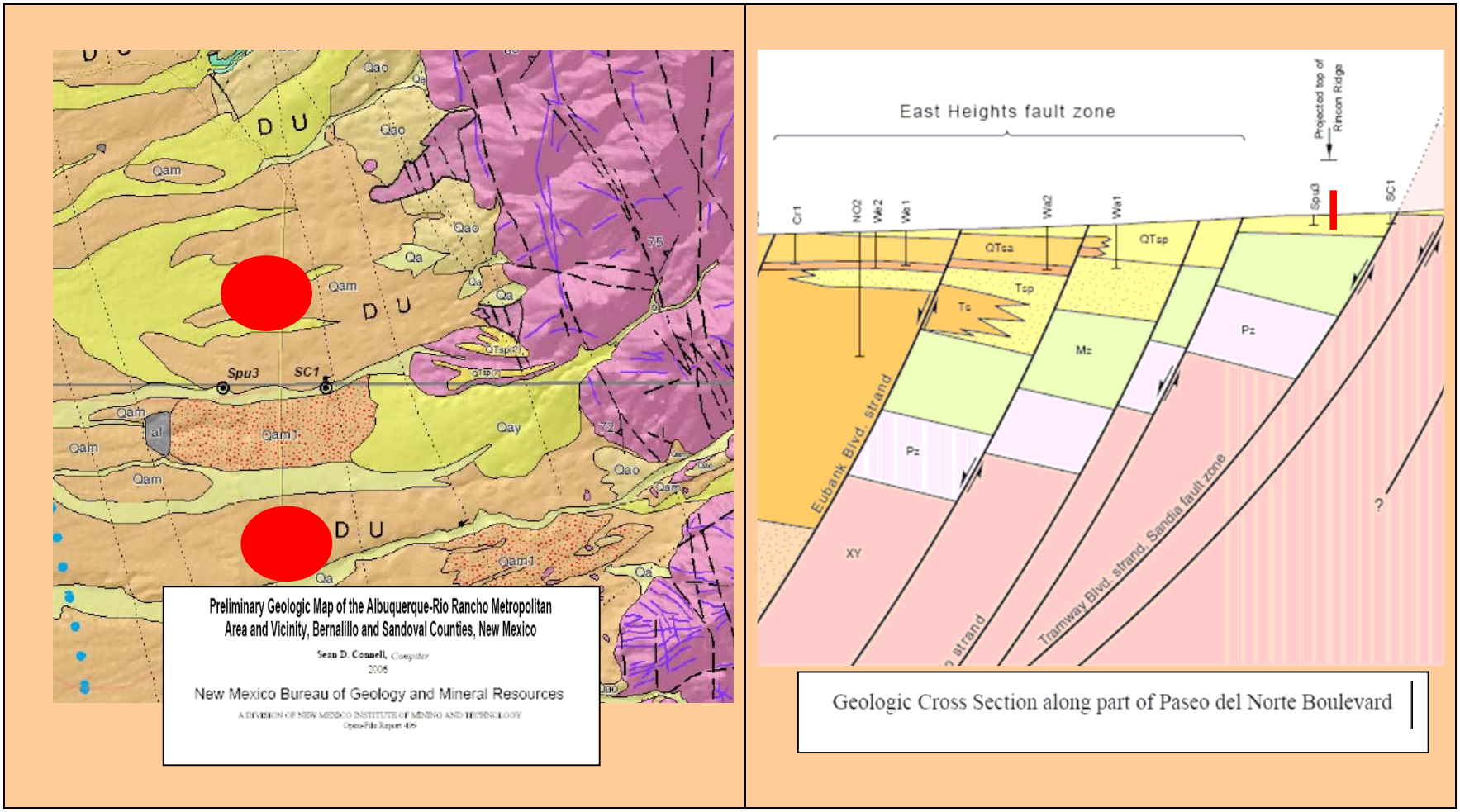
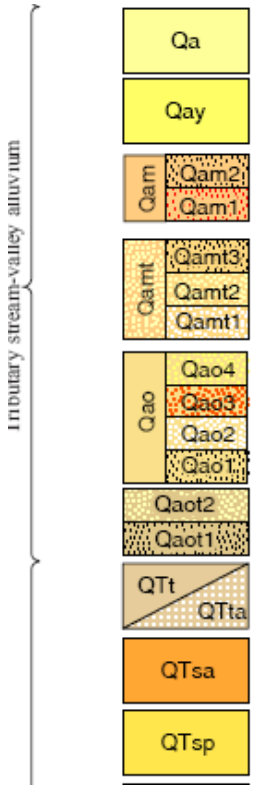


Figure 3.28a Geologic Setting of the Cedar Hill and San Rafael Wells



Active stream-valley alluvium (Qa, historic-Holocene)— light grayish- to yellowish-brown (10YR hues) sand, silty to clayey sand, and gravel; boulders are commor along western flank of the Sandia Mts; associated with modern incised stream valleys; very weakly developed (stage I) to nonexistent soils; 1-12 m thick.

Younger stream-valley alluvium (Qay, upper Pleistocene-Holocene)— pale-to light-brown (10YR hues) sand, muddy sand, and pebble to cobble gravel; boulders locally present along front of the Sandia Mountains; weakly developed soils (Stage I and II); commonly contains active stream-valley alluvium; up to 24 m thick.

Intermediate stream-valley alluvium (Qam, upper-middle Pleistocene)— yellowish-brown to reddish-yellow (7.5-10YR hues) sand, silty clay, and gravel; granite and limestone clasts dominant east of Rio Grande; variable lithology, dominated by chert and volcanic clasts west of the Rio Grande; surface is commonly mantled by eolian sand; variable soil development; divided into two subunits: Younger subunit (Qam2) contains moderately developed soils (stage II and III); Older subunit (Qam1) contains weakly developed soils (stage II); 5-43 m thick.

Intermediate stream-valley alluvium of Tijeras Canyon (middle Pleistocene)— sand and gravel associated with drainage courses of ancestral Tijeras Canyon; gravel composition more diverse than in Intermediate stream-valley alluvium with greenstone and sandstone; divided into three subunits: Younger subunit (Qam3t), Intermediate subunit (Qam2t), Older subunit (Qam1); 5-43 m thick.

Older stream-valley alluvium (Qao, middle Pleistocene)— light reddish-brown (7.5-10YR hues) sand and gravel; soil development is variable and exhibits stage I to III carbonate morphology with few or no clay films; divided into four subunits based on surface morphology and inset relationships: subunit 4 (Qao4), subunit 3 (Qao3), subunit 2 (Qao2), subunit 1 (Qao1); 2-14 m thick.

Older stream-valley alluvium of Tijeras Canyon (middle Pleistocene)— sand and gravel derived from former drainage courses of Tijeras Canyon; divided into younger subunit (Qaot2) and older subunit (Qao1t); 0-15 m thick.

Tuerto Formation (QTt, QTta, Pliocene-lower Pleistocene)— Tuerto gravels of Stearns (1953); pale-brown (10YR hues) pebbly to cobbly sandstone; unconformab overlies Sierra Ladrones Fm; locally capped by petrocalcic soils with stage III+ to IV+ carbonate morphology; gravels are predominantly limestone; subdivided into the gravel of Lomos Altos of Connell and Wells (1996) (QTta) west of the San Francisco fault, where the basal contact is 80-100 m above local base level; 4-18 m thick.

Sierra Ladrones Formation, axial-fluvial member (QTsa, Miocene(?)-lower Pleistocene)— light-gray to yellowish-brown (10YR hues), pebbly to cobbly sand, sand, and sparse mud; clasts dominated by rounded othoquartzite and volcanic rocks; interpreted as ancestral Rio Grand depostits; base not exposed; estimated thickness more than 300-800 m.

Sierra Ladrones Formation, upper piedmont member (QTsp, Pliocene-lower Pleistocene)— reddish- to yellowish-brown (7.5-10YR hues), conglomerate, sandstone, and minor mudstone; contains weakly developed paleosols and upward fining sequences of gravel, sand, and mud; generally poorly consolidated; 0-600(?) m thick.

Figure 3.28b Geologic Setting of the Cedar Hill and San Rafael Wells

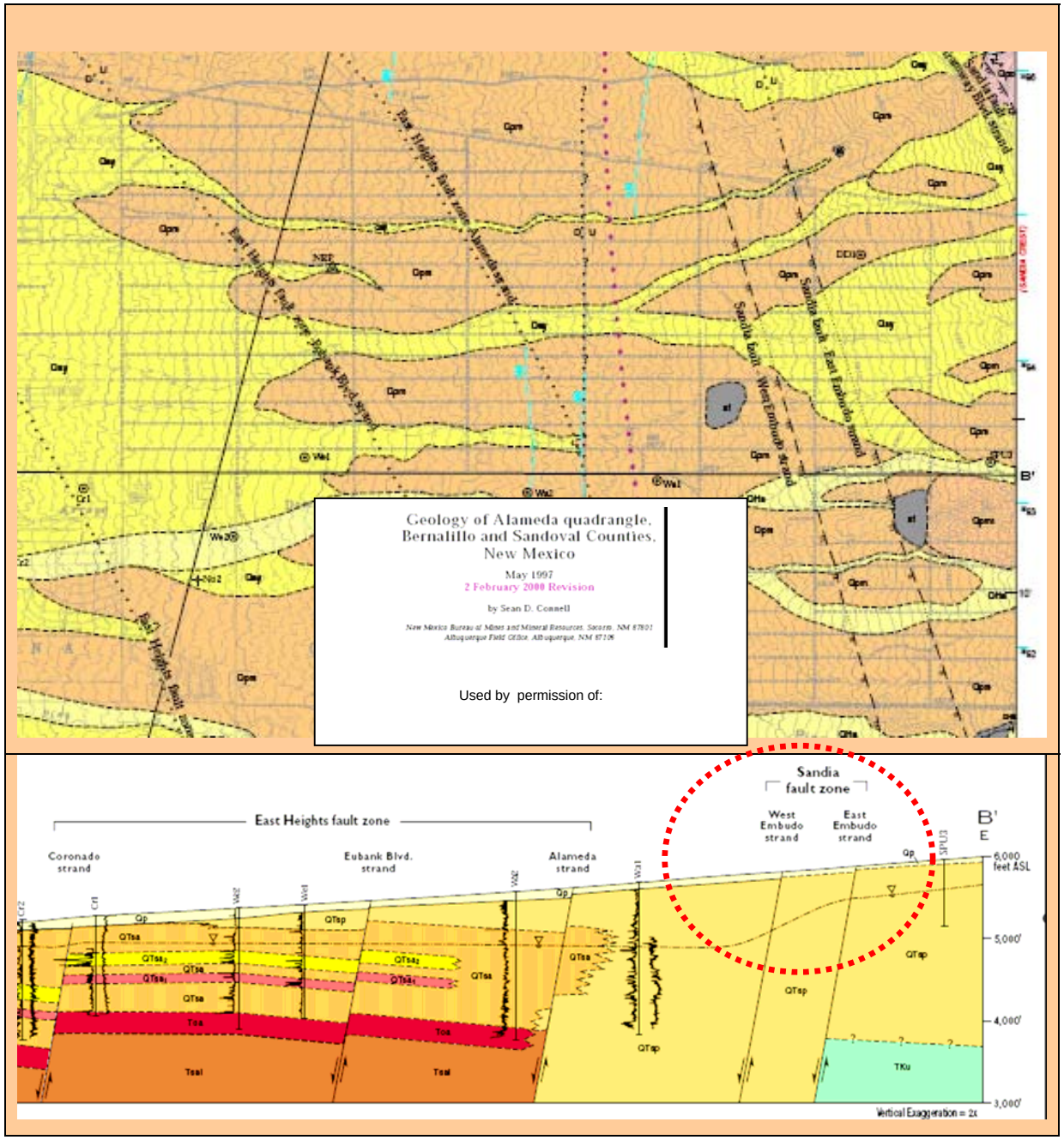
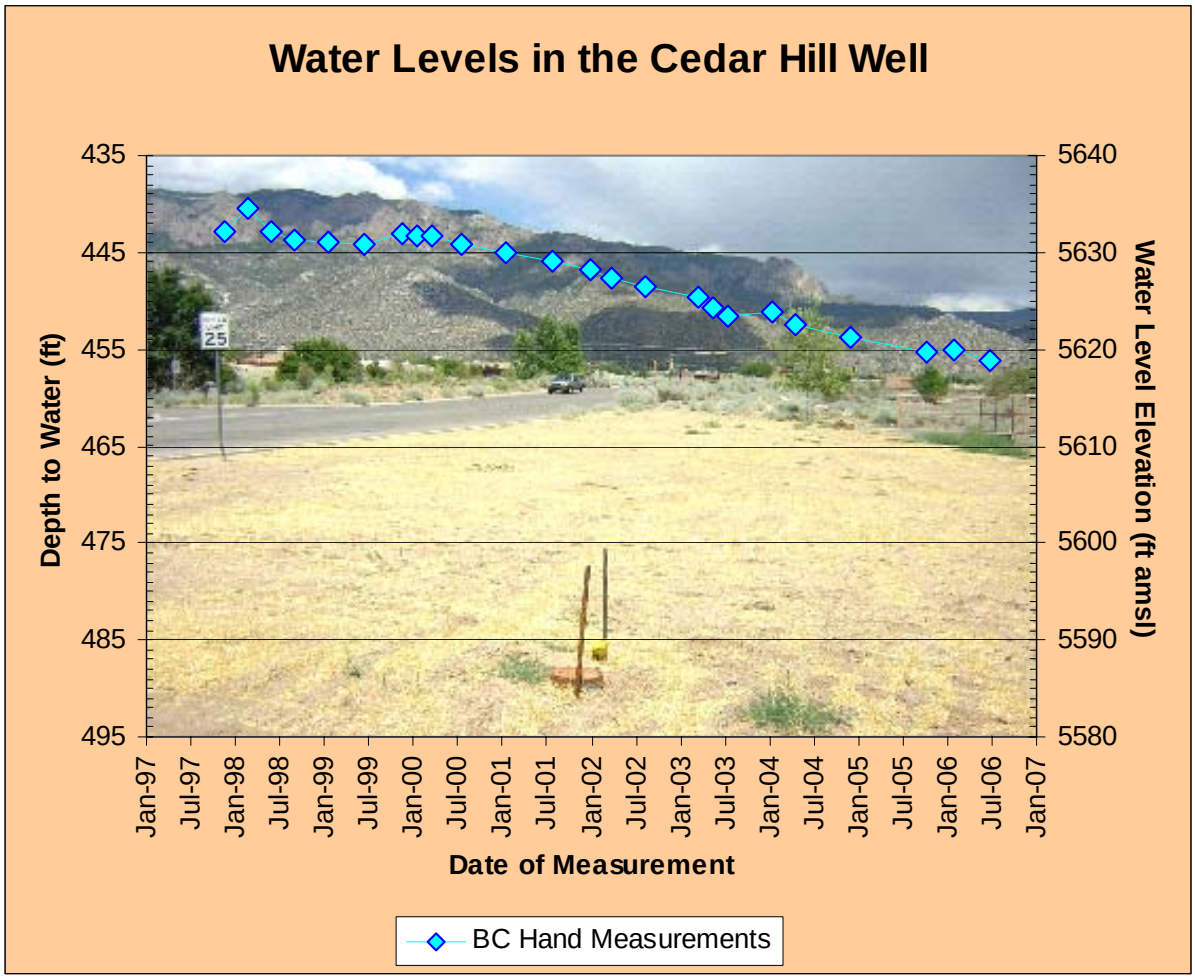
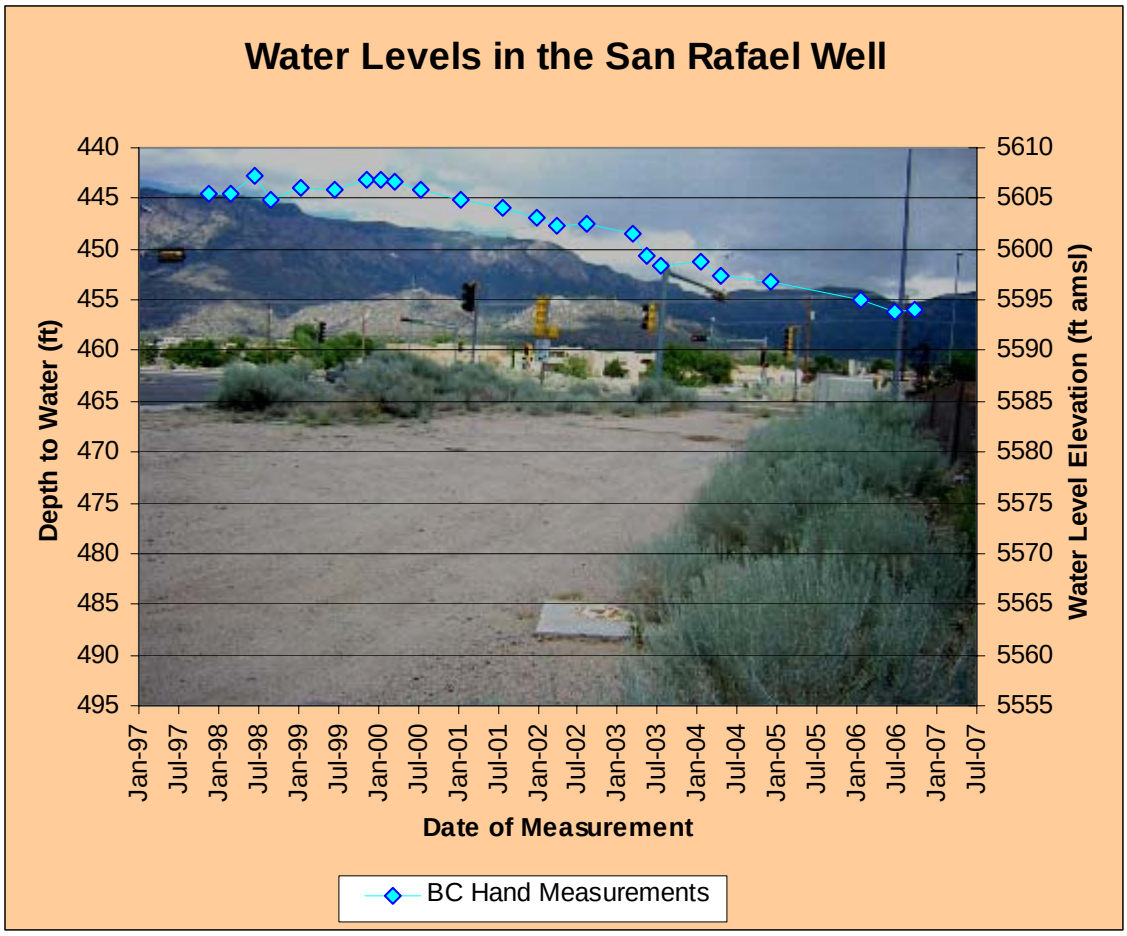


Figure 3.29 Locations of Faults in the Far Northeast Height



Cedar Hill Location – 1999	Cedar Hill Location - 2004

Figure 3.30 Water Levels and Comparative Aerial Photos for the Cedar Hill Location



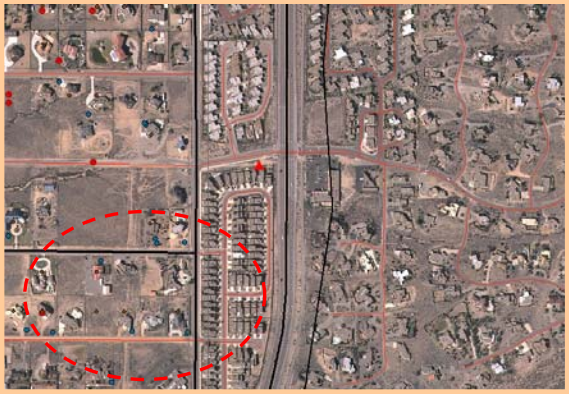
San Rafael – 1999	San Rafael - 2004
	

Figure 3.31 Water Levels and Comparative Aerial Photos for the San Rafael Location

At least four factors may account for this difference in decline rates between the County monitoring wells and the USGS nested piezometer. First, declines are expected because New Mexico has been in drought conditions since 1996 so water level declines should be anticipated. Some minor variations in decline rates are to be expected due to change in locales – however, the Nor Este and the monitoring wells are in relatively close proximity and screen the same aquifer and the same depths. Therefore, the normal variation should not be significant. A second factor may be localized effects of geology. As mentioned, there are a series of faults that separate the Nor Este location from the monitoring wells. These faults likely affect groundwater flow and are reflected in differing responses to various stressors. The third factor may be the effects of municipal pumping. The Nor Este piezometer nest has three municipal wells located within 1.5 miles (4,000, 7,000 and 9000 feet). There is a similar distribution of municipal pumping for the monitoring well locations (2 wells at 3,000 ft, and wells at 9000, and 12,000 feet). Differences in pumping rates, distances between wells, and specifics of the geologic setting likely account for noticeable differences in the decline rate. However, pumping data from the respective wells is not readily available for review to verify this assumption. The fourth factor is likely differences and/or increases in the density of nearby individual domestic wells.

The Nor Este piezometer nest is located in a residential area served by ABCWUA, and based on available County and OSE records, the nearest domestic wells are located at a distance of approximately 2,000 feet from the Nor Este piezometer location. The nearest municipal wells are the Webster 1 and 2 wells located approximately 1 mile to the south, and the Walker 1 and 2 and Coronado Wells 1 and 2 located approximately 1½ miles to the southeast and southwest respectively. Due to the distances involved, declines in the piezometer water levels are not predominately due to increases in domestic well pumping. Municipal pumping is the primary cause of drawdown in the Nor Este piezometer nest.

For Cedar Hill Well 1, the distribution of domestic wells is similar to that for the Nor Este piezometer nest, but most of the wells have been constructed since 2000 (although the records are not definitive in that regard). By contrast, the San Rafael well has at least 25 domestic wells within a one-mile radius. Figures 3.30 and 3.31 provide aerial photos for the area surrounding the two locations and provide a visual comparison of 1999 to 2004 growth in the number of residences, most

of which are supplied by individual domestic wells. The red, blue, and brown dots represent plotted well locations taken from OSE and BCOEH databases with varying spatial accuracy. Rather than representing individual wells, adjacent dots of differing color likely indicate a single well location. A comparison of the aerial photographs for the San Rafael location indicate that within 2000 feet of the San Rafael location, no less than 10 new residences supplied by domestic wells were constructed between 1999 and 2004. This agrees with the number of building permits issued within a 2,000-foot radius. At least one of these residences includes a swimming pool. Although more building permits have been issued for a comparable radius around the Cedar Hill well, these residences are on the ABCWUA supply, not individual wells. There is no significant increase in individual wells near the Cedar Hill well. Coupled with relative distance to fault strands, the domestic well pumping and municipal well pumping likely result in the increased rate of drawdown in the monitoring wells. This also accounts for the increased rate of decline compared to the Nor Este piezometer.

Figure 3.32 provides a simulation plot for the effect of pumping from a 2 gpm domestic well at 1,000 feet from a monitoring well and for pumping from a 500 gpm well at 3,000 feet from a monitoring well. The 2 gpm rate is an average value for domestic well use, and the 500 gpm is based on reported annual volume produced by Sandia Peak Utilities. Although only an approximation, the figure indicates that for a domestic well pumping at 2 gpm, the rate of decline is approximately 0.006 feet/year at a point 1,000 feet distant ((0.23 ff-0.17 ft) / 10 years). The figure also indicates that after thirty years of pumping, the rate of decline from the 500 gpm well at a distance of 3,000 feet from the pumping well is about 0.1 ft/yr (35 ft – 34 ft / 10 year).

For the San Raphael well, there are at least 10 domestic wells within a 2,000 foot radius (suggesting a resulting rate of decline of perhaps 0.05 to 0.1 feet /year). Two of the Sandia Peak Utility production wells are located approximately 3,000 feet from the Cedar Hill and San Rafael monitoring wells, suggesting an additional rate of decline of 0.2 feet/year due to nearby community system pumping. This represents at least 0.3 feet/year decline (and likely greater) of the difference between the Nor Este piezometer and the County well locations.

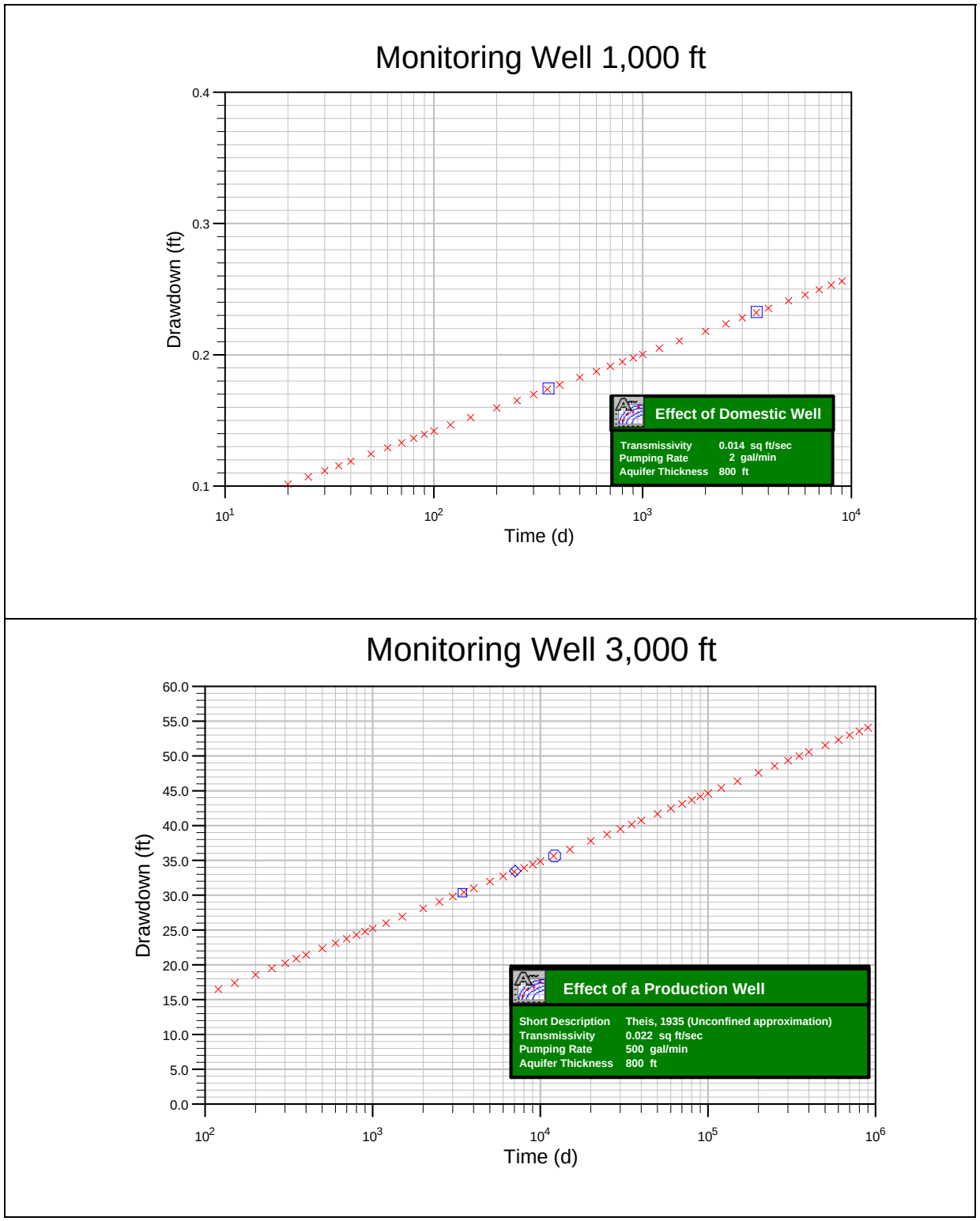


Figure 3.32 Simulated Effects of Pumping

Existing water level data are inadequate to define gradient directions for the eastern portion of the aquifer. Locally, gradients are affected by the presence of low-transmissivity fault structures and the production from high-volume community supply wells. Based on 2002 USGS data (USGS WRIR 02-4233), the lower portion of the alluvial aquifer demonstrates a gradient to the south - southeast. However, the water level contours were inferred and are bounded by an "apparent hydraulic discontinuity not near a known fault". The USGS models, however, do not incorporate measurements from production wells located within the Far Northeast Heights. Based on the available hydrogeology and location of production wells (see Figure 3.23), it is suspected that the general gradient is southerly and in some locations may be to the southwest. Using the three known shallow water levels (the two monitoring wells and the Nor Este piezometer), simple triangulation suggests a gradient to the west – southwest in the shallow portion of the aquifer and likely shifting more southerly as one moves westward and downward in the aquifer, due to the effect of increased municipal pumping.

1.6.2.2 Water Quality in Cedar Hill and San Rafael Wells

General trends in water quality in the Far Northeast Heights were previously discussed. Water quality data for the two wells for late 1997 through 1998 is available in Thomson et al. (2000). After 1998, data were collected by Bernalillo County.

Groundwater samples from wells in the Far Northeast Heights have not exceeded the Primary Drinking Water Standards. Secondary standards for iron and manganese have been exceeded in the Cedar Hill well, and on one occasion for aluminum in the San Rafael well. Again, this may be due to issues of analysis of unfiltered vs. filtered samples.

Figure 3.25 provides Piper plots and time-series plots for the Cedar Hill and San Rafael wells. Neither of the wells has ever exceeded the drinking water standard for nitrate. However, elevated concentrations of nitrate (nitrate + nitrite as total N and greater than 2 mg/L), have been reported consistently for the Cedar Hill well. A maximum concentration of 3.9 mg/L was reported in September 1998; subsequent analyses indicate concentrations ranging from 3.4 to 3.6 mg/L. Statistical trend determinations were inconclusive and showed neither increasing nor decreasing trends in concentration. Regardless, the reported concentrations do appear elevated compared to

concentrations from the Elena Gallegos well, which is located east and hydraulically upgradient of Sandia Heights. Concentrations in that well in 1997 – 1998 were all less than 0.25 mg/L. The initial nitrate concentrations in the San Rafael well were reported at 3.2 mg/L. Subsequent measurements since 2001 have yielded concentrations of less than 1.5 mg/L. Modeling results presented in Thomson et al. (2000, Figures 5-6 and 5-7) suggest that nitrate concentrations would likely reach a maximum concentration of 6 mg/L based on current septic tank densities and practices, and recharge and water use conditions.

The San Rafael well was sampled and analyzed for the 66 compounds USGS considered indicative of anthropogenic effects on water quality (i.e., emerging contaminants). None of the compounds were detected in the sample from the San Rafael location. The lack of detection is reasonable given the minimal nitrate concentrations in the San Rafael well. Samples from the Cedar Hill well were not analyzed for these compounds.

The two wells have been sampled for volatile and semi-volatile organic compounds. There have been only two reported low-level detections of organic compounds: methyl ethyl ketone and phthalate compounds. Both of these compounds are common laboratory contaminants, and the detections are anomalous events, suggesting they were laboratory-related contaminants.

1.7 ***North Valley Monitoring Wells***

Bernalillo County does not currently conduct groundwater monitoring in the North Valley / Paradise Hills area. The North Valley encompasses the ABCWUA's Griegos, Duranes, Gonzales and Atrisco wellfields. These wells are actively monitored by the ABCWUA and by the USGS. The shallow hydrology of this area is complicated by the interaction of surface and groundwater along numerous irrigation and drainage channels and the Rio Grande. As a result, the USGS also monitors well transects at the Paseo del Norte, Montano, Central Ave., and I-25 bridges where they cross the Rio Grande. Information is available at Bosque Piezometers (http://nm.water.usgs.gov/bosque.html). In addition, the USGS monitors multiple shallow and deep wells on the perimeter of the North Valley.

The following discussion is limited to presentation of data from the USGS- monitored piezometer nests. These piezometer nests are the only source of readily available, long-term water level and water quality data near the North Valley. Additional, short-term water level information for other wells is available at the USGS website (USGS Ground water for New Mexico: Water Levels). All discussion below is based on ABCWUA- and USGS–generated information. Bernalillo County Water Resources does not currently monitor any wells within the North Valley.

Locations of community supply wells, USGS piezometer nests, and individual water wells are shown in Figure 3.33. The piezometer nests are located beyond the perimeter of the North Valley. The piezometers discussed below include:

- the Sister Cities nest,
- the Hunters Ridge nest,
- the Sierra Vista nest,
- the Garfield nest,
- the West Bluff nest.

1.7.1 *North Valley Water Levels.*

Water level and water quality monitoring is routinely conducted by the USGS in piezometer nests outside the perimeter of the North Valley area. The data presented below was collected by the USGS and downloaded for this report from the USGS website (USGS Ground water for New Mexico: Water Levels). It is included for completeness in describing groundwater quality conditions within the unincorporated areas of Bernalillo County.

Sister Cities

The Sister Cities Park nested piezometer is located east of I-25 and south of San Antonio Drive. This location represents conditions along the eastern perimeter of the North Valley area. The deep piezometer (1,308 ft) indicates a minimal downward trend in water levels of one to two feet per year, with seasonal fluctuations of about 10 to 15 feet (see Figure 3.34). The upper well (789 ft.), however, indicates a continual decrease of approximately 6 feet since 1998, with seasonal fluctuations of approximately 4 to 5 feet, a decline rate of approximately 0.75 feet per year.

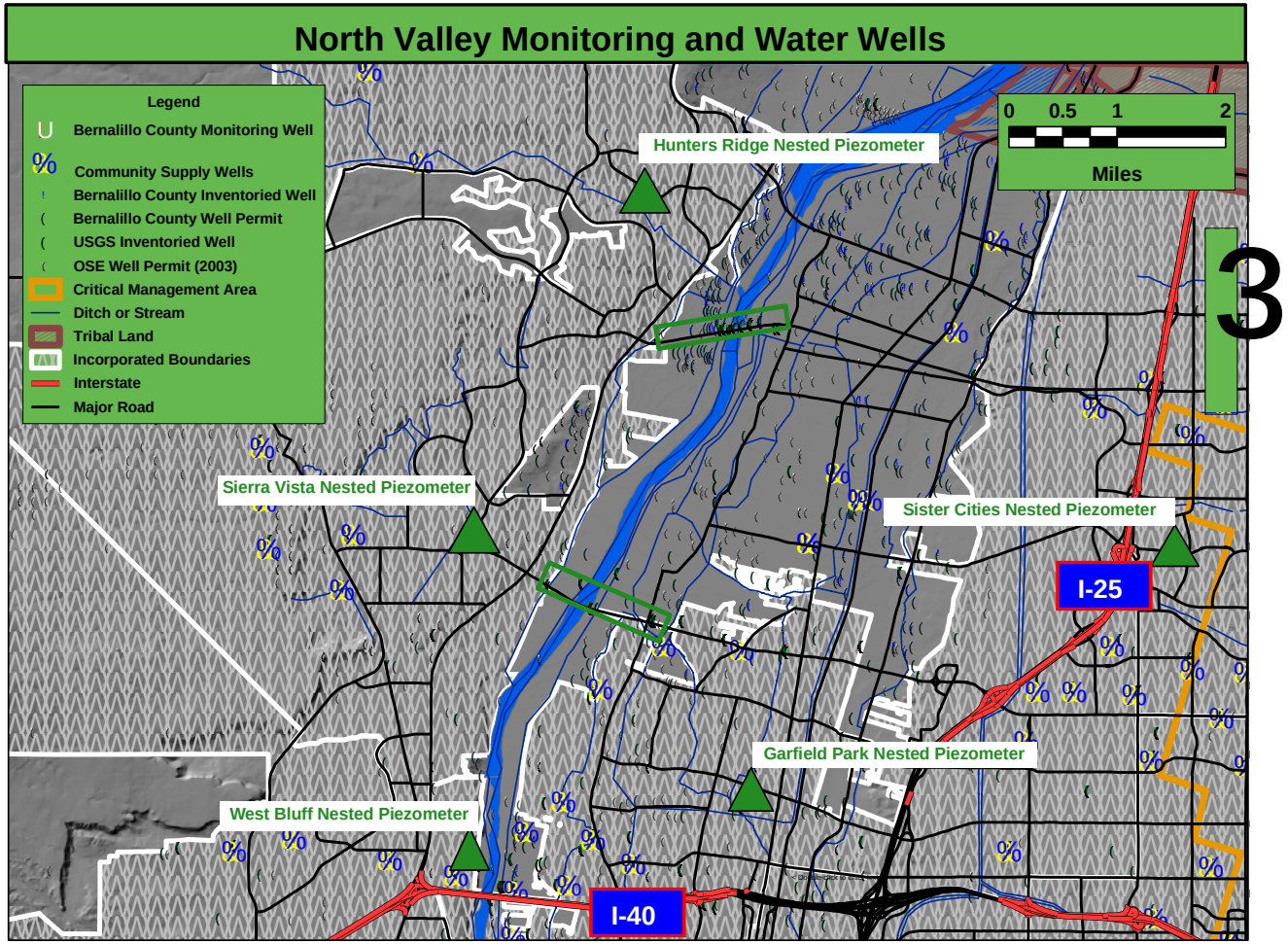
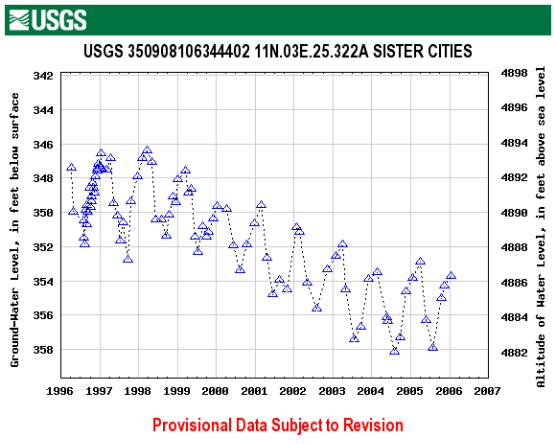


Figure 3.33 North Valley Monitoring and Water Wells

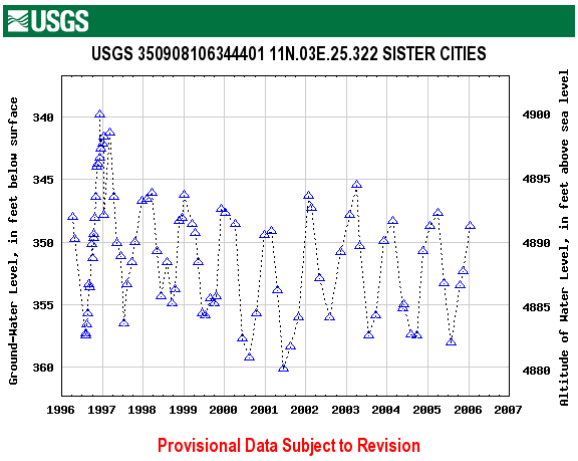


Well Information

Land Surface Elevation: 5,240 amsl.

Top of Screen: 789 ft

Depth of Well: 799 ft.



Well Information

Land Surface Elevation: 5,240 amsl.

Top of Screen: 1,298 ft

Depth of Well: 1,308 ft.

Figure 3.34 Water Levels in the Sister Cities Park Nested Piezometer

The Sister Cities nest lies between two major zones of pumping, with the Coronado wellfield located approximately two miles to the north, and the Vol Andia and Leyendecker wellfields located approximately two miles to the southwest and southeast. The upper piezometer screens the production interval used by the wellfields and thus demonstrates increased drawdown effects compared to the lower piezometer. The vertical gradient at the Sisters Cities site is upward.

Hunters Ridge

The Hunters Ridge nested piezometer is located along the northwest of the North Valley near the coalescing of two major arroyos draining from the northwest. The location consists of two piezometer nests, with three wells each (see Figure 3.35). The first nest piezometers screen the shallow (128 ft.), middle (845 feet), and deep (1,508 ft) portions of the aquifer. The second nest piezometers screen only the shallow portions of the aquifer (238 ft., 295 ft., and 349 ft.) and screen depths overlap with the screen interval of the shallow well constructed in the first nest. The series of hydrographs indicate a downward hydraulic gradient. The nearest large quantity production wells are located approximately two miles to the west and are operated by New Mexico Utilities.

Figure 3.35 provides the water level graphs for each of the piezometers in the Hunters Ridge nest. The graphs have been organized by depth of the screened intervals rather than retaining the nested groupings. From shallowest to deepest, the graphs are ordered top to bottom and then left to right – the shallowest well (128 feet) is in the upper left hand corner of the figure and the deepest (1,508 ft) is in the lower right-hand corner.

Two salient trends are readily identifiable. First, in each of the graphs there is a continual decline in water levels with respect to the initial measurements in the wells taken in 1996. The amount of decline is approximately 5 feet in the shallowest well, and increases to 6 to 8 feet in the deeper intervals below about 300 feet. This equates to a 0.5 to 1.0 feet of decline per year. Seasonal fluctuations are approximately 1 to 2 feet in the shallower portions of the aquifer, and approximately 2 to 4 feet in the deeper intervals. Water level declines in this area are the result of municipal pumping, with the nearest municipal well being the New Mexico Utilities Well #2 located approximately 2 miles to the west.

The second noticeable feature of the graphs is a marked jump in water levels occurring in 1999. In mid-1999, there was an approximately 3-foot jump in water levels in the shallowest of the piezometers. The rise is also clearly seen in each of the piezometers with screens located above approximately 300 feet.

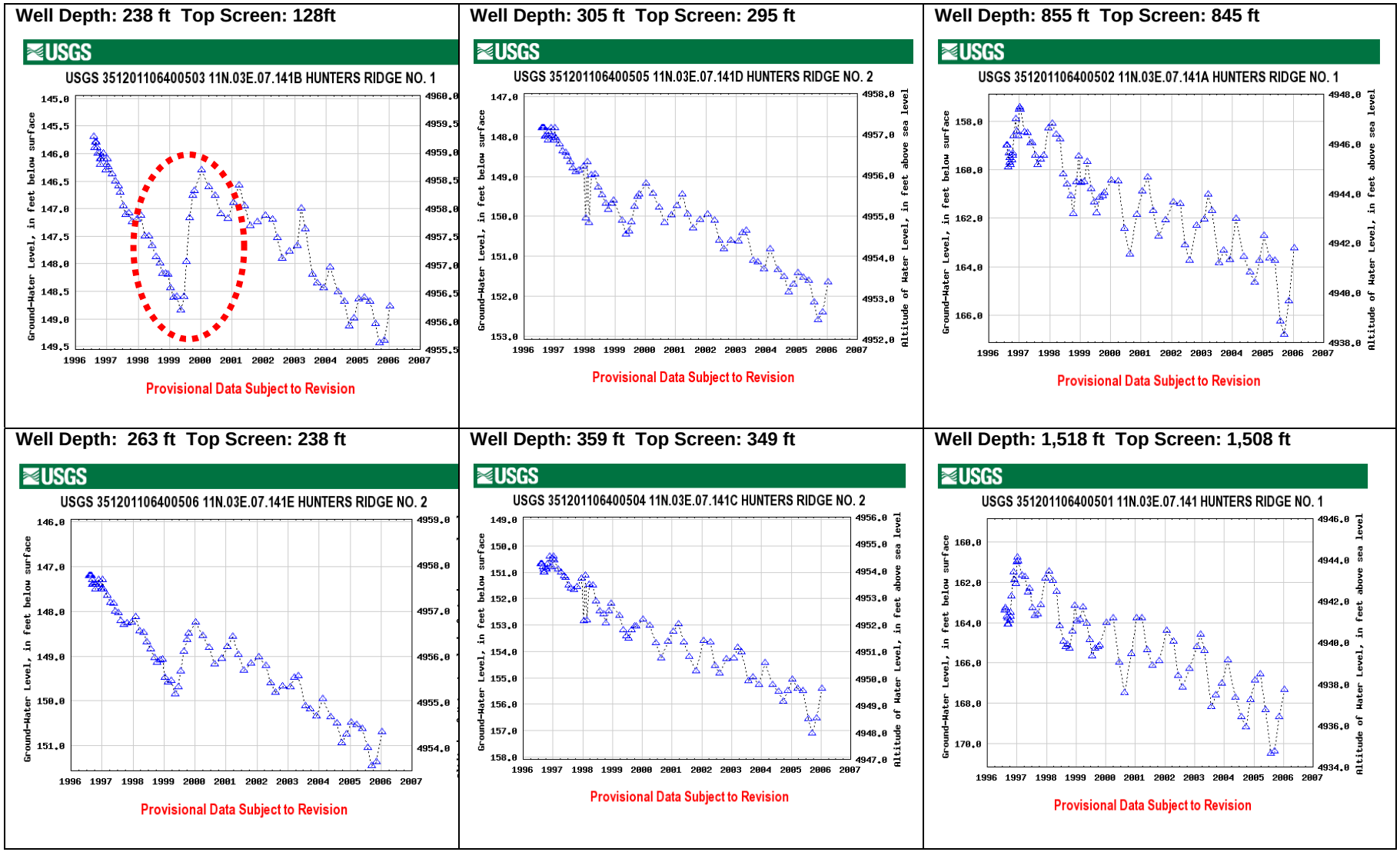
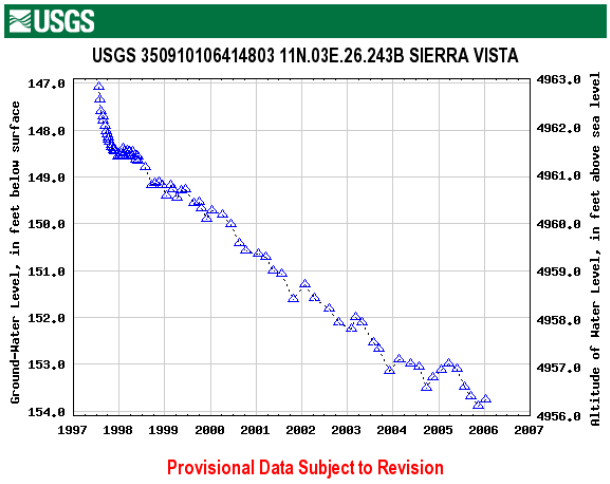


Figure 3.35 Water Levels in the Hunter's Ridge Nested Piezometer

However, this rise is not discernible in the three deeper wells (349 ft., 845 ft., and 1,508 ft.). This suggests that some surface-related phenomena occurred, such as increased recharge from the arroyos or cessation of pumping from a nearby shallow well. The piezometer nests are located near Arroyo de las Calabacillas and Black Arroyo. No stream gauging stations are available at that location. A review of the peak flow records for surface water gauging stations on Boca Negra Arroyo located approximately 5 mile southwest show a significant flow event stemming from the West Mesa in mid-1999. This characteristic indicates that significant recharge to the shallow portions of the aquifer can occur via the arroyos, but any gains at depth may be masked by continually declining water levels stemming from municipal pumping.

Sierra Vista

The Sierra Vista nested piezometer is located west of the Rio Grande near the intersection of Montano Rd. and Valle Vista Rd. This location is west of the North Valley (see Figure 3.33). Hydrographs are provided as Figure 3.36. Hydrographs for each of the piezometers (210 ft., 928 ft., and 1,644 ft.) indicate an approximately 7-foot decline in water levels since 1997, with the vertical gradient being downward in this area. The water levels in early 2006 ranged from 154 feet in the shallowest well to 188 feet in the deepest. The Sierra Vista nest is located approximately two miles east of the Volcano Cliffs wellfield and one mile east of the Zamora wellfield. The rate of decline, 0.7 ft / year is similar to that demonstrated by the shallow well in the Sister Cities nest. The nests are similarly situated with respect to nearby municipal production wells.

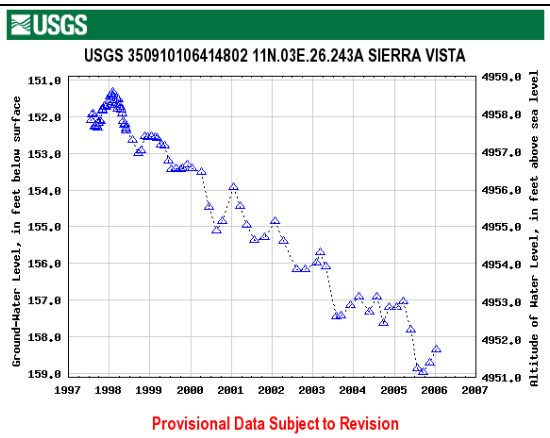


Well Information

Land Surface Elevation:
5,110 ft. amsl

Top of Screen: 140 ft.

Depth of Well: 210 ft.

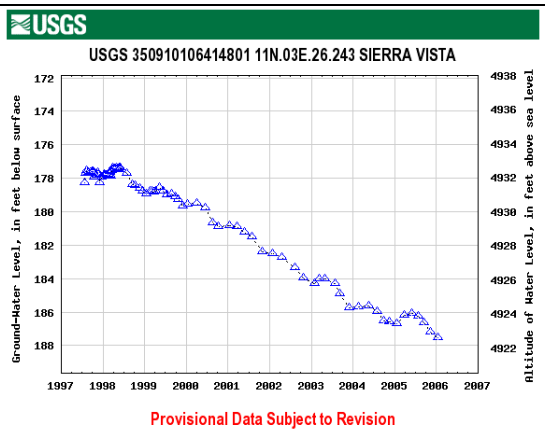


Well Information

Land Surface Elevation:
5,110 ft. amsl

Top of Screen: 918 ft.

Depth of Well: 928 ft.



Well Information

Land Surface Elevation:
5,110 ft amsl

Top of Screen: 1,634 ft.

Depth of Well: 1,644 ft.

Figure 3.36 Water Levels in the Sierra Vista Nested Piezometer

Garfield Park

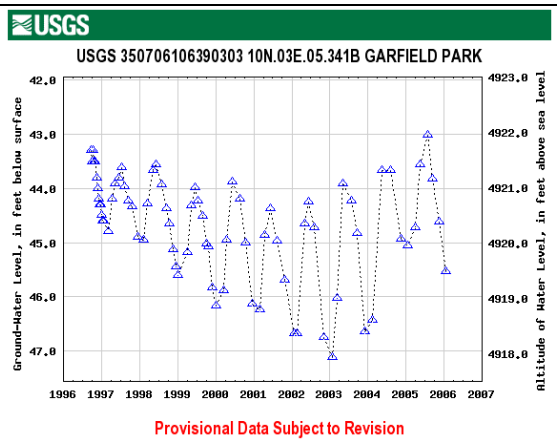
The Garfield Park nested piezometer is located near Matthew Ave. and east of 12th Street, approximately 2 miles east of the Rio Grande. The location is representative of the groundwater conditions in the inner valley floor.

Hydrographs for the piezometers are provided in Figure 3.37. The water levels in the shallow piezometer (83 ft.) show a declining trend of about two feet from 1996 through 2003. Since 2003, water levels in the well have risen by that same amount. Whether this rise is due to conservation efforts, decreased pumping from nearby individual domestic wells, or changes in river conditions or inner valley irrigation is unknown. Seasonal fluctuations are about 1 to 3 feet. The intermediate depth well (582 ft.) shows a similar pattern, although the rise in water levels appears to have begun as early as 2000. Again, seasonal fluctuations are about one to three feet. The deepest of the piezometers (1,020 ft.) provides a hydrograph quite similar to that of the intermediate well. The vertical gradient in this area appears to be downward, with water levels ranging from about 45 feet in the shallowest piezometer to 50 feet in the deepest. This suggests loss of water from the surface to the deeper subsurface, indicative of loss of water from the river to the aquifer, or from the shallow aquifer to the deeper pumped zones.

West Bluff

The West Bluff nest consists of two sets of piezometers located on the western bluff, north of the I-40 bridge. This piezometer nest is tied into a transect of shallow piezometers stretching across the floodplain, which is actively monitored by the USGS to aid in determining shallow groundwater / stream interactions.

Figure 3.38 provides the hydrographs for the piezometer nest. The water levels in each of the piezometers clearly reflects seasonal fluctuations in water levels, with low water levels occurring during the summer months, and then recovering through the winter months to peak in the January

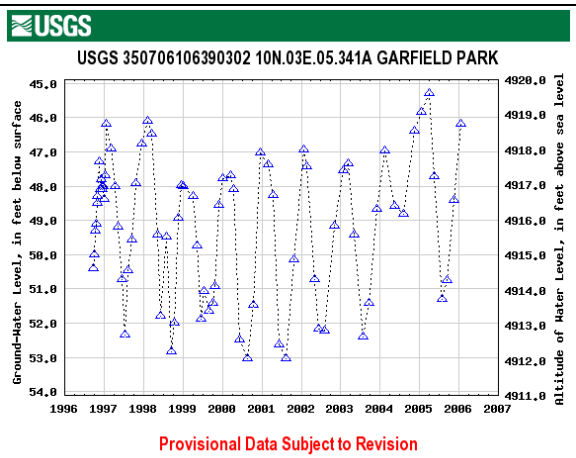


Well Information

Land Surface Elevation:
4,965 ft amsl.

Top of Screen: 43 ft

Depth of Well: 93 ft.

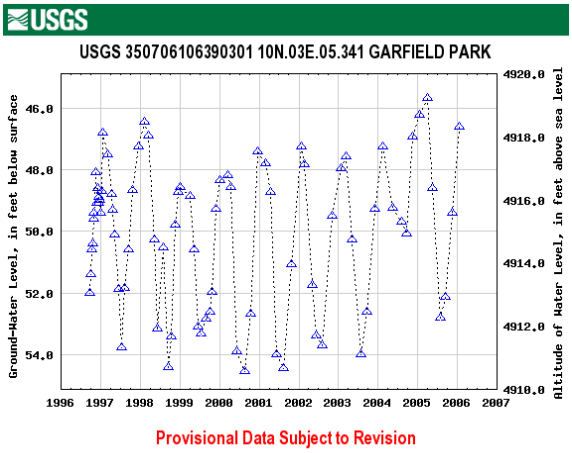


Well Information

Land Surface Elevation:
4,965 ft amsl.

Top of Screen: 552 ft

Depth of Well: 582 ft.



Well Information

Land Surface Elevation:
4,965 ft amsl.

Top of Screen: 995 ft

Depth of Well: 1020 ft.

Figure 3.37 Water Levels in the Garfield Park Nested Piezometer

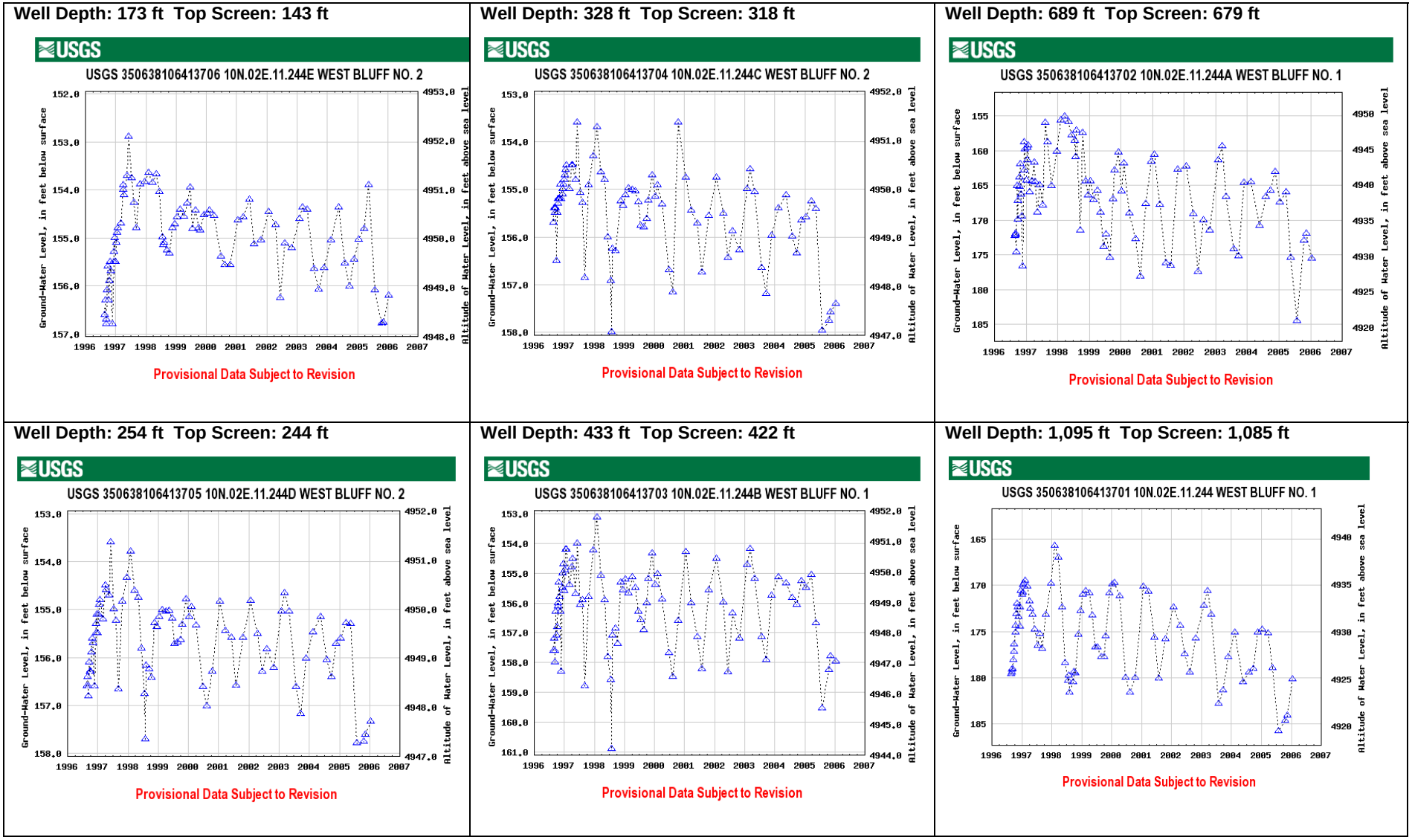


Figure 3.38 Water Levels in the West Bluff Nested Piezometer

to March time frame. Peak water levels were measured in 1997 and 1998 in each of the wells. Peak water levels appeared to remain reasonably stable through 2003, but record low measurements were measured in 2005. The record low was approximately 1 to 1.5 feet less than the preceding measurements for the piezometers completed above a 500 foot depth. In the two deeper piezometers, the drop was approximately three to five feet. The water levels indicate a downward vertical gradient, suggesting stream loss recharging to the underlying aquifer system and/or the effects of municipal pumping from deeper portions of the aquifer. This response is expected as the piezometer site lies in close proximity and between the Gonzales wellfield to the west and the Duranes wellfield to the east. The measured water levels and the wide seasonal fluctuation are a function of both river stage and increased pumping during the summer months.

With respect to trends, the shallowest of the wells suggests an overall decline of only two feet from 1996 to the low measurement in 2006, the other wells show either a lesser decline or minimal decline for most of the measurement period. This lack of trend is due largely to recharge occurring from the river.

1.7.2 *North Valley Water Quality*

The USGS has collected and analyzed water samples from throughout the North Valley, under a cooperative agreement with the CABQ. Water quality data for the USGS piezometer nests were provided by CABQ and are summarized below. Figure 3.39 and 3.40 present a Piper Plot and a statistical summary for the metals and inorganic concentrations for water samples taken from the piezometer nests.

The Piper plot for the North Valley piezometers shows a much broader composition than those previously demonstrated for the East Mountain area and in the Far Northeast Heights. The samples shown are either mean values based on the period of record (i.e., designated as “stat”) or are the most currently available sample. The lower right diagram shows an almost continuous and linear range in calcium to sodium contribution. This distribution indicates that magnesium is seldom a

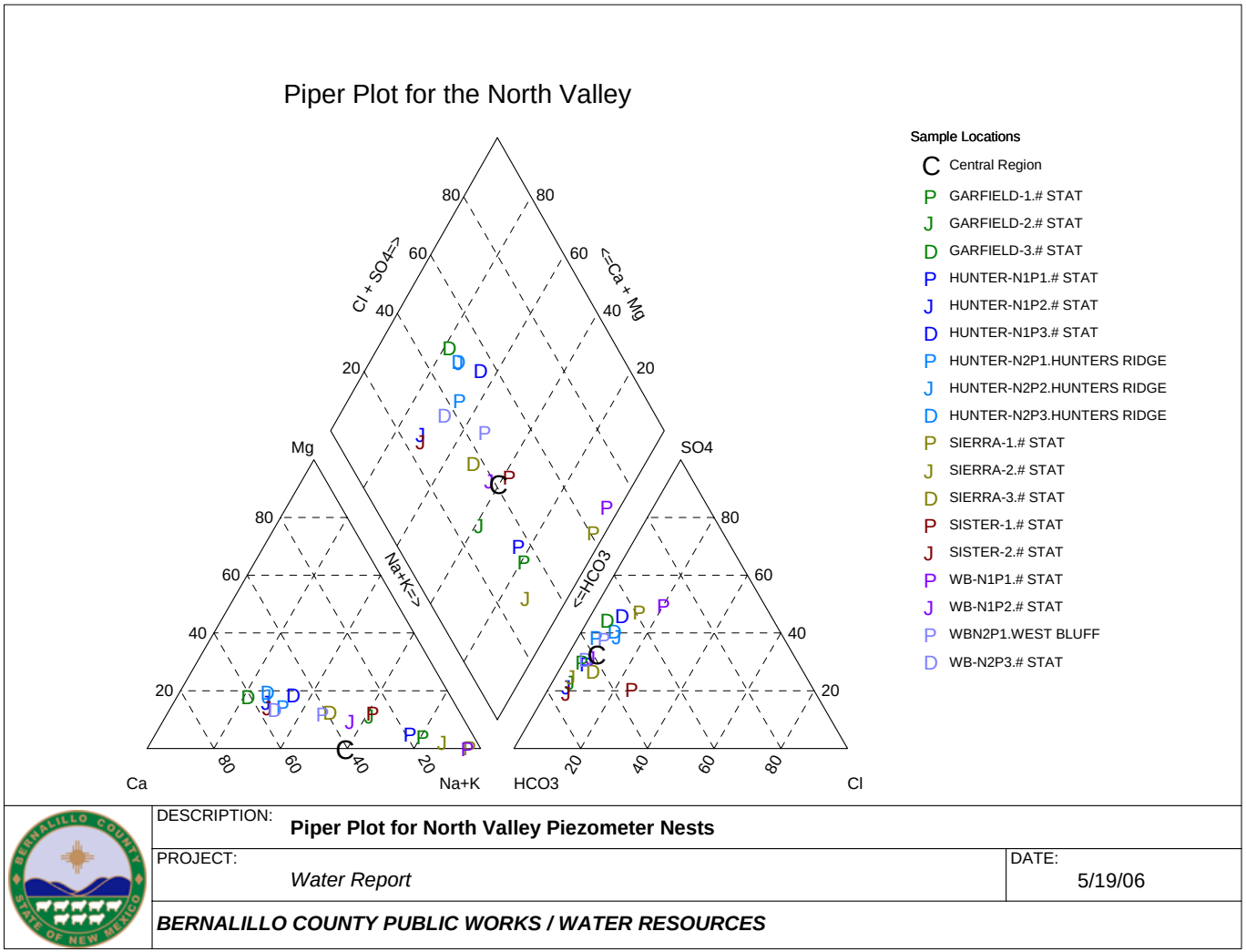
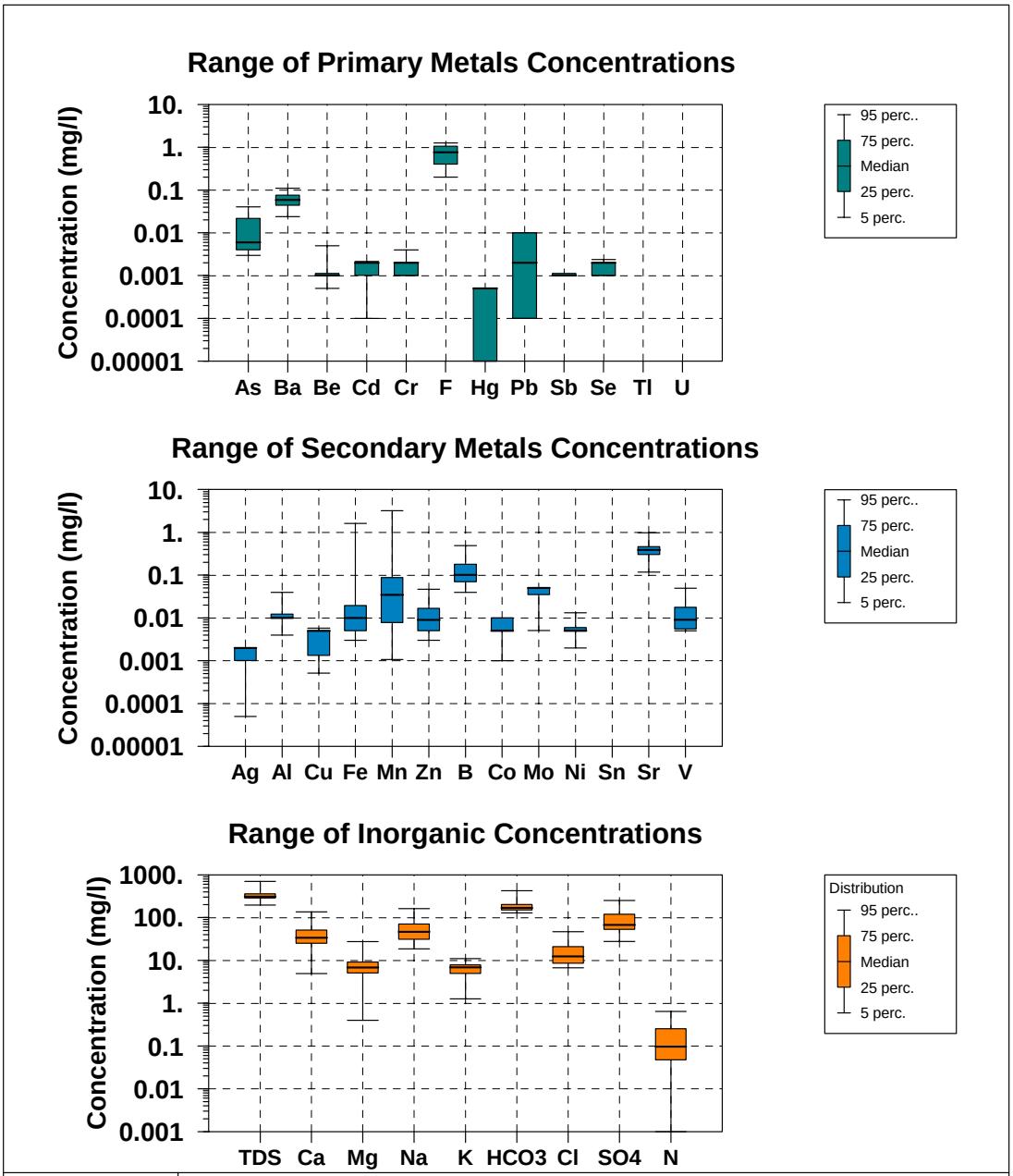


Figure 3.39 Piper Plot for the USGS North Valley Piezometer Nests



DESCRIPTION:
Metals and Inorganics Concentrations in the North Valley

PROJECT: *Water Report*

DATE: 5/19/06

BERNALILLO COUNTY PUBLIC WORKS / WATER RESOURCES

Figure 3.40 Metals and Inorganic Concentrations in the North Valley

significant component. The Piper plot also indicates that the importance of sodium increases with depth (i.e. the plots at the Na+K vertices are all for deep piezometers.) The greatest shift in composition appears to be for the Sierra Vista and West Bluff piezometer nests, which are both located on the west side of the Rio Grande and in areas of dense municipal pumping.

The lower right diagram indicates that chloride contributes to less than 20 percent of the anion loading and that bicarbonate is still the predominant anion but with increased distribution of sulfate compared to other areas of the County. There does not appear to be a relationship between depth and the relative types of anion contribution, although three exceptions occur. The deep wells for West Bluff Nest 1, Sierra Vista, and for Sister Cities demonstrate an increased contribution from chlorides compared to the other nested piezometer locations and their respective shallow wells. The trends and observations are all consistent with a downward migration of water and subsequent exchange of the calcium and sodium cations with increasing depth. A "mean" composition for the Central Region bordering the Rio Grande is plotted. However, it is not representative of the wide distribution in anion-cation values than can occur due to differences in location and depth.

A summary plot of metals and inorganics for the North Valley is also provided. The plotted values are based on all readily available data from the USGS monitoring program, not just from the piezometers indicated above. (USGS inventoried well locations are shown in Figure 3.3 along with the piezometer locations). Exceedances of drinking water standards are shown in Table 3.10 and include significant exceedance of the arsenic standard (i.e., the 75th percentile value is 0.02 mg/L compared to a standard of 0.01 mg/L, maximum concentration was 0.5 mg/L) and there is occasional exceedance of the beryllium standard. The 95th percentile values for the remainder of the metals are below the respective MCLs. Total dissolved solids, iron, and manganese also occasionally exceed their respective secondary standards.

There was no evidence of elevated nitrate concentrations in the samples included in the summary. Of the available 123 samples, approximately 40 percent indicated concentrations greater than 0.1 mg/L and less than 1 percent indicated concentrations greater than 1 mg/L.

Table 3.10 Exceedances of EPA Drinking Water Standards – North Valley

Parameter	Primary Standard	Secondary Standard	Total Number of Samples	Percent of Samples Exceeding Standard
Arsenic	0.010		212	25
Beryllium	0.004		155	5
Total Dissolved Solids		500	136	10
Iron		0.3	198	10
Manganese		0.5	203	12

The maximum reported nitrate concentration was 2.8 mg/L. The lack of elevated nitrate concentrations is a bit surprising because the North Valley septic systems are generally older than those in the East Mountains, North Albuquerque Acres, and Sandia Heights, and the valley has been populated for much longer period. The limited range of nitrates may be the result of a spatial sampling bias – that is that the majority of the samples included in the summary are from areas serviced by the ABCWUA wastewater system. Alternatively, the samples may have been collected in areas where groundwater conditions are anoxic, resulting in elevated iron and manganese concentrations, but lacking elevated nitrate concentrations. The soils present in the inner valley may be more conducive to septic disposal due to depth, texture, and biologic activity than those in other areas of the County. This benefit is offset by the shallow water table and the greater probability for older, improperly constructed wells and anoxic conditions.

1.8 ***South Valley Monitoring Wells***

The South Valley encompasses the area from Central Avenue to Isleta Pueblo and from Coors Rd. to I-25. The northern urbanized neighborhoods of the South Valley merge into the semi-urban and agricultural areas farther south. This area has a highly diversified land use pattern including agriculture, residential, and commercial and industrial use. Generally, as one moves from north to south through this area, the availability of ABCWUA-supplied municipal water and sewer decreases and reliance on individual wells and septic tanks increases. The existing water and sewer infrastructure are undergoing significant expansion in these areas.

Groundwater in the San Jose and Mountain View neighborhoods, as well as other areas, has been significantly impacted by industrial and agricultural land use and by petroleum products. The

ABCWUA's Atrisco and San Jose wellfields are located within the South Valley and are closely monitored due to potential for contamination with chlorinated solvents. Portions of the San Jose wellfield remain un-pumped due to the potential for contamination.

Bernalillo County actively monitors groundwater in the South Valley under four different projects. Shallow groundwater levels and groundwater quality near irrigation canals and drains were monitored as part of an Agrichemical Water-Quality Impact monitoring program. This Bernalillo County program included water level monitoring, and groundwater and surface water sampling. This shallow groundwater monitoring well network includes 20 shallow wells of 15-foot depth along two transects across the South Valley: one is south of Rio Bravo Boulevard (RBG-1 through RBG-8), and the other is along Malpais Road (MG-1 through MG-8). Since sampling started in 1996, no agrichemical by-products have been detected to date in any of the shallow wells or surface waters at the part per billion level. Only low-levels of phthalate compounds have been reported for this series of wells. An initial report on this study was completed in September 2006 (McGregor 2006) and the program is essentially complete. Additional sampling has focused on construction dewatering projects occurring in areas of significant agricultural land use and not immediately adjacent to canals and drains. The additional sampling will be completed in 2007-2008, depending on South Valley utility construction schedules. Results for the additional samples to date have indicated that absence of residual organic compounds at significant concentrations.

Under NMED-requirements, groundwater and methane generation are monitored at the South Broadway landfill in compliance with NMED landfill closure requirements. The South Broadway Landfill monitoring well was drilled in 1992 and is sampled annually to assess the any ground-water quality impact from the County's portion of the South Broadway Landfill, a potential regional ground-water threat. The City of Albuquerque has additional ground-water wells in which water quality and water level data are collected annually. The monitoring and reporting is conducted jointly by CABQ and Bernalillo County. Information on the sampling and results can be found in a series of annual monitoring reports submitted to the NMED by February of each year. As of late 2006, there has been no indication of groundwater contamination from this potential source.

In cooperation with the Bernalillo County Open Space program, wells on the Durand property were previously sampled. Only phthalate compounds were detected, and the low-level concentrations suggest laboratory contamination of the sample. A report of groundwater monitoring in the Open Space properties, including monitoring at the Durand Open Space, is slated for 2007.

The focus of this section of the report is on the regional groundwater monitoring conducted by Bernalillo County at two nested piezometer locations in the South Valley. The two nested piezometers are located at Rio Bravo Park and near the junction of the Isleta Drain and I-40, just north of the Isleta pueblo boundary. These two locations are jointly monitored in cooperation with the USGS. The location of community supply wells, USGS transects and piezometers, individual domestic wells and the two piezometer nests are shown in Figure 3.41.

1.8.1 *USGS South Valley Monitoring Wells*

The shallow hydrology of the South Valley area is complicated by the interaction of surface and groundwater along numerous irrigation and drainage channels and the Rio Grande. As a result, the USGS monitors wells in transects south of the Bridge Boulevard, Rio Bravo Boulevard, and I-25, where they cross the Rio Grande. These transects are used to evaluate interaction between the Rio Grande and the regional aquifer. These transects are monitored in conjunction with similar transects mentioned for the North Valley. The USGS transects along Rio Bravo Boulevard and I-25 overlap or are adjacent to the Bernalillo County transects for the Agrichemical Water Quality Impact study (McGregor, 2006). More information is available at Bosque Piezometers (http://nm.water.usgs.gov /bosque.html).

With respect to regional monitoring, the USGS monitors water levels in wells at one ABCWUA well location (San Jose 9), locations in the South Valley, and in two nested piezometers located on Mesa Del Sol (Montessa Park site,and Mesa Del Sol site).

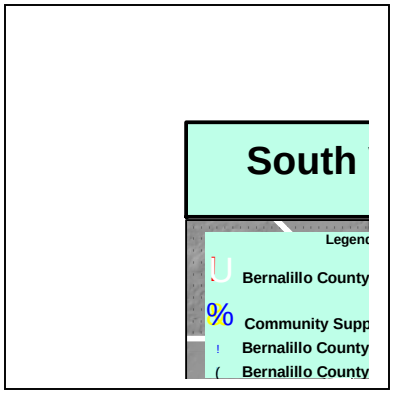


Figure 3.41 South Valley Monitoring and Water Wells

1.8.1.1 Water Levels in the South Valley

The USGS database provides water level information for one deep well location within the South Valley and two piezometer nests located on the southeast mesa. The first well is located in the San Jose wellfield (San Jose 9). Figure 3.42 provides a hydrograph for the subject well. The hydrograph does not show any significant trends in water levels aside from a general decline from 1991 to 1994 of approximately 15 feet. However, there is no indication of a significant rise or decline since that time. The seasonal fluctuations in this well are approximately 5 to 7 feet, with the peaks generally occurring during January – a time of minimal municipal pumping and water use, and lows occurring during the summer months.

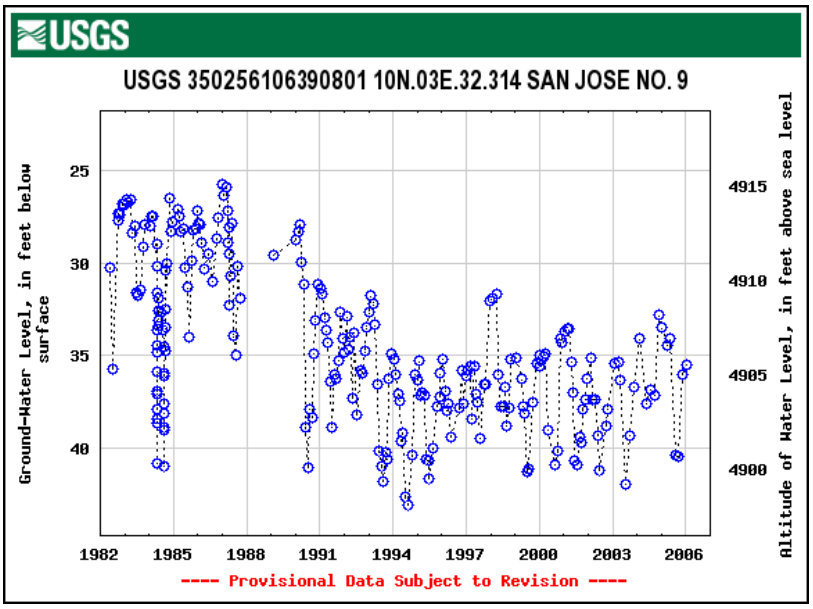
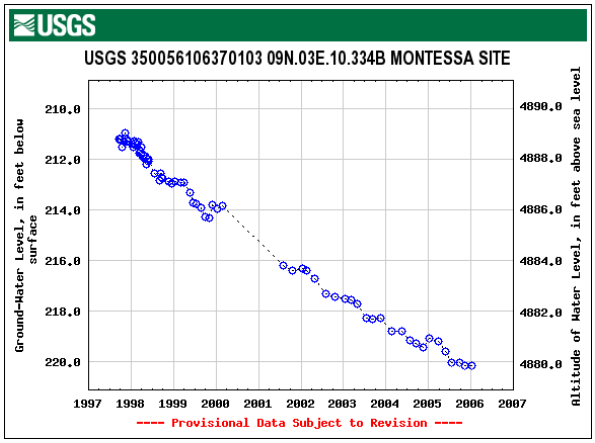
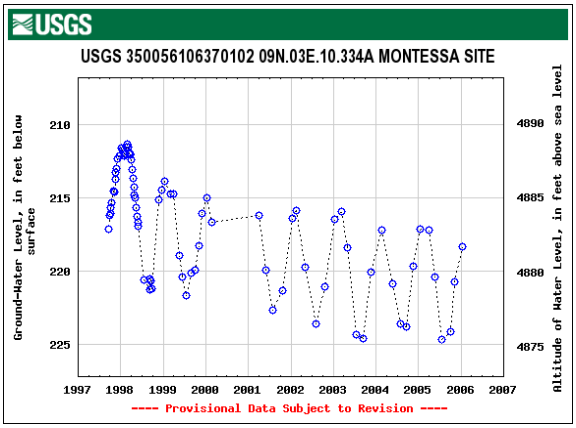


Figure 3.42 Water Levels in the San Jose Well 9

A better estimation of regional conditions can be garnered from hydrographs for the Montessa and Mesa Del Sol nested piezometers. These nested piezometers are located on the mesa east of I-25 and south of Kirtland AFB. Figure 3.43 and 3.44 provide hydrographs for those piezometer nests.

	**Well Information** Land Surface Elevation: 5,100 ft amsl. Top of Screen: 260 ft Depth of Well: 330 ft.
	**Well Information** Land Surface Elevation: 5,100 amsl. Top of Screen: 699 ft Depth of Well: 708 ft.
	Well Information Land Surface Elevation: 5,100 ft amsl. Top of Screen: 1,618 ft Depth of Well: 1,628 ft.

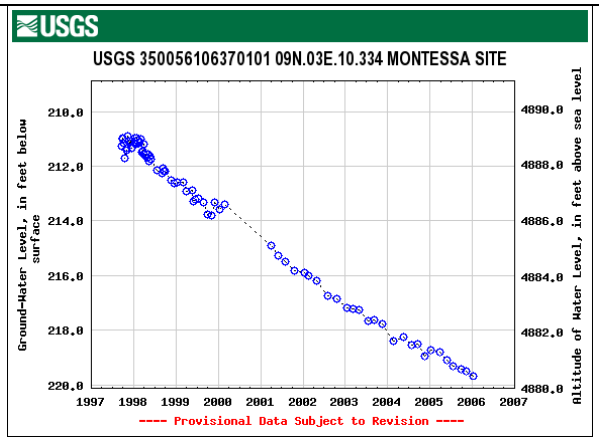
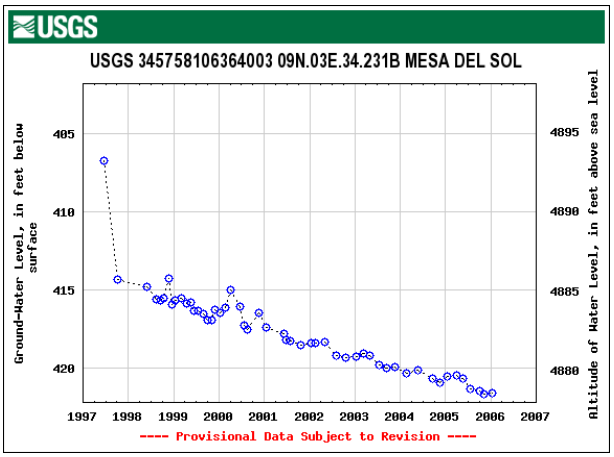


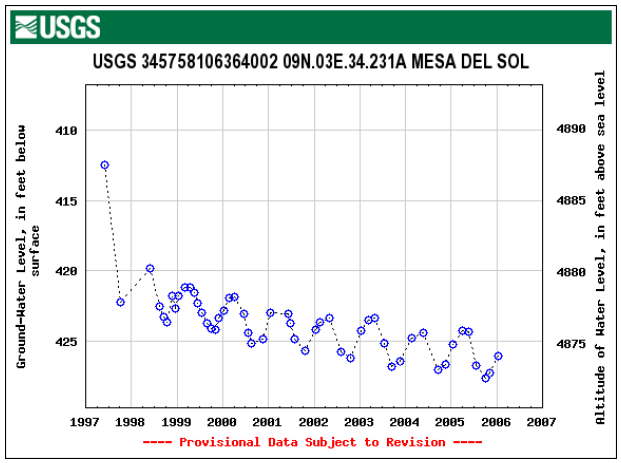
Figure 3.43 Water Levels in the Montessa Park Nested Piezometer



Well Information

Land Surface Elevation:
5,300 ft amsl.

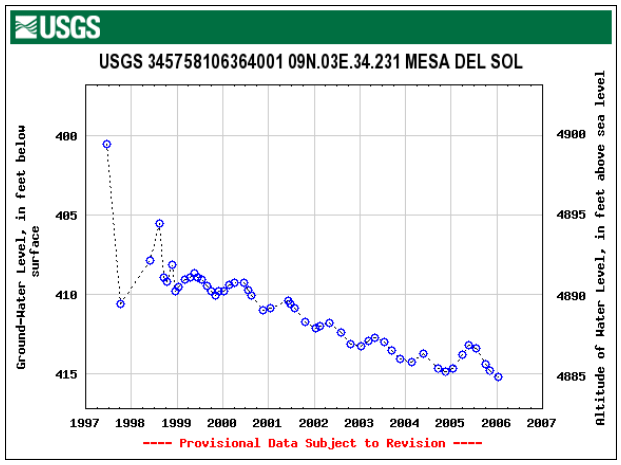
Depth of Well: 525 ft.



Well Information

Land Surface Elevation:
5,300 amsl.

Depth of Well: 1,015 ft.



Well Information

Land Surface Elevation:
5,300 ft amsl.
t

Depth of Well: 1,630 ft.

Figure 3.44 Water Levels in the Mesa Del Sol Nested Piezometer

The hydrographs for the Montessa Park site all indicate a continual and significant decline in water levels near Tijeras Arroyo south of Kirtland AFB. Since 1997, the water level in the shallowest portion of the aquifer (330 ft.) has declined approximately 9 feet, or at a rate of 1 foot per year. In the intermediate portion of the aquifer (708 ft.), the decline is approximately 5 feet and the rate of decline is about one-half of that in the upper portions of the aquifer. The intermediate well hydrograph shows a strong seasonal fluctuation of approximately 7 feet. This fluctuation is likely caused by nearby pumping of large volume production wells at the UNM Championship Golf Course (1 ½ miles northwest) and at Kirtland AFB (1 mile north). Other domestic and livestock wells to the northeast may also be affecting the water level. The deepest of the wells (1,628 ft) is similar to that of the shallowest. With respect to vertical gradients, during the pumping periods, the potentiometric surface (water table surface) in the intermediate zone is lower than in the overlying or deeper zone, suggesting movement of water from the overlying and underlying zones to the pumped zone. However, once pumping decreases during the winter months, the potentiometric conditions are reversed.

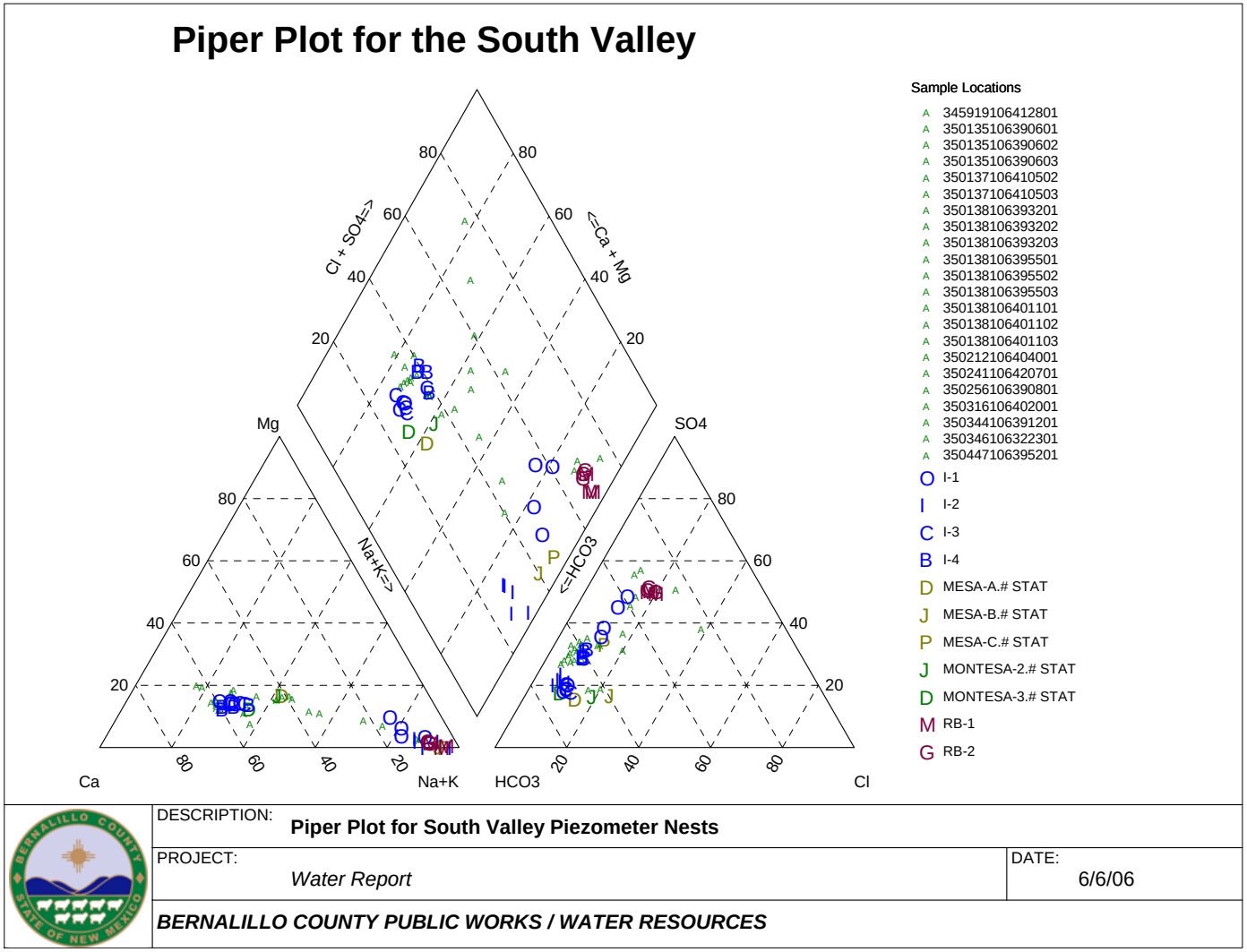
Declining trends are also evidenced in the piezometer nest located at Mesa del Sol, although the amount of decline is about one-half of that seen in the Montessa Park wells. Each of the piezometers shows approximately 5 feet of decline since 1997, with the middle (1,015 ft.) and lower wells (1,630 ft) evidencing seasonal pumping fluctuations of one to two feet. The peaks in the deepest of the wells appear to occur in early spring rather than at the first of each year. This likely reflects time delays as recharge moves from the mountain front areas toward the river. Unlike the Montessa site, the potentiometric surface in the intermediate zone (1,015 ft.) continually remains less than that in the overlying and underlying zones, suggesting movement towards the locus of pumping.

1.8.1.2 Water Quality in the South Valley

The USGS has collected and analyzed water quality samples throughout the South Valley under a cooperative agreement with the CABQ and in cooperation with Bernalillo County. Water quality data for the USGS piezometer nests at Montessa Park and at Mesa Del Sol were provided by CABQ; data for individual well locations was taken from the USGS database. The South Valley contains multiple industrial contamination sites, which are routinely monitored under NMED oversight – the results of those monitoring activities are not addressed within this report.

Figure 3.45 presents a Piper Plot for water samples taken from the South Valley. This plot only reflects the results of on-going groundwater monitoring of fresh water supply from the aquifer. The Piper plot for the South Valley shows a much broader composition than those previously demonstrated for the East Mountain area and in the Far Northeast Heights, and is remarkably similar in distribution to that of the North Valley. This is expected as the wells in the South Valley screen the same portions of the aquifer as those used to represent the North Valley (see Figure 3.39 for comparison). The samples shown are either mean values based on the period of record (i.e., designated as "stat") or are the most currently available sample. All samples for the Rio Bravo Park and the Isleta piezometer nests are shown. As with the North Valley plot, the lower right diagram shows an almost continuous and linear range in calcium to sodium contribution. This distribution demonstrates that magnesium is seldom a significant component, and that the importance of sodium increases with depth (i.e. the plots at the Na+K vertices are all for deep piezometers.).

The lower right diagram indicates that, typically, chloride contributes to less than 20 percent of the anion loading, and that bicarbonate is still the predominant anion but with increased distribution of sulfate compared to other areas of the County, excluding the North Valley. The plot also shows that results from each of the monitoring wells except Isleta 1 (I-1) are tightly clustered, while the results for I-1 indicate a wider distribution in composition. The plots for the two Rio Bravo Park piezometers plot similar to the West Bluff piezometers shown in the North Valley plot. Again, this is not surprising given the same relative position of the piezometers with respect to the Rio Grande. A comparison of the Montessa Park and Mesa del Sol plots, located on the mesa east of the inner valley, indicate that water composition is comparable to that of the inner valley and shows similar changes in composition with increasing depth.



DESCRIPTION:	**Piper Plot for South Valley Piezometer Nests**
PROJECT: *Water Report*	DATE: 6/6/06
BERNALILLO COUNTY PUBLIC WORKS / WATER RESOURCES	

Figure 3.45 Piper Plot for the South Valley

All samples are from routinely monitored wells or transects. The exceedances with respect to drinking water standards are show in Table 3.11.

Table 3.11 Exceedances of EPA Drinking Water Standards – South Valley

Parameter	Primary Standard	Secondary Standard	Total Number of Samples	Percent of Samples Exceeding Standard
Arsenic	0.010		87	50
Total Dissolved Solids		500	64	13
Aluminum		0.05	75	19
Iron		0.3	85	11
Manganese		0.5	86	26

A statistical summary for the metals and inorganic concentrations is provided in Figure 3.46. A summary plot of metals and inorganics for the South Valley is also provided and includes all readily available data from the USGS monitoring programs, inclusive of the Rio Bravo Park and Isleta piezometers, which are monitored by the USGS. The plot is biased in that no individual domestic wells are represented.

Figure 3.46 suggests that trace metal concentrations may at times exceed the respective drinking water standards for beryllium, cadmium, chromium, mercury, and lead. Detection limits are used for statistical summation in the event that non-detect concentrations are reported, suggesting that some exceedances have occurred. A review of the data set indicates that all concentrations for these compounds were reported as "not detected" and that no measured exceedances have occurred. Of particular note is the elevated range in aluminum concentrations (secondary standard of 0.05 mg/L). The range is caused solely by wide fluctuations in aluminum concentrations in samples from the deep well of the Isleta nested piezometer. The cause for the aluminum fluctuations is discussed below in the Isleta well discussions.

Of interest are concentrations of arsenic (maximum recorded concentration is 0.9 mg/L), total dissolved solids (maximum recorded concentration is 1,360 mg/L), iron (maximum reported concentration is 16 mg/L), and manganese (maximum recorded concentration is 2.4 mg/L). The presence of elevated concentrations of both iron and manganese generally infers a reducing (anaerobic or anoxic) environment possibly related to microbial interaction with septic wastes.

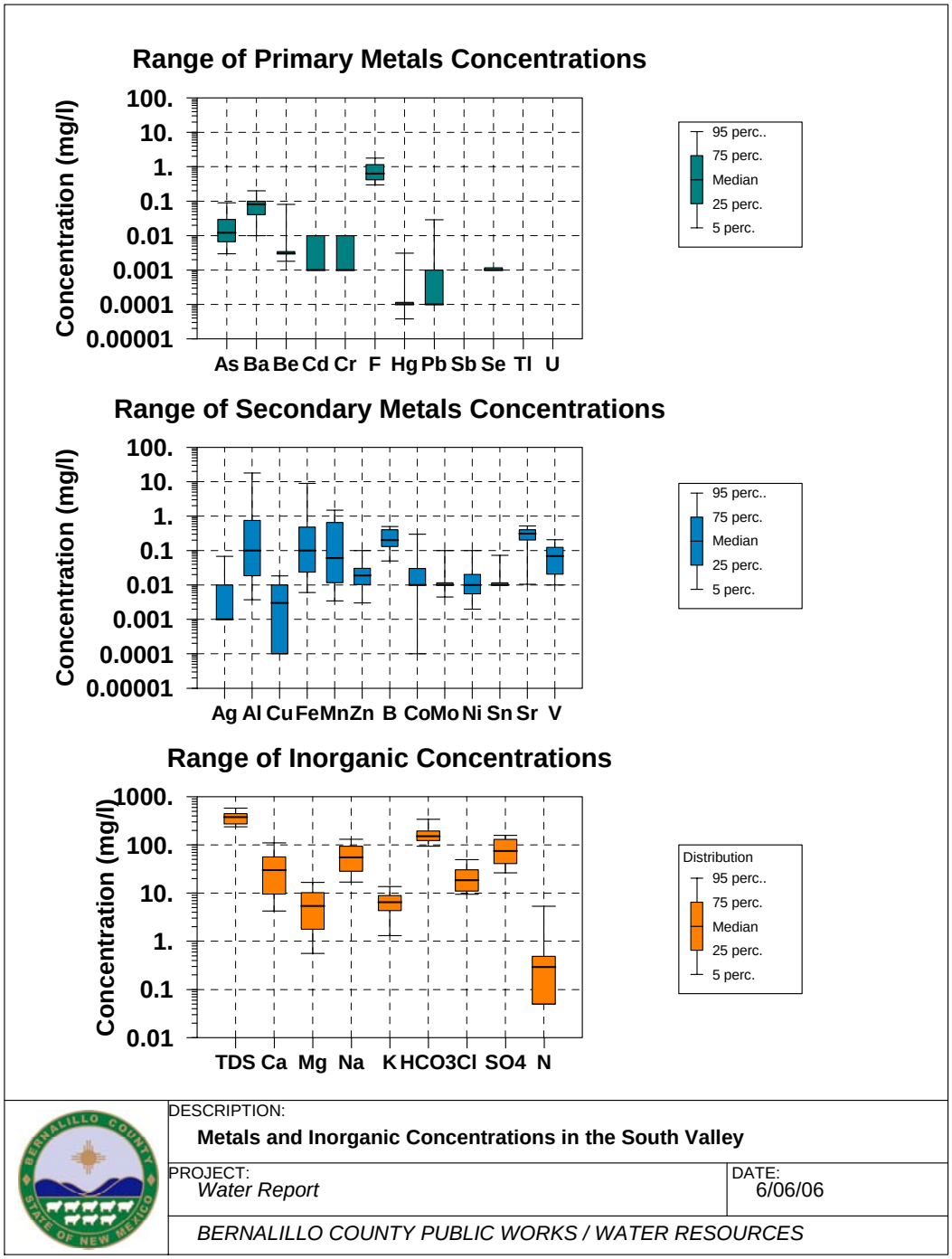


Figure 3.46 Metals and Inorganic Concentrations in the South Valley

Although none of the samples had total nitrate + nitrite concentrations in excess of the primary drinking water standard of 10 mg/L, the distribution indicates a 95th percentile value on the order of 7 mg/L. The values greater than the 75 percentile are from transect wells sampled by the USGS, suggesting localized septic waste contamination of the wells. There is a known bias in the sample set in that no individual domestic wells are represented. In the South Valley, nitrate is a known groundwater contaminant in some local communities and is being monitored under NMED programs. Large portions of the South Valley do rely on septic systems, though installation of sanitary sewers and ABCWUA drinking water supply throughout the South Valley is an on-going capital improvement project.

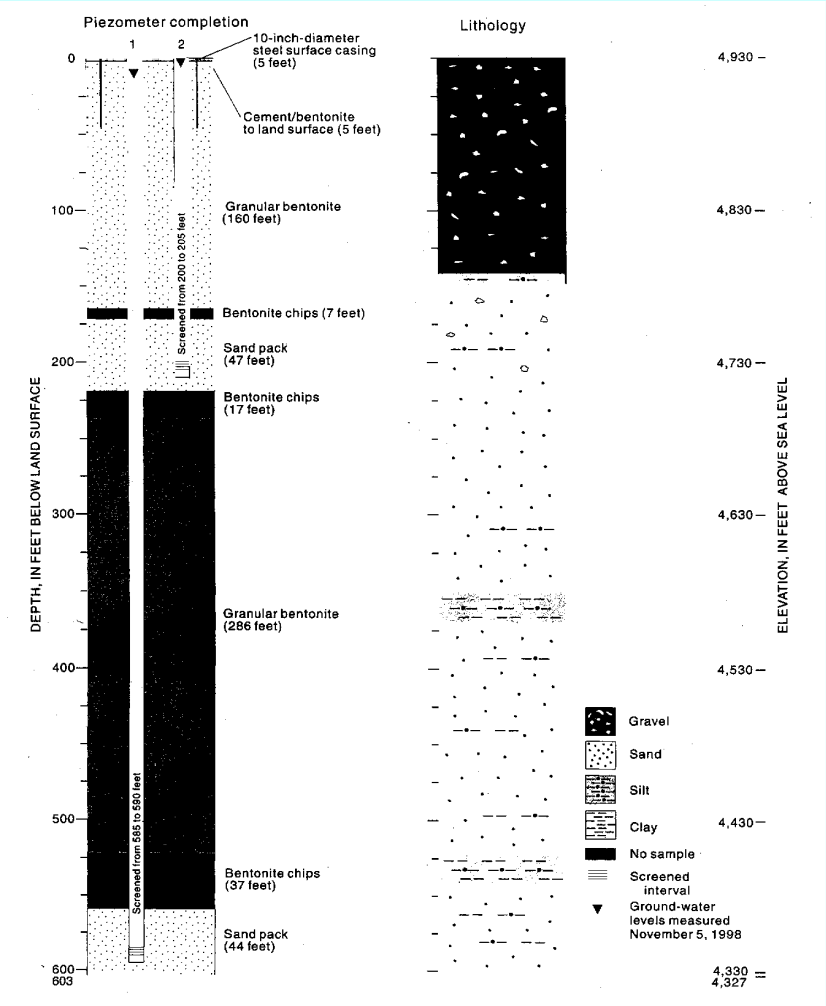
1.8.2 *Rio Bravo Park and Isleta Nested Piezometers*

The Rio Bravo Park and Isleta nested piezometers were drilled to access deep aquifer conditions in the middle and southern section of the inner portions of the South Valley. They monitor water pumped from the alluvial aquifer system, which extends from the mountain front to the Rio Grande. Well construction details are provided in Table 3.12 and Figure 3.47.

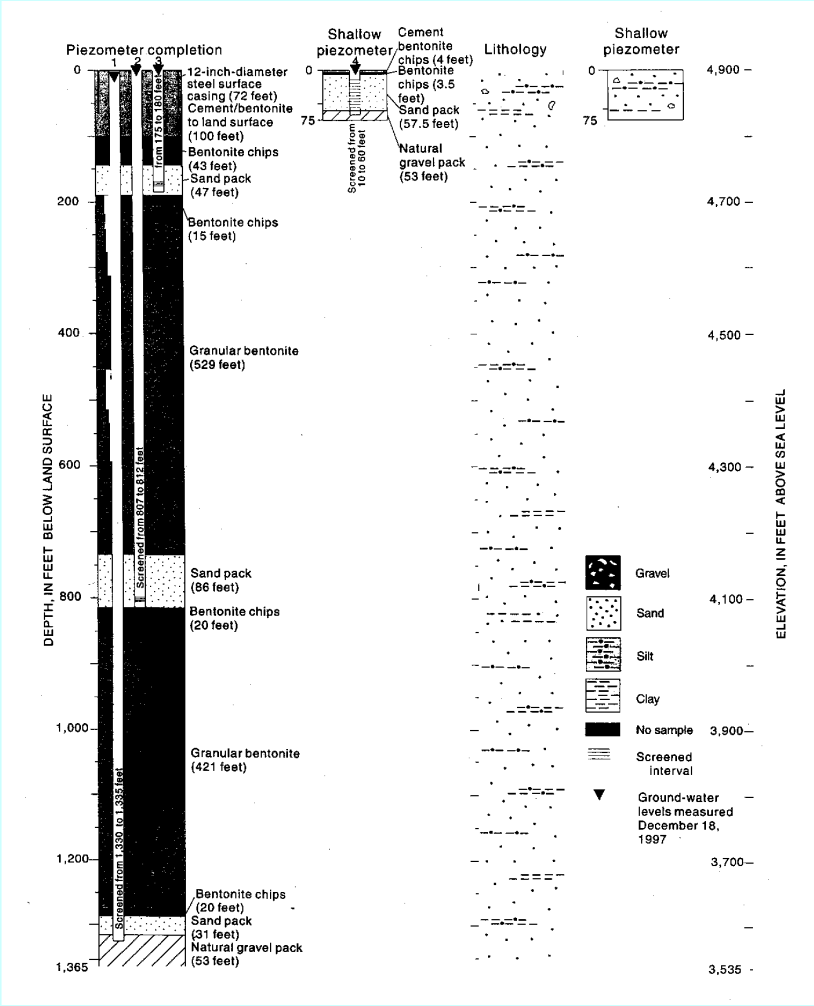
This aquifer is prominent in the Albuquerque/Middle Rio Grande region and consists of gravel, sand and silt as reflected in the geologic map and cross-sections provided on Figures 3.47 and 3.48. The alluvial material was deposited as floodplain deposits of the Rio Grande and the outwash from the breakdown of the Sandia Mountains and the associated granites and overlying formations. The ABCWUA pumps from this aquifer.

Table 3.12 Bernalillo County Regional Monitoring Well Network – South Valley Wells

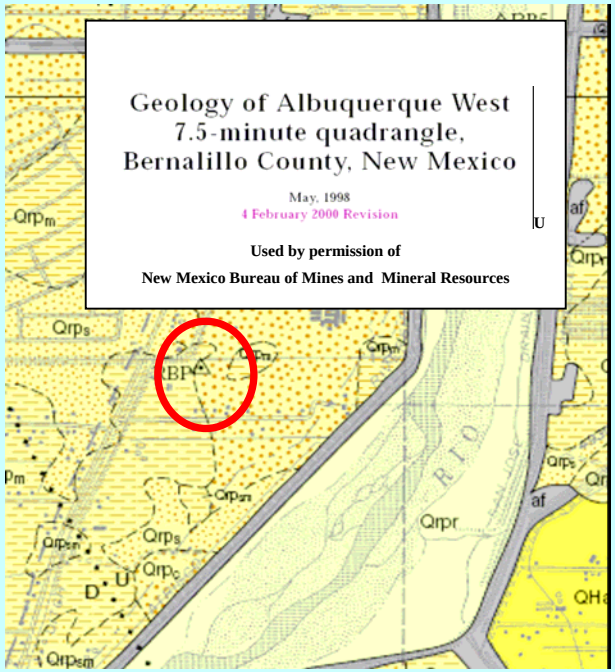
Well	Well Type	Well / Hole Depth (ft)	Screen Settings (ft)
Isleta	Nested	1,365	
(I1)	Deep	1,365	1,315-1,320
(I2)	Middle	1,365	805-810;
(I3)	Middle	1,365	175-180
(I4)	Shallow	1,365	10-50
Rio Bravo Park	Nested	603	
(RB1)	Deep	603	585-590
(RB2)	Middle	603	200 -205



Rio Bravo Park Piezometer Construction
(Taken from USGS OFR 03-290 Figure 23L)



Isleta Piezometer Construction
(Taken from USGS OFR 03-290, Figure 23J)



Rio Bravo Park Nested Piezometer

Isleta Nested Piezometer

Qrpr	**Modern channel deposits (Historic)** — Unconsolidated sand and gravel within the active channel of the *Rio Grande*. Delineated using aerial photography.
Qrpc	**Gravelly to sandy stream and floodplain deposits (Historic)** — Unconsolidated coarse-grained sand and pebbly sand. Interpreted to represent channel deposits. Includes Brazito series of Hacker (1977).
Qrps	**Sandy stream and floodplain deposits (Historic)** — Unconsolidated medium-grained sand and loamy sand. Interpreted to represent channel and floodplain deposits. Includes Vinton series of Hacker (1977).
Qrpsm	**Silty to sandy stream and floodplain deposits (Historic)** — Unconsolidated fine-grained sand, silt and clay. Interpreted to represent fine-grained sloughs or oxbows. Includes Glendale and Gila series of Hacker (1977).
Qrpm	**Silty to clayey stream and floodplain deposits (Historic)** — Unconsolidated fine-to medium-grained sand, silt and slay. Interpreted to represent fine-grained floodplain deposits. Includes Anapra, Armijo, Agua, and Gila series of Hacker (1977).

Qa	Alluvium (Holocene to upper Pleistocene)
Qe	Eolian deposits (Holocene to middle Pleistocene)
QTs	Upper Santa Fe Group (middle Pleistocene to uppermost Miocene)—Includes Camp Rice, Fort Hancock, Palomas, Sierra Ladrones, Arroyo Ojito, Ancha, Puye, and Alamosa Formations
Tpb	Basaltic to andesitic lava flows (Pliocene)—Includes minor vent deposits and small shield volcanoes. Flows are commonly interbedded in the Santa Fe and Gila Groups

Figure 3.48 Geologic Setting of the Rio Bravo Park and Isleta Nested Piezometer

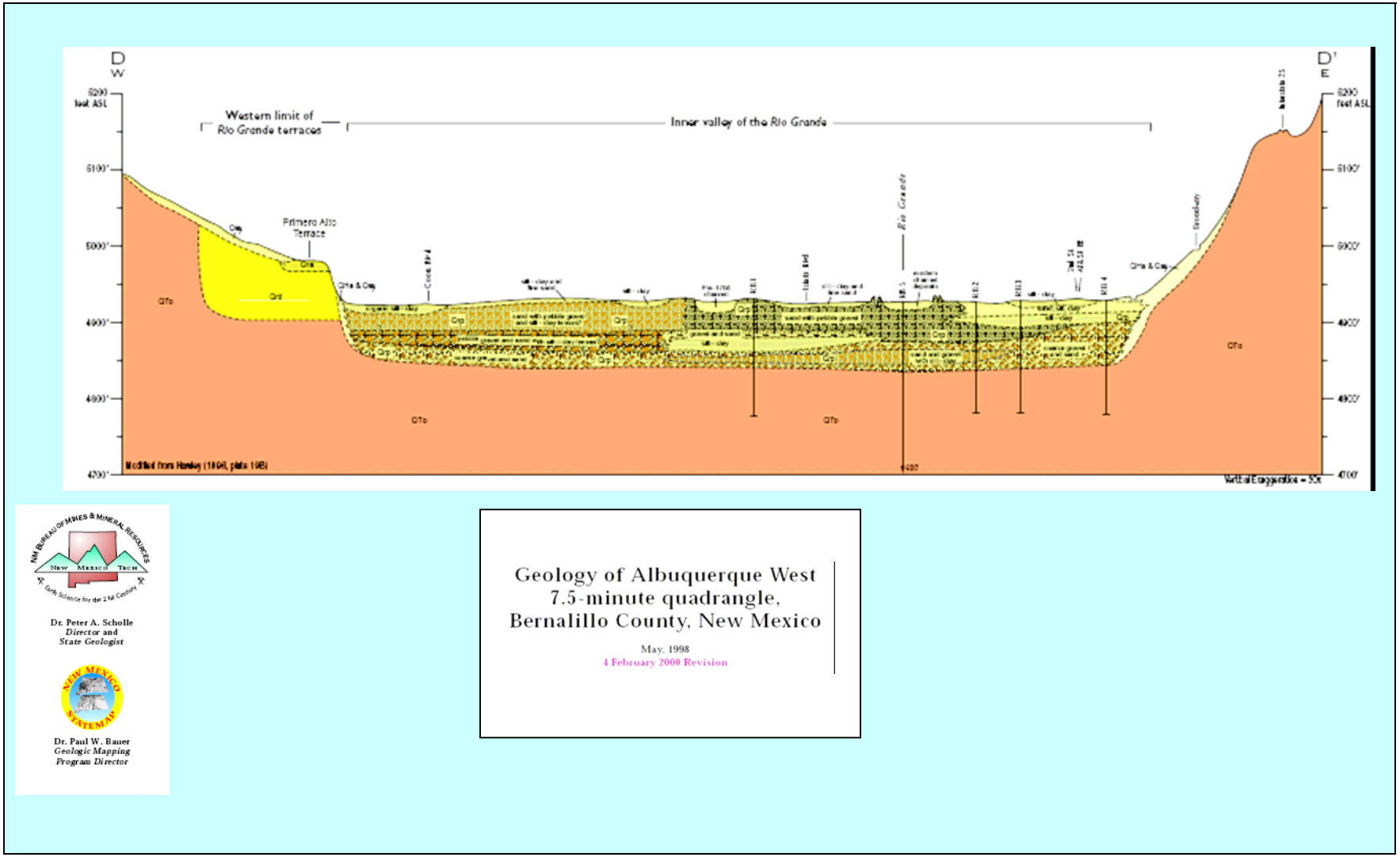


Figure 3.49 Geologic Cross Section through the South Valley along Rio Bravo Boulevard

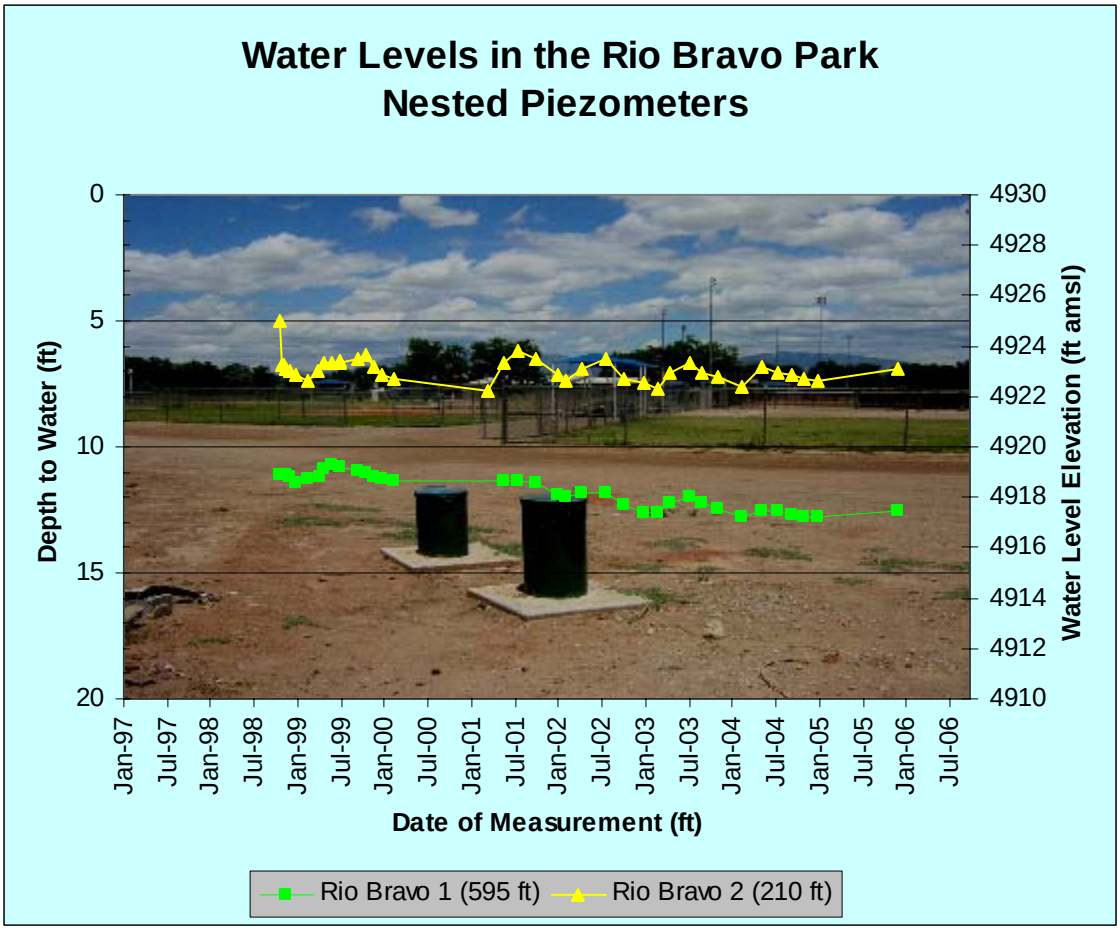
1.8.2.1 Water Levels in the South Valley Piezometers

The USGS provides continuous water level measurements for the Rio Bravo Park and Isleta piezometers using pressure transducers and dataloggers. Graphs of the USGS data are provided in Figure 3.50 along with plots of the hand measurements collected annually by Bernalillo County.

The Rio Bravo Park piezometers (RB-1 and RB-2) are located south of Rio Bravo Boulevard and due west across the river from the ABCWUA Waste Water Treatment facility. For the Rio Bravo Park piezometers, the measurements indicate that water levels in the shallow piezometer, Rio Bravo Park 2 (RB-2, 210 ft.) exceed those in the deep piezometer, Rio Bravo Park 1 (RB-1, 595 ft.), suggestive of a downward vertical gradient in this reach of the Rio Grande. The gradient does not invert during the year, indicating that the Rio Grande is recharging the aquifer in this reach.

Records for the shallow piezometer indicate that the lowest water levels occur during the spring of the year, followed with rapid rise to peak levels during the spring to early summer and with subsequent decline. This fluctuation is likely indicative of seasonal recharge from the Rio Grande during spring melt, and possibly due to seasonal irrigation, with subsequent delays for the peaking events to extend into the subsurface. There are no nearby municipal supply wells and more distant wells screen lower portions of the formation, so the fluctuations seen in Rio Bravo Park 2 are not likely the result of pumping effects. The low points of the hydrograph indicate an overall rise in water levels since 2001, suggesting no significant decline or perhaps a slight rise in water levels in the upper portion of the aquifer at this location. This is due largely to the effects of annual recharge or is possibly related to discharge from the ABCWUA Wastewater Treatment facility located immediately east across the river.

The deeper piezometer, Rio Bravo Park 1 (RB-1, 595 ft) shows a continual decline since measurement started in late 1998. Total declines are approximately 1.8 feet over the eight-year period, or a decline rate of 0.2 ft/year. This decline is likely due to the long-term effects of municipal pumping, but is less than rates noted for the North Valley due to greater distance from the municipal wells. The deep well also shows some indication of the effects of annual recharge events (an annual increase of no more than 0.2 to 0.5 feet), but the subsequent declines tend to be slightly greater, leading to a net decline through time.



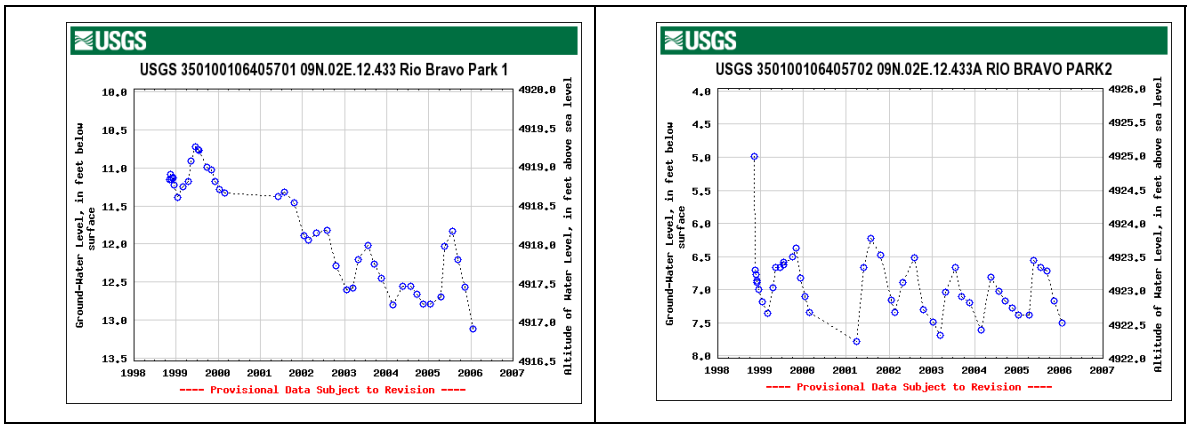
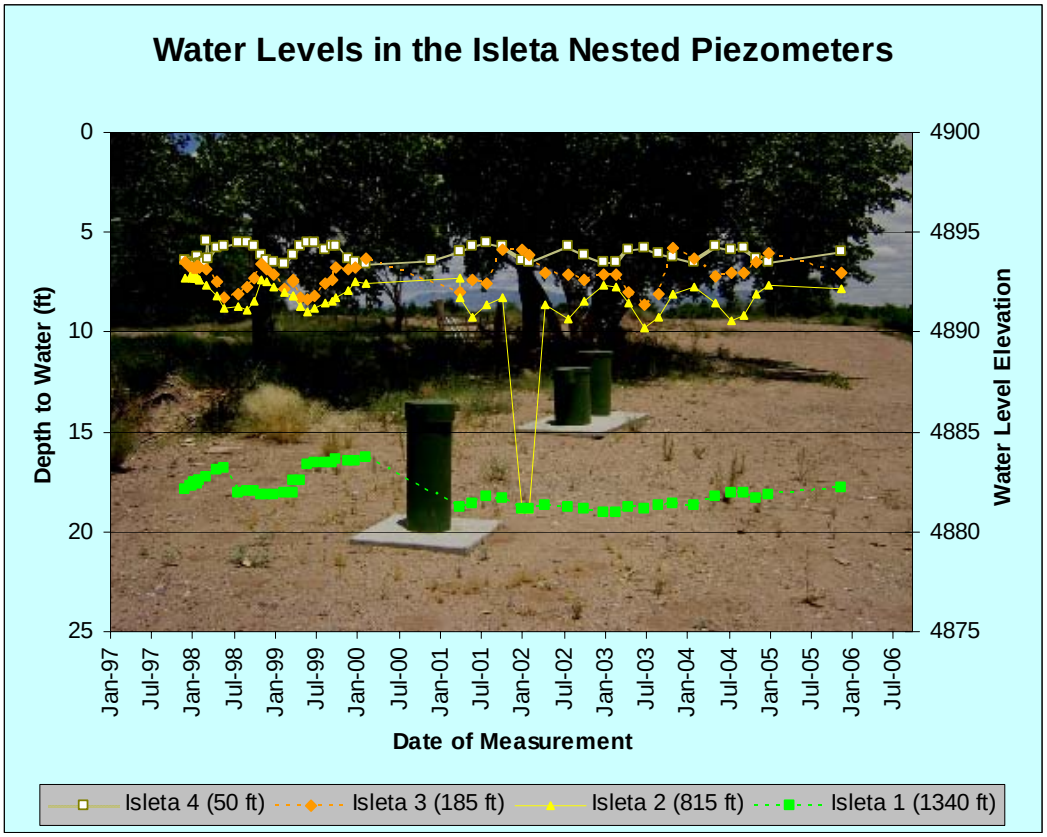


Figure 3.50 Water Levels in the Rio Bravo Park Nested Piezometer

The Isleta nested piezometer is located near the confluence of the Isleta Drain, the Los Padillas Drain, and the Arenal Main Canal just north of the Isleta Pueblo boundary. Geologically, the location is unique due to the presence of the Rio Grande floodplain and associated alluvial material juxtaposed against the basalts on Black Mesa which lie immediately southwest of the piezometer locations. The piezometer nests consist of four piezometers, with total depths ranging from very shallow (50 ft) to extremely deep (1,340 ft).

Generally, the water levels indicate an overall downward vertical gradient. However, as can be seen in Figure 3.51 the water levels in the two shallow piezometers (I-4, 50 ft; and I-3, 185 ft.) on occasion invert during the winter months, and vertical flow may be upward during the early portions of each calendar year. Given the location near two of the primary drains and a primary source canal, this annual pattern is attributable to the annual irrigation cycle. Shallow recharge occurs from the irrigation canals and field irrigation during the late spring and summer months, and fields drain during the fall and winter months. The recharge to the aquifer occurs during the irrigation season. The recharge is reflected as water level peaks occurring progressively later in the year and at greater depths as recharging water moves downward through the aquifer system. Together, the irrigation cycle and vertical movement of water result in the "pinch and swell" nature of the hydrographs seen in Figure 3.51 when comparing the shallowest and mid-level hydrographs. This cyclical rise and fall in water levels is minimized by the time the deepest of the piezometers is reached.

The influence of the surface irrigation on water levels is supported by a comparison of shallow and deep groundwater quality relative to the water quality evidenced in the irrigation canals and drains, as is discussed below. The hydrographs indicate that seasonal recharge can be traced at least to the intermediate level of the aquifer as evidenced by the response in Isleta Well 2 (I-2, 815 ft). The USGS hydrographs for the deepest of the piezometers, Isleta 1 (I-1, 1,340 ft.) indicates minor seasonal fluctuations on the order of 0.1 feet or less. The minor changes in water level are insufficient to conclude that seasonal recharge is reaching the deepest portions of the aquifer. The hydrograph also shows a gradual rise in the deep aquifer levels since 2001.



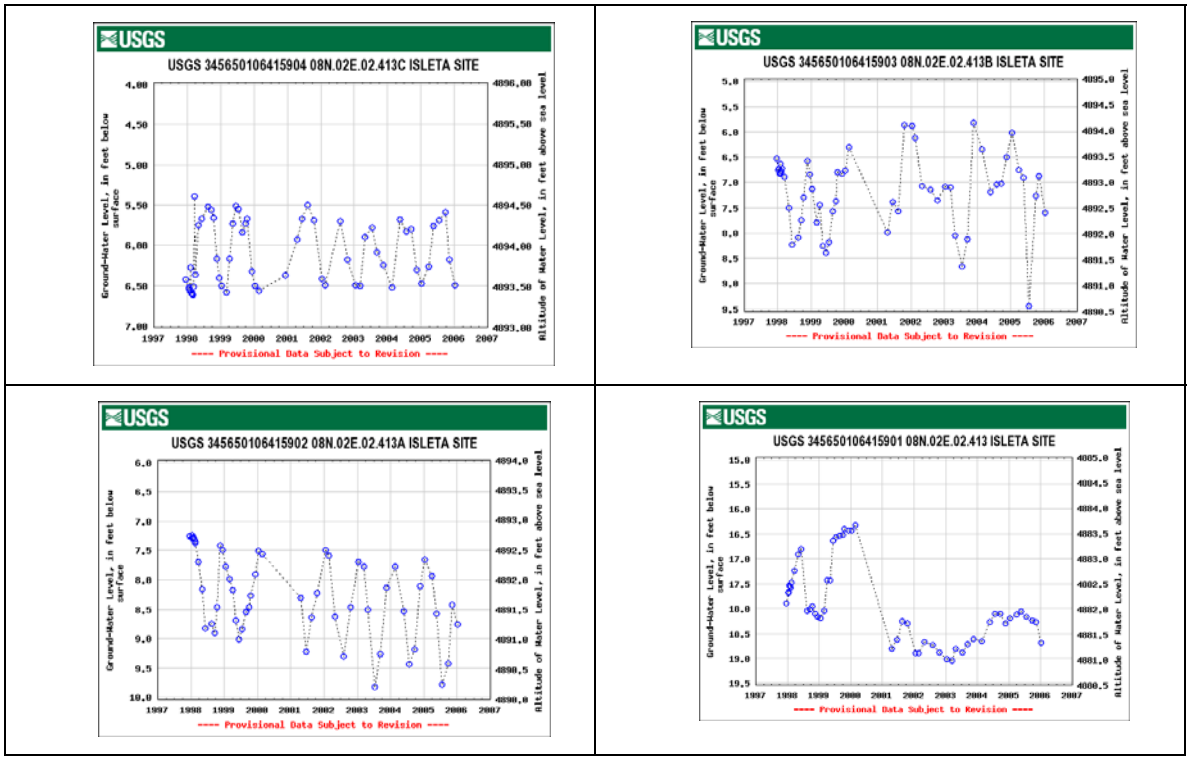


Figure 3.51. Water Levels in the Isleta Nested Piezometer

The hydrographs presented in the upper portion of Figure 3.51 are hand measurements taken by Bernalillo County. There are some discrepancies in these hydrographs compared to the electronically measured values available from the USGS website (USGS Ground water for New Mexico: Water Levels) and shown in the lower half of the figure. With two notable exceptions, these differences appear to be a result of measurement frequency rather than measurement errors. The first exception is the extreme low data point occurring in the Isleta 2 (815 ft) in 2002. This measurement appears to duplicate the measurements for the deepest piezometer, but no field records are available to verify the measurement. This measurement is presumed to be a data entry error because the sudden drop in water levels is not reflected in the electronic data presented by the USGS. Similarly, the USGS data indicate a low measurement point occurring in the Isleta 3 (150 ft.) in the summer of 2005, which is not reflected in the series of available hand measurements. However, the measurement is reasonable and there is no evidence to suggest an error. It is presumed correct.

1.8.2.2 Water Quality in the South Valley Piezometers

Groundwater samples from the Rio Bravo Park piezometers have not exceeded the primary drinking water standards with the exception of arsenic. Arsenic concentrations in RB-1 have ranged from non-detect to 0.050 mg/L, while the standard is 0.01 mg/L. Of the five samples collected, arsenic was not analyzed in one sample, was below the standard in one sample, and exceeded the standard in three others. Arsenic concentrations in samples from RB-2 were above the standard at 0.011 mg/L in the initial sample, but have since been reported as below the detection limit. Neither well suggests any problems with nitrate concentrations.

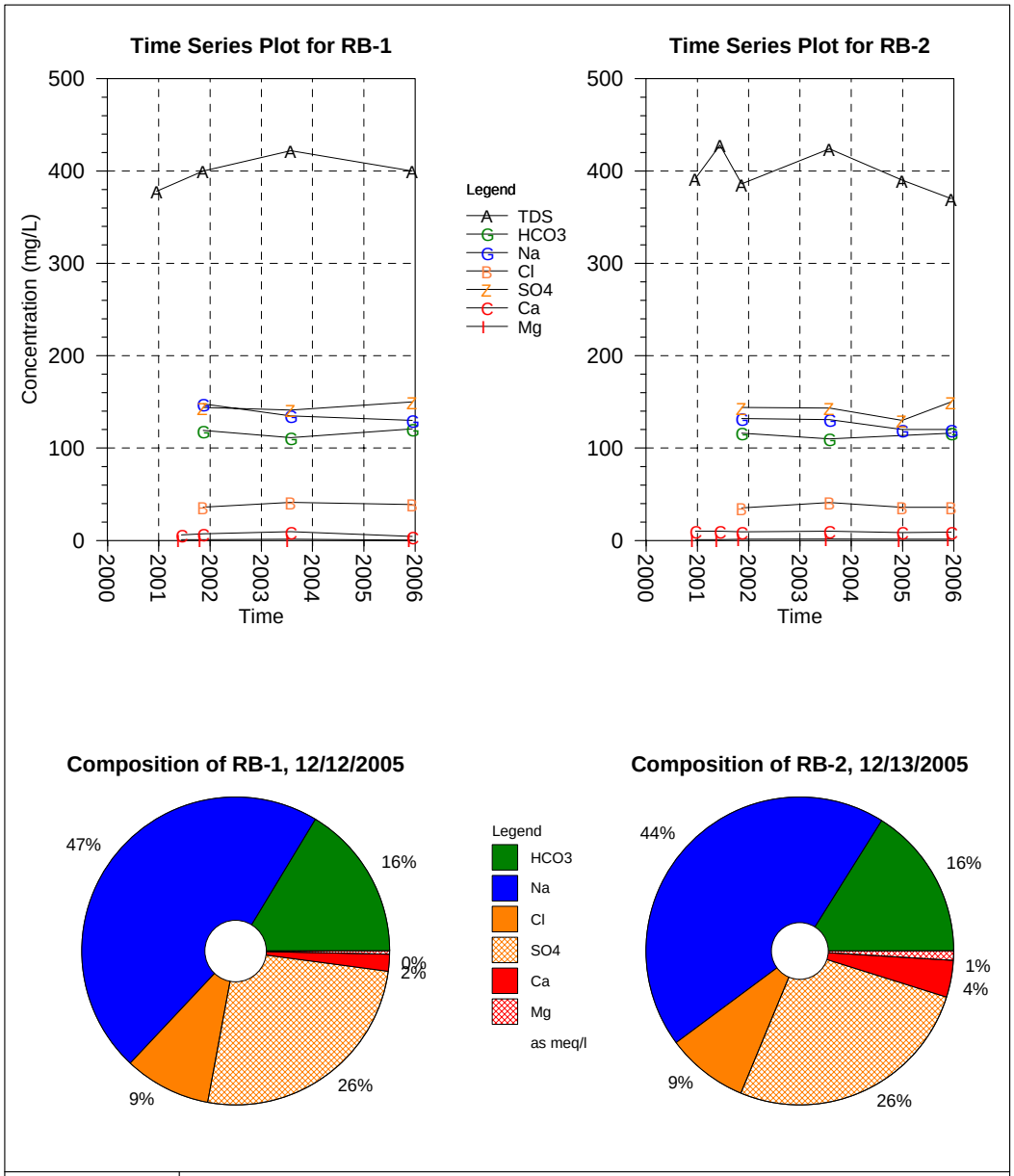
With respect to organic compounds, detected compounds in the Rio Bravo Park and Isleta piezometers have been limited to low concentrations of phthalate compounds and one instance of methyl ethyl ketone. Since changing analytical laboratories in 2003, there have been no reports of these compounds in either of the Rio Bravo Park or the Isleta piezometers. Consequently, it is suspected that the compounds were laboratory contaminants. Phthalates are a common plasticizers used in sample bottles, labware, and tubing, and methyl ethyl ketone is common laboratory solvent and surrogated compound. Both compounds are commonly recognized as laboratory contaminants.

There has been one instance of detection of 1,4-Dioxane (140 ug/L) in the 2004 sample from the deepest of the Isleta piezometers (I-1). The reported concentration was 130 ug/L. The source of this compound is not known. This is an isolated instance and is puzzling because there are no similar detections in the shallower wells or in the quality control blanks. The compound 1,4-dioxane is not a common laboratory contaminant.

Figure 3.52 provides a time series plot for the inorganic constituents in the Rio Bravo Park piezometers. There are no significant trends in concentrations with time. The composition and concentration of the water in the two wells is quite similar. Both wells indicate that the waters are largely of a sodium sulfate composition, consistent with other deep wells located within the inner portions of the South Valley.

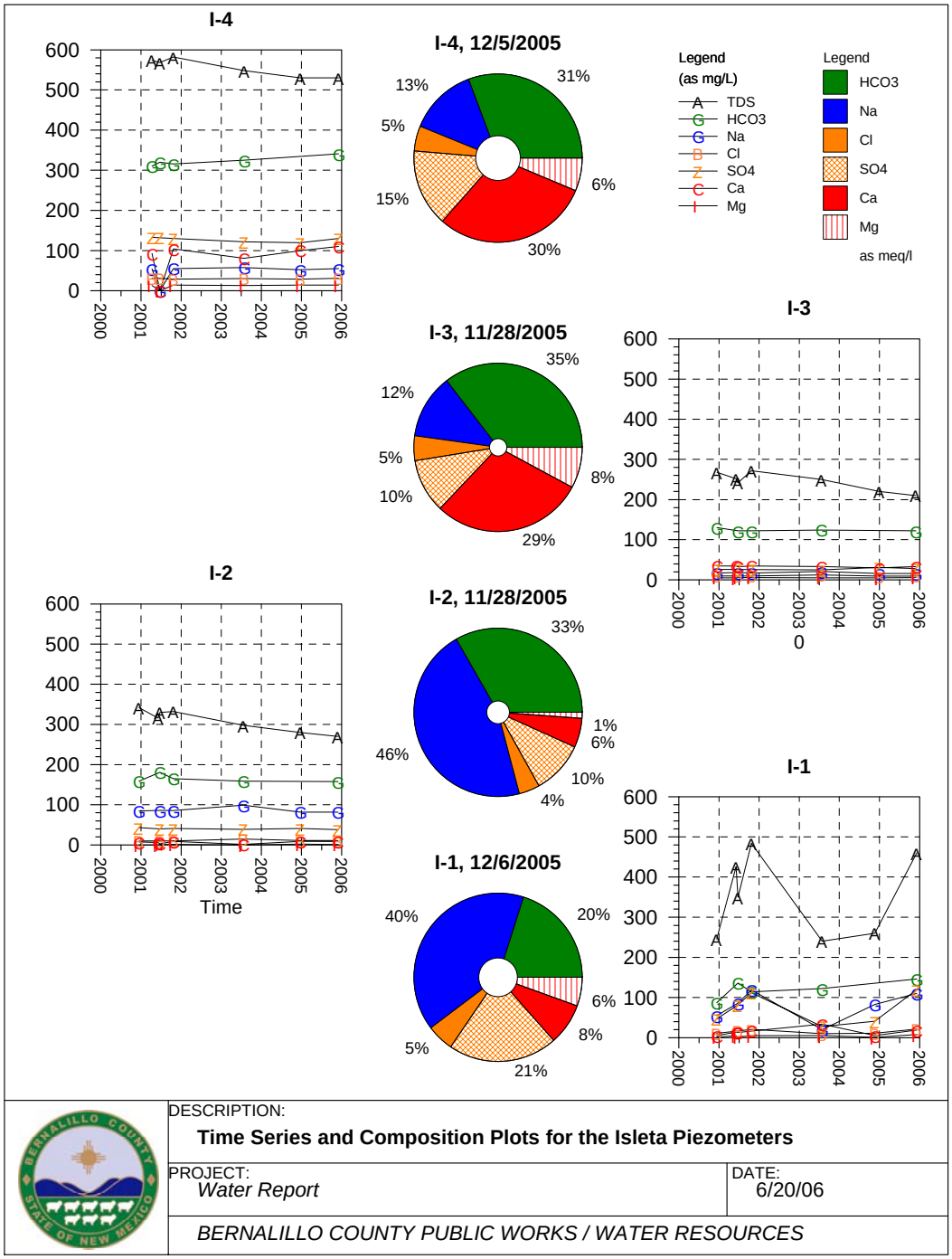
Figure 3.53 provides a time series plot for the inorganic constituents in the Isleta piezometers. Groundwater samples taken from the four Isleta piezometers have not exceeded the primary drinking water standards with the exception of arsenic. The arsenic standard (0.01 mg/L) has not been exceeded in the two shallowest wells. In the two deeper wells, the arsenic standard has been exceeded in three out of five sampling rounds in Isleta 1. Reported concentrations were 0.090 mg/L in I-1 in all instances. In Isleta 2, there have been two exceedances in five samples, at concentrations of 0.045 and 0.050 mg/L. These concentrations are consistent with naturally occurring arsenic in groundwater throughout the area.

Secondary drinking water standards have also been exceeded in the Isleta piezometers. The total dissolved solids concentrations have consistently exceeded 500 mg/L in the shallowest piezometer (Isleta 4), as have the secondary standards for iron (0.30 mg/L) and manganese (0.05 mg/L); the maximum report concentrations were 0.50 mg/L and 1.4 mg/L respectively. Samples from the shallow well (Isleta 3) on two occasions have exceeded the limit for manganese, but not for iron. No secondary standards have been exceeded in the intermediate depth well (Isleta 2).



DESCRIPTION: **Inorganic Time Series Plots for the Rio Bravo Park Piezometers**	
PROJECT: *Water Report*	DATE: 6/20/06
BERNALILLO COUNTY PUBLIC WORKS / WATER RESOURCES	

Figure 3.52 Time Series Plots for the Rio Bravo Park Nested Piezometer



DESCRIPTION:

Time Series and Composition Plots for the Isleta Piezometers

PROJECT: *Water Report*

DATE: 6/20/06

BERNALILLO COUNTY PUBLIC WORKS / WATER RESOURCES

Figure 3.53 Time Series Plots for the Isleta Nested Piezometer

The deepest of the piezometers (Isleta-1), has shown multiple exceedances of the secondary standard for iron and manganese. Concentrations of iron are uniquely high, with a maximum reported concentration of 16 mg/L. Exceedances of manganese included a maximum reported concentration of 0.26 mg/L. Samples from Isleta 1 also yield significantly elevated concentrations of aluminum, but with significant fluctuation through time. The reported aluminum concentrations range from 0.7 mg/L to as great as 24 mg/L. Available analyses suggest that detectable concentrations of strontium and vanadium may occur from time to time. These metals concentrations are either naturally occurring or may be attributable to differences in acidified and unacidified samples.

There are two significant observations to be made regarding trends in the Isleta piezometers. First is the change in composition of the groundwater with increasing depth. As shown in Figure 3.53, there is a significant increase in the relative contribution of sodium, at the expense of calcium and magnesium, and a slight decrease in the relative contribution of bicarbonate. In the deepest well (I-1), there is a significant decrease in bicarbonate, with an increase in contribution of sulfate. A visual comparison of the composition charts for the Rio Bravo Park piezometers indicates that those two relatively deep wells are similar to the composition for the deeper two of the Isleta wells. This is shown in Figure 3.45, the Piper Plot for the South Valley, by the plotting of the respective compositions along the lower right portion of the central diamond. One noticeable difference is the predominance of sulfate in the Rio Bravo piezometers, compared to the deep Isleta piezometers.

This change in chemistry with depth is thought to be due to the influence of the annual flux of surface water from the Rio Grande via the irrigation canals and drains into the shallow aquifer system. Noticeable in the Piper Plot (Figure 3.45) is that the two shallow Isleta Piezometers plot toward the upper-left center of the diamond, along with many of the USGS sampled wells. The USGS wells are primarily shallow wells within the USGS Rio Bravo transect and located immediately adjacent to the Rio Grande. Further evidence of this source stems from results of the Agrichemical Water-Quality Impact Study (McGregor, 2006). As part of that study, water samples were taken from the canals and drains, and shallow wells associated with the irrigation ditch system. The composition of the analysis for the locations near the Isleta piezometer nest from the last round of samples is plotted as Figure 3.54.

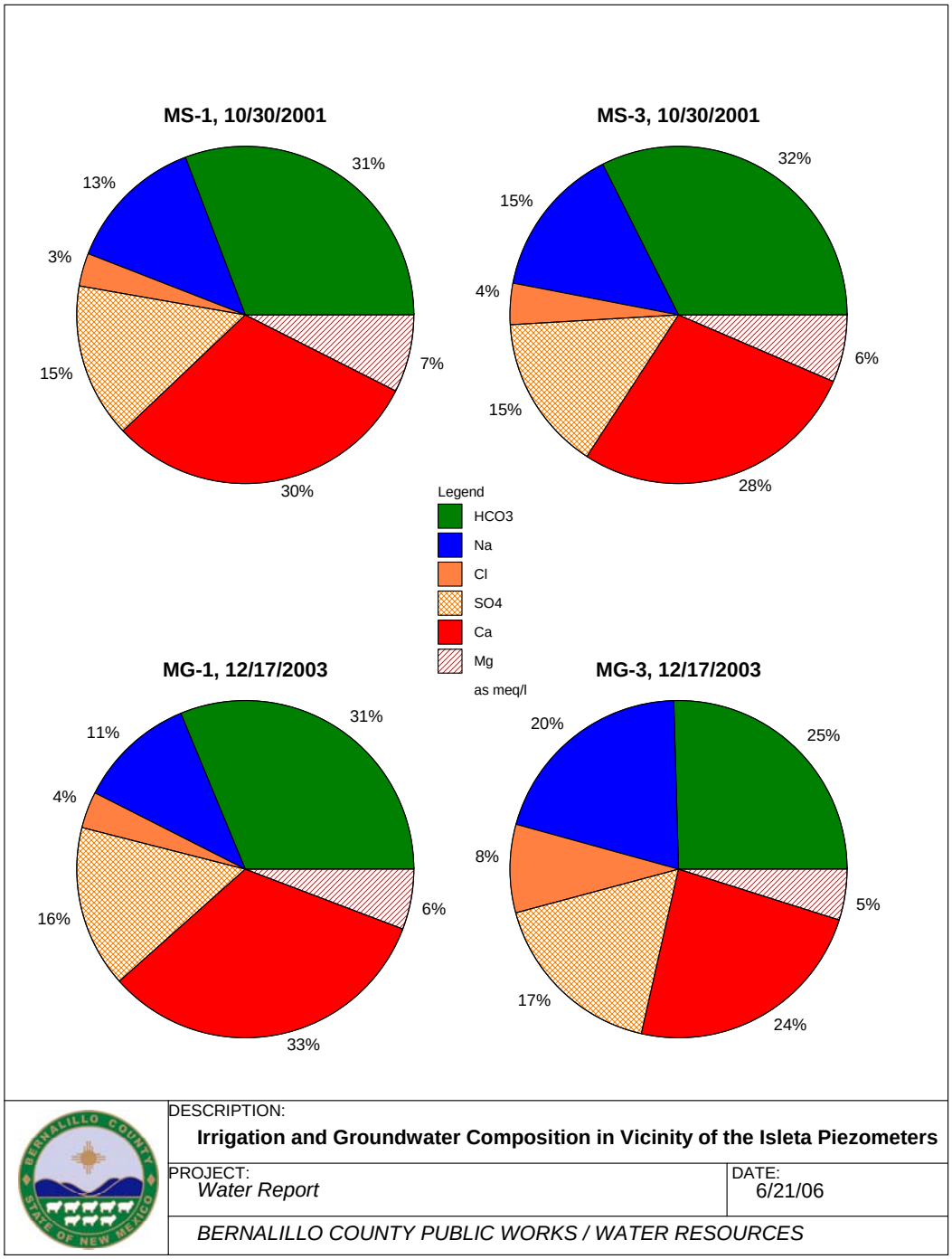


Figure 3.54 Composition of Surface Water and Shallow Groundwater in the South Valley

The MS locations indicate surface water samples, and the MG locations indicate groundwater locations. A visual comparison of the plots for the irrigation supply samples, the nearby shallow ground levels, and the two shallowest Isleta piezometers (Isleta 4, Isleta 3), indicate similarity in composition and strongly suggests influence of irrigation supplies.

The second observation regards the change in composition in the deepest Isleta piezometer (Isleta 1), through time. As shown in Figure 3.53, total dissolved solids and inorganic concentrations fluctuate over a narrow range in the three, uppermost piezometers (Isleta 4, Isleta 3, and Isleta 2). Isleta 1, however, exhibits a marked decrease in TDS in 2003 and 2004. Fluctuations are also seen in total dissolved solids, sodium, chloride, and aluminum, and concentrations of iron and aluminum are distinctively elevated compared to the shallower Isleta piezometers.

The geologic setting may be the key to answering "why". The shallower wells are influenced by the flux of irrigation water through the canals and ditches. This annual replenishment of shallow groundwater tends to moderate any subordinate changes in groundwater quality that might otherwise occur. This annual flux, however, does not reach the deeper portions of the formation, or at least not at rates that significantly affect the deep water levels.

Thus, in the deeper zone, arsenic concentrations may be elevated and sodium concentrations increase and other fluctuations may be seen. The source and fluctuations of the fluctuating concentrations of iron, aluminum, and other trace metals in Isleta 1 is hypothesized to be the near-surface basalt formations of Black Mesa, immediately southwest of the piezometer site. Difference in geochemistry with depth in the alluvial aquifer would explain stable differences in geochemistry with depth, but would not account for the fluctuations. A second plausible explanation for the fluctuation may be a difference in field methodology. Existing records are inadequate to determine if samples collected in 2003 and 2004 were field filtered to remove suspended materials. If so, then trace metal concentrations could expect to be lower than in samples that were left unfiltered and then acidified for preservation. However, this would not explain the variation in sodium and chloride concentrations that also occur.

1.9 ***West Mesa Monitoring Wells***

For discussion purposes, the West Mesas consist of three general areas. These areas include: (1) the Northwest Mesa, which generally encompasses the Albuquerque volcanoes, Double Eagle airport, and points north and west of those locations; (2) The West Mesa, which includes the area between approximately 1 mile north of I-40 and as far south of Southwest Rd.; and (3) the Southwest Mesa, which is bounded to the north by Southwest Rd and to the south by the Isleta Pueblo boundary. These areas are characterized as open ranchland, with residential and commercial development currently focused in the West Mesa and along the Coors Road and I-40 corridors. Some institutional and industrial development exists (e.g., the Metropolitan Detention Center, Double Eagle Airport, Petroglyphs National Monument), and residential development via master planned communities on the eastern edges and southward from Rio Rancho is occurring.

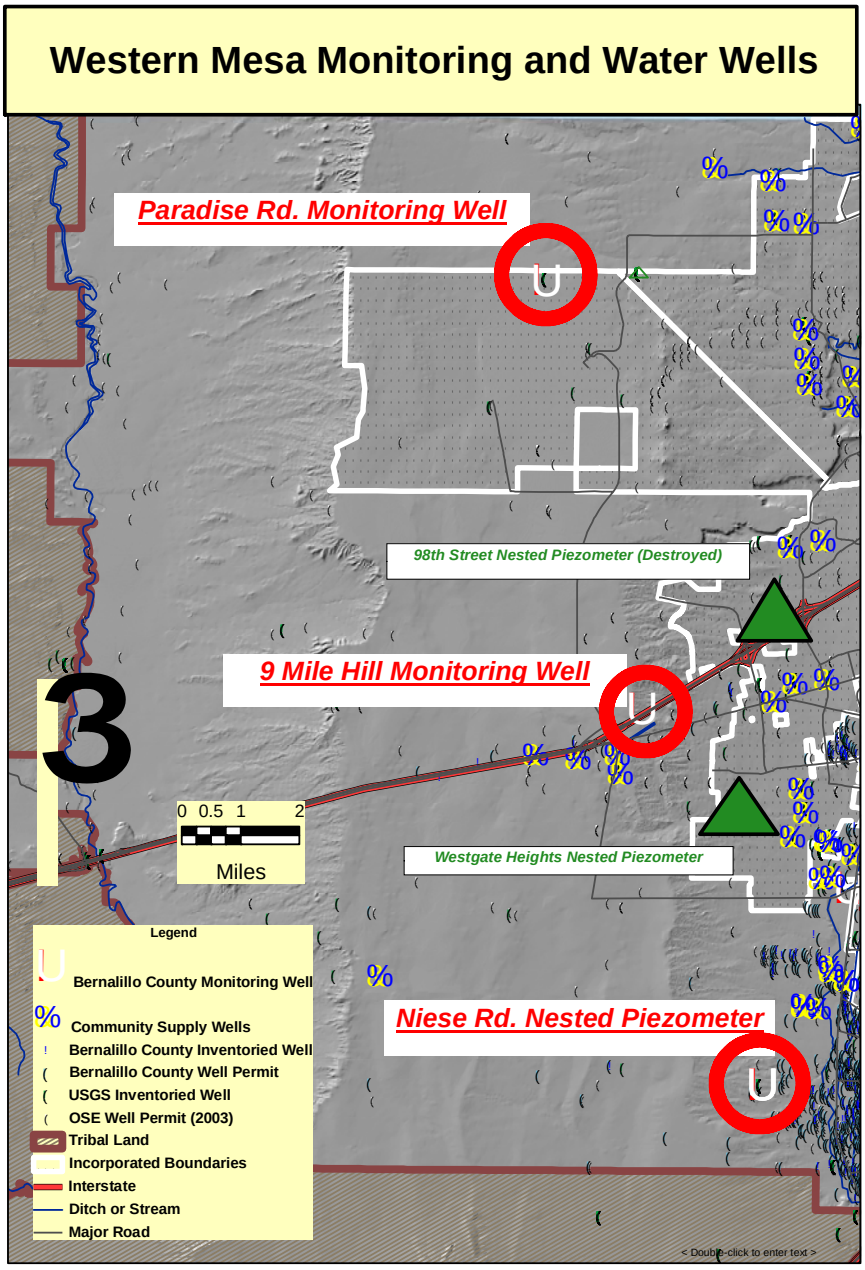
Bernalillo County maintains and monitors two wells and one piezometer nest on the West Mesas: the Paradise Road well located north of the Double Eagle Airport and on the eastern edge of the City of Albuquerque's soil amendment facility; the 9-Mile Hill well located near the intersection of I-40 and Paseo Del Volcan at the closed County landfill; and the Niese Road piezometer nest located along Niese Road and east of the Southwest Landfill, which is a construction-debris-only facility. The USGS provides continuous water level monitoring at the Niese Road piezometer nest.

The location of the various Bernalillo County wells, the USGS wells, and community supply wells are shown in Figure 3.55.

1.9.1 *USGS West Mesas Monitoring Wells*

The USGS water level monitoring on the West Mesa also includes activities in the Lincoln Middle School piezometer nest (in Rio Rancho), the 98th Street Piezometer nest located east of the 9 Mile Hill Well, and the Westgate Heights nested piezometer located southwest of 98th Street and Sage Rd. Monitoring is also conducted by the USGS in cooperation with the ABCWUA in the Volcano Cliffs, Zamora, College, West Mesa, and Leavitt wellfields.

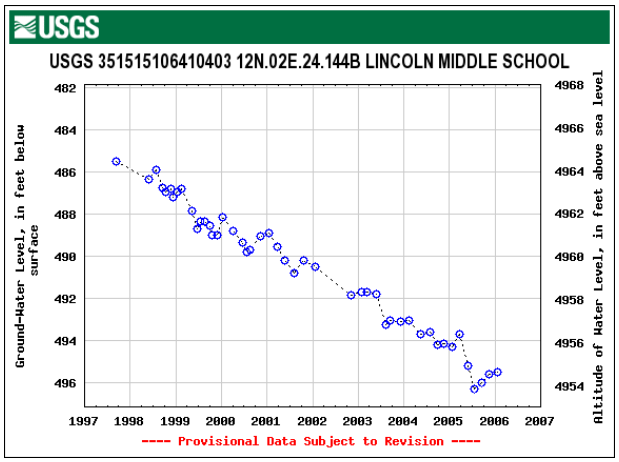
Figure 3.55 West Mesa Monitoring and Water Wells



1.9.1.1 Water Levels in the West Mesas

Figures 3.56 and 3.57 provide the summary hydrographs for the USGS-monitored locations on the Northwest Mesa. The USGS maintains a nested piezometer at the Lincoln Middle School located in Sandoval County, approximately 11 miles northeast of the Paradise Road Well. Water levels in the uppermost and lowermost piezometers indicate consistent declines in water levels since 1997, when monitoring began. Water levels in the uppermost aquifer (595 ft.) have declined approximately 11 feet during that period, or approximately 1.2 ft/yr. A similar decline is seen in the deepest piezometer (1,260 ft.). These declines are likely due to continued and expanding groundwater withdrawals used to support development of Rio Rancho. The intermediate piezometer (890 ft.) shows slightly less decline, approximately 8 feet in 9 years, or about 0.9 ft/yr. The graphs are somewhat misleading due to the choice of scales needed to represent an anomalous reading recorded in 2004. The relative potentiometric elevations indicate flow from the uppermost and lowermost zones into the intermediate zone. The difference in decline rate is due to flow into the intermediate layer. Flow occurs at the expense of water levels in the overlying and underlying portions of the aquifer.

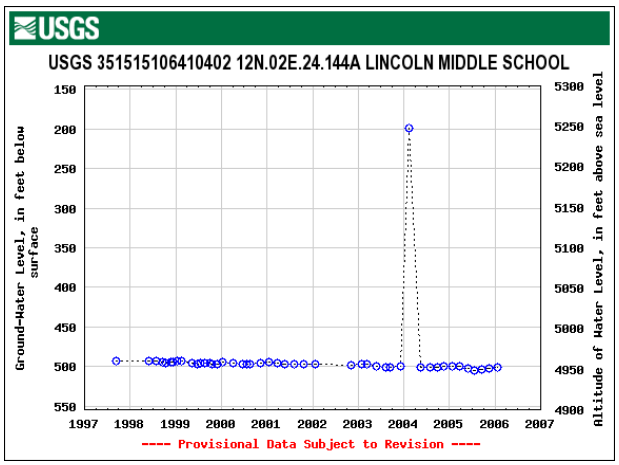
The 98th Street piezometer nest was located approximately 2.5 miles northeast of the 9 Mile Hill well monitored by Bernalillo County. This piezometer nests consisted of four wells. The shallowest of the wells (438 ft.) indicated continual decline in water levels since monitoring began in 1997, though the decline totals less than 3.5 feet, or an average rate of 0.4 ft/yr. It is likely that the decline is due to a general lack of precipitation over that period coupled with nearby municipal pumping. Each of the deeper wells (749 ft., 1,112 ft., 1,554 ft.) at that location showed a general decline from 1997 to about 2002. The total decline ranged from 7 feet to 12 feet deepening on depth. Since 2002, water levels have risen back to 1997 levels. The water levels in the deep piezometer demonstrate seasonal pumping effects of 8 to 10 feet from winter to summer prior to 2002, and approximately 4 to 6 feet since. The 98th Street piezometer nest was lost to development in 2005 and is no longer in service.



Well Information

Land Surface Elevation:
5,450 ft amsl.

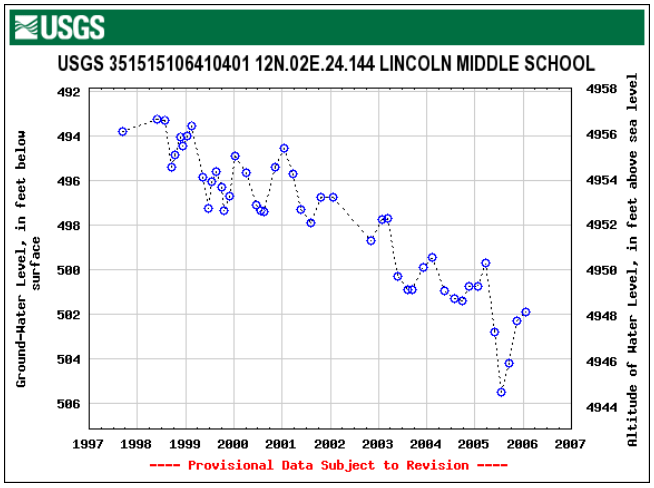
Depth of Well: 595 ft



Well Information

Land Surface Elevation:
5,450 ft amsl.

Depth of Well: 835 ft.



Well Information

Land Surface Elevation:
5,450 ft amsl.

Depth of Well: 1,260 ft

Figure 3.56 Water Levels in the Lincoln Middle School Nested Piezometer

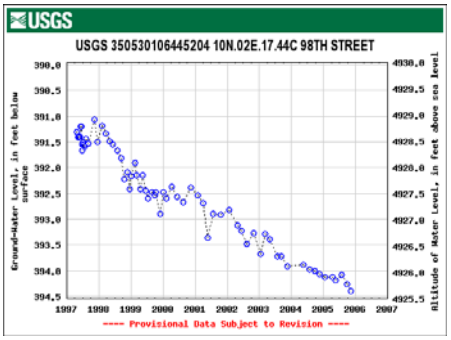
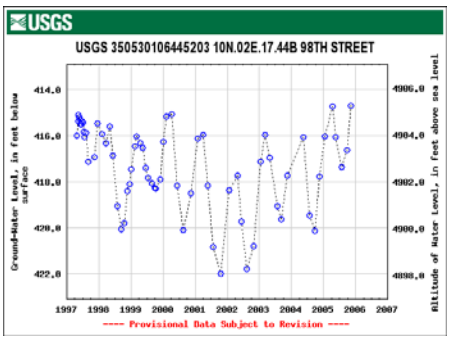
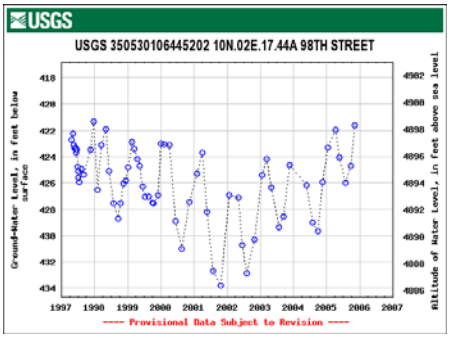
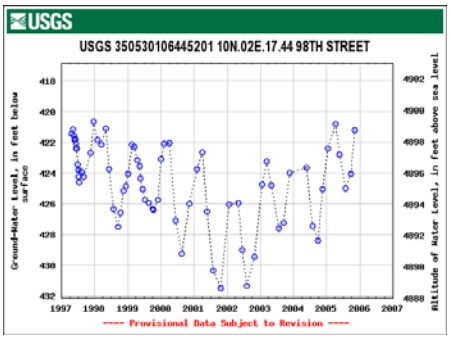
	**Well Information** Land Surface Elevation: 5,320 ft amsl. Depth of Well: 438 ft
	**Well Information** Land Surface Elevation: 5,320 ft amsl. Depth of Well: 749 ft.
	**Well Information** Land Surface Elevation: 5,320 ft amsl. Depth of Well: 1,112 ft
	**Well Information** Land Surface Elevation: 5,320 ft amsl. Depth of Well: 1,554 ft

Figure 3.57 Water Levels in the 98th Street Nested Piezometer

ABCWUA pumping records were provided courtesy of the USGS and annual total pumping by wellfield are shown in Figure 3.58. Figure 3.59 shows that pumping in the College and West Mesa wellfields, which are the wellfields closest to the 98th Street piezometer nest, were significantly reduced in 1987, with combined pumping being least from 1991 to 1992. The resurgence in pumping from the West Mesa wellfield from 1992 to 1998 is evidenced by the declining levels in the 98th Street deep piezometers though 2000. A reduction in pumping is again seen beginning in 1998, with additional reductions from the College wellfield starting in 2002. These reductions are evidenced as rises in water levels in the 98th street piezometers (Figure 3.56) beginning in 2000 and continuing through the present.

The USGS hydrographs for College 1 and College 2 (Figure 3.60) indicate that data have been collected somewhat sporadically and trends are not clearly indicated. Based on the available data, it appears that declines have occurred in both wells. In College 1, water levels in the winter of 1997 were at a depth of 434 feet, while in winter 2006, the water level was measured at approximately 445 feet, suggesting a net decline of 11 feet, or an average decline rate of 1.1 ft/yr. Data presented for College 2 suggest that water levels have stabilized since about 1997. Figure 3.60 provides a comparison of pumping from the College 1 and College 2 wells. Although overall pumping has decreased since 1997, the decrease has come from reduced pumping only in College 2. Thus, water levels in College 1 are expected to continue to decline, while levels in College 2 stabilize.

Hydrographs for other West Mesa pumping wells (Figure 3.61) are also available, but recorded data are sporadic. Water levels in the Volcano Cliffs Well 1 suggest a continual decline since monitoring was initiated in 1970. Total decline over the 36-year period is approximately 110 feet, or an average rate of 3 ft/yr. The Zamora Well 1, located east of the Volcano Cliffs well field, shows a total decline of 36 feet over a 13-year period, or an average rate of 2.7 ft/yr. These declines are consistent with reduction of pumping from the Volcano Cliffs field starting in 1997 but with increased pumping in the Zamora well field to compensate for the reduction (see Figure 3.58). There has been no net recovery in water levels.

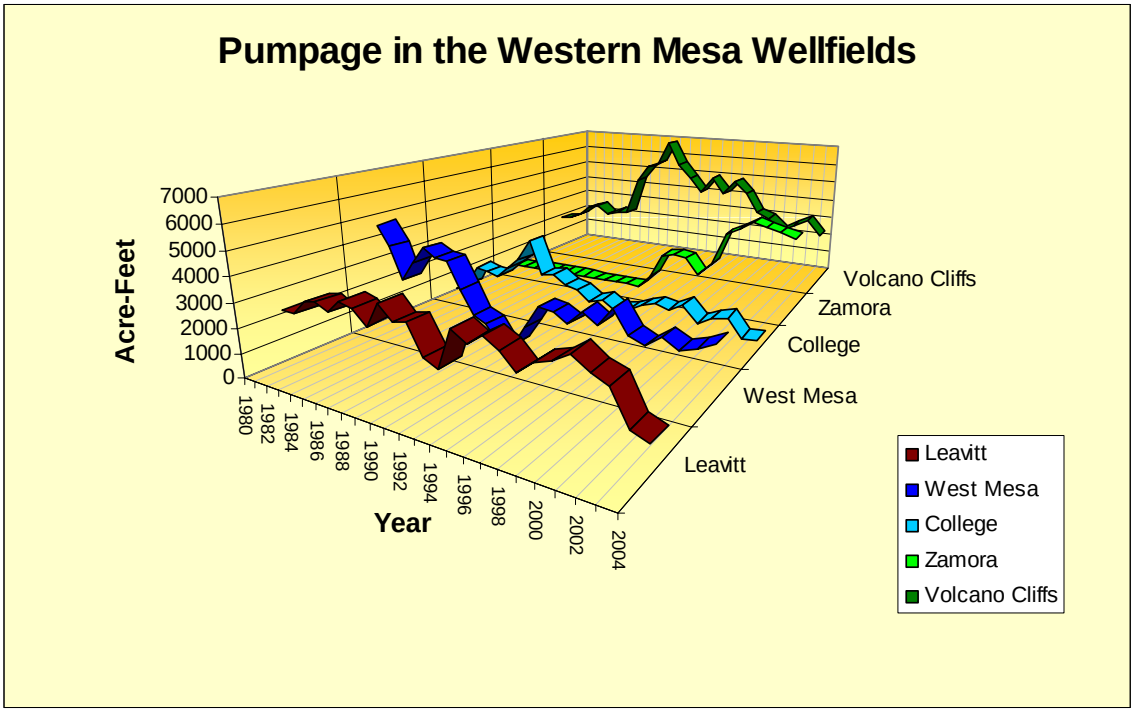


Figure 3.58 Pumping History for the West Mesa Well Fields

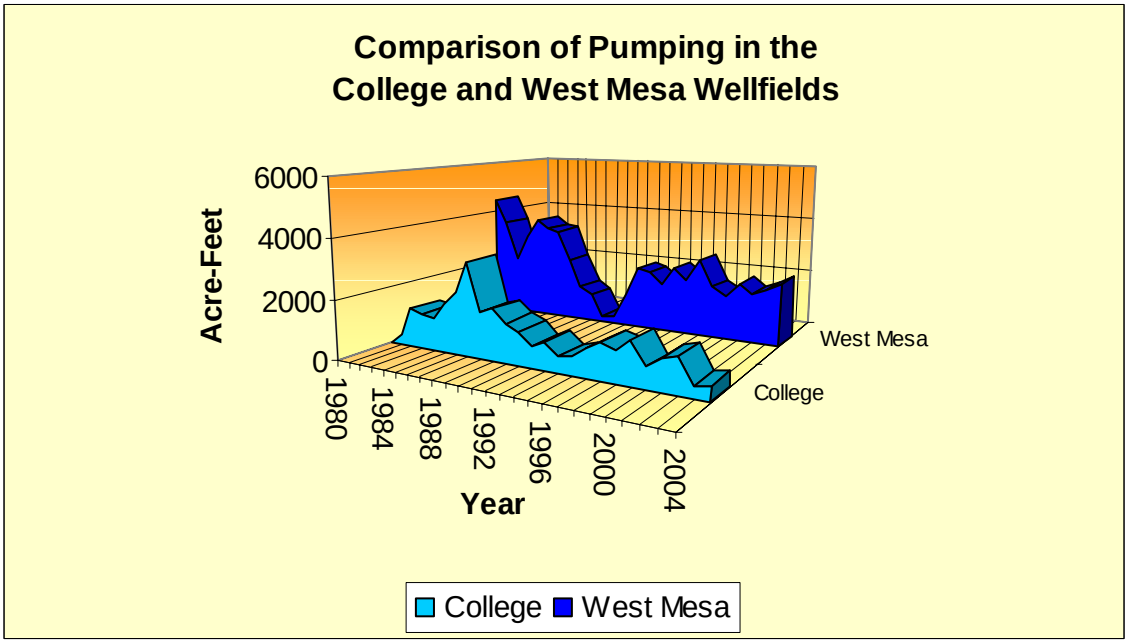
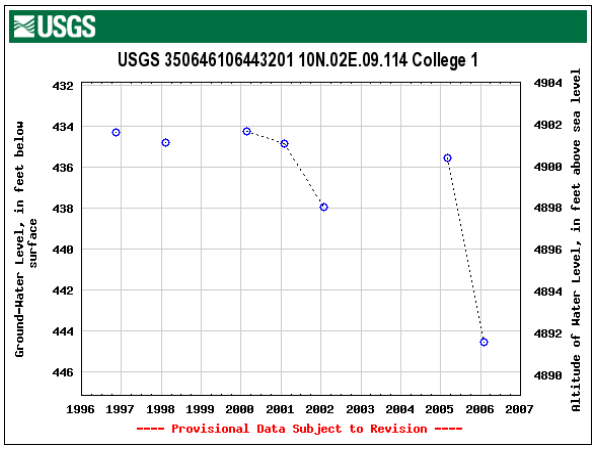


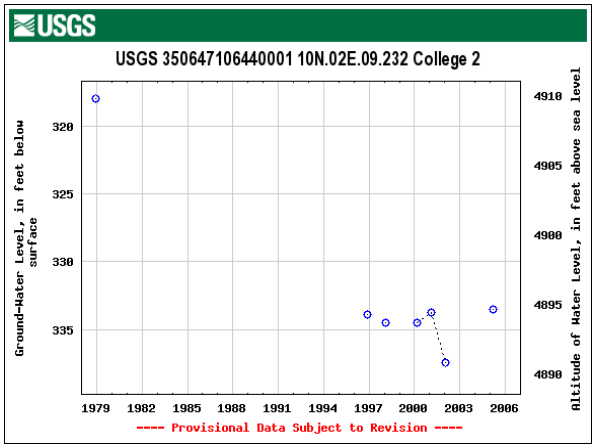
Figure 3.59 Comparison of the Pumping in the College and West Mesa Well Fields



Well Information

Land Surface Elevation:
5,336 ft amsl.

Depth of Well: 1,662 ft



Well Information

Land Surface Elevation:
5,336 ft amsl.

Depth of Well: 1,647 ft

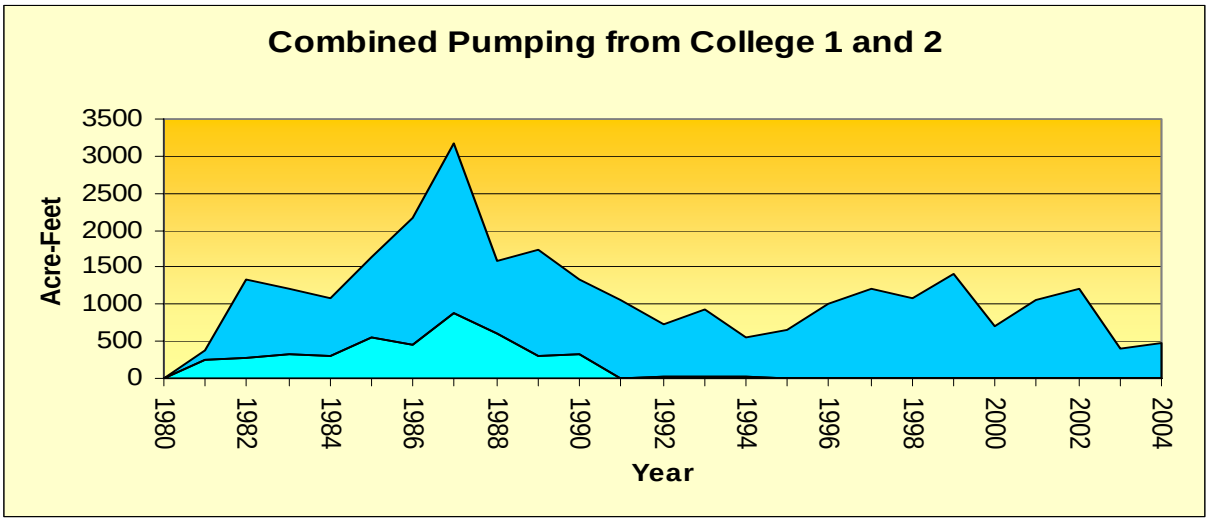
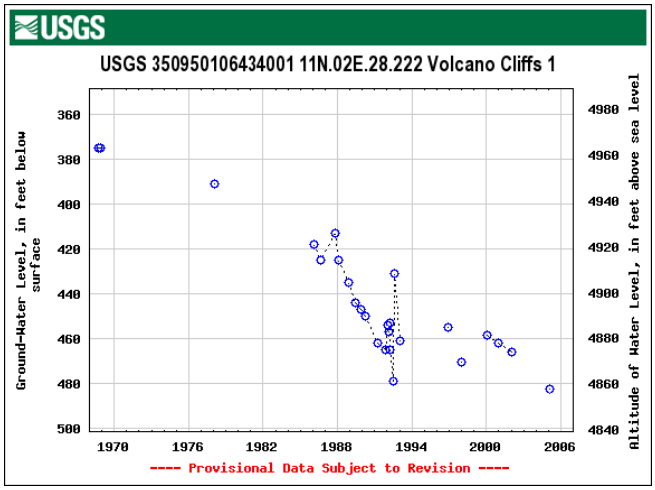


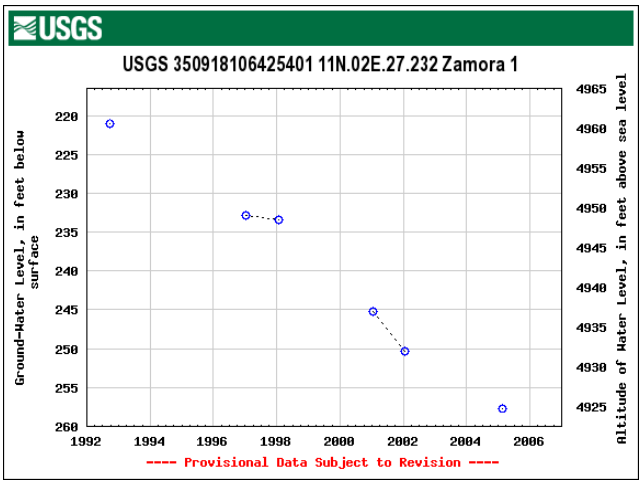
Figure 3.60 Water Levels and Pumping in College 1 and 2



Well Information

Land Surface Elevation:
5,339 ft amsl.

Depth of Well: 1,080 ft



Well Information

Land Surface Elevation:
5,182 ft amsl.

Depth of Well: 970 ft.

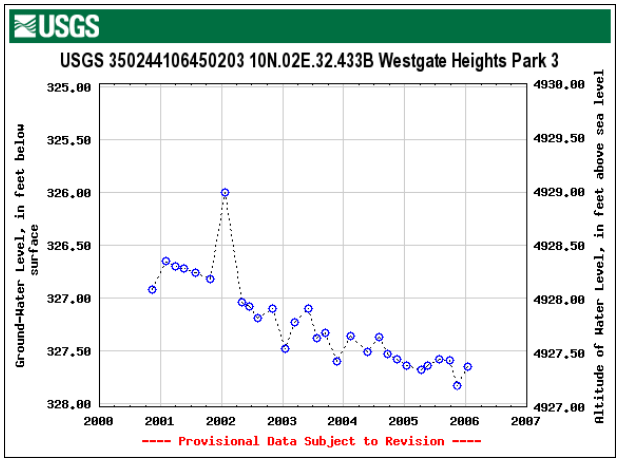
Figure 3.61 Water Levels in Volcano Cliffs and Zamora Well Fields

The USGS also maintains a piezometer nest in the Westgate Heights Park. The piezometer nest is located approximately 1.5 miles southeast of the Don well field, two miles southwest of the West Mesa well field, and 1.25 miles west of the Leavitt well field. The hydrographs for the Westgate Heights piezometers are of similar character to those of the 98th Street piezometers and are provided as Figure 3.62. The shallowest piezometer (370 ft.) shows a decline of approximately 1 foot over a 5-year period, or an average rate of 0.2 ft/yr. This decline is likely due to natural, drought-related causes as there are no nearby shallow wells, although some portion of the decline may be attributable to municipal pumping. In contrast, the intermediate (749 ft. and 1,112 ft.) and deep (1,554 ft.) piezometers show a net increase in water levels of approximately 11 feet since mid-2000. Seasonal fluctuations are seen in the intermediate and deep wells, with seasonal change typically being approximately 6 feet. The cause of the recovering water levels is likely reduced municipal pumping in the nearby Leavitt well field.

Water level data for Leavitt 2 are only available sporadically, but indicate an approximately 4-foot rise in water levels since 2000 consistent with water level changes in the Westgate Heights deep piezometers. Figure 3.63 provides the pumping history of the West Mesa and Leavitt well fields, the two fields closest to the Westgate Heights piezometers. The graph shows that pumping in the Leavitt well field peaked in 2000 and has been reduced since that time; whereas, pumping from the West Mesa well field has remained consistent or risen only slightly. Consequently, the trends in the Westgate Heights piezometers appear to be driven by the changes in the Leavitt well field pumping.

1.9.1.2 Water Quality in the West Mesa

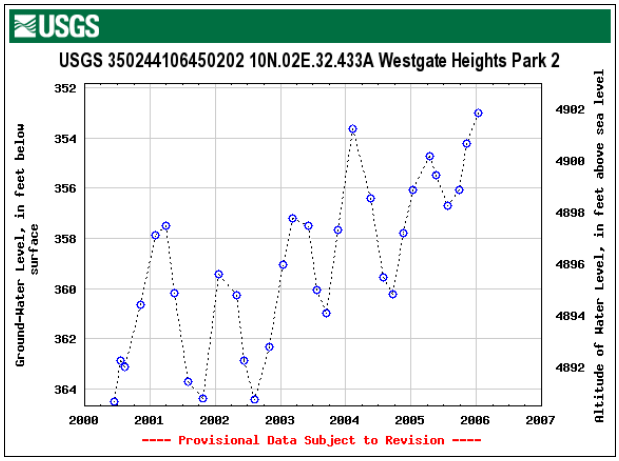
Water quality samples have been collected throughout the West Mesas and analyzed by the USGS through cooperative agreements with the CABQ and Bernalillo County. Water quality data for the Volcano Cliffs, College, West Mesa and Leavitt well fields has been provided by CABQ and is summarized below. Data for individual well locations and the USGS-monitored piezometer nests was taken from the on-line USGS database. Bernalillo County has collected samples and provided analysis for three sampling locations: Paradise Road, 9 Mile Hill, and the Niese Road piezometer nest.



Well Information

Land Surface Elevation:
5,255 ft amsl.

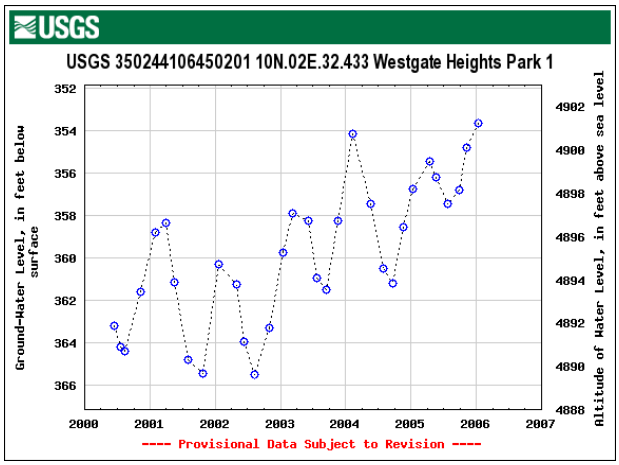
Depth of Well: 370 ft.



Well Information

Land Surface Elevation:
5,255 ft amsl.

Depth of Well: 868 ft

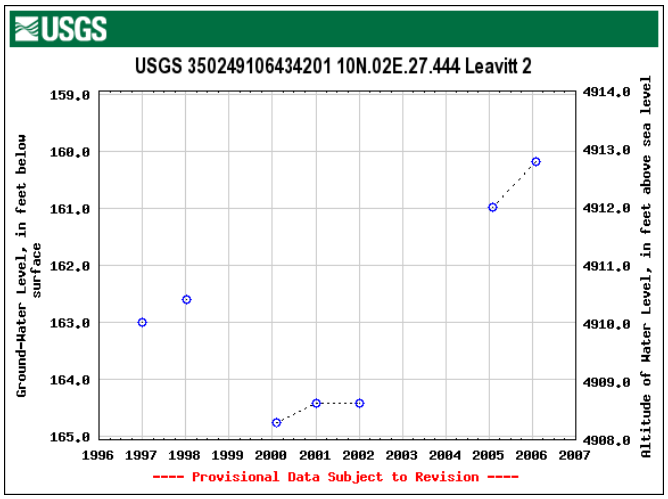


Well Information

Land Surface Elevation:
5,255t amsl.

Depth of Well: 1.290 ft

Figure 3.62 Water Levels in the Westgate Heights Nested Piezometer



Well Information

Land Surface Elevation:
5,073 ft amsl

Depth of Well: 1,133 ft

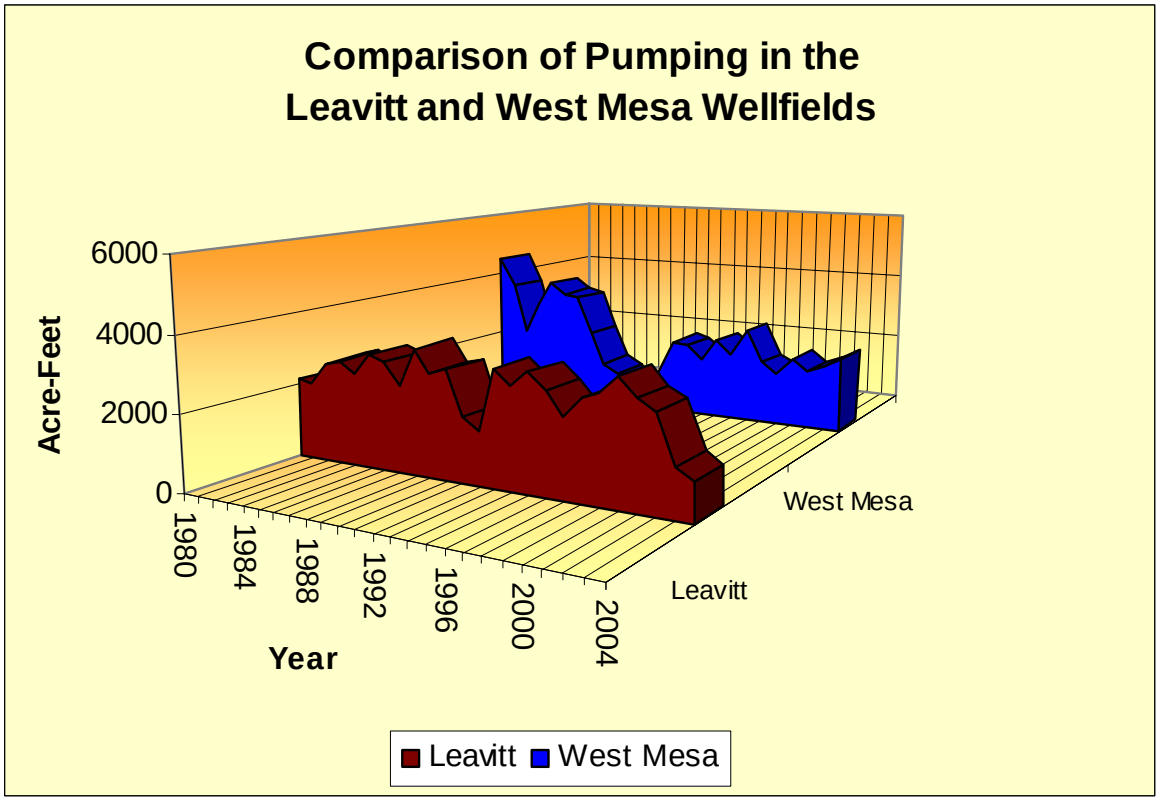


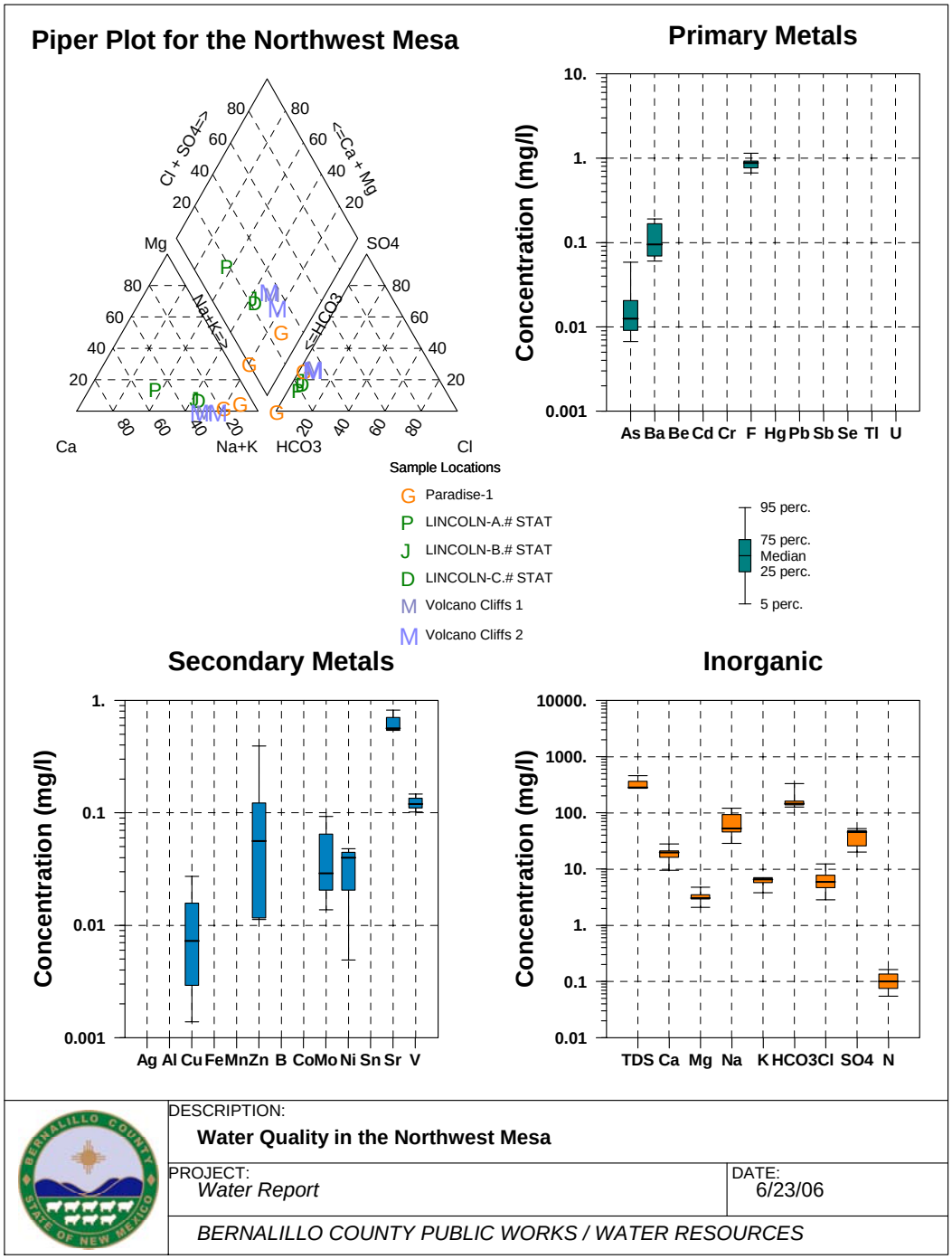
Figure 3.63 Water Level Rise and Decreased Pumping in the Leavitt Well Field

Figures 3.64 through 3.66 present a Piper Plot and a statistical summary for the metals and inorganic concentrations for water samples taken from the Northwest Mesa, the West Mesa, and the Southwest Mesa. These plots only reflect the results of on-going groundwater monitoring of fresh water supply from the aquifer. The non-Bernalillo County samples shown on the Piper Plot are either mean values based on the period of record (i.e. designated as "stat") or are the most currently available sample. The available data for the Westgate Heights nested piezometer was included in the summaries for both the West Mesa and Southwest Mesa because it is located on the boundary between the two areas.

The Piper plots for the three subareas generally plot to the lower right hand side of the center diamond, indicating a predominantly sodium and bicarbonate composition. Increased concentrations of sulfate may be present in some individual samples from time to time, but chloride concentrations typically remain low. The Piper Plots for the West Mesa, particularly the intermediate and deep piezometers, generally overlap or fall within the plot area for samples taken from the South Valley. This is consistent with the generally held model of water moving from the West Mesa towards the east and southeast toward the Rio Grande and areas of municipal pumping. It also reflects the similarity in formations and resulting geochemistry.

The plots for the available sample from the 9 Mile Hill well and the shallowest of the Niese Road piezometers plot at the center of the diagram, similar to the plots for the monitored locations in the Far Northeast Heights and the North Valley. This is likely due to the wells screening upper portions of the formation and the effect of direct recharge by precipitation and subsequent changes in groundwater chemistry as the groundwater moves to greater depths.

Available data on primary and secondary metals is limited for the non-municipal well locations. The available data indicate that arsenic is a problem throughout the West Mesa and aluminum, iron, and manganese can be problematic. Total dissolved solids may also exceed the secondary standard. The statistical summations for inorganic constituents indicate that there are few, if any, concerns with exceedances for chloride or sulfate in any of the three subareas. These parameters are likely to be of concern at depths greater (i.e., > 1,500 ft.) than those represented in the statistical analysis.



DESCRIPTION:
Water Quality in the Northwest Mesa

PROJECT: *Water Report*

DATE: 6/23/06

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Figure 3.64 Water Quality in the Northwest Mesa

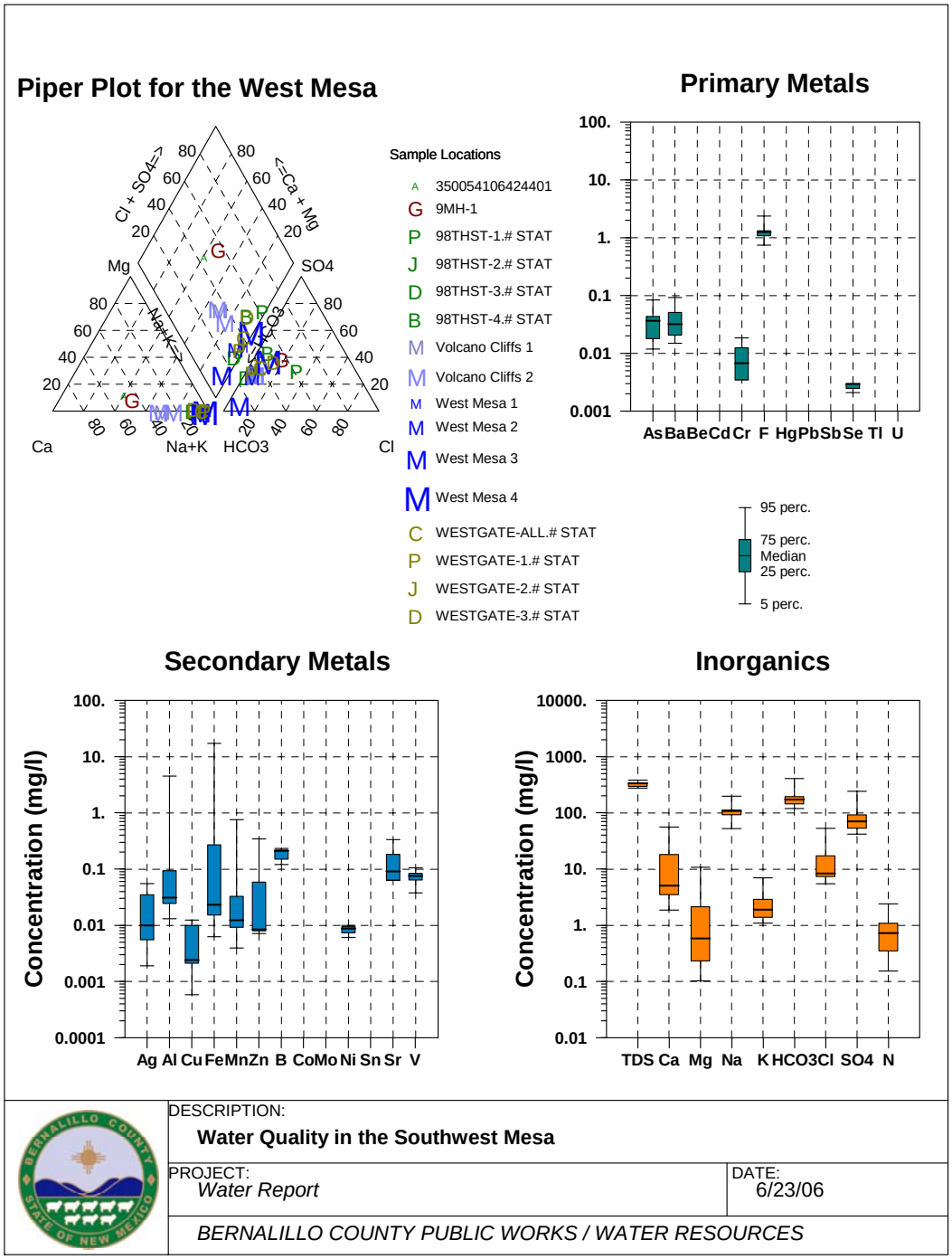
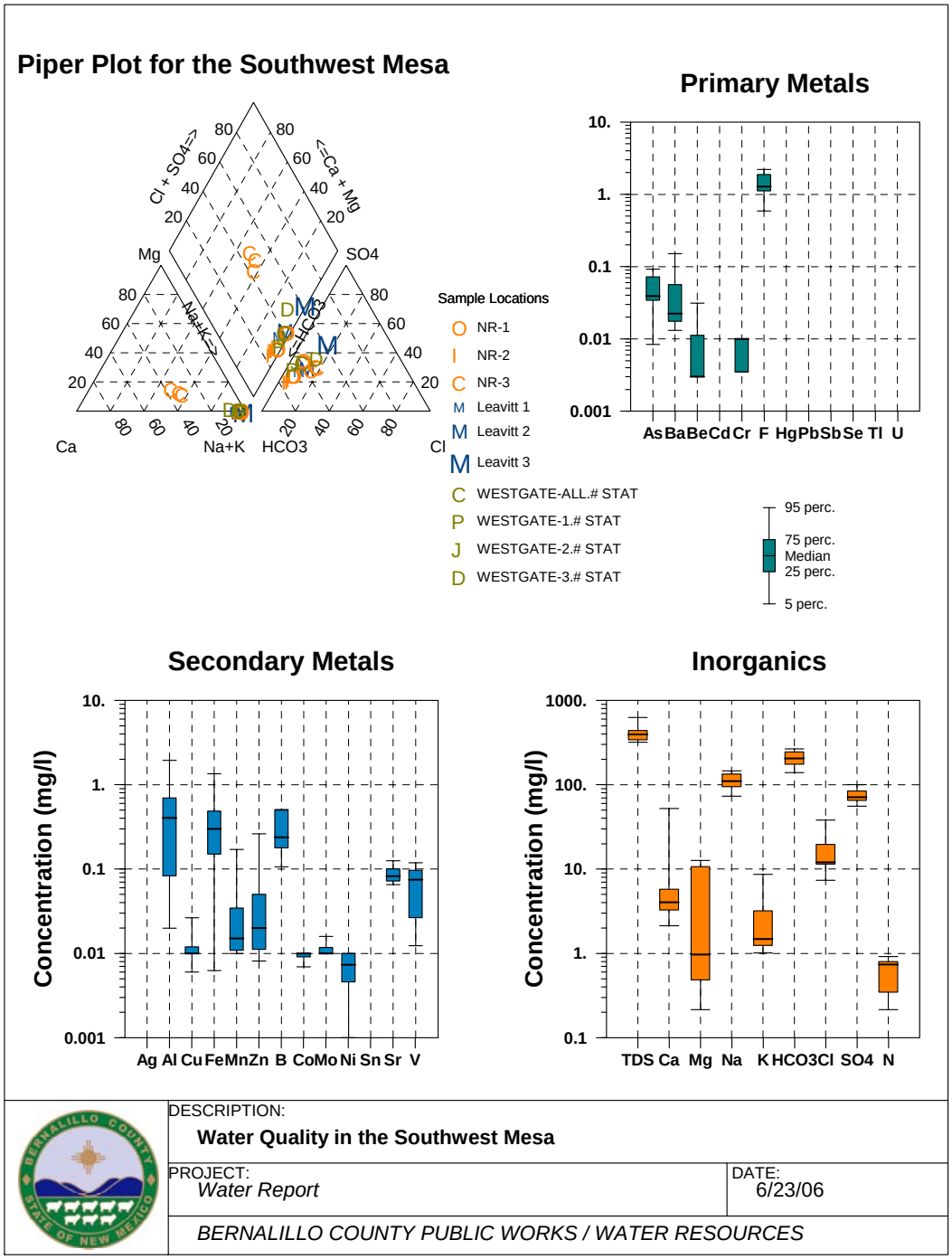


Figure 3.65 Water Quality in the West Mesa



DESCRIPTION:
Water Quality in the Southwest Mesa

PROJECT: *Water Report*

DATE: 6/23/06

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Figure 3.66 Water Quality in the Southwest Mesa

Table 3.13 provides a summary of the drinking water standards by each of the three West Mesa subareas. The table indicates the respective standard, the number of samples used for the analysis, the percent of those samples exceeding the standard, and the maximum and mean values used in the summation. The available data for the Westgate Heights piezometers was included in the summaries for both the West Mesa and Southwest Mesa because they are located on the boundary between the two areas. This results in a slight upward bias (about 10 percent) in the stated number of samples exceeding the arsenic standard for the Southwest Mesa.

Table 3.13 Exceedances of EPA Drinking Water Standards – West Mesa

Parameter	Primary Standard	Secondary Standard	Total Number of Samples	Percent of Samples Exceeding Standard	Maximum Concentration (mg/L)	Mean Concentration (mg/L)
Northwest Mesa						
Arsenic	0.010		6	35	0.07	0.02
Aluminum		0.05	6	35	9.2	2.9
Iron		0.3	6	35	8.6	2.7
Manganese		0.5	6	35	0.17	0.04
West Mesa						
Arsenic	0.010		42	96	0.11	0.03
Total Dissolved Solids		500	32	28	1069	474
Aluminum		0.05	36	23	5	0.037
Iron		0.3	34	8	24	1.3
Manganese		0.5	34	8	1.5	0.06
Southwest Mesa						
Arsenic	0.010		22	55	0.11	0.029
Total Dissolved Solids		500	20	10	650	407
Aluminum		0.05	20	30	2	0.38
Iron		0.3	6	30	1.5	0.25
Manganese		0.5	6	10	0.18	0.025

The presence of arsenic in the West Mesa area has resulted in the ABCWUA's intentional shifting of pumping away from the western well fields with the intent of achieving compliance with drinking water standards. With regard to other secondary and trace metals, concentrations for strontium and vanadium from Northwest Mesa samples are, at times, elevated compared to other groundwater in the Albuquerque area. Strontium is sometimes detected at low concentrations in samples from the Southwest Mesa as well. There are no drinking water standards for strontium or vanadium. The presence of these elements is expected as the geologic source materials yielding elevated arsenic concentrations are also a likely source of other trace metals.

1.9.2 *Paradise Road Well*

The Paradise Road well was drilled in 2001 to assess aquifer conditions on the West Mesa near the Double Eagle 2 Airport and to collect deep aquifer water quality, specifically arsenic concentrations. The well is located within the eastern boundary of the City of Albuquerque's Soil Amendment Facility, north of Double Eagle 2 Airport and west of Paseo Del Vulcan (see Figure 3.53). As shown in Table 3.14, the total well depth is 1,742 feet and depth to water is approximately 900 ft. Samples from this well are taken from a depth of approximately 900 feet due to limitations of available pumping equipment. A well construction diagram is provided as Figure 3.67.

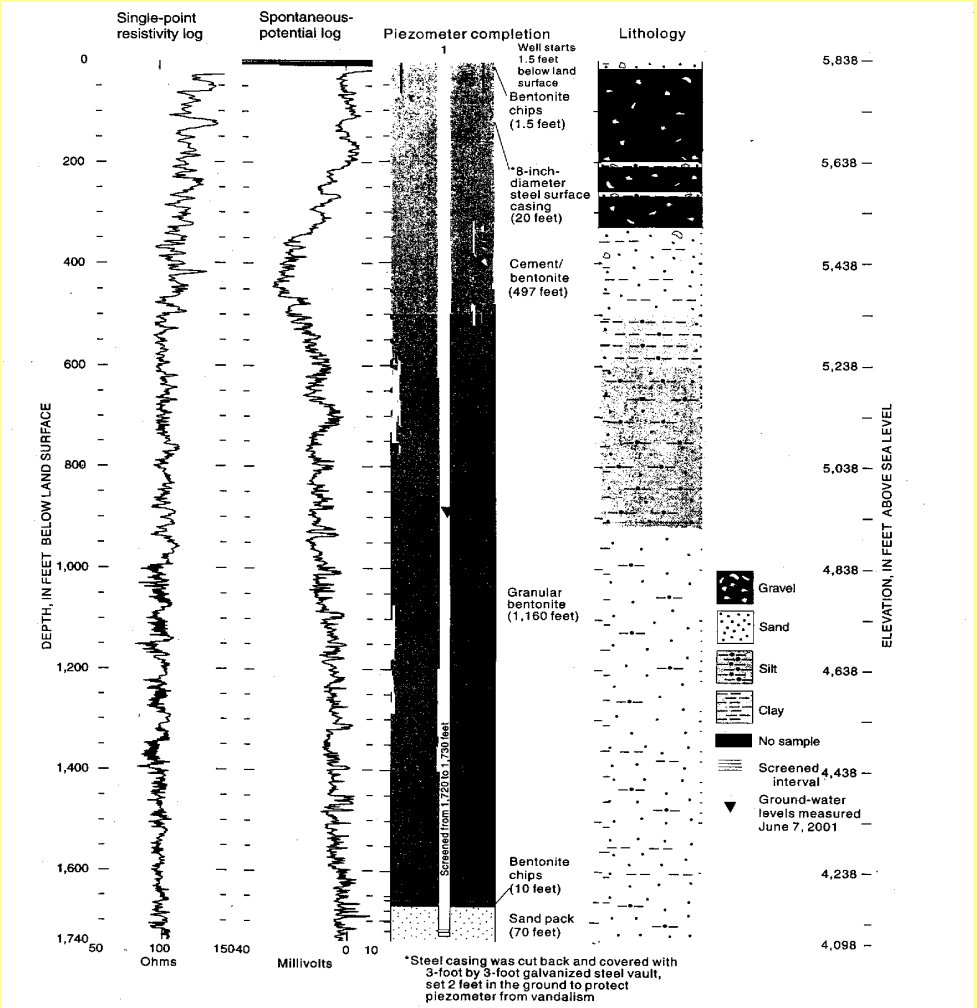
Surface deposits at the well location are mapped as eolian deposits, while the well is completed in the upper portions of the underlying Santa Fe Group Aquifer. The geologic setting is shown in Figure 3.68

1.9.2.1 Water Levels in the Paradise Road Well

Water Levels in the Paradise Road are routinely hand measured by the USGS, and a hydrograph taken from the USGS website (USGS Ground water for New Mexico: Water Levels) is provided in Figure 3.69. The data are a combination of the USGS recorded data and hand measurements collected by Bernalillo County as part of the annual sampling effort. The plot indicates that water levels have declined approximately 1 to 2 feet since monitoring was initiated in 2001.

Table 3.14 Bernalillo County Regional Monitoring Well Network – Paradise Road Well

Well	Well Type	Well / Hole Depth (ft)	Screen Settings (ft)
Paradise Boulevard (Paradise Road)	Single	1,742	1,720 – 1,730



(Taken from USGS OFR 03-290, Figure 23O)

Figure 3.67 Paradise Road Well Construction Log

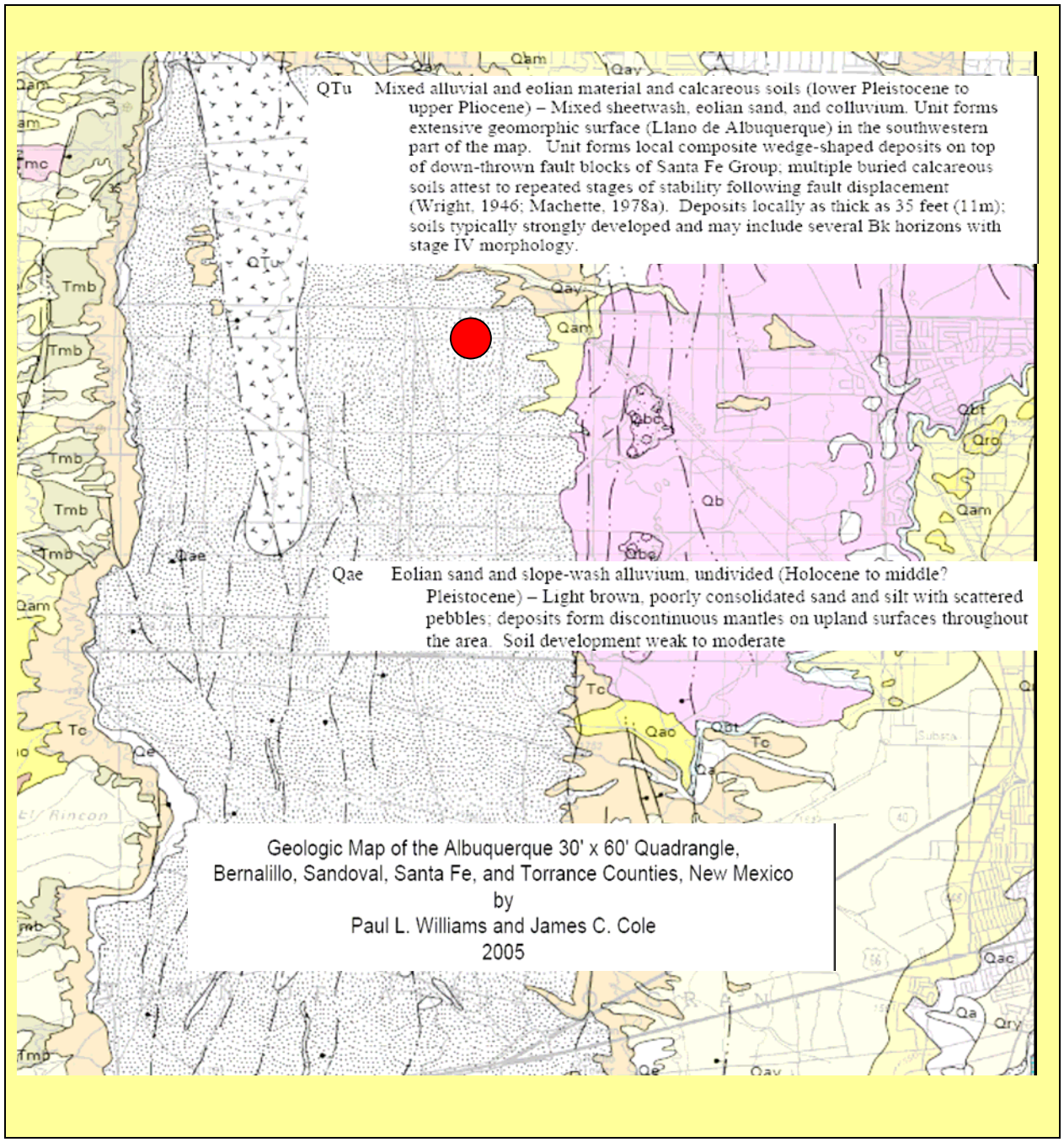
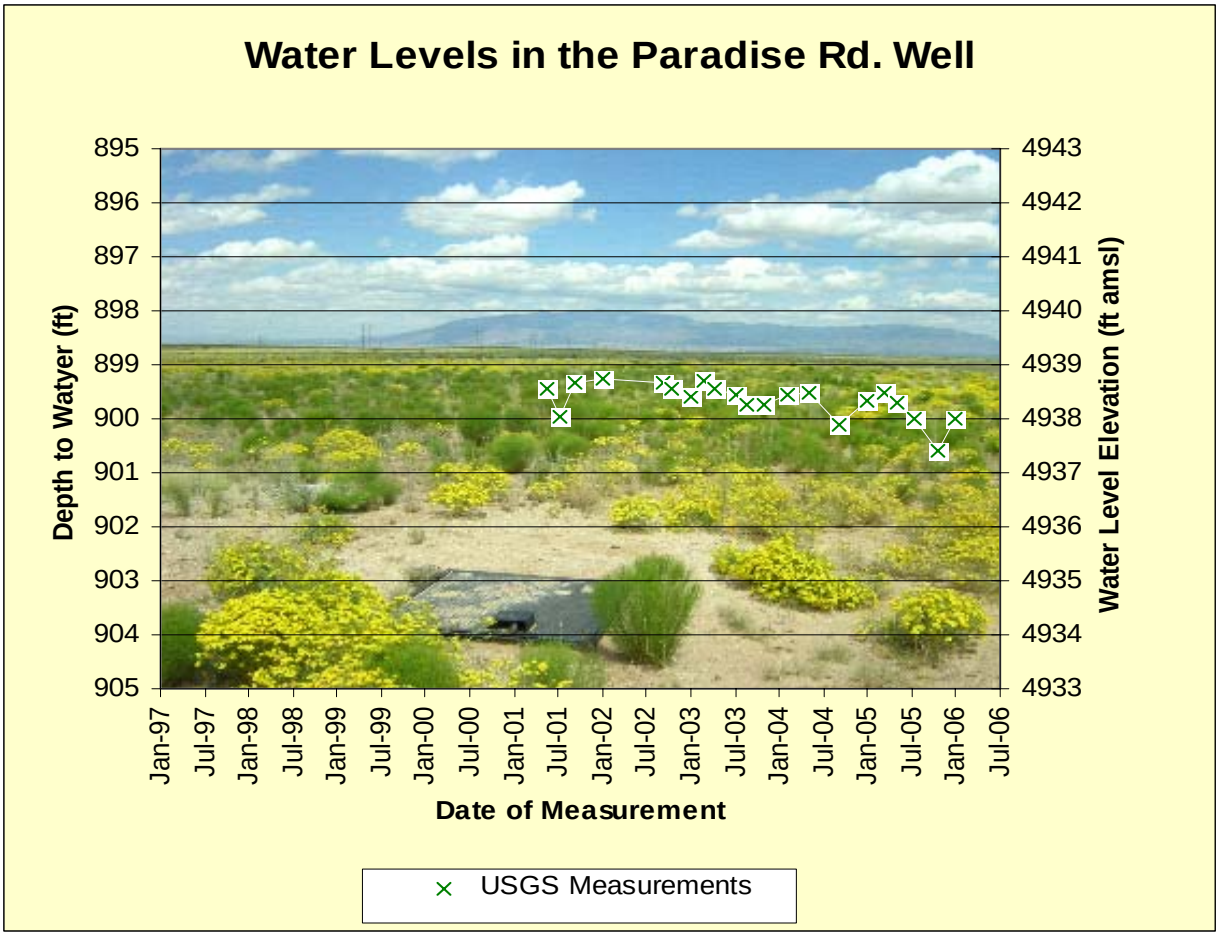


Figure 3.68 Geologic Setting of the Paradise Road Monitoring Well



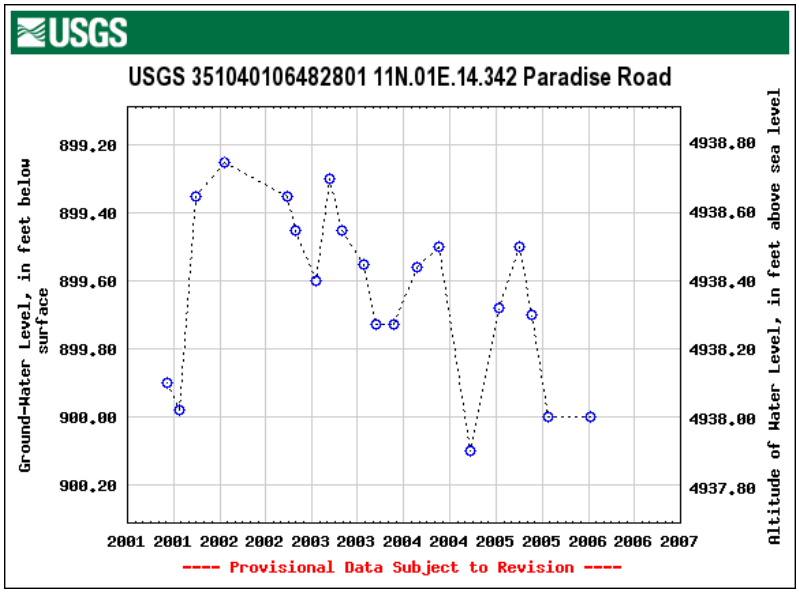


Figure 3.69 Water Levels in the Paradise Road Well

The water level decline shown in Figure 3.69 is likely due primarily to naturally occurring decline due to drought conditions, as there is no nearby municipal pumping in the area. The record low water level (900.59 feet below ground surface) was recorded by Bernalillo County in October 2005. A subsequent USGS measurement data in early 2006 indicates a one-half foot rise back to 900.00 feet.

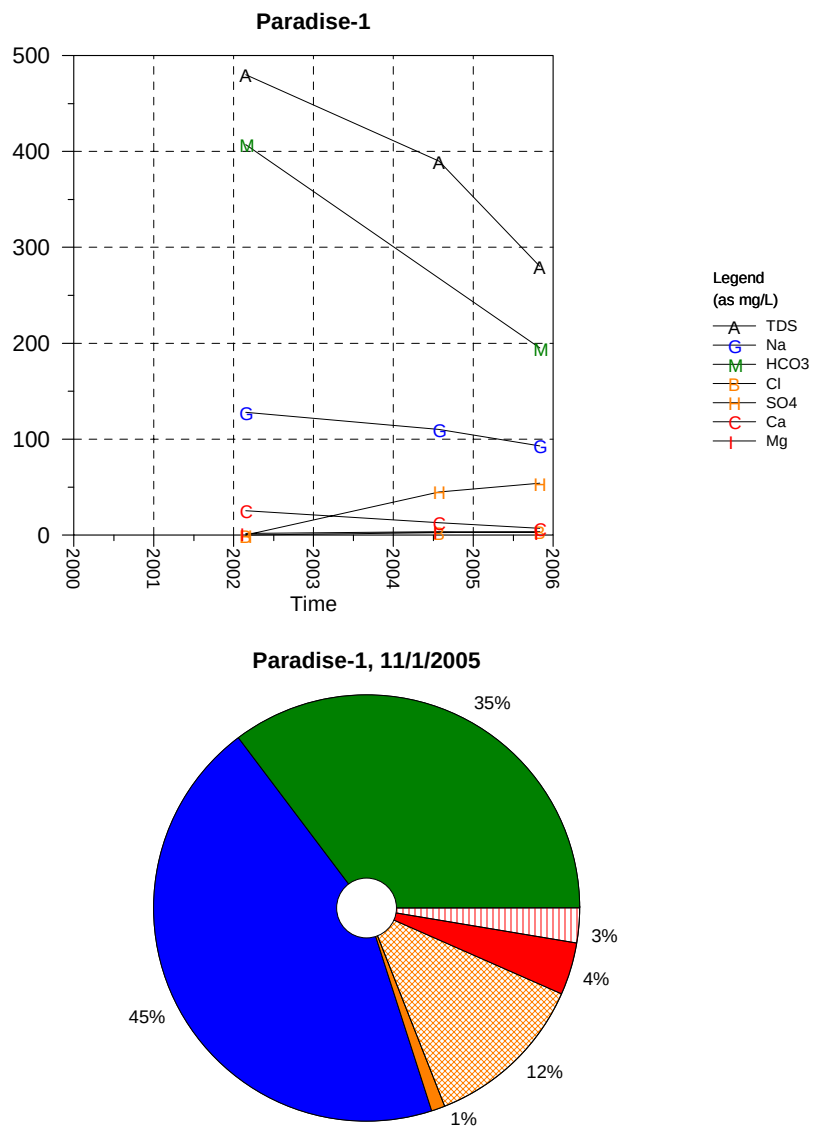
1.9.2.2 Water Quality in the Paradise Road Well

Figure 3.70 provides a time series plot for the inorganic parameters measured in samples from the Paradise Road well. Only three samples have been collected in the well since its installation in 2001, so observed trends cannot be shown to be statistically significant.

The available data suggests that total dissolved solids concentrations have decreased significantly, with the primary decrease occurring in the bicarbonate concentrations and some minor decrease in sodium and chloride. There has been a minor increase in sulfate concentrations. Whether the changes are temporal or an artifact of increased well purging and use is unknown at this time.

The pie plot shown in the figure is for the latest collected from the well in the fall of 2005. The composition of the sample is typical of deeper portions of the aquifer under the West Mesa, with composition dominated by sodium and bicarbonate and with sulfate typically in slightly greater predominance than chloride.

Analyses have indicated that the arsenic concentration (0.037 to 0.030 mg/L) is in excess of the primary drinking water standard (0.1 mg/L). Additionally, chromium (0.770 mg/L) and beryllium (0.50 mg/L) are in excess of their respective standards (0.1 and 0.004 mg/L). The presence of elevated trace metals is consistent with the volcanic origins of the sediments comprising the Santa Fe Group aquifer.



DESCRIPTION:
Water Quality Time Series in the Paradise Rd. Well

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DATE: 6/23/06

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Figure 3.70 Time Series Plot for the Paradise Road Well

Aluminum concentrations have ranged from non-detect to as great as 9.2 mg/L, which exceeds the secondary standard of 0.2 mg/L. Likewise, iron concentrations reported as 8.6 mg/l exceed the secondary standard for iron (0.3 mg/L) by an order of magnitude, and manganese concentrations (0.17 to 0.92 mg/L) exceed the standard of 0.05 mg/L. Part of the exceedance may be a difference in filtering and acidification of the samples.

No organic compounds have been detected in concentrations in excess of drinking water standards in the Paradise Road Well. Given its remote location, no organic contamination is suspected, as there are no known or suspected sources for those types of contaminants. In the initial sample in 2002, phthalate compounds were detected at low concentrations and are attributed to laboratory contamination. Likewise, the 2002 sample was reported as containing a methylphenolic compound at a concentration two times the detection limit. There has been no repeat occurrence of this compound in subsequent samples. Laboratory contamination of the sample is suspected, though the reported compound is not typically identified as such.

1.9.3 *9 Mile Hill Well 1*

The 9-Mile Hill Landfill well was drilled in 2003 to collect water quality data to determine if the closed landfill has had an adverse affect on ground-water quality and to provide for on-going water quality monitoring in accord with the GPPAP goals and objectives. The well is located east of the I-40 / Paseo del Volcan interchanges (see Figure 3.53). The well was drilled to the top of the uppermost water-bearing zone and, as shown in Table 3.15, was completed to a depth of 750 feet. Figure 3.71 provides a well construction diagram and previously unpublished driller's log for the well.

Figure 3.72 provides the surface geology map and the location of other nearby monitoring and ABCWUA production well. The monitoring well is completed in the Santa Fe Group aquifer, a sedimentary aquifer similar to the aquifer found in the Middle Rio Grande, but much older in age and much finer grained. The sedimentary aquifer contains sediment originating from the Jemez area and Valles Caldera, an origin with higher arsenic- and trace metal- bearing rocks.

Table 3.15 Bernalillo County Regional Monitoring Well Network – 9 Mile Hill Well

Well	Well Type	Well / Hole Depth (ft)	Screen Settings (ft)
9-Mile Hill (9MH)	Single	750	710-740

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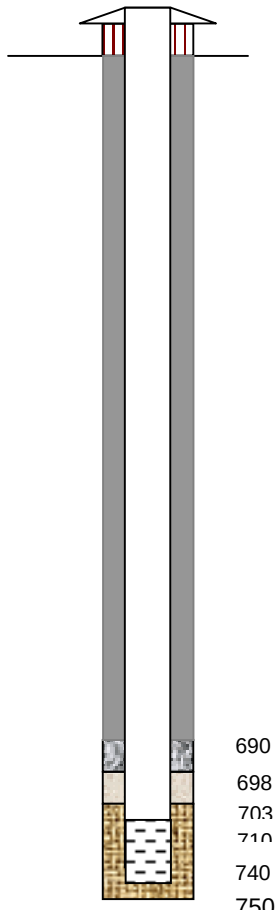


Materials and Dimensions

Flush mount completion with 3ft pad

8-inch diameter surface casing to 20 ft.

8-inch diameter borehole

4-inch diameter Sch 40 PVC casing

Cement Grout

Bentonite Pellet Seal

20/40 Fine Sand Seal

10/20 Gravel Pack

4-inch diameter Sch 80 PVC
0.20 slotted screen

Drillers Log

0 -1 Top sand

1 - 14 Concrete, asphalt, steel bands

14 - 16 Sandy clay

16 – 25 Trash

25-27 Coarse Sand with small gravel and trash

27-124 Medium to small gravels with coarse sand

124 – 174 Silty tan clay with medium sand

174-191 Medium to coarse sand

191-222 Medium to coarse sand with small gravels

222-243 Medium to coarse sand

243-260 Medium to coarse sand with silty tan clay

260-283 Medium to coarse sand with small gravel

283-365 Medium sand

365-383 Medium to coarse sand with small gravels

383-750 Light brown clay with silty, fine sand layers

Figure 3.71 9 Mile Hill Well Construction and Driller's Log

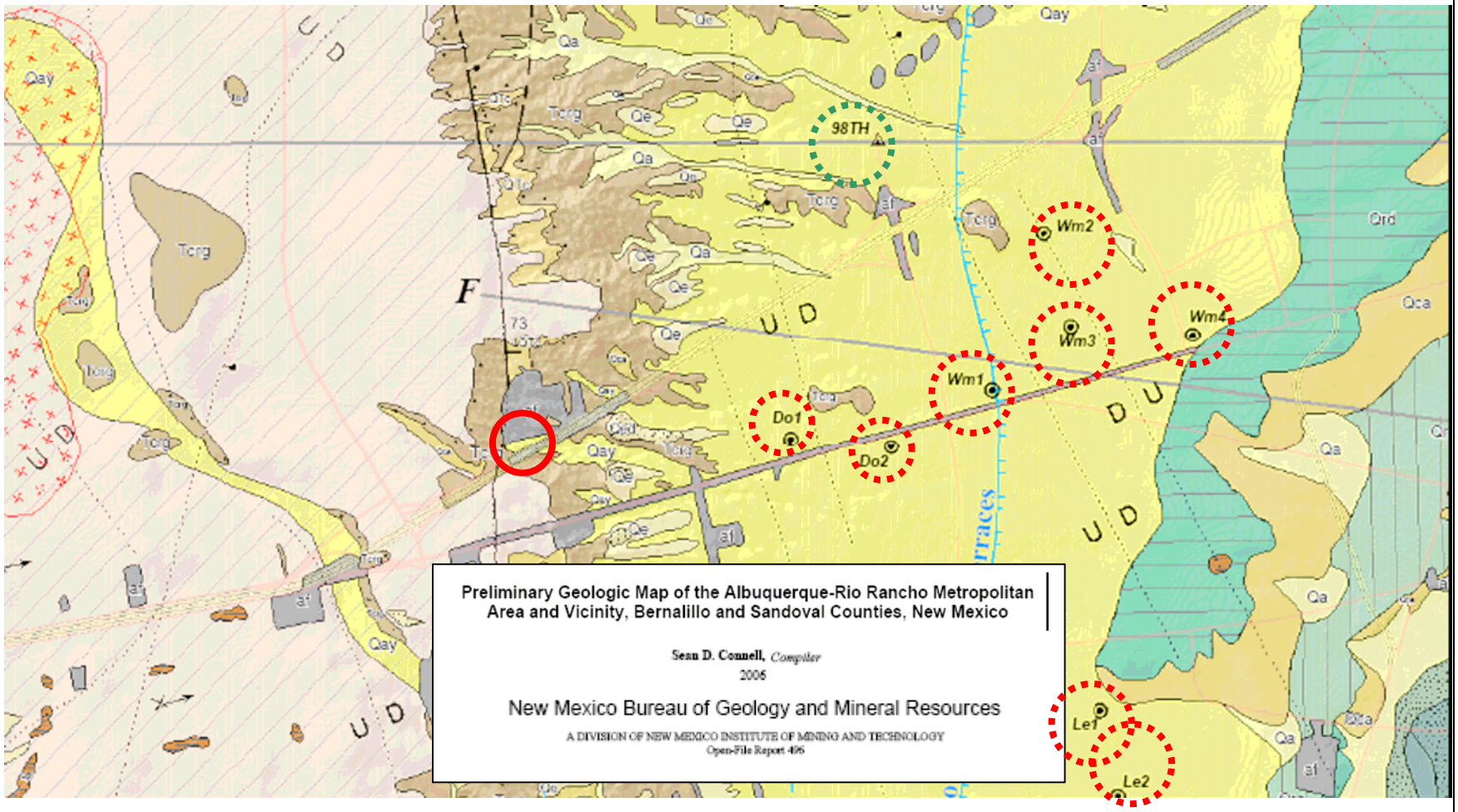


Figure 3.72 9-Mile Hill Monitoring Well Location and Nearby Well Fields

The well is located just east and on the downthrown side of a deep fault structures (e.g., the County Dump Fault) The deep fault structures have the ability of transmitting deeper water with higher arsenic and trace metal concentrations, and increases the probability for detected increased arsenic and trace metal concentrations.

1.9.3.1 Water Levels in the 9 Mile Hill Well

Due to the location of the 98th Street nested piezometer to the east, and its closer proximity to the ABCWUA well fields, water levels have not been measured at consistent intervals, and only four hand measurements have been taken in the well as shown in Figure 3.73. No field documentation for the initial measurements was available, whereas the last three measurements have been measured by the author and are known to be reliable.

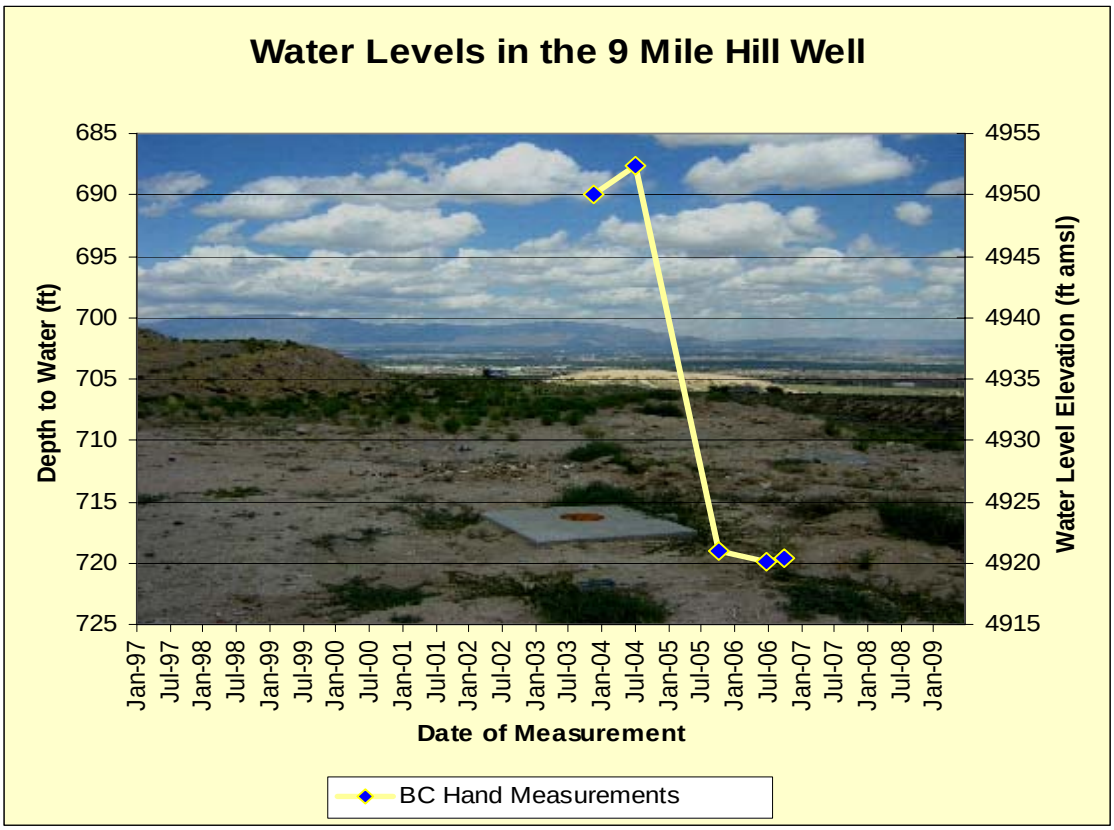


Figure 3.73 Water Levels in the 9 Mile Hill Well

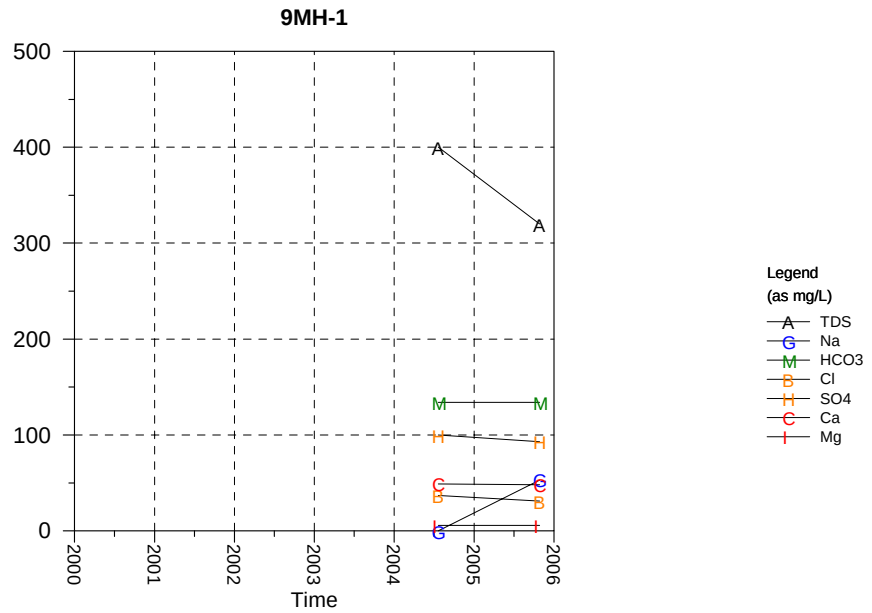
The available data suggest a significant drop in water levels (over 30 feet) in a little over one year's time. Given that no such declines are seen in the 98th Street piezometer nest or in the well fields, the accuracy of the measurements is in question. Additional measurements confirm that a depth to water of approximately 719 feet is correct. With the destruction of the 98th Street nest, increased monitoring of this well is justified. The USGS does not currently monitor water levels at this location.

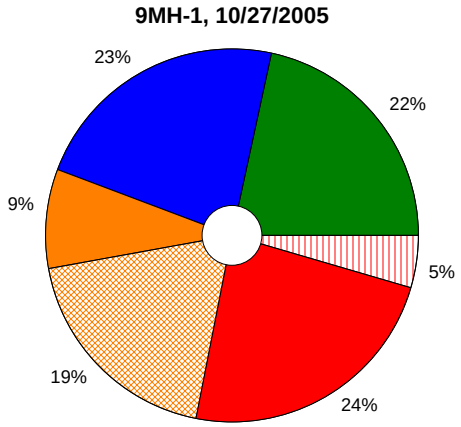
1.9.3.2 Water Quality in the 9 Mile Hill Well

Installation and monitoring of this well is consistent with the GPPAP implementation adopted by Bernalillo County. The analyses list for the initial sample collected in 2004 included volatile organic compounds, semi-volatile organic compounds, major anions and cations, metals and total dissolved solids. These analyses are consistent with the water quality monitoring requirements set forth by the New Mexico Environment Department Solid Waste Bureau for other landfill facilities. An additional sample was collected in 2005 and on-going annual monitoring of this site is planned.

Figure 3.74 provides a plot of the primary inorganic constituents, none of which appears to be elevated above naturally occurring concentrations. The distribution of anions and cations as shown in the pie plot are typical of groundwater found in the upper saturated portion of the Santa Fe Group aquifer on the West Mesa and is similar to that shown for the shallowest of the Niese Road. piezometers, as will be discussed below.

No primary drinking water standards have been exceeded. The 2004 water quality sample was analyzed specifically for arsenic and the reported arsenic concentration was 0.004 ug/L, substantially less than the arsenic concentrations for the region and less than half of the primary drinking water standard of 0.01 ug/L. Aluminum concentrations appear elevated, with reported concentrations of 3.8 and 5.0 mg/L. Likewise, iron (8.7 to 24.0 mg/L) and manganese (0.068 to 1.5 mg/L) are elevated and all three metals are above their respective secondary drinking water standards. Again, documentation is inadequate to show whether this is due to acidification of samples without prior filtering or whether these are naturally occurring dissolved concentrations.





DESCRIPTION:
Water Quality Time Series in the 9 Mile Hill Well

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Figure 3.74 Water Quality in the 9 Mile Hill Well

No organic compounds have been detected in the samples, with the exception of benzoic acid. Reported concentrations were 0.59 mg/L in the 2004 sample only, with a detection limit of 0.50 mg/L. This detection is thought to be due to laboratory contamination, though it is not a common laboratory-induced contaminant.

1.9.4 *Niese Road Nested Piezometer*

The Niese Road nested piezometer was drilled in 1999 in cooperation with the City of Albuquerque and the USGS to access water quality from various depths in the aquifer and to assess water quality at various depths west of the South Valley floor. The piezometer is located downgradient, although in excess of one mile to the east, of the Southwest Landfill (see Figure 3.53). Piezometers are screened at depths of 297 ft., 960 ft., and 1,455 ft, as indicated on Table 3.16 and in Figure 3.75

Figure 3.76 shows the geologic setting. The wells are completed at various depths within the Santa Fe Group aquifer. There are no nearby municipal wells, although residences to the east and southeast of the location are supplied by wells pumping from the same aquifer zones. Permits for a community supply well in this general area are in progress.

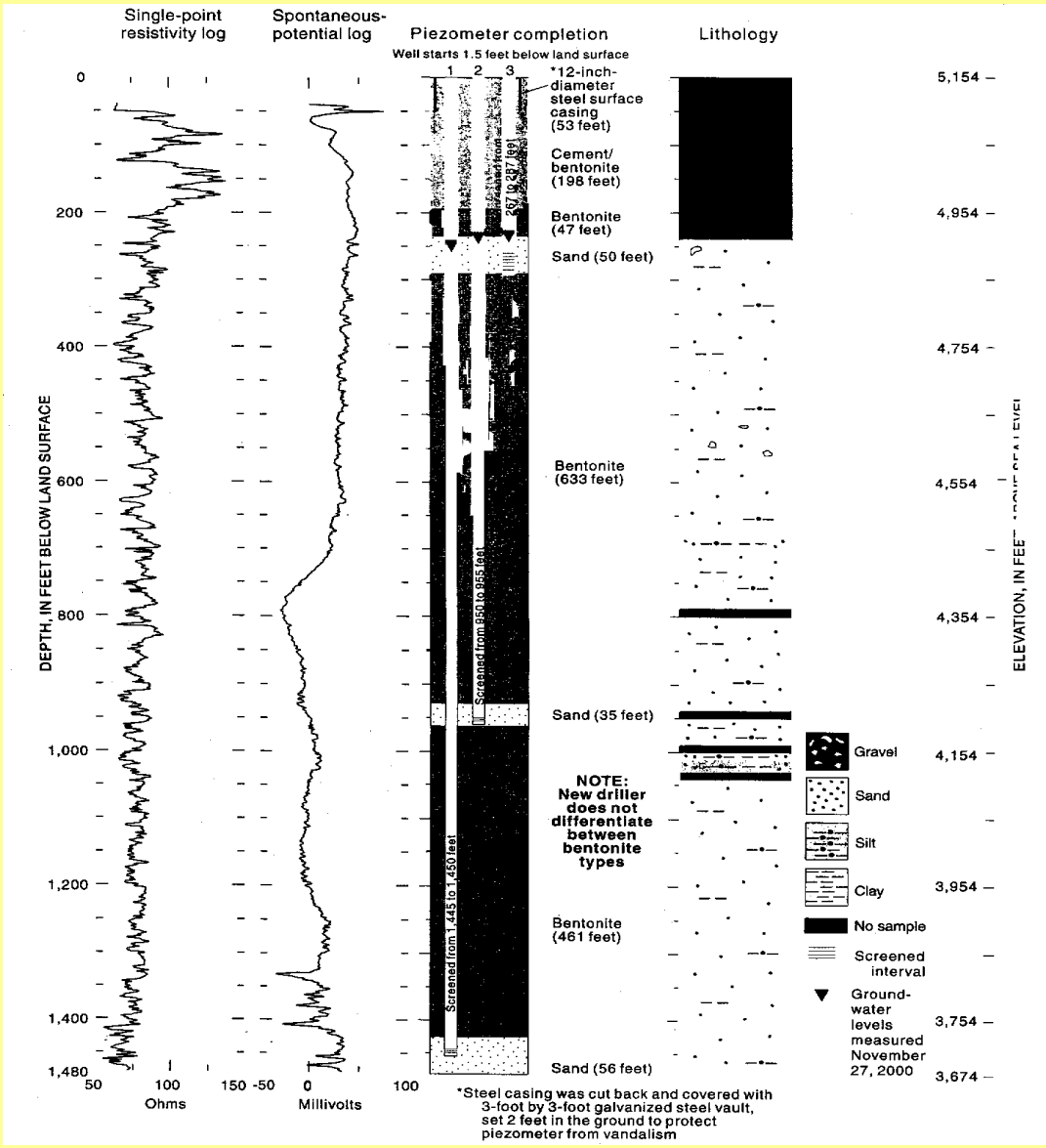
1.9.4.1 Water Levels in the Niese Road Monitoring Well

The USGS provides continuous water levels monitoring in the three Niese Road piezometers using a pressure transducer and data recorder. Hand measurements are taken periodically by the USGS and at least annually by Bernalillo County as part of the regional monitoring program. Figure 3.77 provides a plot of water level data collected from the three Niese Rd piezometers. The measurements are primarily taken from the USGS collected data set. The last measurement shown is a hand measurement collected by Bernalillo County in late 2005.

The depth to water is significantly less than in the Paradise Rd. and 9 Mile Hill wells, primarily due to location. The hydrographs indicate that there has been only minimal change in the shallow and intermediate piezometer water levels since monitoring began in 2000. The water levels indicate that there is a net downward gradient that has remained consistent over the six-year monitoring period. Water levels in the deepest piezometer have increased 2 to 3 feet during that period, indicating likely recharge from the surface to deeper portions of the aquifer.

Table 3.16 Bernalillo County Regional Monitoring Well Network – Niese Road

Well	Well Type	Well / Hole Depth (ft)	Screen Settings (ft)
Niese Road	Nested	1,480	
(NR1)	Deep	1,480	1,450-1,455
(NR2)	Middle	1,480	950-955
(NR3)	Shallow	1,480	247-287



(Taken from USGS OFR 03-290, Figure 23N)

Figure 3.75 Niese Road Nested Piezometer Well Construction and Driller's Log

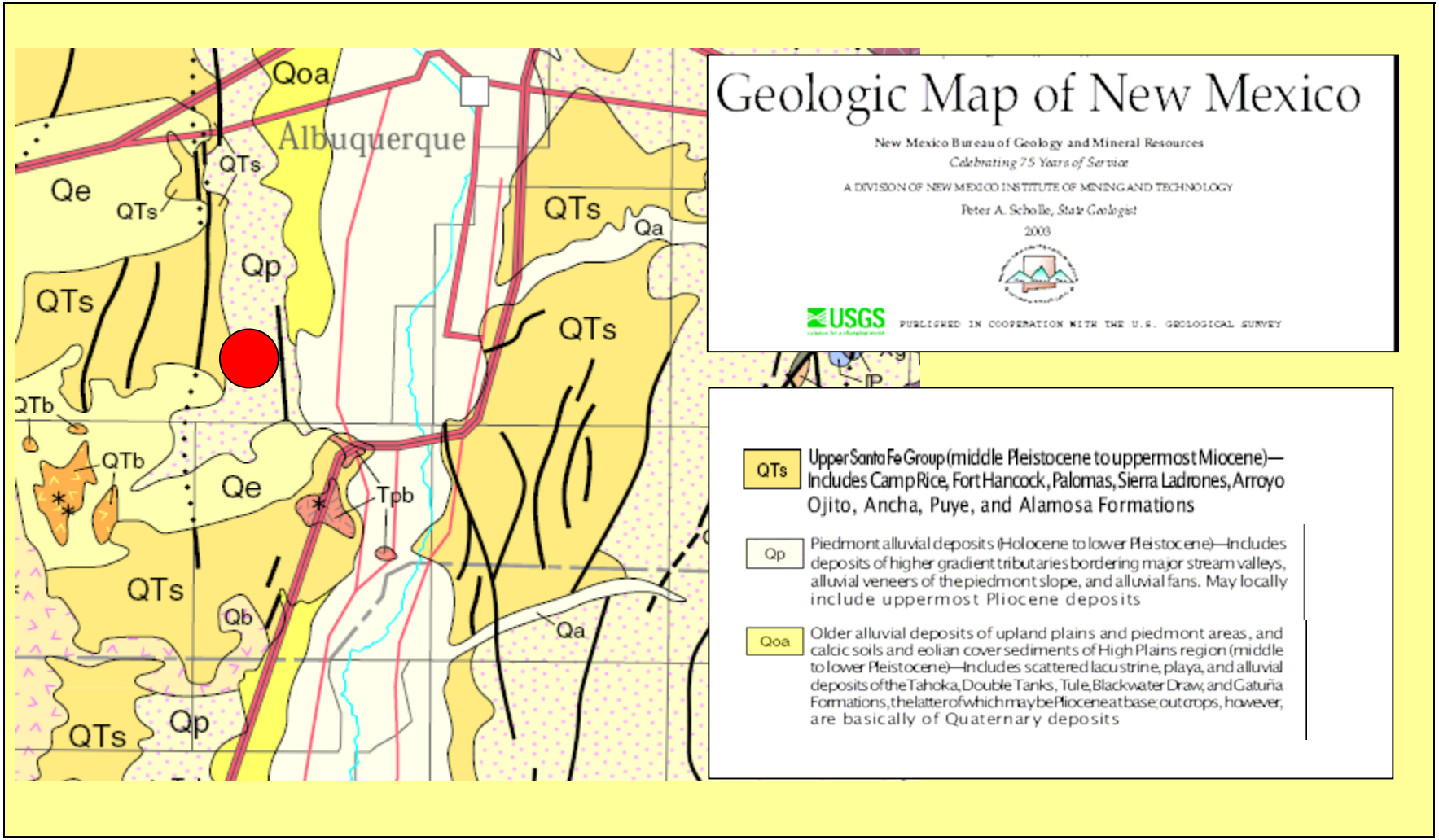


Figure 3.76 Geologic Setting and Well Construction of the Niese Road Nested Piezometer

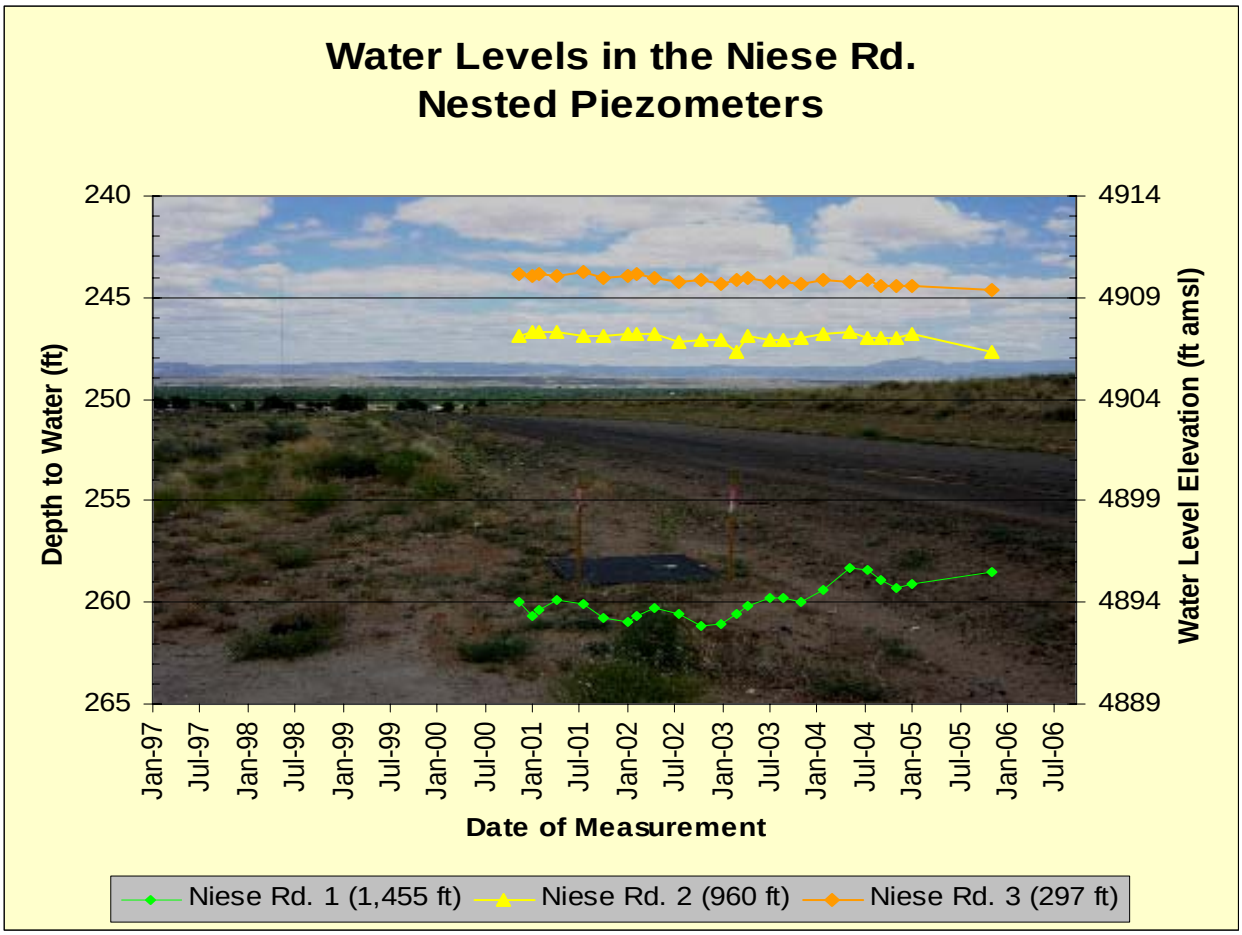


Figure 3.77 Water Levels in the Niese Road Nested Piezometer

1.9.4.2 Water Quality in the Niese Road Piezometers

Figure 3.78 provides a time series plot for inorganic constituents for each of the piezometers as well as pie charts showing the relative predominance of anions and cations. The pie charts show a change in composition with depth. The composition of the sample from the shallow piezometer (NR-3) is similar to that demonstrated by the 9 Mile Hill Well with approximately equal predominance of sodium and calcium and bicarbonate and sulfate. With depth, the water becomes primarily sodium bicarbonate or sodium sulfate in composition. Calcium is reduced with respect to sodium.

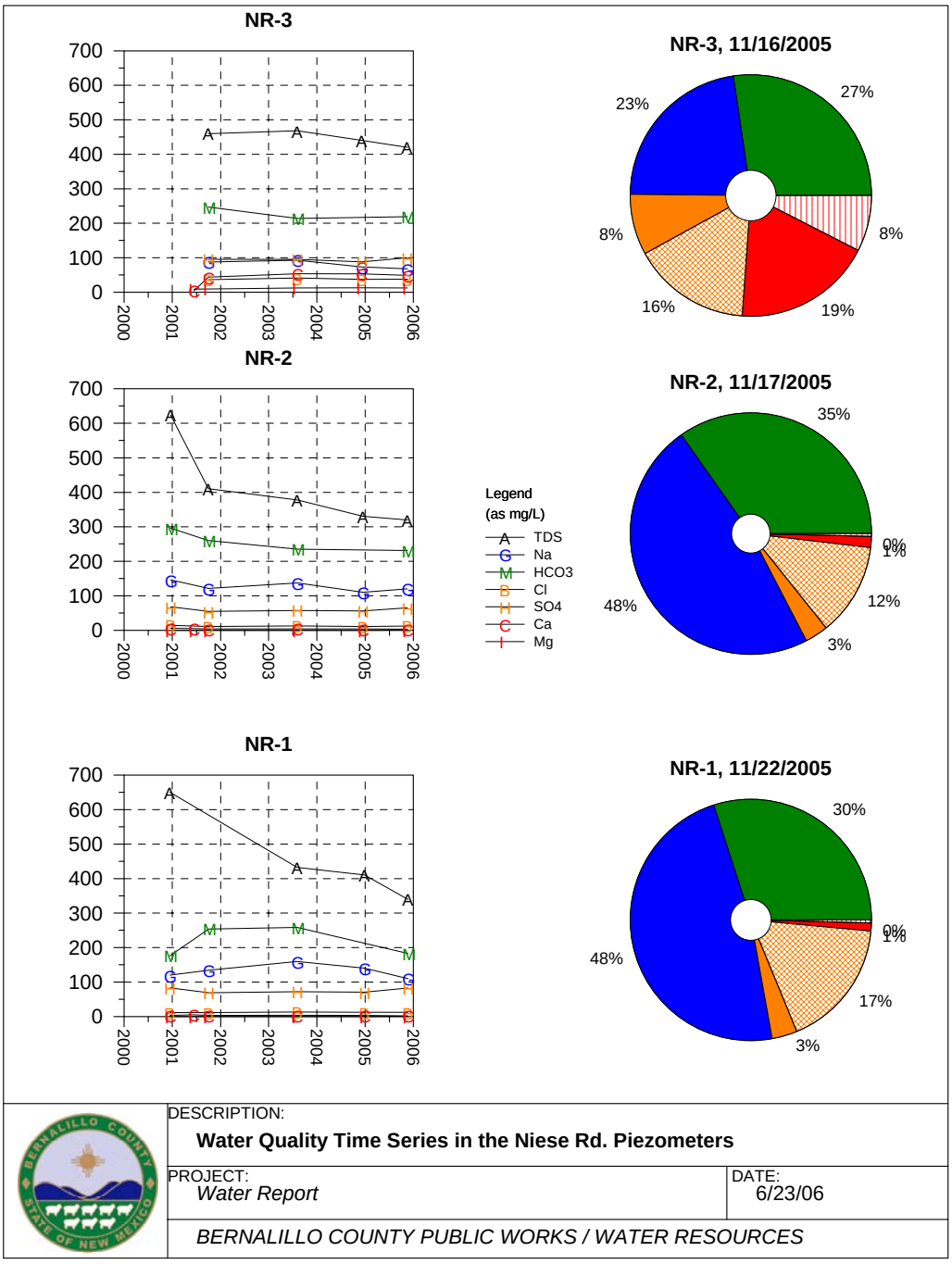


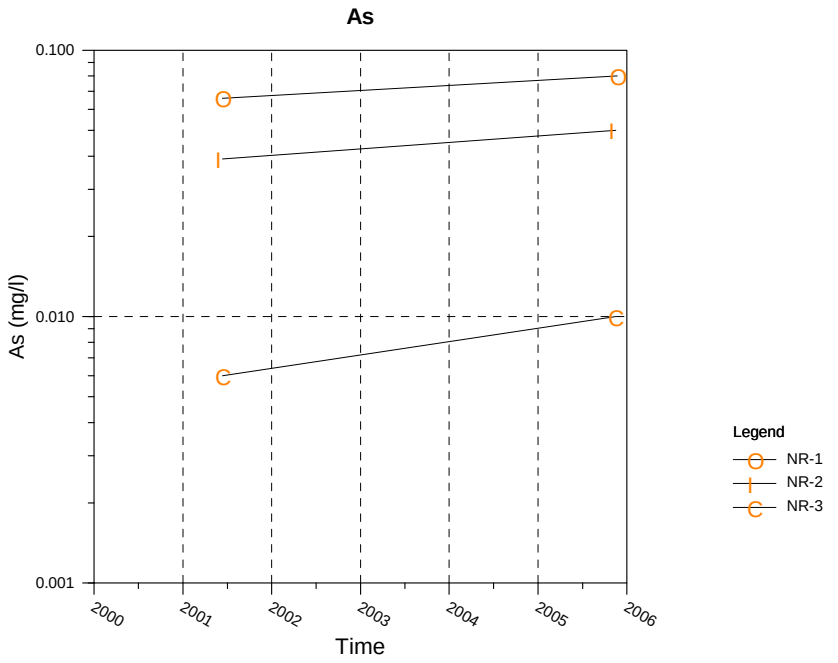
Figure 3.78 Time Series Plots for the Niese Road Nested Piezometer

Arsenic concentrations have been in excess of the primary drinking water standard of 0.10 mg/L in the deep and intermediate well. The reported concentrations are shown in Figure 3.79 for each of the three piezometers There is one instance in the 2000 sample for NR-1 wherein the beryllium concentration (0.036 mg/L) exceeded the primary drinking water standard.

No significant trends in the inorganic data are apparent aside from a minor decrease in total dissolved solids concentrations with time. The decrease in total dissolved solids appears to be due to a general decrease in constituent concentrations. The decrease may be due to repeated sampling of the well through time, with inherent improvement in the representativeness of the collected sample.

Similar to the other West Mesa wells, aluminum, iron, and manganese may at times exceed their respective standards as well. However, the reported concentrations for these three metals are less than 2 mg/L in all instances, which is substantially lower than for the Paradise Rd and 9 Mile Hill wells.

No organic compounds have been detected in the Niese Road wells in excess of drinking water standards, and in most cases have been reported as "not detected". There have been several instances of detection of low concentrations of phthalate compounds and methyl ethyl ketone – these are commonly detected laboratory contaminants. Low concentration, one-time detections of other components have occurred: 1,2,4-Trimethylbenzene in Niese Road 1 at 0.4 ug/L and 1,4-Dioxane in Niese Road 2 at 42 ug/L. The source of these compounds in the samples is not known, but their presence is not a reoccurring phenomenon.



DESCRIPTION:
Arsenic Time Series in the Niese Rd. Piezometers

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Figure 3.79 Arsenic Concentrations in the Niese Road Piezometer