# 5. Water Resources

This section provides an overview of regional climatic conditions (Section 5.1), water supply, including both surface and groundwater supply (Sections 5.2 and 5.3), and water quality (Section 5.4). Summary information on the regional water supply relative to demand is provided in Section 7.

## 5.1 Climate

In order to assess climatological conditions in the Northeast region, Western Regional Climate Center (WRCC) climatological records were compiled. DBS&A identified 23 climate data collection stations that have historically been and/or are currently located in the region. Based on an assessment of the completeness and quality of the data, including consideration of the period of record, 13 of these stations were used to characterize climatic conditions in the region. Only stations that had a relatively long period of record and continued operation through the present were used in the evaluation. In addition to completeness of the records, the 13 weather stations were selected based on location and how well they represented areal conditions. For example, where two stations are located relatively close to each other, the station with the longest record was selected to be representative of local conditions in that area. Table 5-1 lists the periods of record for the 23 identified weather stations in the Northeast Region and indicates the 13 stations analyzed in more detail. Figure 5-1 shows the locations of the 13 elected stations.

Table 5-1 also lists 2 snowpack telemetry (SNOTEL) stations that were used to document snowfall in the higher elevations. No SNOTEL stations are present in the Northeast region, and so the stations used are located outside the planning region, in Taos and Colfax Counties (Figure 5-1).

### *5.1.1 Temperature*

Temperatures in the Northeast region range from an average minimum of 35°F in Pasamonte, in western Union County, to an average maximum of 74°F in Portales (Table 5-2). Average

## Table 5-1. Climate Stations in the Northeast Region

| Station Name [a] | Period of Record | | Latitude | Longitude | Elevation (ft msl) |
|---|---|---|---|---|---|
| | Start | End | | | |
| *Union County* | | | | | |
| Des Moines | 04/01/1916 | 06/30/1994 | 36° 46’ | 103° 50’ | 6,620 |
| Grenville | 01/01/1941 | 06/30/2004 | 36° 36’ | 103° 37’ | 5,990 |
| **Clayton WSO Airport** | 02/01/1896 | 06/30/2004 | 36° 27’ | 103° 09’ | 5,000 |
| **Pasamonte** | 01/01/1914 | 06/30/2004 | 36° 18’ | 103° 44’ | 5,650 |
| Hayden | 01/01/1914 | 09/30/1965 | 36° 03’ | 103° 13’ | 4,800 |
| **Amistad 3 ESE** | 04/01/1925 | 06/30/2004 | 35° 55’ | 103° 06’ | 4,500 |
| *Harding County* | | | | | |
| **Roy** | 01/01/1914 | 06/30/2004 | 35° 57’ | 104° 12’ | 5,880 |
| **Mosquero** | 12/01/1915 | 06/30/2004 | 35° 49’ | 103° 55’ | 5,550 |
| *Quay County* | | | | | |
| **McCarty Ranch** | 11/01/1983 | 06/30/2004 | 35° 36’ | 103° 22’ | 4,410 |
| Rinestine Ranch | 10/01/1968 | 10/31/1983 | 35° 36’ | 103° 21’ | 4,350 |
| Obar | 06/01/1938 | 06/30/1968 | 35° 33’ | 103° 12’ | 4,100 |
| Ute Dam | 02/01/1965 | 08/31/1979 | 35° 21’ | 103° 27’ | 3,820 |
| Logan | 01/01/1914 | 01/31/1960 | 35° 22’ | 103° 25’ | 3,830 |
| **Tucumcari 4 NE** | 12/16/1904 | 06/30/2004 | 35° 12’ | 103° 41’ | 4,100 |
| Tucumcari FAA | 01/01/1941 | 09/30/1982 | 35° 11’ | 103° 36’ | 4,060 |
| **San Jon** | 01/01/1914 | 06/30/2004 | 35° 07’ | 103° 20’ | 4,230 |
| Cameron | 01/01/1948 | 05/31/1998 | 34° 54’ | 103° 26’ | 4,580 |
| **Ragland 3 SSW** | 02/01/1935 | 06/30/2004 | 34° 48’ | 103° 45’ | 5,060 |
| *Curry County* | | | | | |
| **Melrose** | 04/01/1914 | 06/30/2004 | 34° 26’ | 103° 37’ | 4,600 |
| Clovis 13 N | 07/01/1929 | 06/30/2004 | 34° 36’ | 103° 13’ | 4,440 |
| **Clovis** | 11/24/1910 | 06/30/2004 | 34° 25’ | 103° 12’ | 4,290 |
| *Roosevelt County* | | | | | |
| **Portales** | 01/01/1914 | 06/30/2004 | 34° 11’ | 103° 21’ | 4,010 |
| **Elida** | 05/01/1914 | 06/30/2004 | 33° 57’ | 103° 39’ | 4,350 |
| *SNOTEL Stations* [b] | | | | | |
| **North Costilla** [c] | 10/01/1979 | 02/24/2005 | 36° 99’ | 105° 26’ | 10,600 |
| **Tolby** [d] | 10/01/1998 | 02/25/2005 | 36° 47’ | 105° 19’ | 10,180 |

Source: Western Regional Climate Center (http://www.wrcc.dri.edu/summary/mapnm.html), unless otherwise noted

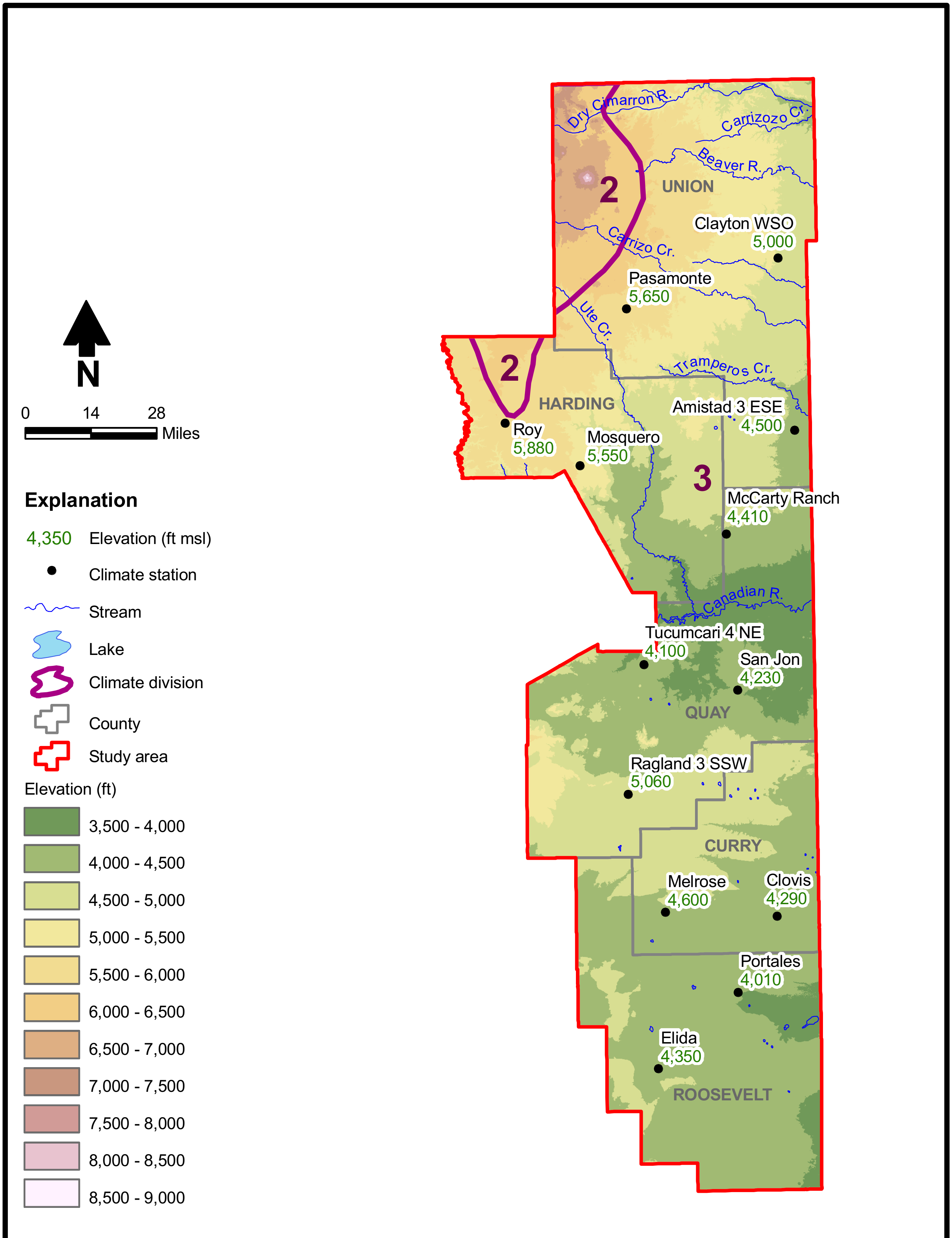
[a] Stations in **bold** type were selected for detailed analysis.

[b] No SNOTEL stations are located in the Northeast Region; North Costilla and Tolby stations are located in Taos and Colfax Counties, respectively.

[c] Source: http://www.wcc.nrcs.usda.gov/snotel/snotel.pl?sitenum=65&state=nm

[d] Source: http://www.wcc.nrcs.usda.gov/snotel/snotel.pl?sitenum=934&state=nm

ft msl = Feet above mean sea level



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NORTHEAST NEW MEXICO REGIONAL WATER PLAN

**Climate Stations**

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03/22/2007

WR04.0147

Figure 5-1

## Table 5-2. Precipitation and Temperature at Representative Climate Stations in the Northeast Region

| | | Precipitation (inches) | | | | Temperature (°F) | | | |
|---|---|---|---|---|---|---|---|---|---|
| Station Name | Elevation (ft msl) | Annual Average | Minimum Annual Average [a] | Maximum Annual Average [b] | % of Period of Record [c] | Annual Average | Minimum Annual Average [d] | Maximum Annual Average [e] | % of Period of Record [c] |
| Clayton WSO | 5,000 | 15.5 | 5.5 | 37.7 | 88 | 53.3 | 39.0 | 67.5 | 88 |
| Pasamonte | 5,650 | 15.8 | 5.8 | 34.1 | 95 | 51.1 | 35.4 | 66.9 | 62 |
| Amistad 3 ESE | 4,500 | 15.7 | 6.7 | 37.0 | 97 | 55.5 | 40.0 | 71.0 | 68 |
| Roy | 5,880 | 15.5 | 6.6 | 33.9 | 94 | 51.8 | 37.3 | 66.4 | 57 |
| Mosquero | 5,550 | 16.6 | 5.5 | 44.1 | 86 | 52.6 | 37.9 | 67.4 | 83 |
| McCarty Ranch | 4,410 | 16.8 | 14.2 | 25.8 | 98 | 55.5 | 41.3 | 69.6 | 98 |
| Tucumcari 4 NE | 4,100 | 16.1 | 6.1 | 34.9 | 99 | 58.4 | 43.6 | 73.2 | 98 |
| San Jon | 4,230 | 16.7 | 7.3 | 34.8 | 96 | 58.6 | 43.6 | 73.5 | 71 |
| Ragland 3 SSW | 5,060 | 17.7 | 9.5 | 40.3 | 97 | 55.5 | 40.7 | 70.3 | 62 |
| Melrose | 4,600 | 16.4 | 8.2 | 27.6 | 88 | 57.5 | 42.3 | 72.7 | 60 |
| Clovis | 4,290 | 17.9 | 7.6 | 46.9 | 98 | 57.4 | 42.9 | 72.0 | 96 |
| Portales | 4,010 | 16.8 | 7.5 | 44.1 | 96 | 58.1 | 42.3 | 74.0 | 75 |
| Elida | 4,350 | 15.3 | 8.0 | 43.4 | 86 | 57.8 | 42.9 | 72.7 | 67 |

Source: Western Regional Climate Center ( http://www.wrcc.dri.edu/summary/mapnm.html)

[a] Values reflect the lowest total annual precipitation recorded at this station for its period of record.

[b] Values reflect the highest total annual precipitation recorded at this station for its period of record.

[c] For period of record shown (through January 24, 2006 for this summary table), percentage of observations that were available; for example, 90% indicates that data were missing for 10% of the months.

[d] Values reflect the lowest annual average temperature recorded at this station for its period of record.

[e] Values reflect the highest annual average temperature recorded at this station for its period of record.

annual temperatures in the region range from 51°F at Pasamonte to almost 59°F in San Jon, east of Tucumcari (WRCC, 2006a). Appendix D1 contains figures showing the long-term monthly average, minimum, and maximum temperatures and the annual average temperatures at these 13 stations. Figure 5-2 shows the annual temperature range at the Clayton WSO Airport climate station, which has the longest period of record (1896 to present) in the region. This figure demonstrates the large annual variability in temperature that is common in the region.

### *5.1.2 Precipitation*

Precipitation varies considerably across the region and is influenced by both location and elevation. Table 5-2 shows the maximum, minimum, and long-term average annual precipitation (rainfall and snowmelt) at the 13 representative stations, and figures showing the long-term average monthly precipitation amounts and annual precipitation at these stations are provided in Appendix D1. Total annual precipitation measured at climate stations in the region ranges from a minimum of 5.5 inches in Mosquero, in western Harding County, to a maximum of 46.9 inches in Clovis. Average annual precipitation in the region ranges from 15.3 inches in Elida, in western Roosevelt County, to 17.9 inches in Clovis (Table 5-2; WRCC, 2006a).

Contoured precipitation throughout the Northeast Region is illustrated in Figures 5-3 and A-4a and A-4b (in Appendix A). Records from climate stations in the planning region show large annual variability in precipitation. For example, the total annual precipitation at the Clayton WSO Airport station, which has the longest period of record (1896 to present) in the region, ranges from 5.5 to 37.7 inches per year (in/yr) (Figure 5-4).

The two SNOTEL stations (Table 5-1) west of the region, near the headwaters of the Canadian River, provide both rainfall and snow water equivalent (SWE) data. The stations, located in Taos County and Colfax County, began recording data in 1979 and in 1998, respectively; both stations are still active. Appendix D1 contains figures showing daily SWE values and monthly average, minimum, and maximum snowpack from each of the stations for the period of record available. As indicated by these figures, snowpack is highly variable from year to year.

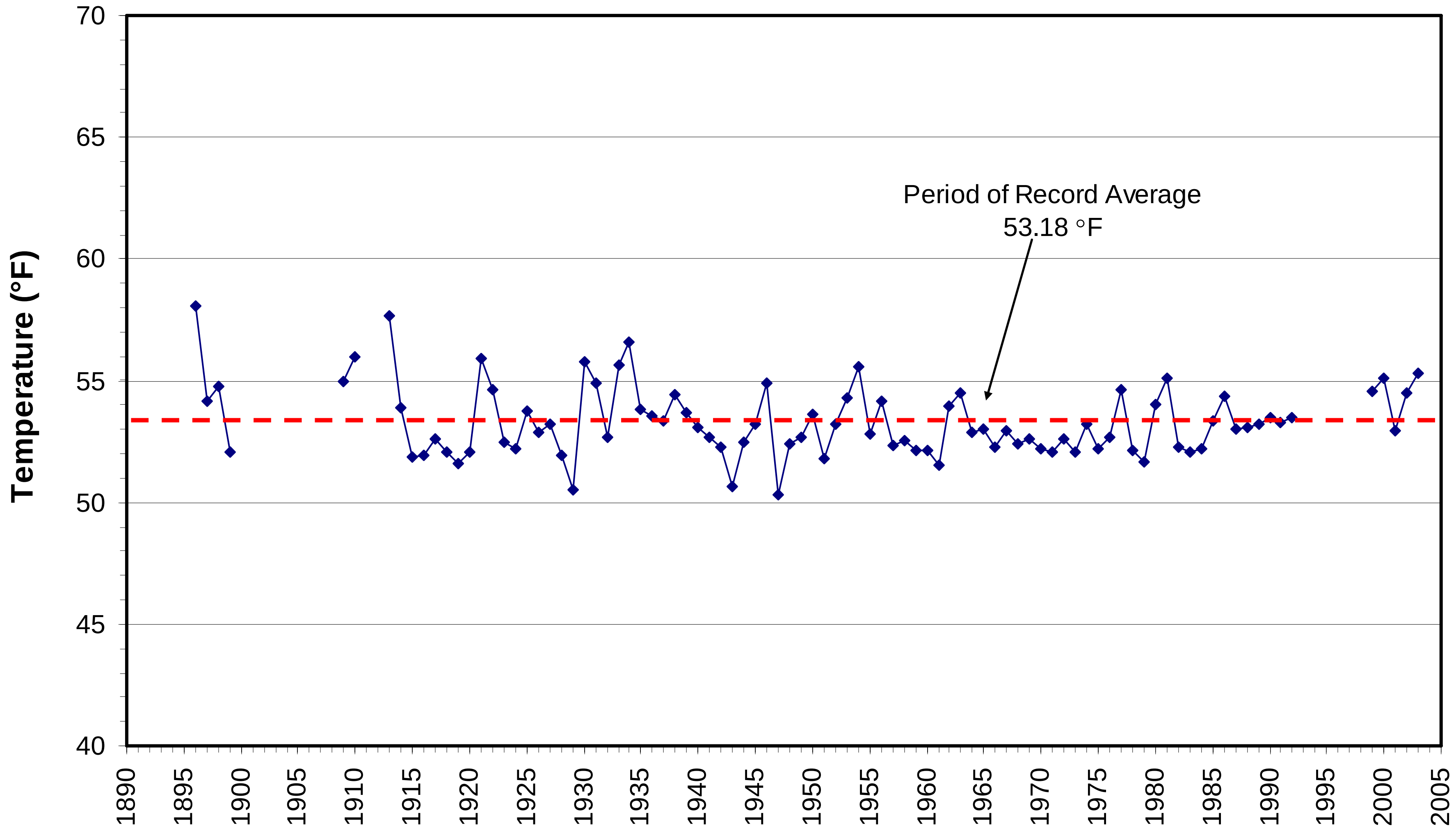

Figure 5-2

NORTHEAST NEW MEXICO REGIONAL WATER PLAN

**Average Annual Temperatures**

**Clayton WSO Airport Climate Station**

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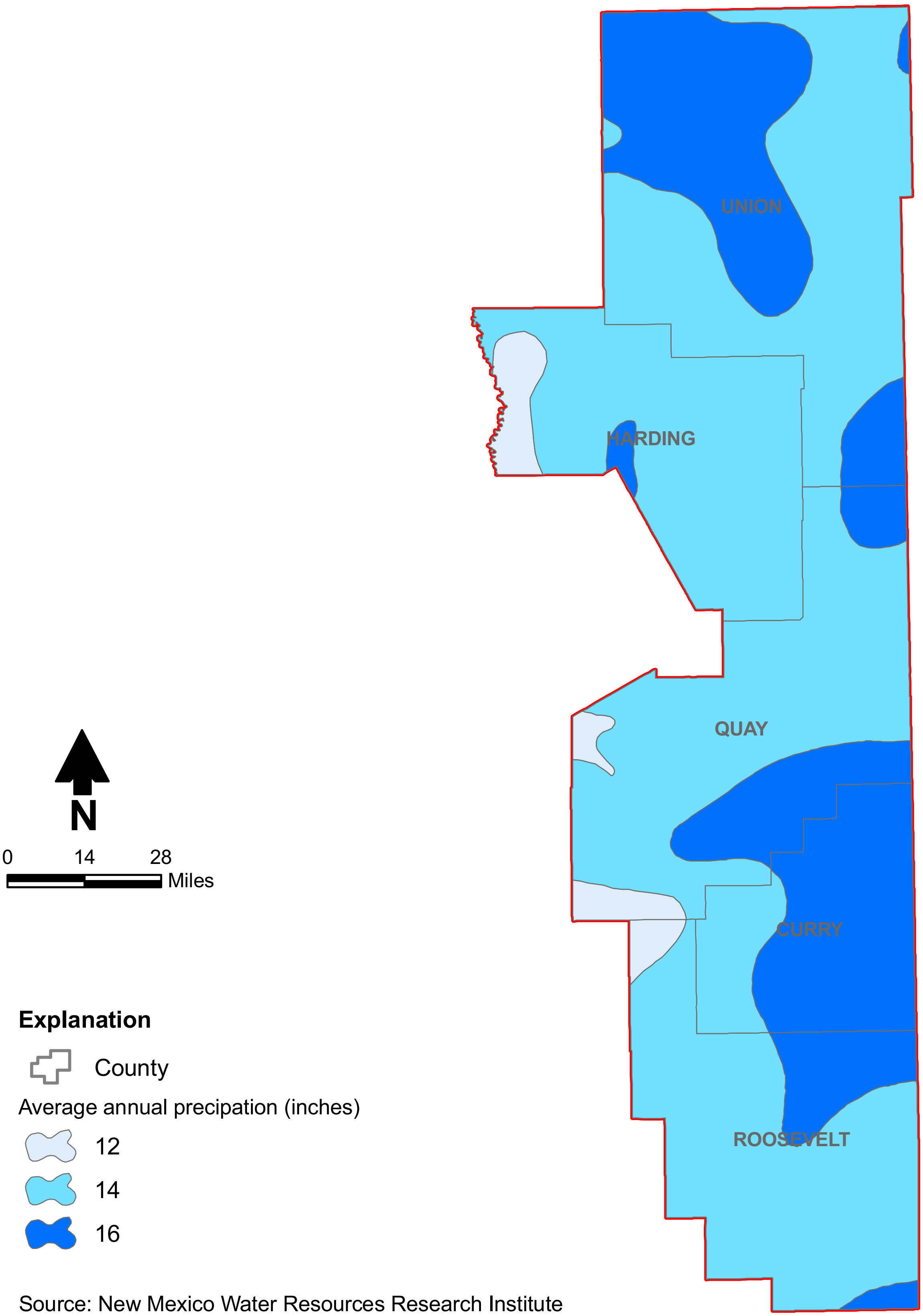

Source: New Mexico Water Resources Research Institute
(Appendix A, Figures A-4a and A-4b)

NORTHEAST NEW MEXICO REGIONAL WATER PLAN

**Average Annual Precipitation**

Figure 5-3

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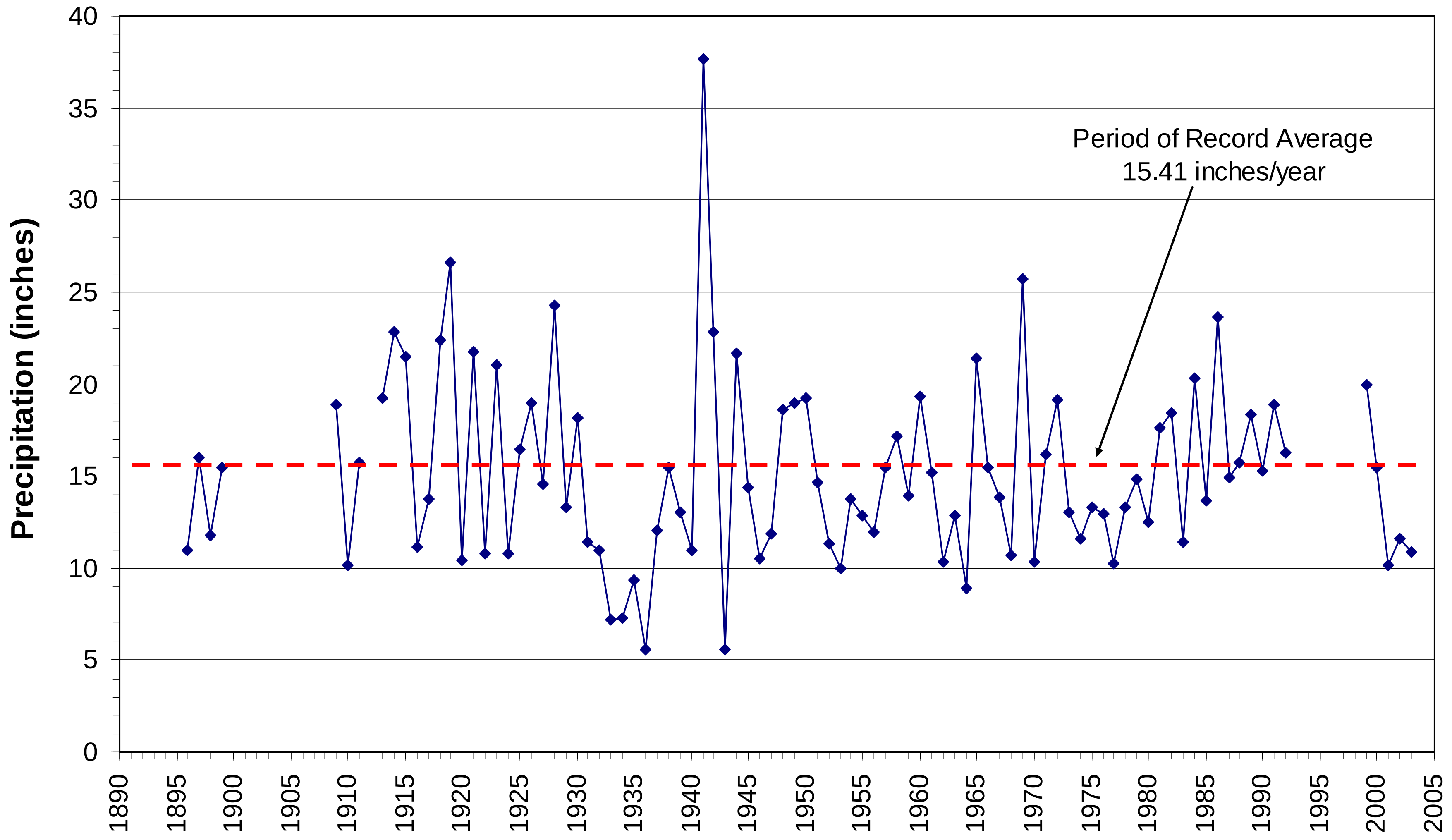

NORTHEAST NEW MEXICO REGIONAL WATER PLAN

## Total Annual Precipitation
## Clayton WSO Airport Climate Station

Figure 5-4

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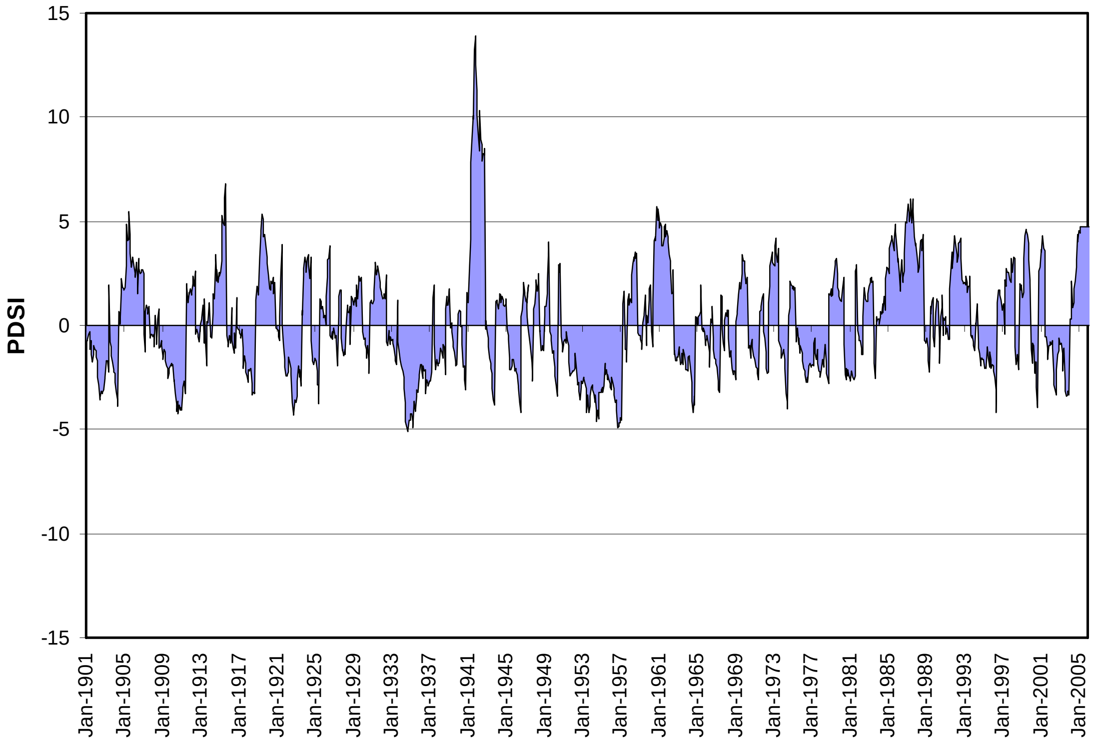
### *5.1.3 The Palmer Drought Severity Index*

A drought index consists of a ranking system derived from the assimilation of data, including rainfall, snowpack, streamflow, and other water supply indicators for a given region, and can be used as aids in planning and decision-making. The Palmer Drought Severity Index (PDSI) was created in 1965 by W.C. Palmer to measure the variations in moisture supply. The PDSI is calculated using precipitation and temperature data, along with the available water content of the soil. These data are then used to calculate evapotranspiration, soil recharge, runoff, and moisture loss from the surface layer. Moisture conditions are standardized so that comparisons between regions and differing timeframes can be made (Hayes, 1999). Table 5-3 presents the PDSI classifications.

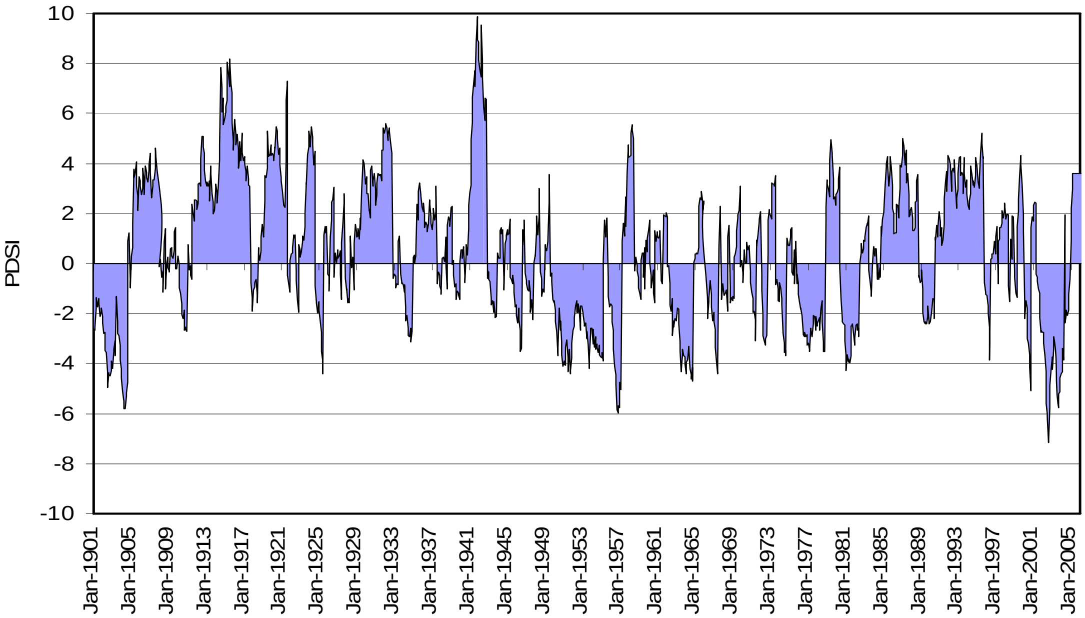
**Table 5-3. Palmer Drought Severity Index Classifications**

| PDSI Ranking | Climatic Condition |
|---|---|
| + 4.00 or more | Extremely wet |
| +3.00 to +3.99 | Very wet |
| +2.00 to +2.99 | Moderately wet |
| +1.00 to +1.99 | Slightly wet |
| +0.50 to +0.99 | Incipient wet spell |
| +0.49 to –0.49 | Near normal |
| –0.50 to –0.99 | Incipient dry spell |
| –1.00 to –1.99 | Mild drought |
| –2.00 to –2.99 | Moderate drought |
| –3.00 to –3.99 | Severe drought |
| –4.00 or less | Extreme drought |

The PDSI is calculated for climate divisions throughout the United States. The Northeast region is almost entirely in the Northeastern Plains climate division (Division 3), with northwestern Union and Harding Counties also extending into the Northern Mountains climate division (Division 2). Figure 5-5 shows the long-term PDSI for these two climate divisions. Of interest are the large variations from year to year.



**a. New Mexico Climate Division 3**



**b. New Mexico Climate Division 2**

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NORTHEAST NEW MEXICO REGIONAL WATER PLAN

**Palmer Drought Severity Index**
**Climate Divisions 3 and 2**

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3/23/07

Figure 5-5

### 5.1.4 Pacific Decadal Oscillation

The Pacific Decadal Oscillation (PDO) is a long-lived El Niño-like pattern of Pacific climate variability that serves as an indicator of climatic trends that can help predict long-term precipitation. The warm (positive) PDO phase is correlated with anomalously wet climatic conditions, and the cool (negative) PDO phase is correlated with anomalously dry climatic conditions in the southern United States (Mantua, 2002). A warm (positive) PDO phase began in 1977, and 20th century PDO events have typically lasted for approximately 20 to 30 years (Mantua, 2002); however, it is difficult to detect real-time shifts in the PDO, and scientists are not clear if a shift back into the cool (negative) phase has yet occurred (Gutzler et al., 2002; Gutzler, 2006).

### 5.1.5 Climate Change and Impacts to Water Supply

As noted in a recently completed report on the effects of global climate change on New Mexico's water supply and ability to manage water resources (NM OSE, 2006c), global temperatures are rising, as evidenced by decreased icepack and snowfields and retreat of glaciers. This global warming is thought to be due to the presence of greenhouse gases, concentrations of which are continuing to increase. In New Mexico, wintertime average temperatures have increased statewide by about 1.5 degrees since the 1950s (NM OSE, 2006c). Increased temperatures lead to high evapotranspiration, lower soil moisture, and a greater potential for drought. More intense but probably less frequent storms could lead to more extreme flooding events.

According to the OSE report, the following effects of global climate change are likely to occur in New Mexico:

- Temperature is expected to continue to rise.
- A greater percentage of precipitation is expected to fall as rain rather snow.
- The amounts of snowpack and snow water equivalency are expected to decrease.

- Smaller spring snowmelts and/or earlier runoff are expected to diminish supplies of water for irrigation and ecological health.

- Reservoir and other open water evaporation are expected to increase.

- Evapotranspiration is expected to increase due to water temperatures and longer growing seasons.

- The severity of droughts and floods is expected to be more extreme.

While there is no quantitative model for climate change impacts specifically in the Northeast Region, climate changes in the planning region are likely to have the following effects:

- More extremes could occur in the surface water flow regime, including larger floods and prolonged droughts resulting in lower surface flows. Thus the supply of water for irrigators along the Dry Cimarron and Canadian Rivers may be inadequate a greater percentage of the time.

- More extreme flood events could increase erosion and impact housing and structures close to surface water resources.

- Prolonged drought could lower recharge rates at the same time that groundwater pumping is likely to increase to compensate for the lower surface water supply available for agriculture and landscape irrigation. The convergence of these two drought effects would hasten the rate of aquifer decline. This is of particular importance for Curry, Roosevelt, and Union Counties where projected demands are increasing while the supply from the Ogallala aquifer is diminishing.

## 5.2 Surface Water Supply

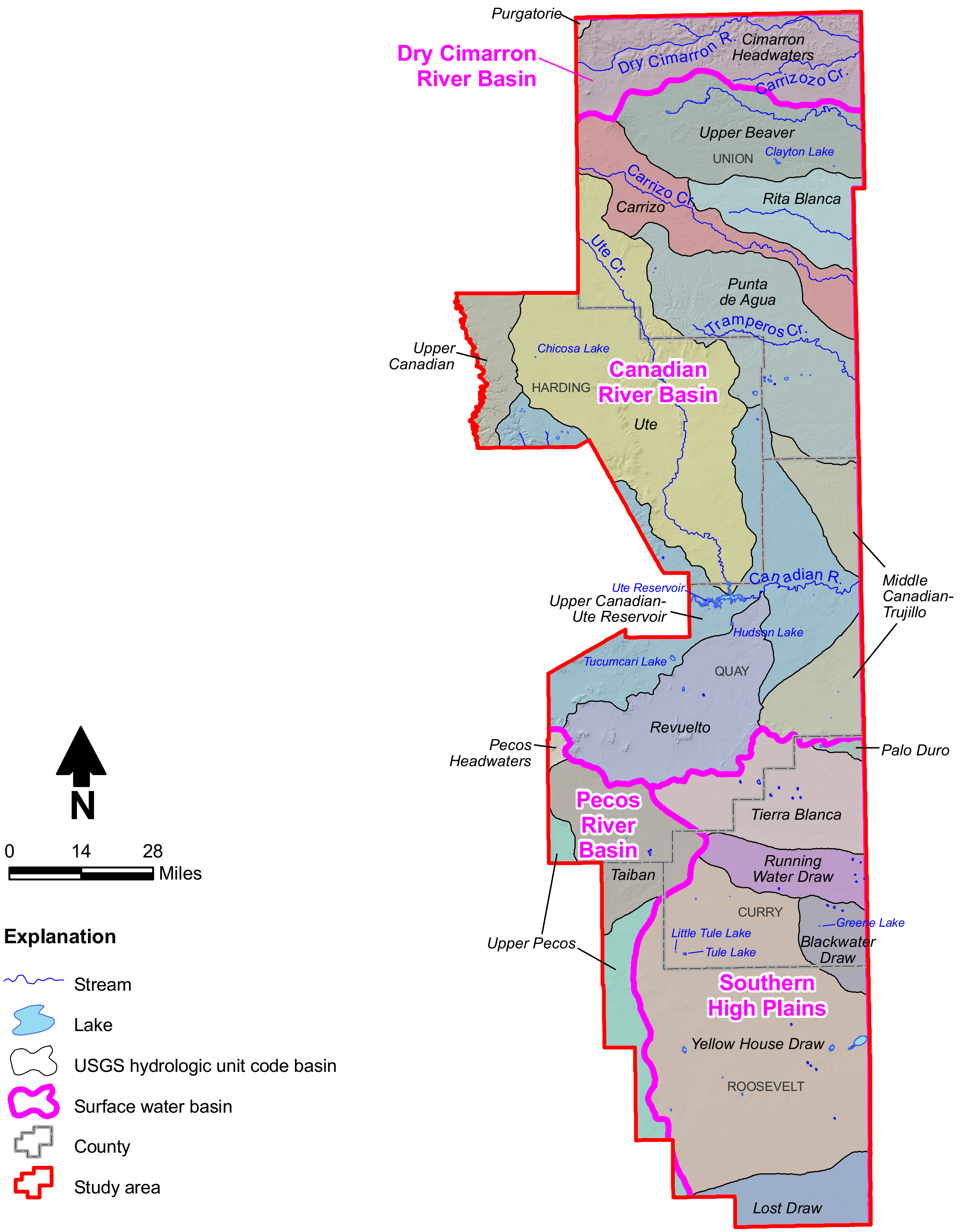
Surface water supplies less than 25 percent of the water currently used in Union, Harding, Quay, Curry, and Roosevelt Counties; however it is becoming more and more important as groundwater supply diminishes. Surface water originates primarily in the mountains to the northwest of the planning region in Colfax County and to the north in Colorado. From these origins, it flows east and south to the Canadian and Dry Cimarron Rivers (Figure 5-6), which continue flowing east out of the region. No perennial surface water features exist in the region south of the beginning of the Caprock (a caliche layer in the Ogallala Formation that marks the boundaries of the High Plains aquifer) in southern Quay County. Section 5.2.1 describes regional surface water drainages, and streamflow data are summarized in Section 5.2.2. Lakes and reservoirs in the region are discussed in Section 5.2.3.

### *5.2.1 General Hydrologic Setting*

The major surface water features in the Northeast New Mexico water planning region are the Dry Cimarron River, Canadian River, and Ute Creek. These features are part of the Arkansas River Basin, which drains to the Lower Mississippi River Basin. The southwestern corner of Quay County, southern half of Curry County, and all of Roosevelt County are part of the Western Gulf of Mexico Basin; however, no perennial surface water features are present in those areas. Major surface drainages and watersheds are shown on Figures 5-6 and A-5a and A-5b (in Appendix A).

### *5.2.2 Summary of Streamflow Data*

Streamflow data are collected by the USGS from several gages in the Northeast region, at the locations shown in Figure 5-7. Table 5-4 lists the locations, periods of record, and types of data collected at these stream gages, as well as the estimated acreage irrigated by surface water diversions upstream of the station, as reported in USGS publications. Table 5-5 summarizes the minimum, median, average, maximum, and standard deviation of annual water yields based on data available from the USGS for the entire period of record for each station. As indicated in Tables 5-4 and 5-5, four of the seven stream gages in the region are no longer used. Table 5-6 summarizes water yield and flow statistics for the three active stations, for a standard period of record.



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**Surface Water Resources**

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Figure 5-6

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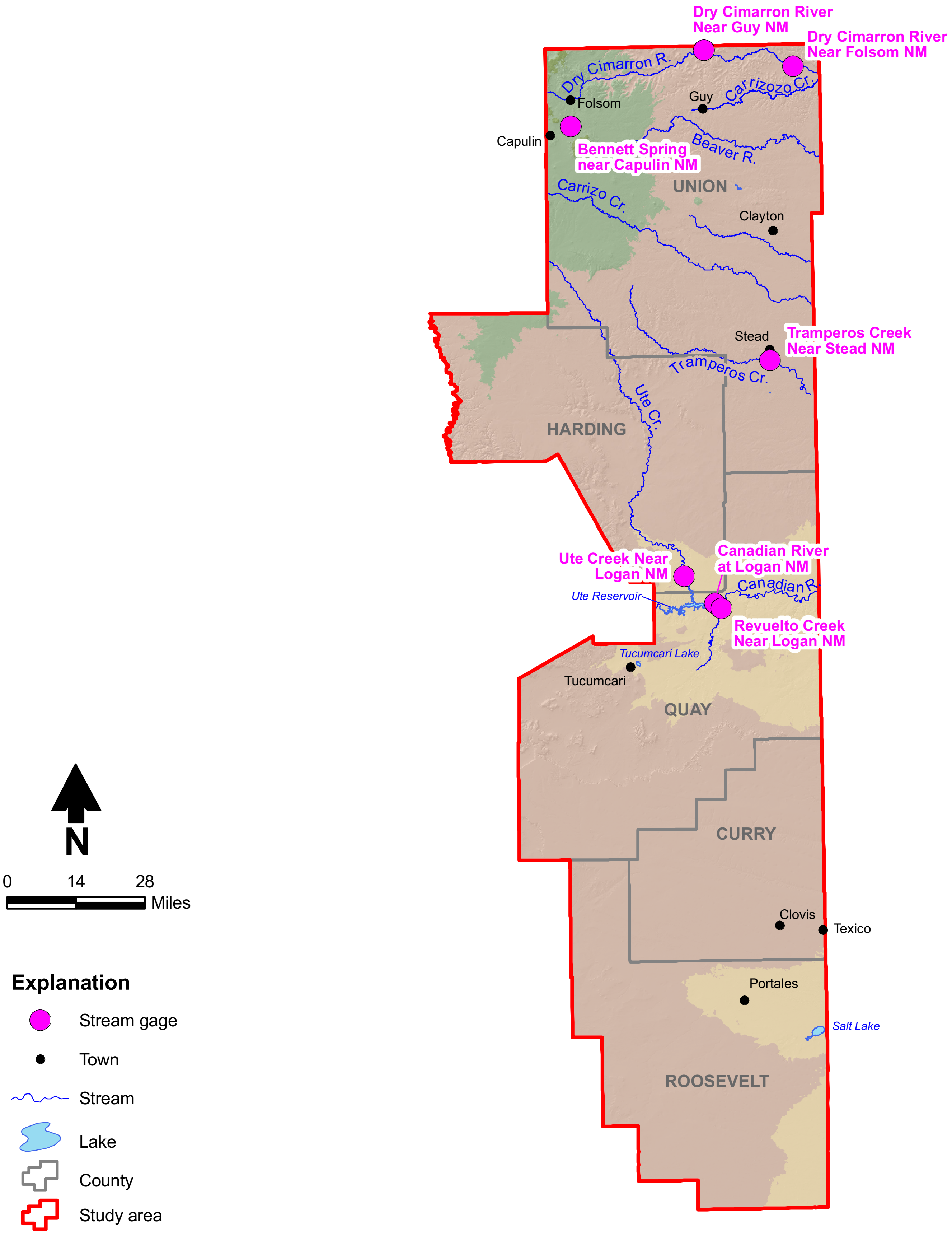

NORTHEAST NEW MEXICO REGIONAL WATER PLAN

## USGS Stream Gage Locations

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WR04.0147

Figure 5-7

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## Table 5-4. USGS Stream Gages in the Northeast Region

| USGS Site Name [a] | USGS Site Number | Latitude | Longitude | Elevation (ft msl) | Drainage Area (acres) | Irrigated Land Upstream of Gage (acres) | Period of Record | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Start Date | End Date |
| *Union County* | | | | | | | | |
| Dry Cimarron River near Guy, NM | 07153500 | 36°59'15" | 103°25'25" | NA | 348,801 | NA [a] | 10/01/1942 | 12/31/1973 |
| Cimarron River near Folsom, NM | 07154000 | 36°56'05" | 103°05'55" | NA | 572,802 | NA [a] | 10/01/1927 | 09/30/1933 |
| Bennett Spring near Capulin, NM | 07153410 | 36°46'04" | 103°55'01" | NA | NA | NA [a] | 07/12/1977 | 10/14/1981 |
| Tramperos Creek near Stead, NM | 07227200 | 36°04'15" | 103°12'10" | NA | 355,841 | NA [a] | 06/17/1966 | 12/31/1973 |
| *Harding County* | | | | | | | | |
| Ute Creek near Logan, NM | 07226500 | 35°26'18" | 103°31'31" | 3,820.00 | 1,318,405 | "a few hundred" | 01/01/1942 | 07/24/2005 |
| *Quay County* | | | | | | | | |
| Canadian River at Logan, NM | 07227000 | 35°21'25" | 103°25'03" | 3,667.10 | 7,130,269 | 90,000 | 01/01/1909 | 06/29/2005 |
| Revuelto Creek near Logan, NM | 07227100 | 35°20'28" | 103°23'40" | 3,660.00 | 503,042 | NA | 08/01/1959 | 07/24/2005 |

[a] Station is not active; unable to confirm irrigated acreage above gage.

USGS = U.S. Geological Survey
ft msl = Feet above mean sea level
NA = Data not available

Sources:
USGS, 2002
USGS, 2006
Personal communication from Robert Gold, USGS, 2006 (for information after September 30, 2002)

# Table 5-5. USGS Stream Gage Water Yield Statistics for Period of Record

| USGS Site Name | USGS Site Number | Period of Record | Water Yield for Period of Record [a] (acre-feet) | | | | |
|---|---|---|---|---|---|---|---|
| | | | Minimum | Median | Average | Maximum | Standard Deviation |
| Dry Cimarron River near Guy, NM | 07153500 | 1943–1973 | 2,152 | 5,619 | 7,307 | 24,694 | 5,870 |
| Dry Cimarron River near Folsom, NM | 07154000 | 1928–1932 | 3,194 | 6,083 | 7,753 | 16,728 | 5,257 |
| Bennett Spring near Capulin, NM | 07153410 | 1978–1980 | 159 | 167 | 171 | 188 | 15 |
| Tramperos Creek near Stead, NM | 07227200 | 1967–1973 | 66 | 2,006 | 3,166 | 9,197 | 3,521 |
| Ute Creek near Logan, NM | 07226500 | 1942-2004 | 152 | 8,762 | 14,418 | 62,640 | 13,330 |
| Canadian River at Logan, NM | 07227000 | 1909–1913<br>1927–1928<br>1930–2004 | 927 | 53,660 | 122,711 | 1,568,531 | 231,231 |
| Revuelto Creek near Logan, NM | 07227100 | 1960-2004 | 3,461 | 25,780 | 31,481 | 160,764 | 24,823 |

[a] Data presented in this table are based on the calendar year streamflow statistics for each station available on the USGS website (http://waterdata.usgs.gov/nwis/annual).

## Table 5-6. Summary of Water Yield and Flow Distribution Statistics for Active Stream Gaging Stations from 1960 to 2004

| USGS Site Name | Average Streamflow for Period of Record (cfs) | Annual Yield for Period of Record (ac-ft) | | | | | Percentile Flows (ac-ft) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Minimum | Median | Average | Maximum | Standard Deviation | $Q_{10}$[a] | $Q_{25}$[b] | $Q_{50}$[c] | $Q_{75}$[d] | $Q_{90}$[e] |
| Ute Creek near Logan, NM | 14.25 | 152 | 5,803 | 10,321 | 36,220 | 9,834 | 2,137 | 3,519 | 5,803 | 13,479 | 26,354 |
| Canadian River at Logan, NM | 47.70 | 928 | 14,198 | 34,544 | 160,451 | 43,016 | 1,629 | 2,674 | 14,198 | 54,991 | 101,698 |
| Revuelto Creek near Logan, NM | 42.99 | 3,463 | 25,809 | 31,134 | 160,989 | 24,687 | 12,756 | 20,333 | 25,809 | 31,724 | 56,784 |

[a] Water yields were below this value in 10 percent of the years from 1960 to 2004.
[b] Water yields were below this value in 25 percent of the years from 1960 to 2004.
[c] Water yields were below this value in 50 percent of the years 1960 to 2004 (same as median).
[d] Water yields were below this value in 75 percent of the years from 1960 to 2004.
[e] Water yields were below this value in 90 percent of the years from 1960 to 2004.

cfs = Cubic feet per second
ac-ft = Acre-feet

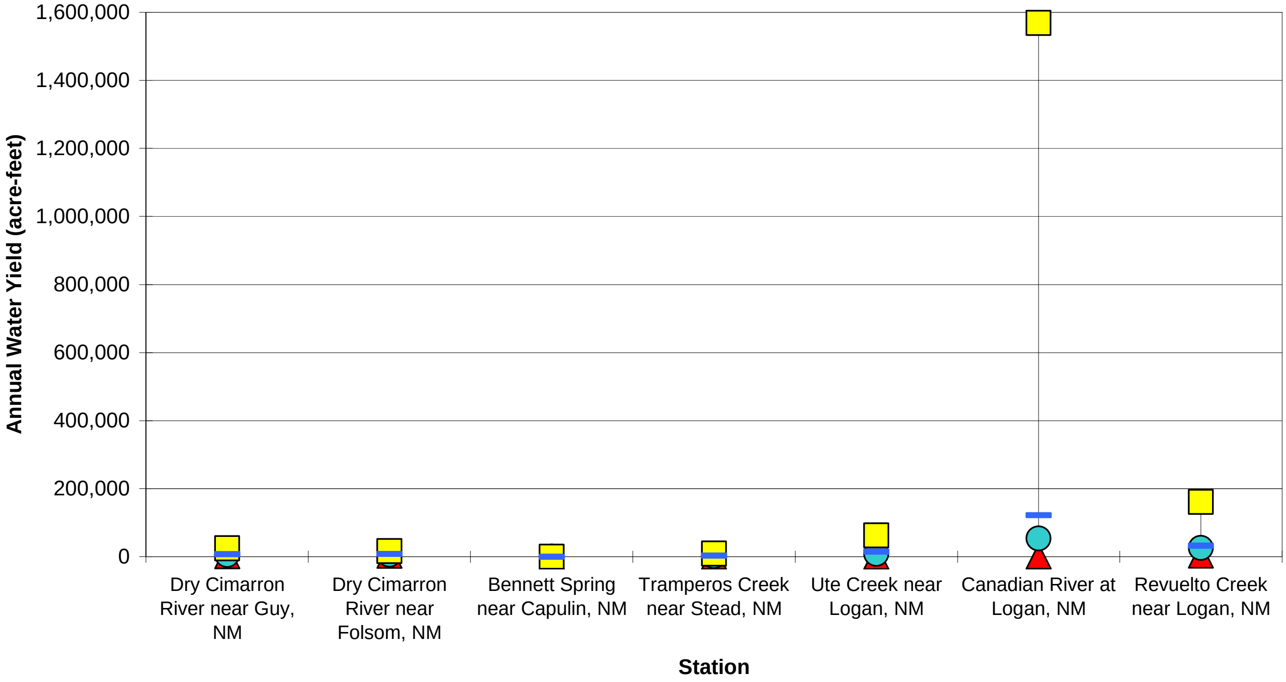
For this study, data from all seven stations in the planning region were used in the analysis because they each have a distinct hydrologic location. Figure 5-8a shows descriptive statistics for annual water yield at these stations for the period of record. Figure 5-8b shows these statistics without the maximum value for the Canadian River at Logan, as the flow in 1941 was so high that the scale is unreadable for the other stations when that point is included. Figure 5-9 shows annual water yield statistics per unit area for a standard period of 1960 through 2004.

Graphs illustrating annual streamflow for the stream gage stations, including the monthly distribution of streamflow over a water year, are presented in Appendix D2. These graphs indicate large variability of streamflow from year to year. The Canadian River at Logan gage plot (Appendix D2) shows a significant decrease in flow after construction of Ute Reservoir in 1962. The Canadian River at Logan stream gage is located approximately 2 miles downstream of Ute Reservoir, and as illustrated by the plot, more recent flows out of Ute Reservoir are much less than historical flows on the Canadian River.

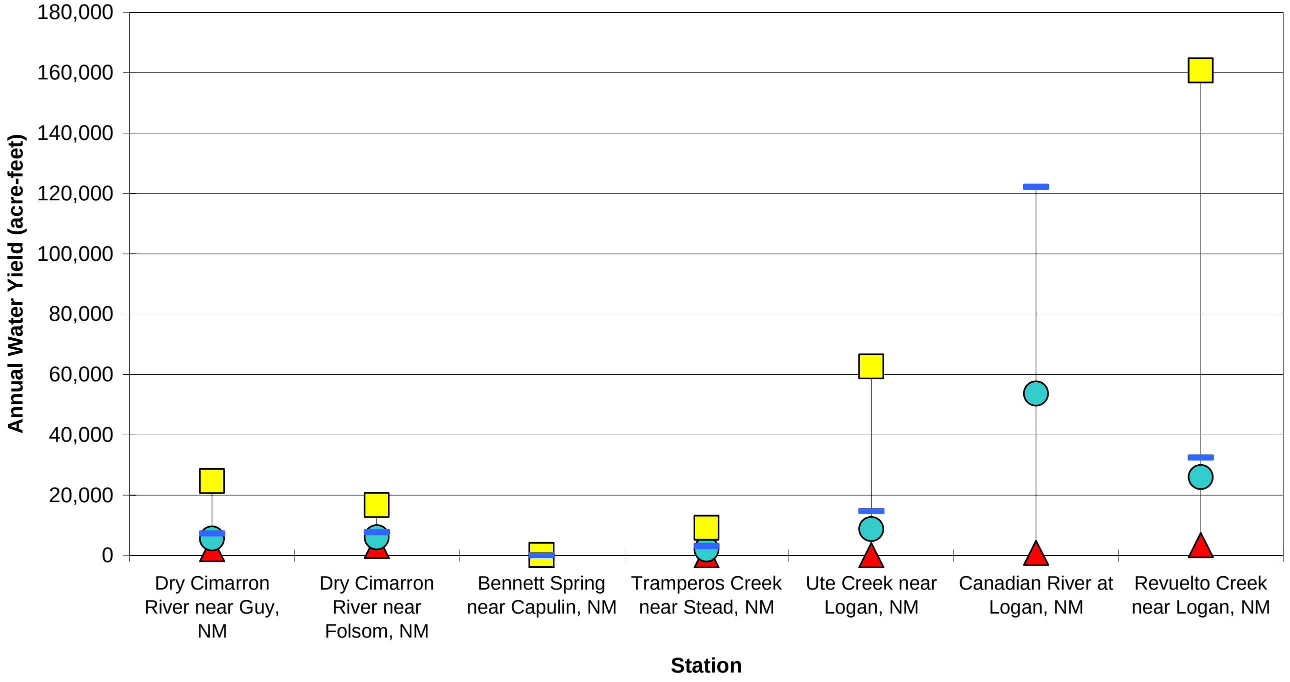
### *5.2.3 Lakes and Reservoirs*

Several lakes and reservoirs are present in the Northeast New Mexico planning region, and their characteristics are summarized in Table 5-7. Those lakes and reservoirs outside of the planning region with bearing on potential supply have also been included on this table.

The lakes and reservoirs within the planning region, which range from stockpond impoundments to several major reservoirs, are generally multipurpose reservoirs, and are commonly used to store water from storm events. Ute Reservoir is the largest reservoir in the region, and it was completed in 1962 to capture Canadian River water that New Mexico is entitled to, for the purpose of municipal and industrial use in eastern New Mexico. The Canadian River Compact limits the amount of water in storage to 200,000 acre-ft. Ute Lake State Park is operated by the New Mexico State Park division under agreements with the ISC, and Ute Reservoir is a major recreational area (NM ISC, 2000).



**a. With the Canadian River at Logan Maximum Flow**



**b. Without the Canadian River at Logan Maximum Flow**

▲ Minimum ● Median
■ Maximum – Average

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NORTHEAST NEW MEXICO REGIONAL WATER PLAN

**Annual Water Yield**

*Daniel B. Stephens & Associates, Inc.*

3/23/07

Figure 5-8

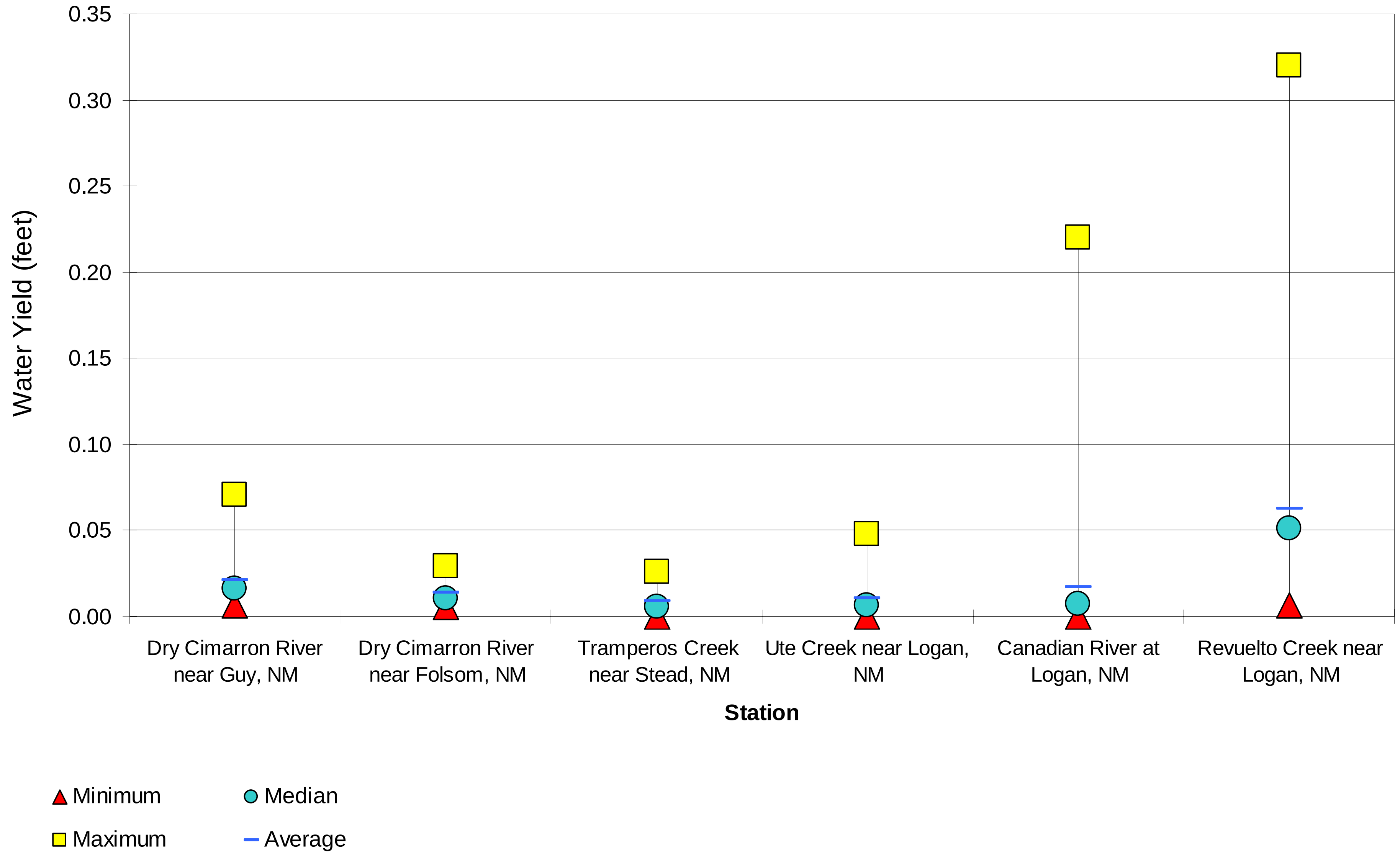

Figure 5-9

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NORTHEAST NEW MEXICO REGIONAL WATER PLAN

**Standardized Annual Water Yield**

# Table 5-7. Summary of Lakes and Reservoirs in the Northeast Region
## Page 1 of 2

| Reservoir/Dam | River | Purpose [a] | Owner | Maximum Storage Capacity (ac-ft) [b] | Normal Storage (ac-ft) [b] | Average Surface Area (acres) | Evaporation Rate (ft/yr) | | Surface Water Depletion (Evaporate Loss) (ac-ft) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Gross | Net | |
| *Union County* | | | | | | | | | |
| Gardner Dam | Pinabetes Creek (Tramperos Creek tributary) | I | M.D. Gonzales | 140 | 120 | 10 [c]<br>16 [b] | 4.83 | 3.50 | 35.0 |
| Tramperos Creek No. 2 Dam | Garcia Creek tributary | FODCTR | Tramperos Watershed District | 990 | 635 | 66 [b] | --- | --- | --- |
| Tramperos Creek Site 1 Dam | Tramperos Creek tributary | FODCTR | Ute Creek SWCD | 7,090 | 5,120 | 372 [b] | --- | --- | --- |
| Howard Robertson Dam | Middle Fork Minneosa Creek | FODCTRIS | H. Robertson | 63 | 0 | 6 [b] | --- | --- | --- |
| Smithson Reservoir No. 1 | Tramperos Creek tributary | I | M.D. Smithson | 200 | 116 | 23 [b] | --- | --- | --- |
| Smithson Reservoir No. 2 | Tramperos Creek tributary | I | M.D. Smithson | 119 | 49 | 7 [b] | --- | --- | --- |
| Smithson Reservoir No. 3 | Tramperos Creek tributary | I | M.D. Smithson | 255 | 117 | 16 [b] | --- | --- | --- |
| Smithson Reservoir No. 4 | Tramperos Creek tributary | I | M.D. Smithson | 230 | 124 | 17 [b] | --- | --- | --- |
| Smithson Lakes (4) | Tramperos Creek | | | | | 39.0 [c] | 4.92 | 3.59 | 140.01 |
| Clayton Dam | Cimarron River tributary | R | New Mexico Department of Game and Fish | 6,600 | 4,100 | 140.0 [c]<br>175.0 [b] | 4.75 | 3.42 | 478.80 |
| Snyder Lake Dam | Garcia Creek tributary | I | Snyder Ranch | 340 | 220 | 15.0 [c]<br>38.0 [b] | 4.67 | 3.34 | 50.10 |
| Eklund Storage Works Dam | Apache Creek | I | Rex Reeves | 32 | 0 | 1.0 [c] | 4.83 | 3.50 | 3.59 |
| Brown Reservoir Dam | Dry Cimarron River tributary | I | John T. Brown Estate | 288 | 162 | 15.0 [c] | 4.50 | 3.17 | 47.55 |
| Poling Irrigation System Dam | Tramperos Creek tributary | I | J.M. Poling, JR. | 227 | 178 | 49 [b] | --- | --- | --- |
| Lower Garret Dam | Ute Creek tributary | D | W.A. Maes | 40 | 0 | 9.0 [c] | 4.5 | 3.17 | 28.53 |
| Poling Erosion Control Dam | Tramperos Creek tributary | IO | J.M. Poling, JR. | 207 | 177 | 34 [b] | --- | --- | --- |
| Weatherly Reservoir Dam | Corrumpa Creek tributary | I | A.D. Weatherly | 1,083 | 300 | 60.0 [c] | 4.50 | 3.17 | 190.20 |
| Claude Hutcherson No. 1 Dam | Monia Creek | FODCTR | Claude Hutcherson | 153 | 78 | 18 [b] | --- | --- | --- |
| Claude Hutcherson No. 2 Dam | Monia Creek | FODCTR | Claude Hutcherson | 50 | 0 | 0 | --- | --- | --- |

[a] C = Flood control / storm water management
D = Debris control
F = Fish and wildlife pond
I = Irrigation
O = Other
R = Recreation
S = Water supply
T = Tailings

[c] Wilson et al., 2003
[b] USACE, 2005

ac-ft = Acre-feet
ft/yr = Feet per year
SWCD = Soil & Water Conservation District
--- = Information not available

## Table 5-7. Summary of Lakes and Reservoirs in the Northeast Region
## Page 2 of 2

| Reservoir/Dam | River | Purpose [a] | Owner | Maximum Storage Capacity (ac-ft) [b] | Normal Storage (ac-ft) [b] | Average Surface Area (acres) | Evaporation Rate (ft/yr) | | Surface Water Depletion (Evaporate Loss) (ac-ft) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Gross | Net | |
| Claude Hutcherson No. 3 Dam | Monia Creek | FODCTR | Claude Hutcherson | 122 | 7 | 3 [b] | --- | --- | --- |
| Claude Hutcherson No. 4 Dam | Monia Creek | FODCTR | Claude Hutcherson | 103 | 2 | 0 | --- | --- | --- |
| Claude Hutcherson No. 5 Dam | Monia Creek | FODCTR | Claude Hutcherson | 56 | 0 | 0 | --- | --- | --- |
| *Harding County* | | | | | | | | | |
| Abbott Lake Upper Dam | Sauz Creek | FIRSTOC | Jaritas Livestock Co. | 156 | 0 | 24 [b] | --- | --- | --- |
| Abbott Lake Lower Dam | Sauz Creek | FIRSTOC | Jaritas Livestock Co. | 111 | 0 | 16 [b] | --- | --- | --- |
| Abbott Lakes | Canadian tributary | --- | --- | --- | --- | 20.0 [c] | 4.75 | 3.67 | 73.40 |
| Carros Reservoir | Carros Creek | --- | --- | --- | --- | 3.0 [c] | 5.50 | 4.25 | 12.75 |
| *Quay County* | | | | | | | | | |
| Ute Dam | Canadian River | R | NM Interstate Stream Commission | 403,000 | 240,250 | 7,443.0 [c] | 5.76 | 4.60 | 34,055.00 |
| Hilton Creek Reservoir | --- | --- | --- | --- | --- | 15.0 [c] | 6.25 | 4.92 | 73.80 |
| Hittson Creek Dam | Plaza Larga Creek | RO | Tom Stribling | 600 | 149 | 41 [b] | --- | --- | --- |
| Quay County Dam (Morris) | NA (Canyon, TX) | STOCTR | Darline Morris | 68 | 1 | 1 [b] | --- | --- | --- |
| *Curry County* | | | | | | | | | |
| Ingram Lake | --- | FODCTR | City of Clovis | 2,149 | 295 | 219 [b] | --- | --- | --- |
| Clovis New Pond | --- | FODCTR | City of Clovis | 425 | 22 | 75 [b] | --- | --- | --- |

[a] C = Flood control / storm water management
D = Debris control
F = Fish and wildlife pond
I = Irrigation
O = Other
R = Recreation
S = Water supply
T = Tailings

[c] Wilson et al., 2003
[b] USACE, 2005

ac-ft = Acre-feet
ft/yr = Feet per year
SWCD = Soil & Water Conservation District
--- = Information not available

## 5.3 Groundwater Supply

Aside from agricultural demands in two counties, the water supply needs of the Northeast region are met almost entirely by groundwater resources, and understanding the available groundwater supply is thus essential to water planning in the region. This section summarizes the regional groundwater supply, including both water-bearing aquifers and relatively impermeable units.

In order to manage groundwater resources in New Mexico, the OSE has the authority to delineate groundwater basins that then require a permit for groundwater withdrawals. These basins are referred to as declared groundwater basins. The Northeast planning region lies completely within eight declared groundwater basins: the Clayton, Canadian River, Tucumcari, Fort Sumner, Curry, Portales, Causey Lingo, and Roswell basins (Figure 4-1). While Section 4.7 discussed the OSE-declared basins in relation to the legal availability of water, the discussion in this section discusses its physical availability, as defined by physical hydrogeologic boundaries (which do not necessarily coincide with the legal boundaries).

Section 5.3.1 discusses the general geologic setting as it relates to groundwater supply and identifies the regional geology and major aquifers that exist within the planning region. Aquifer characteristics, recharge, and the major well fields in the region are discussed in Sections 5.3.2 through 5.3.4, respectively. Section 5.3.5 presents depth to water trends in wells near municipalities in the region, and Section 5.3.6 discusses aquifer sustainability in the areas of highest water consumption.

### *5.3.1 Regional Hydrogeology*

This section presents a general overview of the geology that controls groundwater occurrence and movement within the planning region. A map illustrating the surface geology of the entire planning region is included as Figure 5-10, and a map showing the major groundwater resources in the area is shown in Figure 5-11. Three cross sections for Quay County are provided as Figures 5-12 through 5-14 (the locations of these cross sections are shown on Figure 5-10). Stratigraphic columns are presented for Union County (Table 5-8) and Curry and Roosevelt Counties (Figure 5-15).

## Explanation

● Stratigraphic column location

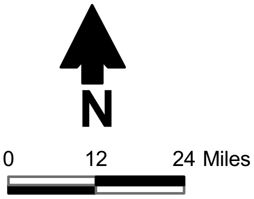
A —— A' Cross section location

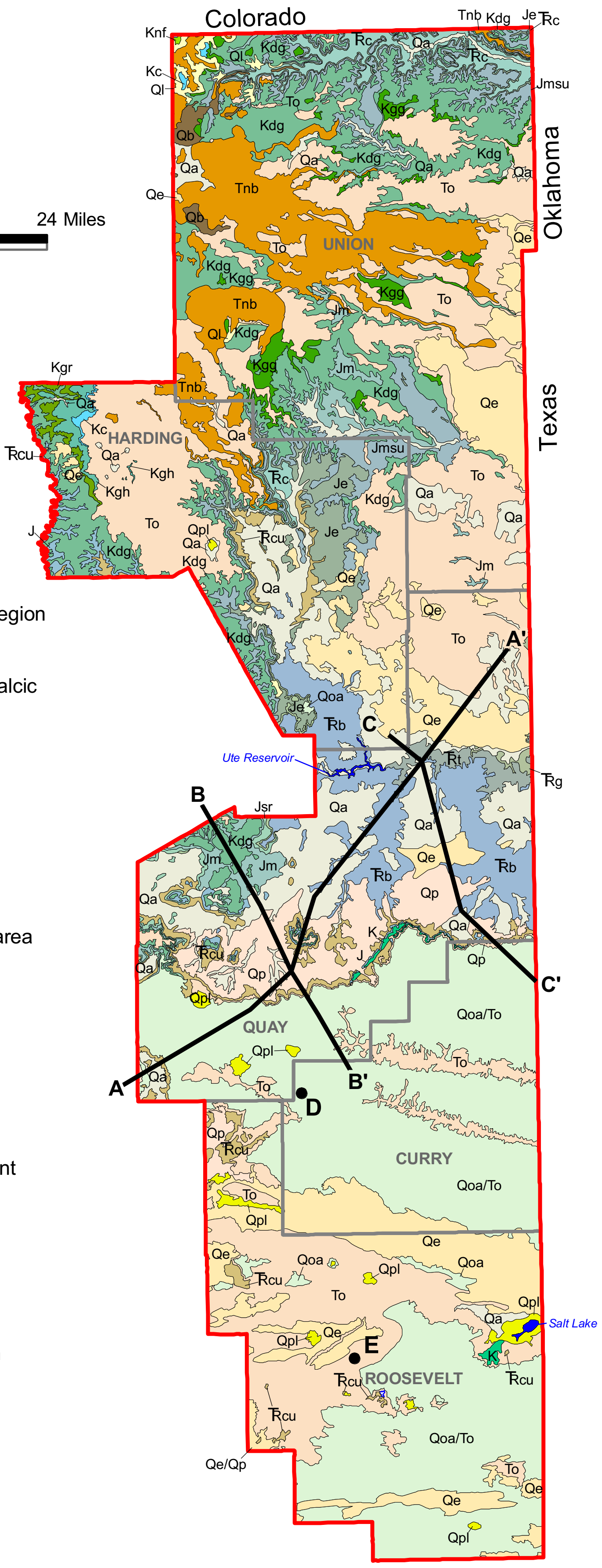
County

Study area

### Geology

| Symbol | Description |
|---|---|
| ▨ | Playa |
| 🟦 | Water |
| Qa | Alluvium, upper and middle Quaternary |
| Ql | Landslide deposits and colluvium |
| Qpl | Lacustrine and playa-lake deposits |
| Qp | Piedmont alluvial deposits: upper and middle Quaternary |
| Qe | Eolian deposits |
| Qoa | Older alluvial deposits of upland plains and piedmont areas, and calcic soils and eolian cover sediments of High Plains region |
| Qb | Basalt and andesite flows and locally vent deposits |
| To | Ogallala Formation, alluvial and eolian deposits, and petrocalcic soils of the southern High Plains |
| Tnb | Basalt and andesite flows (Neogene), which include flows interbedded with Santa Fe and Gila Groups |
| Tv | Middle Tertiary volcanic rocks, undifferentiated |
| K | Cretaceous rocks, undivided |
| Kpn | Pierre Shale and Niobrara Formation |
| Knf | Fort Hays Limestone Member of Niobrara Formation |
| Kc | Carlile Shale (Turonian-Coniacian), limited to northeastern area |
| Kgg | Graneros Shale and Greenhorn Formation, limited to northeastern area |
| Kgh | Greenhorn Formation, limited to northeastern area |
| Kgr | Graneros Shale, limited to northeastern area; Cenomanian |
| Kdg | Dakota Group of east-central and northeast New Mexico |
| J | Jurassic rocks, Middle and Upper, undivided |
| Jm | Morrison Formation; Upper Jurassic nonmarine rocks present only in northern one-third of state |
| Jmsu | Morrison Formation and upper San Rafael Group |
| Je | Entrada Sandstone, Middle Jurassic; Callovian |
| Jsr | San Rafael Group; consists of Entrada Sandstone, Todilto and Summerville Formations |
| Ꞧc | Chinle Group; Upper Triassic; includes Moenkopi Formation (Middle Triassic) at base in many areas |
| Ꞧc | Redonda Formation |
| Ꞧb | Bull Canyon Formation; Norian |
| Ꞧt | Trujillo Formation; Norian |
| Ꞧg | Garita Creek Formation; Carnian |
| Ꞧcu | Upper Chinle Group, Garita Creek through Redonda Formations, undivided |





Source: Green and Jones, 1997

NORTHEAST NEW MEXICO REGIONAL WATER PLAN

**Surficial Geology**

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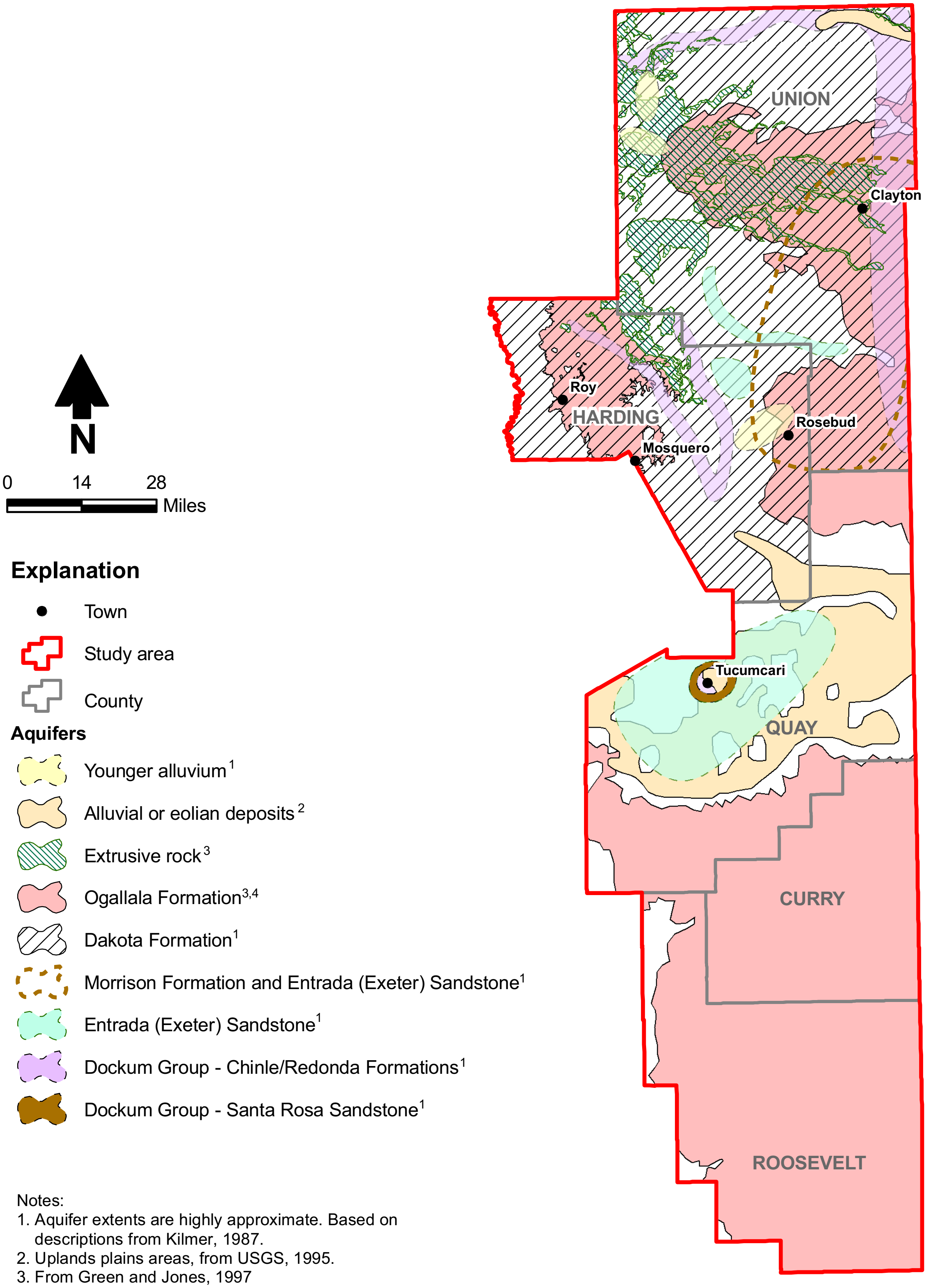
WR04.0147

Figure 5-10



Notes:
1. Aquifer extents are highly approximate. Based on descriptions from Kilmer, 1987.
2. Uplands plains areas, from USGS, 1995.
3. From Green and Jones, 1997
4. From Cederstrand and Becker, 1999.

NORTHEAST NEW MEXICO REGIONAL WATER PLAN

**Groundwater Resources**

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Figure 5-11

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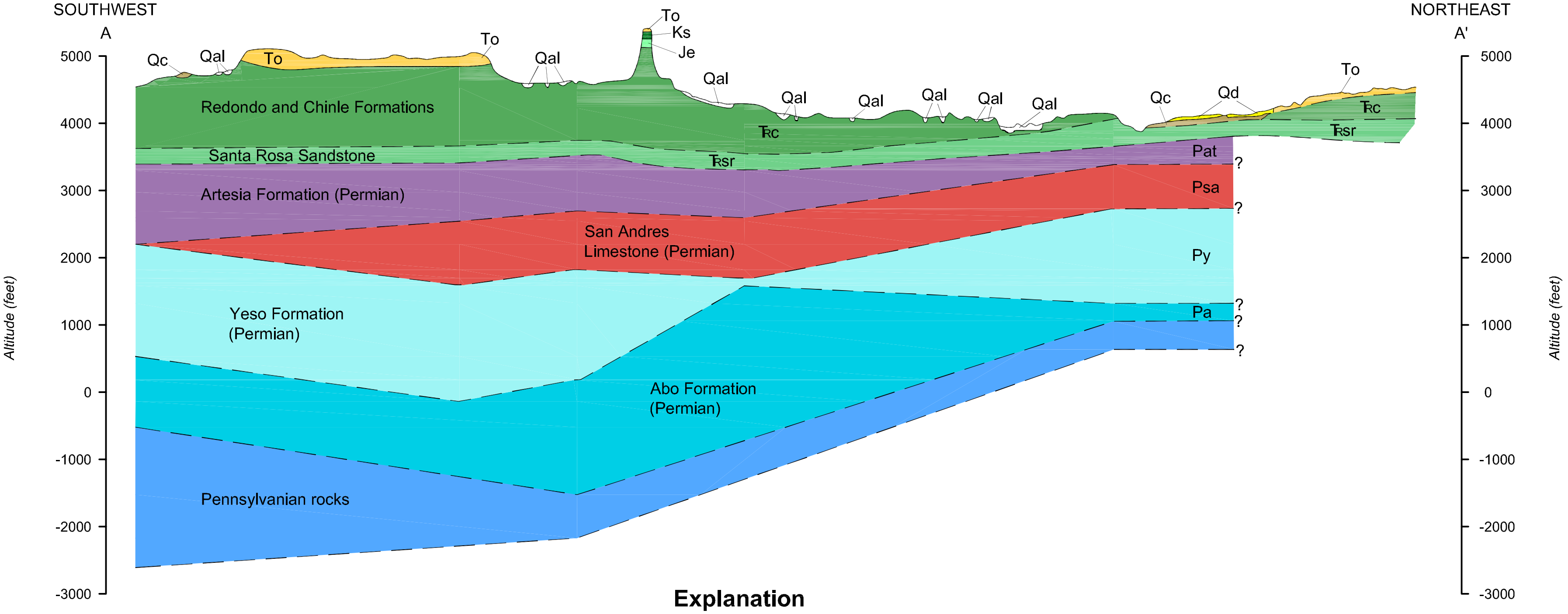


## Explanation

Recent
Pleistocene
QUATERNARY

- 🟨 Qd — Dune sand
- ⬜ Qal — Younger alluvium
- Qc — Upland cover of older alluvium

Pliocene — TERTIARY

- To — Ogallala Formation

Lower Cretaceous — CRETACEOUS

- Ks — Sandstone and Shale

Upper Jurassic — JURASSIC

- Je — Entrada Sandstone

Upper Triassic — TRIASSIC

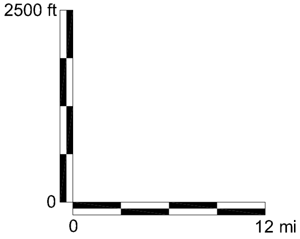
- TRc — Redondo and Chinle Formations
- TRsr — Santa Rosa Sandstone

PERMIAN

- Pat — Artesia Formation
- Psa — San Andres Limestone
- Py — Yeso Formation
- Pa — Abo Formation

- P₽ — Permian & Pennsylvanian rocks, undivided

———— — — — Contact between geologic formations (dashed where approximate)



Modified from Berkstresser and Mourant, 1966

NORTHEAST NEW MEXICO REGIONAL WATER PLAN

**Geologic Cross Section A-A'**

Figure 5-12

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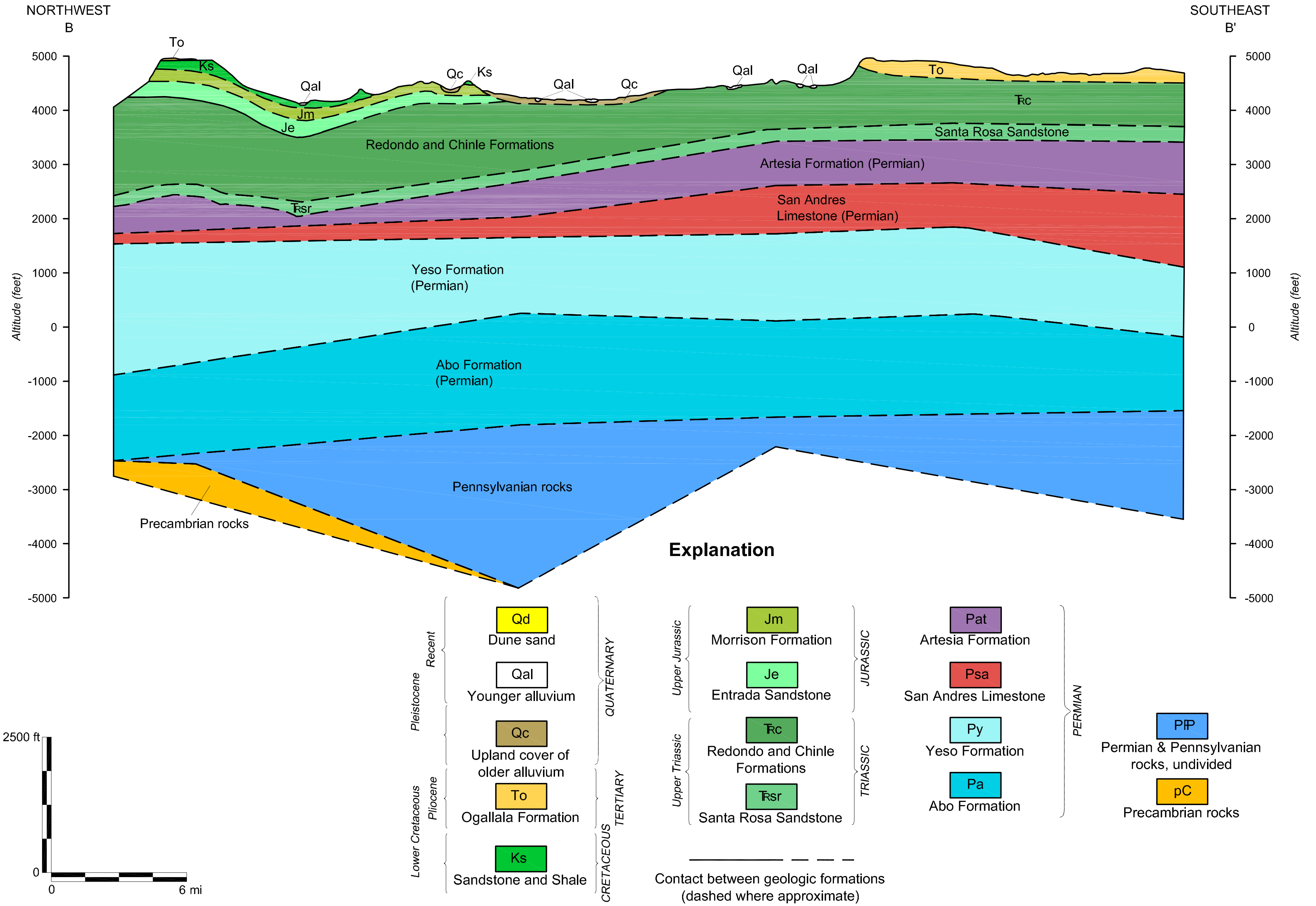

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NORTHEAST NEW MEXICO REGIONAL WATER PLAN

**Geologic Cross Section B-B'**

Figure 5-13

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5-30-06

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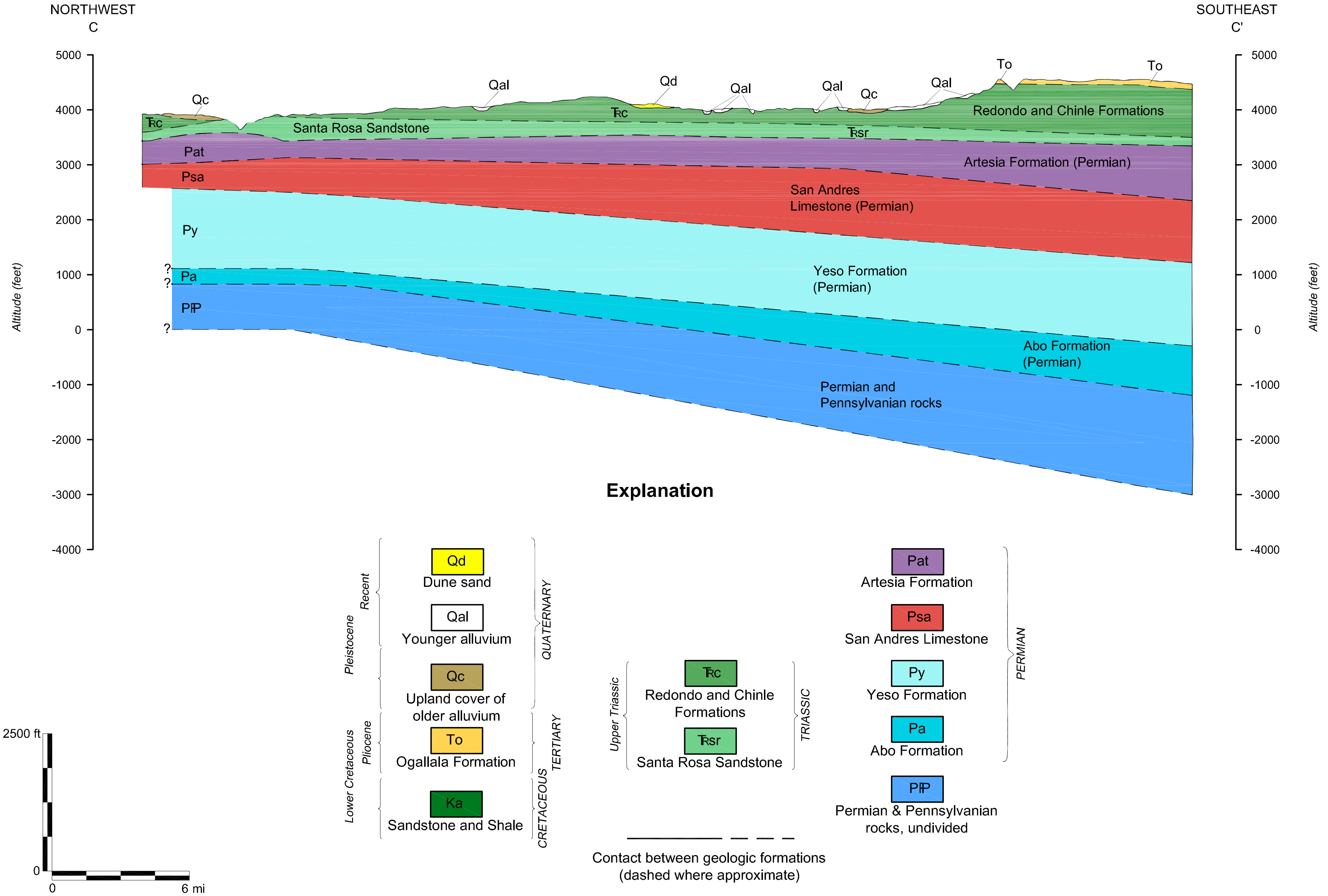

Modified from Berstresser and Mourant, 1966

NORTHEAST NEW MEXICO REGIONAL WATER PLAN

## Geologic Cross Section C-C'

Figure 5-14

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5-30-06

JN WR05.0233

## Table 5-8. Generalized Section of Geologic Formations in Union County, New Mexico
## Page 1 of 2

| System | Stratigraphic Unit | Thickness (feet) | Distribution | Physical Properties | Water-Bearing Characteristics |
|---|---|---|---|---|---|
| Quaternary | Alluvium | 0 - 100 | Countywide along drainage courses. Thickest near Capulin where sheet-like alluvium covers an area of about 20 square miles. | Silt, sand, and gravel; locally includes slope wash and terrace deposits. | Yields adequate quantities of water to domestic and stock wells in many stream valleys. Alluvium near Capulin, and in Cimarron River valley near the east edge of the county, may yield 100 to 300 gpm to wells. Chemical quality generally satisfactory for stock, domestic, and irrigation use. |
| Quaternary and Tertiary | Extrusive rocks | --- | Covers about 725 square miles of Union County, principally in western and central parts of the county. | Basalt, dacite, andesite, tuff, and volcanic cinders. | Lies above water table in many localities. Yields 1,000 gpm or more to a few wells at Capulin. Springs are common at base of basalt flows. Chemical quality generally is better than that of water from deeper aquifers. |
| Tertiary | Ogallala Formation | 0 to 400 | Thickest along eastern side of Union County. Underlies basalt in central and west-central parts. Generally absent in south-central part of and in northern one-third of the county. | Tan sandy clay, silt, sand, and gravel; caliche common near top. Fills ancient valleys formed in underlying bedrock. | Yields adequate quantities of water to domestic and stock wells at nearly all localities where present. Yields 300 to 1,000 gpm to wells drilled into thick sections of saturated material in buried bedrock valleys along the eastern edge of Union County. Chemical quality is generally suitable for stock, domestic, and irrigation use. |
| Cretaceous | Niobrara Formation | 0 - 1050 | Crops out only in northwestern corner of Union County. | Black shale with some thin beds of limestone and marl; light tan limestone at base. | Not known to yield water in Union County. |
|  | Carlile Shale | 0 - 200 | Crops out only in northwestern corner of Union County | Dark gray shale, with thin beds of limestone at top. | Not known to yield water in Union County. |
|  | Greenhorn Limestone | 0 - 30 | Crops out only in northwestern corner of Union County; may be present in the subsurface in central and western parts of the county. | Light tan limestone with thin beds of shale. Fossiliferous. | Not known to yield water in Union County. |

Source: Cooper and Davis, 1967

--- = Information not available.

## Table 5-8. Generalized Section of Geologic Formations in Union County, New Mexico
## Page 2 of 2

| System | Stratigraphic Unit | Thickness (feet) | Distribution | Physical Properties | Water-Bearing Characteristics |
|---|---|---|---|---|---|
| Cretaceous | Graneros Shale | 0 - 125 | Crops out at many places in the upland areas of Union County. Thickest in the northwestern corner of the county. | Dark gray shale with two or three thin beds of limestone. Fossiliferous. | Not known to yield water in Union County. |
| | Dakota Sandstone | 0 - 190 | Crops out in large areas of Union County; directly underlies the Ogallala Formation in part of the county. | Lenticular to parallel-bedded gray shale, shaly sandstone, and sandstone; basal unit is a persistent massive sandstone. | Yields adequate quantities of water to stock and domestic wells in most of county. Massive sandstone at base may yield 100 gpm or more at some localities. Chemical quality varies; generally is suitable for stock and irrigation use; occasionally undesirable for domestic use. |
| | Purgatoire Formation | 0 - 100 | Crops out principally along the Cimarron River valley. Underlies Dakota Sandstone except where locally absent. | Upper member is dark gray shale with minor sandstone, locally cut out by channel of Dakota Sandstone. Lower member is light colored to white sandstone, locally absent. | Lower sandstone member, where present, may yield 500 gpm or more to wells in Union County. Chemical quality is similar to or better than water from the Dakota Sandstone. |
| Jurassic | Morrison Formation | 0 - 550 | Crops out along the Cimarron River valley, and in the south-central part of Union County and at other scattered localities. Underlies all of the county except where the Entrada Sandstone or Dockum Group is at the surface. | Greenish gray, green, and reddish brown sandy clay with local beds of white to brown sandstone, siltstone, and minor limestone; nodules of reddish orange chalcedony (“agate”) near base. | Local sandstone at top may yield some water to wells. Generally does not yield sufficient water for stock or domestic use in Union County. Chemical quality generally unsuitable for domestic use; satisfactory for stock use. |
| | Entrada Sandstone | 0 - 80 | Crops out along the Cimarron River valley and at scattered localities throughout Union County. | Massive white to pink, fine-grained sandstone. | Yields water to several stock and domestic wells in Union County. Yields 500 to 600 gpm to wells along Tramperos Creek. In most of county the sandstone is too deeply buried to be a useful aquifer. Chemical quality generally is better than water from other deep aquifers. |
| Triassic | Dockum Group | 245 - 900 | Crops out only along the Cimarron River valley and tributary valleys; underlies all of Union County. | Thin-bedded, light brown sandstone; light green, red, reddish brown, and purple mudstone. | Yields small quantities of water to stock and domestic wells in the Cimarron River valley in Union County. Chemical quality generally undesirable for domestic use; satisfactory for stock use. |

Source: Cooper and Davis, 1967

--- = Information not available.

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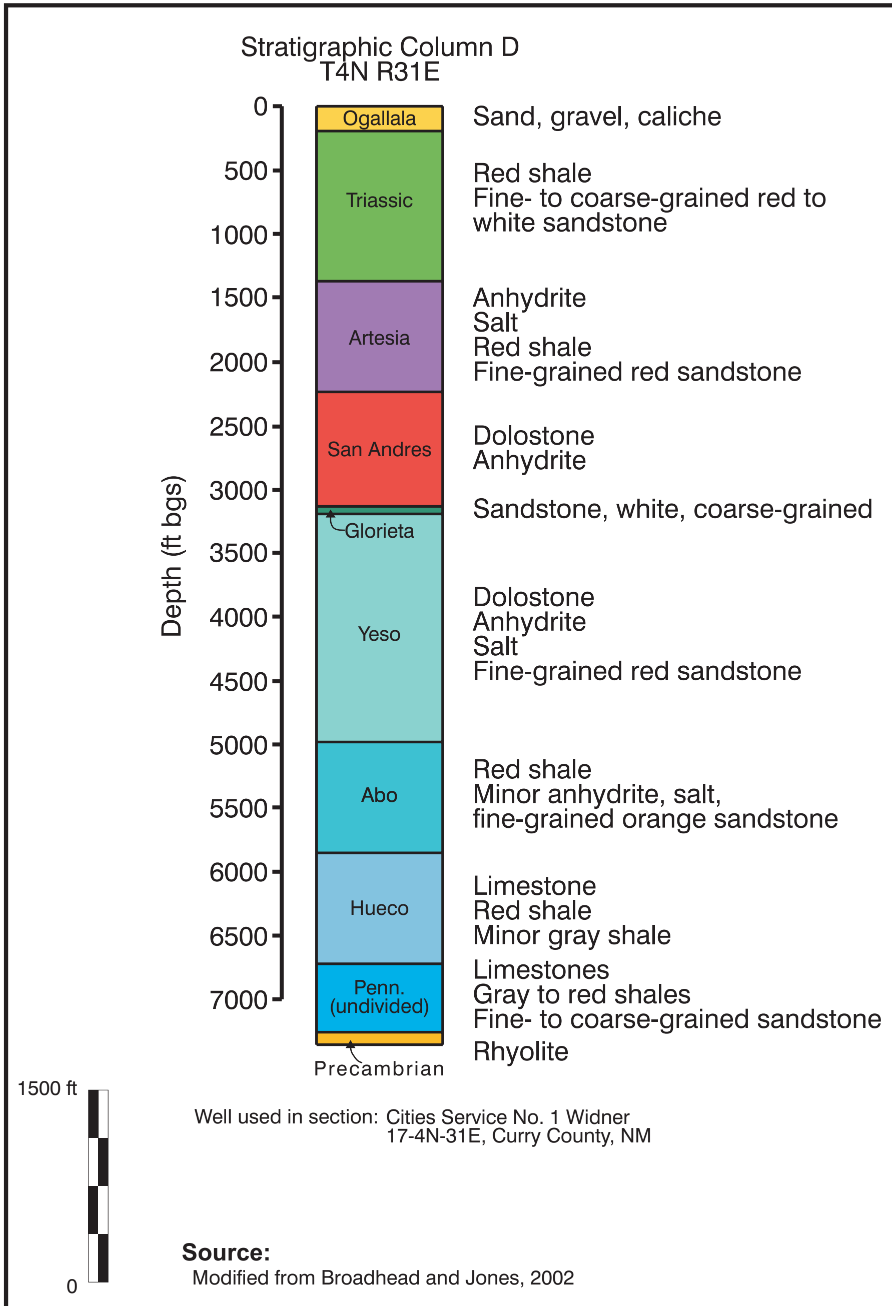
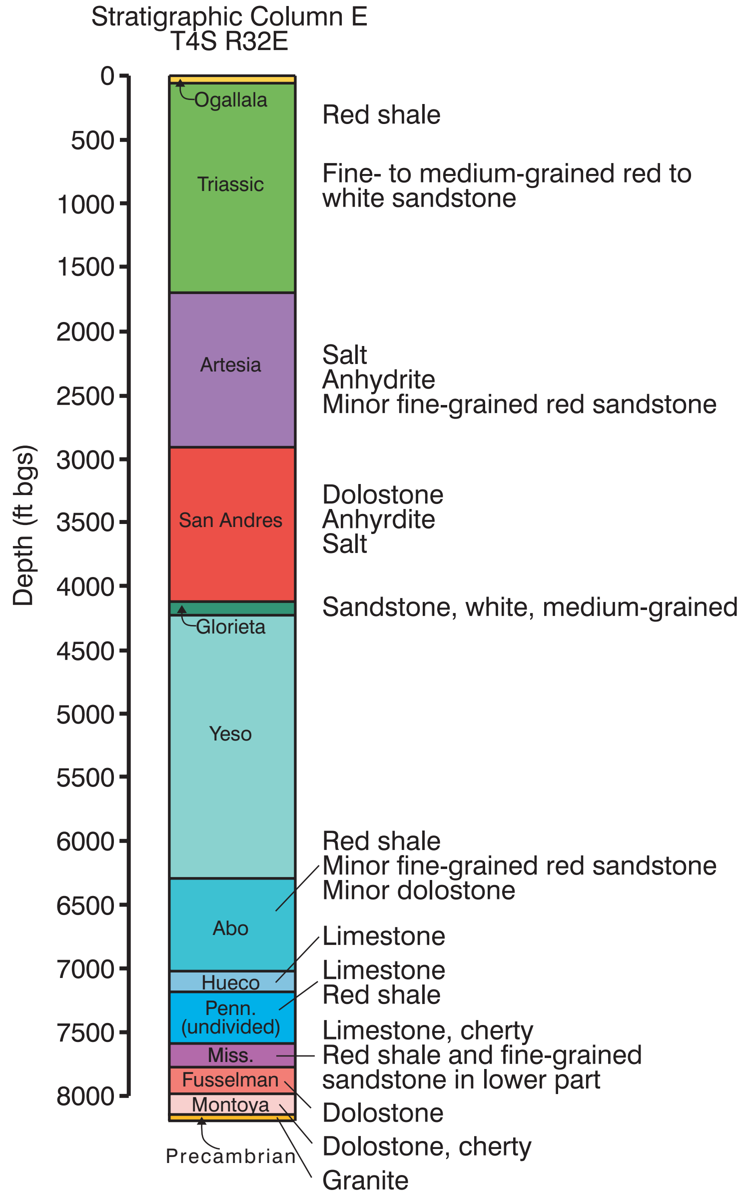


Well used in section: Cities Service No. 1 Widner
17-4N-31E, Curry County, NM

**Source:**
Modified from Broadhead and Jones, 2002



Well used in section: Austral Oil No. 1 Soadler
29-4S-32E, Roosevelt County, NM

Figure 5-15

NORTHEAST NEW MEXICO REGIONAL WATER PLAN
**Stratigraphic Sections**

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6-7-06
JN WR04.0147

According to Gutentag et al. (1984), the first detailed geologic mapping and hydrologic investigations in the area that encompasses the Northeast Region were conducted in the late 19th to early 20th centuries by W.D. Johnson (1901). Johnson's study reported on the geographic, physiographic, and hydrologic features of the High Plains area (Section 5.3.1.2) and concluded that, although the area had vast groundwater resources, major agricultural development was not feasible. Technological advances since that time have made wide-scale irrigation possible.

Investigations that have helped define regional geology, quantify groundwater supply and recharge, and assess water quality include the following:

- Baldwin and Bushman (1957) evaluated the feasibility for groundwater development in Union County.
- Trauger and Bushman (1964) reported on the geology and groundwater around Tucumcari, in Quay County.
- Berkstresser and Mourant (1966) described the groundwater resources and geology of Quay County.
- Cooper and Davis (1967) examined the occurrence and quality of groundwater in Union County.
- Lansford et al. (1982) studied the High Plains-Ogallala aquifer.
- As a part of the U.S. Geological Survey Regional Aquifer System Analysis (RASA) Program (Section 5.3.3.2.1):
  - Gutentag et al. (1984) described the geohydrology of the High Plains aquifer.
  - Luckey et al. (1986) conducted a digital simulation of groundwater flow for the High Plains aquifer.
  - Luckey et al. (1988) discussed the effects of future groundwater pumpage on the High Plains aquifer.
  - Weeks et al. (1988) summarized the full High Plains RASA study.

- Broadhead (1987) described regional geology while researching the occurrence of carbon dioxide in Union and Harding Counties.
- Kilmer (1987) detailed the water-bearing characteristics of geologic formations in northeastern New Mexico and southeastern Colorado.
- Trauger and Churan (1987) discussed the geohydrology of Harding County.
- Gustavson (1996) described the depositional systems and geology of the Ogallala and Blackwater Draw Formations.
- Wood (2000) studied groundwater recharge in the Southern High Plains aquifer.
- Blandford et al. (DBS&A, 2003) modeled groundwater availability in the Ogallala (Southern High Plains [Section 5.3.1.2]) aquifer).
- Dutton et al. (2001a) modeled saturated thickness for the Ogallala aquifer in the Panhandle Water Planning Area of the Central High Plains.

#### *5.3.1.1 Physiographic Regions*

The Northeast New Mexico water planning region falls entirely in the Great Plains physiographic province, which lies between the Rocky Mountains to the west and the Central Lowland on the east (Weeks et al., 1988). The Northeast Region falls into four sections of the Great Plains province: the High Plains, Plains Border, Raton, and Pecos sections (Fenneman, 1931). Regional geology is similar for all of these sections.

#### *5.3.1.2 Major Geologic Units*

The geologic units important to understanding the water supply in the Northeast Region range in age from recent Quaternary deposits to Precambrian igneous rocks. While more than 30 formations crop out in or underlie the region, the geology is fairly straightforward, with a pancake layering of formations dipping to the southeast (Wood, 2000). The sequence of formations is discussed, from youngest to oldest, with regard to their hydrogeologic characteristics. A geologic map of the region is presented in Figure 5-10, and cross sections showing the general geology of the region are provided as Figures 5-12 through 5-14. Geologic characteristics in Union County are summarized in Table 5-8.

*Quaternary Alluvium.* Quaternary age alluvial deposits are laterally discontinuous, and range in composition from younger stream channel and eolian sand, silt, and clay deposits to older piedmont and terrace gravel deposits. Average thickness for the younger deposits is 20 feet, although thicknesses can reach 80 feet in some areas. Older alluvium ranges from 0 to 600 feet thick (Kilmer, 1987). Alluvium is locally water bearing (Cooper and Davis, 1967; Trauger and Bushman, 1964; Berkstresser and Mourant, 1966), yielding up to 300 gallons per minute (gpm) (Kilmer, 1987).

*Extrusive/Igneous Rocks.* Extrusive/igneous rocks are local aquifers in parts of Union and Harding Counties. Extrusive/igneous rocks (Quaternary and Tertiary)—including basalt, dacite, andesite, tuff, and volcanic cinders—cover approximately 725 square miles in western and central Union County (Cooper and Davis, 1967). These deposits range in thickness from 0 to 50 feet (Kilmer, 1987). They are above the water table in most areas; however in areas where flows overlie impermeable sediments, springs are common and wells produce up to 50 gpm (Kilmer, 1987). Where volcanic rocks are thick and saturated, yields may exceed 1,000 gpm (Kilmer, 1987).

*Blackwater Draw.* The Blackwater Draw Formation (Pleistocene), composed of eolian sediments, overlies and coincides geographically (Gustavson, 1996) with the Ogallala Formation. Thicknesses range from 0 to 90 feet (Wood, 2000). This formation does not crop out in the planning region.

*Ogallala Formation.* The Ogallala Formation is one of several formations comprising the High Plains aquifer and is often referred to as the High Plains aquifer. The High Plains aquifer underlies about 174,000 square miles in parts of eight states and consists of undivided Quaternary units and three Tertiary units: the Ogallala Formation, Arikaree Group, and Brule Formation. Only 1 percent of the total High Plains area is in New Mexico (Weeks et al., 1988) and the only High Plains formation present in the state is the Ogallala (Gutentag et al., 1984).

Current distribution of the Ogallala Formation coincides with the extent of the Central and Southern High Plains; other High Plains Formations exist only in the Northern High Plains (Gustavson, 1996). The portion of the Ogallala Formation in Union, Harding, and northern Quay Counties is a part of the Central High Plains, while the portion of the Ogallala Formation present in southern Quay, Curry, and Roosevelt Counties is part of the Southern High Plains. The location of the Ogallala Formation in the planning region is shown in Figure 5-16.

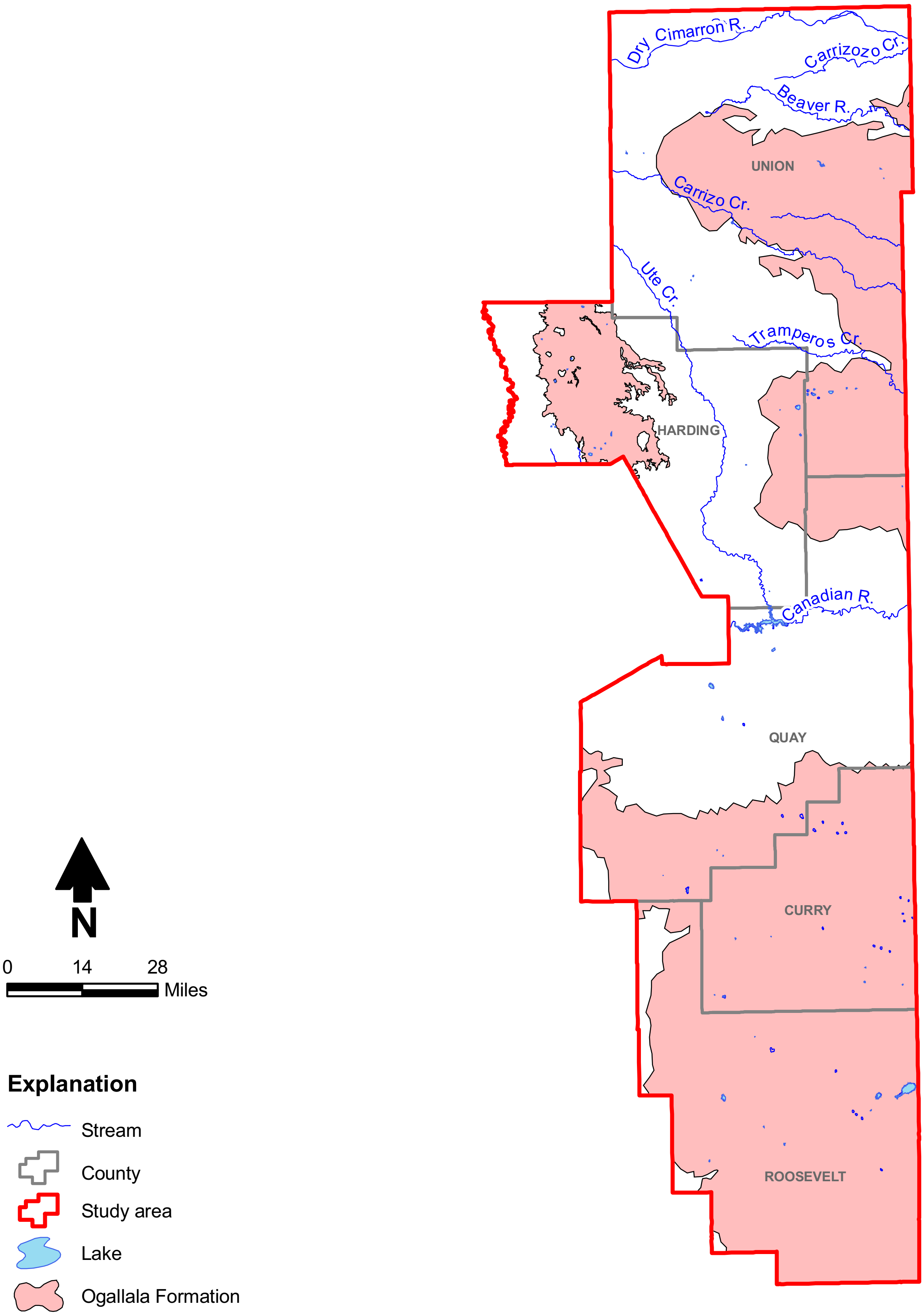
The Ogallala Formation (Pliocene) consists of fine- to coarse-grained sand, silt, and clay (Kilmer, 1987), and ledges of weathering resistant, calcium carbonate-cemented caprock are present near top of the formation (Gutentag et al., 1984). The thickness of the Ogallala Formation in the planning area ranges substantially, from 0 to a maximum thickness of 700 feet. It is up to 400 feet thick in Union County yet is absent in the south central and the northern thirds of the county (Cooper and Davis, 1967). It is up to 260 feet thick in Quay County but has eroded away in the central and southwestern parts of the county (Berkstresser and Mourant, 1966).

Near the surface of much of the Ogallala aquifer are layers of resistant caliche known as "caprock" that are formed by the leaching of carbonate and silica from surface soils and the re-deposition of the dissolved mineral layers below the surface. The caprock is up to 60 feet thick, and it generally marks the boundary of the High Plains aquifer (Weeks et al., 1988).

The Ogallala Formation is used to varying degrees in the planning region:

- The Ogallala is an important aquifer in eastern Union County (the only part of the county where it is present). Well productivity in Union County ranges from a few gpm, in areas of thin saturation, to 1,000 gpm (Kilmer, 1987).

- Although the USGS's mapping of the extent of the Ogallala aquifer indicates that the aquifer is present only in east-central Harding County, the Village of Roy and some studies (Kilmer, 1987; Dennis Engineering, 1998) indicate that the Ogallala aquifer also supplies the Village of Roy in western Harding County. According to Kilmer (1987), the Roy municipal wells are completed in the Ogallala aquifer and are very productive, with



NORTHEAST NEW MEXICO REGIONAL WATER PLAN

**Extent of Ogallala Formation**

*Daniel B. Stephens & Associates, Inc.*

03/22/2007

WR04.0147

Figure 5-16

M:/PROJECTS/WR04.0147_NE_NM_REGIONAL_WATER_PLAN/GIS/MXDS/REPORT_FINAL/FIG5-16_OGALLALA.MXD 702230 yields as high as 1,600 gpm. Some local residents of Harding County, however, question whether the Roy wells are completed in the Ogallala aquifer (Callahan, 2006; Culbertson, 2006). The western extent of the Ogallala aquifer thus remains unclear in Harding County.

- The Ogallala is absent in central and northern Quay County (Berkstresser and Mourant, 1966), but is the principal source of groundwater for the community of House in southwestern Quay County.
- The Ogallala is the principal source of groundwater in Curry and Roosevelt Counties (Lansford et al., 1982).

Wells are commonly completed in multiple aquifers in order to maximize production. For instance, in much of Union County, wells are completed in the Ogallala Formation and into the Dakota-Purgatoire Formations (Kilmer, 1987). Generally, well yields of more than 750 gpm can be obtained throughout much of the High Plains aquifer; however, yields are 250 gpm or less near the edge of the aquifer or where water level declines have greatly reduced the saturated thickness (Luckey et al., 1986).

*Niobrara Formation.* The Niobrara Formation (Upper Cretaceous) (shown as interbedded with Pierre Shale on Figure 5-10), composed of black shale with thin beds of tan limestone, is an aquitard that underlies the Ogallala aquifer. Its thickness in the planning region ranges from 0 to 1,050 feet (Cooper and Davis, 1967). The Niobrara Formation is not known to yield water (Cooper and Davis, 1967).

*Carlile Shale.* The Carlile Shale (Upper Cretaceous) is a fissile black to dark brownish shale with thin beds of limestone (Kilmer, 1987) that also forms an aquitard. It ranges in thickness from 0 to 200 feet (Cooper and Davis, 1967). The Carlile Shale is not known to yield water (Cooper and Davis, 1967).

*Greenhorn Limestone.* The Greenhorn Limestone (Upper Cretaceous) is a light tan limestone with thin beds of shale. It is generally 0 to 30 feet thick (Cooper and Davis, 1967), although it can reach thicknesses of up to 60 feet (Kilmer, 1987). The Greenhorn Limestone yields water at less than 10 gpm (Kilmer, 1987).

*Graneros Shale.* The Graneros Shale (Lower Cretaceous) is a dark gray shale with thin beds of limestone, and is generally 0 to 125 feet thick (Cooper and Davis, 1967). The Graneros Shale-Greenhorn Limestone-Carlile Shale sequence thins to as little as 60 feet in central Harding County and is absent south of Mosquero (Kilmer, 1987). The Graneros Shale is not known to yield water (Cooper and Davis, 1967).

*Dakota Sandstone.* The Dakota Sandstone (Lower Cretaceous), the upper member of the Dakota Group, is an aquifer of local importance in all areas within the planning area (Kilmer, 1987). It consists of dark brown to yellow sandstone, brown to gray shaley sandstone, and gray sandy to silty shale, with a basal unit of massive yellow to brown sandstone (Baldwin and Bushman, 1957). Its thickness ranges from 0 to 190 feet (Cooper and Davis, 1967), with the lower member averaging a thickness of 30 feet (Baldwin and Bushman, 1957). The Dakota Sandstone supplies stock and domestic wells, and its massive basal unit may yield up to 100 gpm water to wells (Cooper and Davis, 1967).

*Purgatoire Formation.* This multi-unit Lower Cretaceous formation is part of the Dakota Group (Trauger and Churan, 1987). The three units in the Purgatoire Formation include (from younger to older):

- The *Pajarito Shale*, a light gray shale and yellow sandstone up to 80 feet thick (Berkstresser and Mourant, 1966).
- The *Mesa Rica Sandstone*, a yellowish gray to light yellow-orange, fine- to medium-grained, massive sandstone (Trauger and Bushman, 1964), averaging 85 feet thick (Kilmer, 1987).
- The *Tucumcari Shale*, a dark gray shale (Broadhead, 1987) up to 60 feet thick (Berkstresser and Mourant, 1966).

The Pajarito Shale yields little to no water (Berkstresser and Mourant, 1966). Where the Ogallala is thin and non-water bearing, the Mesa Rica Sandstone together with the Dakota Sandstone constitutes an important aquifer; however yields are generally less than 5 gpm (Kilmer, 1987). The Tucumcari Shale yields little to no water (Berkstresser and Mourant, 1966). The Purgatoire Formation is not an aquifer in Quay County (Trauger and Bushman, 1964).

*Morrison Formation.* The Morrison Formation (Late Jurassic) is a greenish gray to reddish brown sandy clay, with local beds of white to brown sandstone, siltstone, and minor limestone (Cooper and Davis, 1967), that unconformably overlies the Entrada Sandstone in most of the planning area (Berkstresser and Mourant, 1966). It ranges in thickness from 0 to 600 feet (Kilmer, 1987). The sandstone beds of the Morrison Formation yield only 1 to 2 gpm, and the clay and shale beds yield little to no water (Berkstresser and Mourant, 1966). Thus the Morrison Formation is generally a poor aquifer (Trauger and Churan, 1987).

*Summerville Formation.* The Summerville Formation, formerly termed the Bell Ranch Formation (Lucas and Woodward, 2001) (Late Jurassic), conformably overlies the Entrada Sandstone, where present. It consists of orange to light brown, fine- to coarse-grained sandstone and siltstone (Broadhead, 1987). Its thickness is lumped together with the Morrison Formation, and together they measure up to 600 feet in the planning area (Broadhead, 1987). The Bell Ranch Formation is generally a poor aquifer (Trauger and Churan, 1987).

*Todilto Formation.* The Todilto Formation (Late Jurassic) is a dark gray lacustrine limestone unit, interbedded with minor sandstone and shale at its base (Lucas et al., 2001). This unit is present at thicknesses of 0 to 10 feet in Union and Harding Counties (Broadhead, 1987). The formation is not known to supply water to wells in the Northeast Region.

*Entrada Sandstone.* The Entrada Sandstone (Late Jurassic) is a massive white to pink, fine-grained eolian sandstone (Broadhead, 1987) that forms prominent ledges. While it is generally 0 to 80 feet thick, it can reach thicknesses of up to 300 feet (Kilmer, 1987). The Entrada Sandstone is the principal aquifer in Quay County (Trauger and Bushman, 1964) and a local aquifer in Union and Harding Counties and can yield up to 600 gpm water to wells (Kilmer, 1987).

*Shale and Siltstone.* Buff to grayish orange variegated shale and siltstone (Late Jurassic) overlie the Redonda Formation in some parts of Quay County. These deposits are well cemented and poorly sorted and range in thickness from 20 to 60 feet (Berkstresser and Mourant, 1966). The shale and siltstone deposits are not known to yield water to wells.

*Redonda and Chinle Formations.* Together, the Redonda and Chinle Formations (Late Triassic) form the Dockum Group. The Redonda Formation consists of thinly bedded, brownish red to bluish gray clay and shale; the Chinle Formation is characteristically brownish red to purple clay, shale, and siltstone (Trauger and Bushman, 1964). Together their thickness ranges from 0 to 1,200 feet in the planning region (Kilmer, 1987). The Redonda Formation yields very little water to wells; in the absence of a better aquifer, the Chinle Formation is used as a source of domestic and stock water, yielding 1 to 20 gpm water to wells (Berkstresser and Mourant, 1966).

*Santa Rosa Formation.* The Santa Rosa Formation (Late Triassic) consists of gray sandstone interbedded with red to brown clay and shale, and igneous gravel conglomerate (Berkstresser and Mourant, 1966). Thickness generally ranges from 1 to 375 feet (Kilmer, 1987); however, the formation can reach a maximum thickness of 450 feet (Berkstresser and Mourant, 1966). The Santa Rosa Formation yields 1 to 50 gpm water to wells and discharges to several springs that yield 1 to 150 gpm (Berkstresser and Mourant, 1966).

*Bernal Formation.* The Bernal Formation (Permian) conformably overlies the San Andres Formation and consists of a very fine-grained, reddish orange sandstone with minor dolostone and anhydrite, 150 to 400 feet thick (Broadhead, 1987).

*San Andres Formation.* The San Andres Formation is an interbedded oolitic, anhydritic dolostone, and anhydrite. Together with the Glorieta Sandstone, thickness ranges from 0 to 400 feet (Broadhead, 1987). This formation is not known to supply water to wells in the Northeast region.

*Glorieta Sandstone.* The Glorieta Sandstone (Permian) is a white, fine- to medium-grained quartzose sandstone (Broadhead, 1987), ranging from 0 to 220 feet thick (Kilmer, 1987). This formation yields up to 15 gpm water to wells (Kilmer, 1987).

*Yeso Formation.* The Yeso Formation (Permian) is an interbedded anhydrite, red mudstone, orange fine- to coarse-grained sandstone, and thinly bedded dolostone. Thickness ranges from 200 to 500 feet (Broadhead, 1987). The Yeso Formation is not known to produce potable water to wells in the Northeast Region (Kilmer, 1987).

*Abo/Sangre de Cristo Formation.* The Abo/Sangre de Cristo Formation (Permian/ Pennsylvanian) is an orange-red, fine- to medium-grained sandstone that grades downward into red shale, arkosic conglomerate, and conglomeratic sandstone with minor thinly bedded dolostone. Thickness ranges from 0 to 3800 feet (Broadhead, 1987) in Union and Harding Counties. The Abo/Sangre de Cristo Formation is not known to produce potable water to wells in the Northeast Region (Kilmer, 1987).

*Undivided Sandstone, Shale, and Limestone.* Undivided deposits of sandstone, shale and limestone (Pennsylvanian) lie below the Abo/Sangre de Cristo Formation deposits, which are middle Pennsylvanian-age tectonic features in eastern Union and southern Harding and Quay Counties, respectively. These deposits range in thickness from 0 to 650 feet (Broadhead, 1987) and are not known to supply water to wells in the Northeast Region.

*Arroyo Peñasco Formation.* The Arroyo Peñasco Formation (Mississippian) consists of green to gray shale and limestone. Thickness ranges from 0 to 450 feet (Broadhead, 1987). This formation is not known to supply water to wells in the Northeast Region.

*Viola, Simpson, and Ellenburger Groups.* The Viola, Simpson, and Ellenburger Groups (Ordovician) are present in the Dalhart Basin in Union and Harding Counties and consist of dolostone. Together with the Wilberns Formation, thickness ranges from 0 to 600 feet (Broadhead, 1987). These formations are not known to supply water to wells in the Northeast Region.

*Wilberns Formation.* The Wilberns Formation (Cambrian), a quartzose sandstone, is present in the Dalhart Basin (Broadhead, 1987). Cambrian formations do not supply water to wells in the Northeast Region.

*Precambrian Rocks.* Precambrian rocks found in the planning area include granite, diabase, metavolcanics, and metasediments (Broadhead, 1987). These rocks do not supply water to wells in the Northeast Region.

### 5.3.2 Aquifer Characteristics and Groundwater in Storage

This section discusses the groundwater supply in each of the water-bearing geologic formations in the Northeast region. The following definitions are included to help the reader who may not be familiar with the exact meaning of some of the hydrogeologic terms used in the discussions. Additional terms are defined in the Glossary at the beginning of this report.

- *Hydraulic conductivity.* A rate of proportionality (generally expressed in units of feet per day or centimeters per second) describing the rate at which water can move through a permeable medium. The density and kinematic viscosity of the water must be considered in determining hydraulic conductivity.

- *Specific yield.* The quantity of water that a unit volume of aquifer will yield by gravity after it is saturated, expressed as either a ratio or a percentage of the aquifer volume. In practical terms, specific yield is a measure of the water available to wells.

- *Transmissivity.* The rate (generally presented in units of gallons per day per foot or square feet per day) at which water of a prevailing density and viscosity is transmitted through a unit width of an aquifer or confining bed under a unit hydraulic gradient. Transmissivity is a function of properties of the liquid, the porous media, and the thickness of the porous media.

- *Specific capacity.* The yield of a well per unit of drawdown of the water table, usually expressed as gallons pumped per minute per foot of drawdown (gpm/ft). Specific capacity generally varies with duration of pumping: as pumping time increases, specific capacity decreases. Specific capacity will also typically decrease as the pumping rate decreases.

- *Specific conductance:* The ability of a substance to conduct an electrical current, expressed in microSiemens per centimeter at 25 degrees Celsius (µS/cm @ 25°C). This is a general indicator of water quality, or the amount of dissolved solutes in water.

- *Storage coefficient:* The volume of water that an aquifer releases or takes into storage per unit area per unit change in head. Units are volume, for example the amount of water released when the potentiometric surface declines by a specified amount.

Aquifers in the Northeast region that contain significant recoverable quantities of potable water are found at relatively shallow depths, generally less than 500 feet, and the quality of groundwater generally worsens with depth. In addition, clastic rocks at depths over 2,000 feet have been compacted and are less porous, making them less able to yield water to wells (Kilmer, 1987). The principal aquifers in the planning region that provide some sort of water supply are described below; characteristics of these aquifers are summarized in Table 5-9.

- *Quaternary Alluvium.* In the Northeast Region, younger alluvium constitutes an aquifer only in a few areas in stream valleys where there is sufficient saturated thickness to sustain water yield to wells. Such conditions occur near Capulin, where saturated thickness is as much as 100 feet and yields may reach 300 gpm (Dinwiddie and Cooper, 1966).

- *Extrusive/Igneous Rocks.* Extrusive/igneous rocks yield up to 1,000 gpm in the Capulin area, and one spring in the vicinity of Folsom is reported to yield up to 50 gpm (Dinwiddie and Cooper, 1966).

- *Ogallala Formation.* Hydraulic conductivity and specific yield in the Ogallala Formation vary widely both areally and vertically. Hydraulic conductivity ranges from about 25 to 300 ft/d and averages 60 ft/d. Specific yield ranges from about 10 to 30 percent and averages 15 percent (Luckey et al., 1986). Groundwater in the Ogallala Formation flows from west to east at about 1 foot per day (Weeks et al., 1988). Depth to water ranges from just below land surface to more than 400 feet. While the saturated thickness of the overall Ogallala Formation ranges from nearly 0 to about 1,000 feet, the thicker portions

## Table 5-9. Aquifer Characteristics of Water-Bearing Formations in the Northeast Region

| Formation | Thickness (feet) | Yield (gpm) | Transmissivity (gpd/ft) | Specific Capacity (gpm/ft) | Specific Conductance (µS/cm) | Storage Coefficient |
|---|---|---|---|---|---|---|
| Quaternary alluvium: Younger | 100 max[a] | 300 max[a] | Moderate | 1 – 10 | 452 – 3,980 | Unknown |
| Older | 0 – 600 | 300 max | 6,620 | 1 – 5 | 781 – 3,840 | Unknown |
| Extrusive igneous | 0 – 50[a] | 50 – >1,000[a] | Low to high | 0 – 36 | 86 – 935 | Unknown |
| Ogallala Formation | 700 max[b] | 1,600 max | 3,000 – 90,500 | 1 – 30 | 326 – 820 | 0.1 avg |
| Greenhorn Limestone | 0 – 30[c]<br>60 max | <10 | Very low | <0.5 | 448 – 5,900 | Unknown |
| Dakota Sandstone/Purgatoire Formation | 0 – 300 | 0 – 400 | 3,700 – 66,600 | 0.5 – 5 | 40 – 5,640 | 0.00007 |
| Morrison Formation | 0 – 600 | 1 – 2 | Low to moderate | <1 | 813 – 2,520 | Unknown |
| Entrada Sandstone | 0 – 300 | 0 – 600 | 630 – 5,560 | 0.5 – 5 | 540 – 3,190 | 0.0002 – 0.144 |
| Redonda and Chinle Formations | 0– 1,200 | 0 – 20 | Very low | 0.03 – 1 | 906 – 5,270 | Unknown |
| Santa Rosa Formation | 1 – 375<br>450 max[d] | <10 avg<br>150 max | Low | <1 | 491 – 2,640 | Unknown |
| Glorieta Sandstone | 0 – 220 | 15 max[e] | Low | <1 | Unknown | Unknown |

Source: Kilmer, 1987 (unless otherwise noted)
[a] Dinwiddie and Cooper, 1966
[b] In New Mexico; Ogallala thickness outside New Mexico can range up to 1,000 feet.
[c] Cooper and Davis, 1967
[d] Berkstresser and Mourant, 1966
[e] Locally more

gpm = Gallons per minute
gpd/ft = Gallons per day per foot
gpm/ft = Gallons per minute per foot of drawdown
µS/cm = MicroSiemens per centimeter

of the aquifer do not occur in New Mexico (Luckey et al., 1988). In 2000, the maximum saturated thickness for the Ogallala aquifer in New Mexico was 200 feet (McGuire et al., 2003). Further information regarding the sustainability of the aquifer is provided in Sections 5.3.5 and 5.3.6.

- *Greenhorn Limestone.* The Greenhorn Limestone yields less than 10 gpm in northeast New Mexico (Kilmer, 1987).

- *Dakota Sandstone/Purgatoire Formation.* The Dakota forms an aquifer with the Purgatoire Formation in many areas and is productive over a large area, including Baca County in Colorado, Colfax and Union Counties in New Mexico, and Cimarron County in Oklahoma (Kilmer, 1987).

- *Morrison Formation.* The sandstones of the Morrison and Exeter/Entrada form a single hydrologic unit in some areas, and many wells have multiple completions tapping both the Morrison-Exeter/Entrada aquifer and the Ogallala Formation (Kilmer, 1987).

- *Entrada Sandstone.* The Entrada Sandstone yields up to 600 gpm.

- *Redonda and Chinle Formations.* The Redonda and Chinle Formations (together the Dockum Group) yield up to 20 gpm. The Chinle Formation is sparsely used as an aquifer due to low yields and poor quality resulting from its fine texture (Kilmer, 1987).

- *Santa Rosa Formation.* The Santa Rosa Formation yields less than 10 gpm on average, but can yield up to 150 gpm. In the Tucumcari area, the Santa Rosa Formation occurs at a depth of about 1,500 feet and the water is not usable (Trauger and Bushman, 1961).

- *Glorieta Sandstone.* The Glorieta Sandstone yields up to 15 gpm (locally more).

### 5.3.3 Recharge

Recharge is simply the addition of water to an aquifer. Natural recharge to groundwater commonly occurs as areal recharge, localized recharge, and recharge from mountain fronts (DBS&A, 1999).

- Areal recharge is natural recharge derived from precipitation that falls on large portions of the landscape and percolates downward through the vadose zone to the aquifer.
- Localized recharge occurs where there is prolonged ponding on the surface, such as a losing stream (i.e., a stream from which water is flowing to groundwater), playa lake, reservoir, or flood irrigation.
- Mountain front recharge typically involves complex processes of saturated and unsaturated flow in bedrock and downslope migration into aquifers at the base of the mountains.

Recharge to the aquifers in the Northeast Region occurs through direct rainfall and localized recharge of precipitation from playa lakes, the latter being the primary recharge mechanism. Irrigation return flow may also provide a significant amount of recharge to the Ogallala aquifer (Scanlon et al., 2003); however, this water is not “new” water, as almost all water used for irrigation is groundwater (DBS&A, 2003).

Most of the rainfall in the Northeast Region falls between the months of May through October, when evapotranspiration is at its peak (Nativ, 1988). Because evapotranspiration demand greatly exceeds precipitation in the planning region, little precipitation goes to recharge groundwater (Weeks et al., 1988; Wood, 2000). Recharge is expected to vary considerably from year to year, depending on the amount of precipitation received, and is further thought to alternate between several years with favorable conditions, followed by several years with less favorable conditions, when recharge is negligible (Dugan et al., 1994).

### 5.3.3.1 Documented Recharge Estimates

Recharge to aquifers in the Northeast Region has been estimated by numerous investigators to range from less than 1 percent to 5 percent of total rainfall (Theis, 1937; Havens, 1966; Brown and Signor, 1973; Stone, 1984; Stone and McGurk, 1985; Wood and Sanford, 1995). Documented recharge estimates are summarized in Table 5-10. The highest recharge is estimated to occur from playa lakes, which are relatively sparse in the Northeast Region.

**Table 5-10. Summary of Estimates of Recharge to Groundwater**

| Source [a] | Type of Recharge | Location of Study [b] | Estimated Recharge (in/yr) |
|---|---|---|---|
| Theis (1937) | Regional | Southern High Plains | 0.13–0.67 |
| Havens (1966) | Regional | Northern Lea County | 0.81 |
| Brown and Signor (1973) | Regional | Southern High Plains | 0.02–0.08 |
| Gutentag et al. (1984) | Regional | High Plains aquifer | 0.06–0.11 |
| Stone (1984) | Regional | Curry County | 0.01 |
| Stone and McGurk (1985) | Playa | Southern High Plains | 0.48 |
| Stone and McGurk (1985) | Interplaya | Southern High Plains | 0.03 |
| Wood and Osterkamp (1984) | Regional | Llano Estacado [c] | 0.10 |
| Wood and Osterkamp (1984) | Playa | Llano Estacado [c] | 1.57 |
| Stone (1990) | Interplaya | Eastern New Mexico | 0.03 |
| Nativ (1988) | Playa | Southern High Plains | 0.51–3.15 |
| Dugan et al. (1994) | Regional | High Plains aquifer | 0.51 |
| Wood and Sanford (1995) | Regional | Southern High Plains | 0.43 |
| Wood and Sanford (1995) | Playa | Southern High Plains | 3.03 |
| Scanlon et al. (2003) | Playa | Southern High Plains | 2.36–4.72 |
| Mullican et al. (1997) | Interplaya | Southern High Plains | <0.004 |
| DBS&A (2003) | Regional | Southern High Plains | 0.007-0.043 [d] |

Source: Scanlon et al. (2003)

[a] Sources cited by Scanlon et al. (2003)

[b] The complete High Plains aquifer includes western Wyoming, southern South Dakota, most of Nebraska, eastern Colorado, northwest and southern Kansas, western Oklahoma, western Texas, and eastern New Mexico (Weeks et al., 1988). Given its vast size, the High Plains aquifer is considered to have three subdivisions (Northern, Central, and Southern), two of which are partially located in the Northeast Region:

- The Central High Plains aquifer is found in Union, Harding, and northern Quay Counties
- The Southern High Plains aquifer includes portions of southern Quay, Curry, and Roosevelt Counties.

[c] The term Llano Estacado refers to the semiarid plateau of the Southern High Plains.

[d] New Mexico portion of the study area

### *5.3.3.2 Modeled Recharge Estimates*

Three modeling efforts that pertain to the Northeast Region have been conducted, all of which have modeled the High Plains aquifer (Section 5.3.1.2). Recharge estimates from the calibrated models are discussed in the following subsections.

*5.3.3.2.1 High Plains Regional Aquifer-System Analysis (RASA).* The U.S. Geological Survey initiated the RASA in 1978 to evaluate the historical and future effects of groundwater development in the High Plains aquifer (Weeks et al., 1988). For this analysis, digital, finite-difference models were run for the groundwater flow system in the southern, central, and northern High Plains aquifer.

Separate models were constructed for each part of the High Plains (Northern, Central, and Southern), each one simulating both the pre-development and development periods (Weeks et al., 1988). The three parts were modeled separately because little water is exchanged between the Northern and Central or between the Central and Southern High Plains aquifers (Luckey et al., 1986). Pre-development recharge estimates were varied by simulation until predicted water levels were similar to observed pre-development water levels.

Pre-development recharge ranged from 0.056 to 0.84 in/yr for the Central High Plains and from 0.086 to 1.03 in/yr for the Southern High Plains, with recharge differing by soil type (less recharge in clay-loam and silt-loam soils than in sandy soils) (Luckey et al., 1986). Quantification of irrigation return flow was varied in order to find the best match between simulated and observed water levels. For example, for the 1960–1980 development period, 2 in/yr of recharge were added for the Southern High Plains, due to increased playa recharge and standing water in fields (Luckey et al., 1986).

*5.3.3.2.2 Central High Plains Aquifer Groundwater Availability Model.* A groundwater availability model (GAM) for the central High Plains aquifer was developed by the Texas Bureau of Economic Geology (BEG), with an emphasis on those portions of the aquifer within the PWPA of north Texas. The BEG used a numerical model calibrated under predevelopment (1950) and current (1998) pumping conditions to predict future water-level changes (Dutton et al., 2001a).

The Central High Plains GAM used recharge values that increased based on the amount of precipitation received. For areas that received less than 17 in/yr of precipitation, recharge was set as linear in proportion to precipitation. For areas receiving more than 17 in/yr of precipitation, recharge was set as non-linear, with the rate of recharge increasing as the precipitation rate increased (Dutton et al., 2001a). Recharge was also varied with soil type: decreased for Blackwater Draw (fine-grained eolian) soil types and increased for Ogallala and sandy soil types. Groundwater recharge was less than 1 percent for 72 percent of the modeled area, less than 2 percent for 92 percent, and between 5 and 6 percent for 3 percent of the modeled area. The highest recharge rates occurred in sandy soils on the eastern side of the Central High Plains (in Kansas, Oklahoma, and Texas) (Dutton et al., 2001a).

*5.3.3.2.3 Southern Ogallala Aquifer Groundwater Availability Model.* A second GAM was developed for the southern Ogallala aquifer in New Mexico and Texas (DBS&A, 2003). For this study, a numerical model was developed and used to evaluate future changes in water levels and saturated thickness through 2050. In the transient model, recharge was maintained at pre-development rates, and an enhanced recharge term (for recharge below irrigated and non-irrigated agricultural lands) was added.

This modeling study found that recharge distribution in the Southern Ogallala is a function of both land use and soil type. Enhanced recharge was assumed to be greater in areas where the soil had higher permeability and also greater under irrigated fields than non-irrigated fields. The range in applied recharge values used in the transient model for the New Mexico portion of the study area included 1.75 in/yr for irrigated areas with high permeability and 1.25 in/yr for irrigated areas with medium-high permeability. Non-irrigated areas had recharge rates equivalent to the pre-development rates of 0.007 to 0.043 in/yr. For drought conditions, recharge rates were assumed to be 30 percent lower (the approximate difference between average annual rainfall during a drought on record and for the period of record) than the enhanced recharge rates applied in the transient model (DBS&A, 2003).

#### *5.3.3.3 Maxey-Eakin Recharge Estimates*

For another approximation of recharge, DBS&A estimated recharge using the Maxey-Eakin method, which has been independently evaluated by Watson et al. (1976) and Avon and Durbin (1994). Watson et al. (1976) found the Maxey-Eakin approach to yield reliable “first approximation" estimates of basin recharge. Avon and Durbin (1994) compared Maxey-Eakin recharge estimates to independently estimated recharge values for 146 basins and found the Maxey-Eakin estimate to generally lie within 50 percent of the independent estimates.

Maxey and Eakin (1949) hypothesized that a direct relationship exists between annual precipitation and annual recharge: the higher the annual precipitation, the higher the annual recharge. This hypothesis was supported by basin water balance studies (Maxey and Eakin, 1949) that indicated that higher-elevation, wetter groundwater basins in Nevada exhibited higher annual discharge rates (in the absence of significant groundwater pumping, discharge from a basin should be roughly equal to recharge) than lower-elevation, drier basins. Upon this premise, and using a contoured precipitation map of the state of Nevada prepared by Hardman (1936), they defined average annual recharge to a groundwater basin in Nevada as:

$$\text{Volume recharge} = A_1R_1 + A_2R_2 + A_3R_3 + A_4R_4 + A_5R_5 \qquad (1)$$

where: $A_i$ = the land surface area ($L_2$) in a groundwater basin encompassed between two iso-precipitation contours

$R_i$ = $r_i P_i$

where: $i$ = precipitation contour

$R_i$ = recharge rate (L/T) computed within precipitation zone i

$r_i$ = the percentage of precipitation that becomes recharge within precipitation zone i

$P_i$ = the average annual precipitation in zone i

Given the pre-existence of the contoured precipitation map of the state (Hardman, 1936), from which areas could be determined, the only set of unknowns in this recharge model are the percent recharge values ($r_i$). To estimate $r_i$, Maxey and Eakin (1949) used independent water balance results from 21 groundwater basins in the state of Nevada. These studies provided volume recharge for those 21 basins, and the contoured precipitation map (Hardman, 1936) provided the required $A_i$. Using these two known quantities, Maxey and Eakin (1949) solved for the $r_i$ values using multiple regression. The results of their analysis are summarized in Table 5-11.

### Table 5-11. Comparison of Values for the Percentage of Precipitation that Recharges Groundwater

| Precipitation Zone (inches) | Percentage of Precipitation that Recharges Groundwater (%) | |
|---|---|---|
| | Maxey-Eakin Coefficient [a] | Basins in Northeast New Mexico [b] |
| >20 | 25 | NA |
| 15-20 | 15 | 4.7 |
| 12-15 | 7 | 1.5 |
| 8-12 | 3 | 1 |
| <8 | 0 | NA |

[a] Based on the Maxey-Eakin method developed for Nevada

[b] Values used for this planning study; based on recharge studies in the Northeast Region (Table 5-10)

NA = Not applicable (there are no significant areas in the planning region with more than 20 or less than 8 inches of precipitation)

The percentage of precipitation that recharges basins in northeast New Mexico, as estimated by various researchers, ranges from less than 1 percent to 5 percent (Table 5-10), much lower than rates of recharge in Nevada (Table 5-11).

Recharge in the Northeast Region was estimated by calculating the area of each precipitation contour within each county and multiplying the result by the percentage ranges in Table 5-11. These estimates are shown on Table 5-12.

### Table 5-12. Calculated Recharge Using a Modified Maxey Eakin Method

| County | Annual Recharge | | |
|---|---|---|---|
| | ac-ft | % ppt | in/yr |
| Union | 88,200 | 2.9 | 0.43 |
| Harding | 24,300 | 1.5 | 0.21 |
| Quay | 49,200 | 2.2 | 0.32 |
| Curry | 46,700 | 4.0 | 0.62 |
| Roosevelt | 38,500 | 2.1 | 0.29 |
| Total | 246,900 | 2.5 | 0.33 |

ac-ft = Acre-feet
% ppt = Percent of precipitation

### 5.3.4 Major Well Fields

To gather information on municipal well fields in the Northeast Region, DBS&A surveyed each municipality in the planning region. Based on this survey, the following well fields were identified:

- In Union County, three communities have well fields that provide the municipal water supply. The aquifers in which these water supply wells are completed are:
    - City of Clayton: Ogallala aquifer
    - Village of Grenville: Dakota Sandstone and Permian aquifers
    - Village of Des Moines: Dakota Sandstone aquifer

- In Harding County, the Village of Mosquero water supply wells are completed in the Dakota Sandstone aquifer. The Village of Roy reports that the Roy water supply wells are completed in the Ogallala aquifer, but aquifer completion could not be verified for these wells.

- In Quay County, four communities maintain water supply well fields drawing from the following aquifers:
    - City of Tucumcari: Entrada Sandstone and alluvial aquifers
    - Village of Logan: Santa Rosa Sandstone and alluvial aquifers
    - Village of House: Ogallala aquifer
    - Village of San Jon: Supplied entirely by groundwater from the Village of Logan, delivered by pipeline. Village of San Jon wells (which are no longer in use) are completed in an alluvial aquifer and the Chinle Formation

- In Curry County, the Village of Grady, Village of Melrose, City of Clovis, and Village of Texico water supply wells are completed in the Ogallala aquifer. No water system data were received from Cannon AFB; however, Cannon is likely also supplied by the Ogallala aquifer.

- In Roosevelt County, water supply wells for the City of Portales and Villages of Dora, Causey, and Elida are completed in the Ogallala aquifer. No water system data were received from the Village of Floyd; however, Floyd is likely also supplied by the Ogallala aquifer.

Major irrigated areas identified in the Northeast Region include the area around Sedan in Union County (Trujillo, 2006), acreage irrigated by the Arch Hurley Conservancy District near Tucumcari in Quay County, the House area in Quay County, the Clovis area in Curry County, the Portales area in Roosevelt County, and the Causey Lingo area in Roosevelt County (Woodward, 1998).

DBS&A also obtained information on all permitted wells completed in OSE-declared groundwater basins in each county from the OSE WATERS database (http://www.ose.state.nm.us/waters_db_index.html), as summarized in Table 5-13. Because the Clayton and Causey Lingo basins were not declared until September 23, 2005, numerous un-permitted domestic, stock, and irrigation wells are expected to exist in these newly declared areas, which lie primarily in Union and Roosevelt Counties. Additionally, the WATERS database is continually being updated and may not include all wells that exist.

Further information regarding aquifer sustainability is provided in Sections 5.3.5 and 5.3.6.

### *5.3.5 Water Level Trends*

The following subsections summarize available water level data for municipalities in the Northeast Region, as well as data for wells monitored by the USGS that are within 4 miles of each municipality. These data provide an indication of declines in saturated thicknesses near the major producers (additional discussion of aquifer sustainability is provided in Section 5.3.6). A discussion of water levels in the main irrigation areas is also included. Maps illustrating water level trends throughout the region are included as Figures 5-17 and 5-18, and representative hydrographs showing water level changes over time are provided in Appendix D3.

## Table 5-13. Summary of Groundwater Wells in WATERS Database

| Well Type | Number of Permitted Wells[a] | | | | |
|---|---|---|---|---|---|
| | Union[b] | Harding | Quay | Curry | Roosevelt[c] |
| *OSE-declared groundwater basin(s)* | *Clayton*<br>*Tucumcari* | *Canadian River*<br>*Tucumcari*<br>*Clayton* | *Clayton*<br>*Tucumcari*<br>*Fort Sumner*<br>*Curry* | *Curry*<br>*Portales* | *Causey Lingo*<br>*Portales*<br>*Roswell* |
| Municipal | 1 | 11 | 34 | 16 | 5 |
| Domestic | 7 | 74 | 344 | 753 | 1,963 |
| Multiple domestic | 1 | --- | 4 | 9 | 2 |
| Stock | 21 | 359 | 605 | 104 | 493 |
| Pre-basin | | | | | |
| Domestic | 11 | --- | --- | --- | --- |
| Livestock | 411 | --- | --- | --- | 4 |
| Domestic/livestock | 245 | 1 | 1 | --- | --- |
| Irrigation | 135 | 7 | 95 | 494 | 363 |
| Dairy | --- | --- | --- | 2 | 3 |
| Feed pen operation | --- | --- | --- | 2 | --- |
| Other agriculture | 1 | --- | 1 | --- | --- |
| Industrial | 2 | 43 | --- | 2 | --- |
| Commercial | --- | 16 | --- | 5 | 2 |
| Pollution control | --- | --- | 15 | --- | --- |
| Sanitary | --- | --- | 6[d] | 20 | 10 |
| MDWCA | --- | 1 | 1 | --- | --- |
| Storage | --- | --- | 3[e] | --- | --- |
| Exploration | --- | --- | 15 | 12 | 91 |
| Prospecting | --- | 1 | --- | --- | 5 |
| Oil | --- | --- | --- | --- | 20 |
| Observation | --- | --- | --- | --- | 2 |
| Construction | --- | --- | --- | 1 | 1 |
| Construction of public works | --- | --- | 1 | --- | 8 |
| No use of right or POD | 2 | --- | --- | --- | 1 |
| Total | 837 | 513 | 1,125 | 1,420 | 2,973 |
| Total diversion (ac-ft/yr) | 82,818 | 25,744 | 305,192 | 340,553 | 173,609 |

[a] As of May 26, 2006

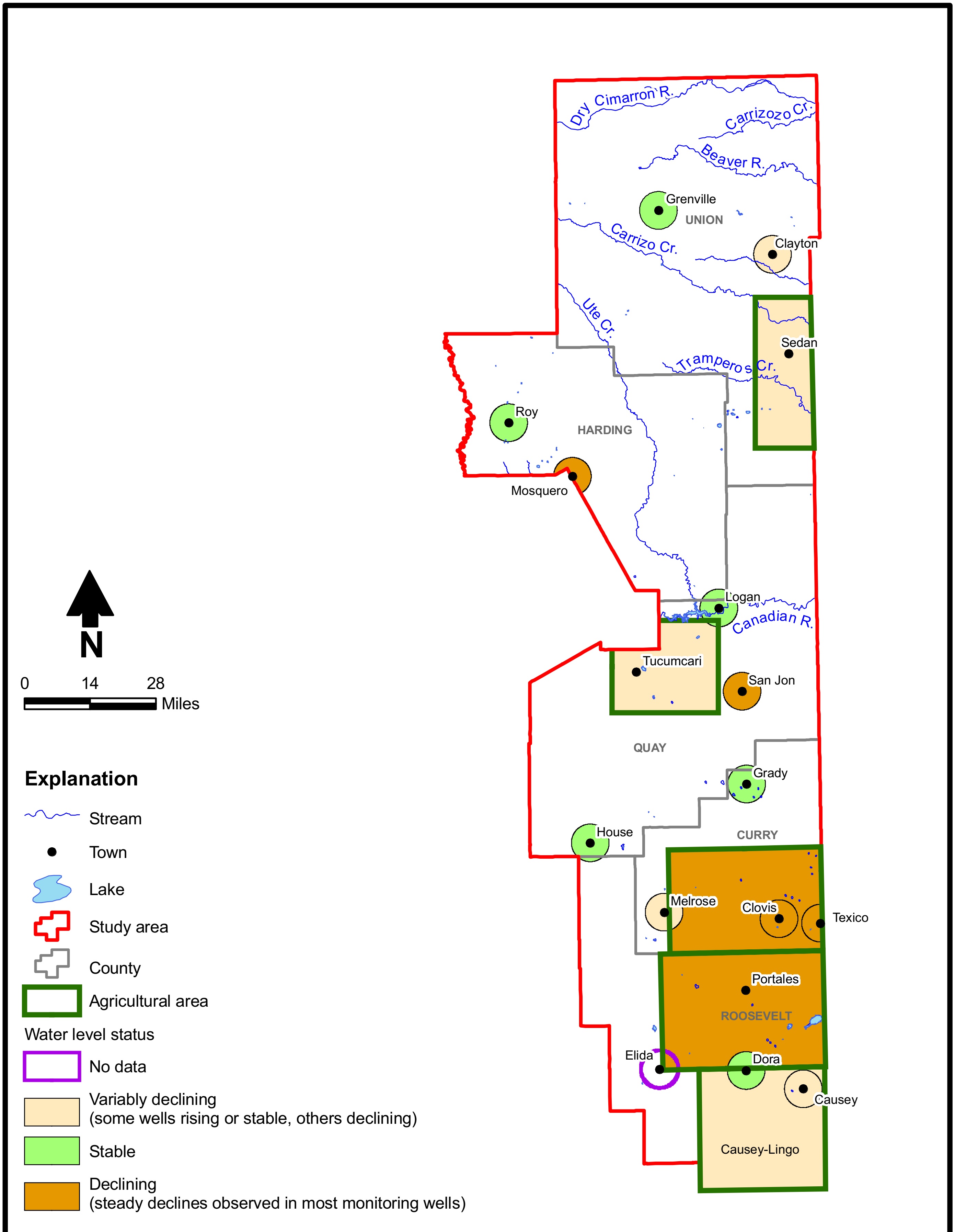
[b] Majority of county is in Clayton Groundwater Basin, which was declared on 9/23/2005, likely explaining the small number of wells in the database.

[c] Majority of county is in Causey Lingo groundwater basin, which was declared on 9/23/2005.

[d] In conjunction with commercial use

[e] Held by ISC for water in Ute Reservoir

--- = No wells listed for this use
MDWCA = Mutual domestic water consumers association
ac-ft/yr = Acre-feet per year



NORTHEAST NEW MEXICO REGIONAL WATER PLAN

**Water Level Declines**

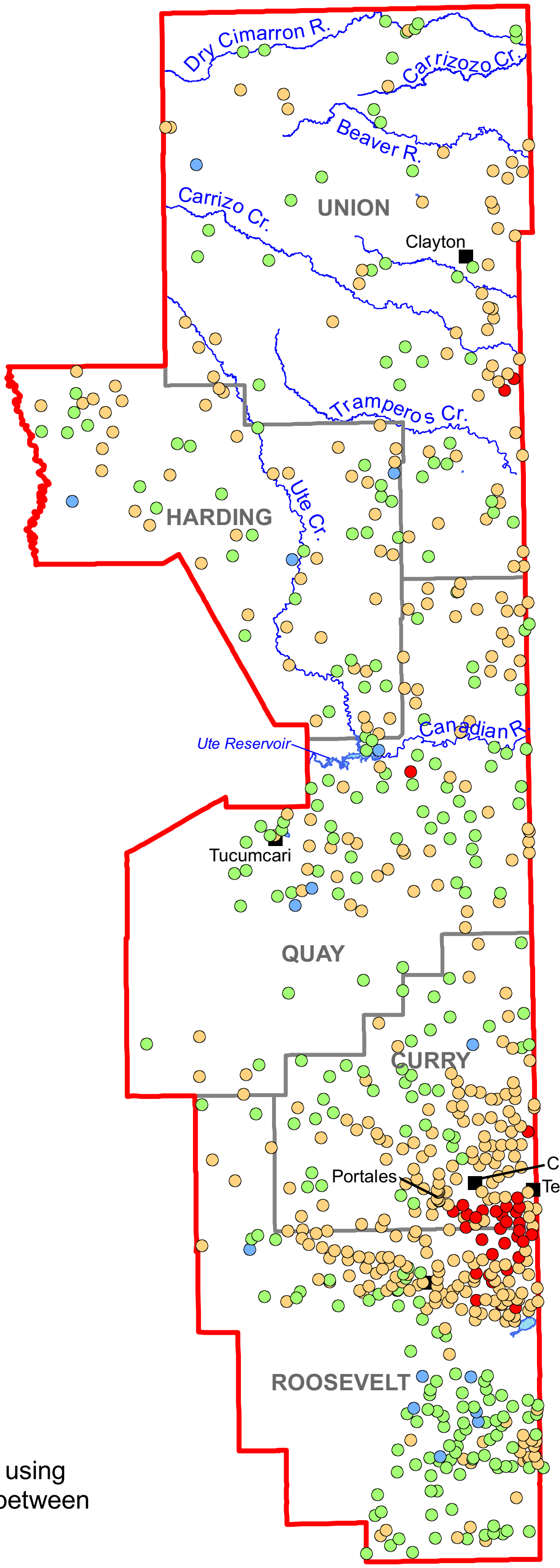
*Daniel B. Stephens & Associates, Inc.*

03/22/2007

WR04.0147

Figure 5-17

M:/PROJECTS/WR04.0147_NE_NM_REGIONAL_WATER_PLAN/GIS/MXDS/REPORT_FINAL/FIG5-17_WATER_LEVEL_DECLINES.MXD 702230



## Explanation

■ Town

Stream

Lake

County

Study area

**USGS well**

Groundwater elevation change

🔴 Decreased more than 75 ft

🟠 Decreased less than 75 ft

🟢 Increased less than 20 ft

🔵 Increased more than 20 ft

Note: Groundwater elevation change calculated using earliest and latest measurements for each well between 1970 and 2005.

NORTHEAST NEW MEXICO REGIONAL WATER PLAN

**Groundwater Elevation Change**

*Daniel B. Stephens & Associates, Inc.*
03/22/2007
WR04.0147

Figure 5-18

M:/PROJECTS/WR04.0147_NE_NM_REGIONAL_WATER_PLAN/GIS/MXDS/REPORT_FINAL/FIG5-18_GW_ELEVATION_CHANGE.MXD 702230

As discussed in these subsections, an evaluation of hydrogeologic data, previous studies, and modeling results by CH2M Hill suggests that communities supplied by the Ogallala aquifer (House, Grady, Melrose, Clovis, Texico, Cannon AFB, Portales, and Causey) may exhaust their supply within 30 to 40 years (CH2M Hill, 2005d). The other portions of the region are not experiencing such severe regional declines, but may experience some localized declines that could affect individual well production.

#### *5.3.5.1 Union County*

Town of Clayton water supply wells are completed in the Ogallala aquifer; however, the Town does not monitor water levels in their municipal wells. Change in depth to water has been tabulated for all wells monitored by the USGS within 4 miles of Clayton, including those completed in other aquifers, as summarized in Table 5-14.

**Table 5-14. Change in Water Levels in USGS-Monitored Wells near Clayton**

| | | Change in Water Level | | | |
|---|---|---|---|---|---|
| | | Period of Record | | Amount [a] (feet) | Average Rate (ft/yr) |
| Aquifer | Well ID | Dates | No. of Years | | |
| Ogallala | 362422103123101 | 1981-1996 | 15 | +2.31 | +0.14 |
| | 362540103095001 | 1965-2005 | 40 | +4.90 | |
| Dakota Sandstone | 362553103073201 | 1970-1996 | 26 | –58.92 | –2.3 |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed December 12, 2005.

[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

Water levels in the wells completed in the Ogallala aquifer have increased for both wells. The average rate of increase for these two wells is 0.14 feet per year (ft/yr). However, these wells only represent trends in their immediate local area; modeling studies indicate that decline of the Ogallala in Union County is expected. The USGS-monitored well completed in the Dakota Sandstone aquifer has declined at an average rate of 2.3 ft/yr over 26 years.

Village of Grenville water supply wells are completed in the Dakota-Purgatoire aquifers; however, the Village does not monitor water levels in their municipal wells. Change in depth to water has been tabulated for all the USGS-monitored wells within 4 miles of Grenville, including those completed in other aquifers, as summarized in Table 5-15.

**Table 5-15. Change in Water Levels in USGS-Monitored Wells near Grenville**

| | | Change in Water Level | | | |
|---|---|---|---|---|---|
| | | Period of Record | | | |
| Aquifer | Well ID | Dates | No. of Years | Amount[a] (feet) | Average Rate (ft/yr) |
| Dakota-Purgatoire | 363451103393901 | 1981-1996 | 15 | +0.30 | +0.02 |
| | 363751103343001 | 1955-1996 | 41 | –0.92 | –0.02 |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed December 12, 2005.

[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

Water levels for the two USGS-monitored wells near Grenville do not show large water level fluctuations. The average rate of increase for the well with a rise in water level has been 0.02 ft/yr over 15 years. The average rate of decline for the well with a drop in water level has been 0.02 ft/yr over 41 years.

One USGS-monitored well is located within 4 miles of Des Moines and within 4 miles of Folsom; however, no depth to water data are available for that well. No other USGS-monitored wells exist near Des Moines or Folsom. The Village of Des Moines does not monitor water levels in their municipal wells, and the Village of Folsom does not have a water system.

Irrigated agriculture in Union County is concentrated in the Sedan area, located 22 miles south of Clayton. Irrigation near Sedan stretches approximately 12 miles north, 20 miles south, 10 miles east, and 7 miles west of town (Carter, 2006). Changes in depth to water for all wells monitored by the USGS within this area are summarized in Table 5-16.

Water levels in the wells completed in the Ogallala aquifer have decreased in five wells and increased in two wells. The average rate of decrease has been 0.90 ft/yr, and the average rate of increase has been 0.10 ft/yr. Water levels in the wells completed in the Dakota Sandstone aquifer have decreased in ten wells and increased in three wells. The average rate of decrease has been 1.95 ft/yr, and the average rate of increase has been 0.16 ft/yr. Water levels in both of the wells completed in the Entrada Sandstone aquifer have decreased. The average rate of decrease has been 1.31 ft/yr.

### Table 5-16. Change in Water Levels in USGS-Monitored Wells near Sedan

| | | Change in Water Level | | | |
|---|---|---|---|---|---|
| | | Period of Record | | Amount[a] (feet) | Average Rate (ft/yr) |
| Aquifer | Well ID | Dates | No. of Years | | |
| Ogallala | 355144103041201 | 1967-2006 | 39 | –4.41 | –0.90 |
| | 355420103062001 | 1981-1996 | 15 | –6.99 | |
| | 360336103033401 | 1967-1996 | 29 | –52.84 | |
| | 361715103075001 | 1981-2006 | 25 | –33.33 | |
| | 361847103064701 | 1968-2005 | 37 | –29.22 | |
| | 355434103073901 | 1981-2006 | 25 | +1.26 | +0.10 |
| | 355934103145201 | 1981-1996 | 15 | +2.26 | |
| Dakota Sandstone | 355602103064001 | 1967-2006 | 39 | –13.82 | –1.95 |
| | 360837103090701 | 1968-2004 | 36 | –67.52 | |
| | 360910103051301 | 1967-1996 | 29 | –114.43 | |
| | 361041103033601 | 1967-2006 | 39 | –119.78 | |
| | 361121103044001 | 1972-2001 | 29 | –58.40 | |
| | 361121103075301 | 1967-2001 | 34 | –44.48 | |
| | 361227103070601 | 1967-2001 | 34 | –50.75 | |
| | 361319103023901 | 1967-2001 | 34 | –70.49 | |
| | 361659103125501 | 1967-1996 | 29 | –42.81 | |
| | 371021103060701 | 1970-1996 | 26 | –47.75 | |
| | 360222103141801 | 1981-1996 | 15 | +1.64 | +0.16 |
| | 361330103103401 | 1968-1996 | 28 | +0.65 | |
| | 361415103143101 | 1967-2001 | 34 | +12.10 | |
| Entrada Sandstone | 360033103023101 | 1981-2006 | 25 | –22.92 | –1.31 |
| | 360037103131601 | 1981-2006 | 25 | –42.49 | |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed June 9, 2006.

[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

#### *5.3.5.2 Harding County*

Village of Mosquero water supply wells are completed in the Dakota Sandstone aquifer; however, the Village does not monitor water levels in their municipal wells. Change in depth to water has been tabulated for all the USGS-monitored wells within 4 miles of Mosquero, as summarized in Table 5-17.

### Table 5-17. Change in Water Levels in USGS-Monitored Wells near Mosquero

| Aquifer | Well ID | Change in Water Level | | | |
|---|---|---|---|---|---|
| | | Period of Record | | Amount [a] (feet) | Average Rate (ft/yr) |
| | | Dates | No. of Years | | |
| Dakota Sandstone | 354651103552201 | 1970-2004<br>2004-2005 | 34<br>1 | –1.09<br>–11.21 | –3.75 |
| | 363751103343001 | 1955-1996 | 41 | –0.92 | |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed December 12, 2005.

[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

The only one of these wells that is currently monitored has shown a dramatic change in the last few years from its historically slightly decreasing water levels. Whereas the average rate of decline between 1970 and 2004 was less than 0.03 ft/yr, the water level decline between 2004 and 2005 was 11.2 feet, a significant change both in water level and annual rate of decline.

The Village of Roy reports that Roy water supply wells are completed in the Ogallala aquifer; however, the Village does not monitor water levels in their municipal wells. Change in depth to water has been tabulated for all the USGS monitored wells within 4 miles of Roy, including those completed in other aquifers, as summarized in Table 5-18.

### Table 5-18. Change in Water Levels in USGS-Monitored Wells near Roy

| Aquifer | Well ID | Change in Water Level | | | |
|---|---|---|---|---|---|
| | | Period of Record | | Amount [a] (feet) | Average Rate (ft/yr) |
| | | Dates | No. of Years | | |
| Ogallala | 355916104110201 | 1967-1997 | 30 | +0.38 | +0.01 |
| Dakota Sandstone | 355514104155101 | 1970-1997 | 27 | +25.66 | +0.95 |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed December 12, 2005.

[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

The water level in the well completed in the Ogallala aquifer has increased, at an average rate of 0.01 ft/yr over 30 years. The water level in the USGS-monitored well completed in the Dakota Sandstone has increased at an average rate of 0.95 ft/yr over 27 years.

As a part of a 40-year planning effort, Dennis Engineering reviewed a 1986 hydrogeology report prepared for the Village of Roy and concluded that withdrawals from the current Village of Roy well field could be increased by up to 25 percent through 2038 without causing significant drawdown in the wells. According to the 40-year plan, water levels in the Village of Roy well field were approximately 1.5 feet higher in 1998 than in 1986 (Dennis Engineering, 1998). This increase is consistent with the increases seen in the USGS-monitored wells.

No major irrigated areas are present in Harding County.

#### *5.3.5.3 Quay County*

Table 5-19 summarizes recent average static water levels for City of Tucumcari wells, which are completed in either alluvial aquifers or the Entrada Sandstone. Five of these wells show a decline in average static water level between 2002 and 2004, six show an increase, two have fluctuated up and down, one has not changed, and seven lack static well level data. No information was available for the new golf course well.

For comparison, change in depth to water has been tabulated for all the USGS-monitored wells within 4 miles of Tucumcari, as summarized in Table 5-20.

The Village of Logan is supplied by groundwater pumped from the Santa Rosa Sandstone and from an alluvial aquifer; however, the Village does not monitor water levels in their municipal wells. Change in depth to water has been tabulated for those USGS-monitored wells within 4 miles of Logan, as summarized in Table 5-21.

While some Village of Logan water supply wells are completed in the Chinle Formation or alluvial aquifers, the majority of the water supply comes from the Santa Rosa Sandstone. Water levels in three of the four USGS-monitored wells completed in the Santa Rosa Sandstone show an average increase of 0.81 ft/yr, while the water level in the other well has shown an average decline of 0.05 ft/yr. Water levels in two of the three USGS-monitored wells completed in the Chinle Formation show an average increase of 0.1 ft/yr, while the water level in the other well has shown an average decline of 1.62 ft/yr

## Table 5-19. Change in Water Levels, 2002-2004
## City of Tucumcari Wells

| | Average Static Well Level (feet below ground surface) | | | Change in Water Level [a] (feet) | Average Rate (ft/yr) |
|---|---|---|---|---|---|
| Well | 2002 | 2003 | 2004 | | |
| 1 | 60 | 53 | 39 | +21 | +10.5 |
| 2 | 8 | 8 | 8 | 0 | 0 |
| 3 | --- | --- | --- | --- | --- |
| 4 | 127 | 134 | 153 | –26 | –13.0 |
| 4 (old) | --- | --- | --- | --- | --- |
| 5 | --- | --- | --- | --- | --- |
| 6 | 152 | 163 | 167 | –15 | –7.5 |
| 6 (old) | --- | --- | --- | --- | --- |
| 7 | --- | 166 | 160 | +6 | +6.0 |
| 8 | --- | --- | --- | --- | --- |
| 10 | 151 | 154 | 155 | –4 | –2.0 |
| 11 | --- | --- | --- | --- | --- |
| 12 | 89 | 94 | 78 | ± | ± |
| 13 | 113 | 103 | 78 | +35 | +17.5 |
| 14 | --- | --- | --- | --- | --- |
| 15 | 113 | 106 | 103 | +10 | +5.0 |
| 16 | 63 | 60 | 78 | ± | ± |
| 17 | 200 | 110 | 70 | +130 | +65.0 |
| 18 | 66 | 67 | 107 | –41 | –20.5 |
| 19 | 75 | 53 | 67 | ± | ± |
| 20 | 52 | 68 | 83 | –31 | –15.5 |

--- = Levels were not checked and/or well was not in production

[a] + = Rise in average static water level
– = Decline in average static water level
0 = No change in average static water level
± = Both rise and fall in static water level

## Table 5-20. Change in Water Levels in USGS-Monitored Wells near Tucumcari

| Aquifer | Well ID | Change in Water Level | | | |
|---|---|---|---|---|---|
| | | Period of Record | | Amount [a] (feet) | Average Rate [a] (ft/yr) |
| | | Dates | No. of Years | | |
| Entrada Sandstone | 350543103501401 | 1988-1998 | 10 | +0.86 | +0.41 |
| | 350605103481701 | 1988-2003 | 15 | +1.56 | |
| | 351040103433602 | 1952-1963<br>1952-2005 | 11<br>53 | +116.46<br>+43.31 [b] | |
| | 351041103442201 | 1983-2003 | 20 | +13 | |
| Alluvial | 350916103380401 | 1948-2003 | 55 | +4.34 | +0.15 |
| | 351126103423201 | 1985-1998 | 13 | +3.60 | |
| | 351231103421001 | 1983-1998 | 15 | +1.51 | |
| Chinle Formation | 351041103461901 | 1952-1998 | 46 | –1.00 | –0.03 |
| | 351246103374801 | 1983-2003 | 20 | –0.37 | |
| | 351332103413501 | 1988-1998 | 10 | –0.50 | |
| Morrison Formation | 350950103481701 | 1988-1998 | 10 | +5.01 | +0.36 |
| | 351158103455201 | 1988-1998 | 10 | +2.20 | |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed December 12, 2005.

[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

[b] Water level rose 116.46 feet between 1952 and 1963 and has declined since then. Although the level declined between 1963 and 2005, it was still higher in 2005 than the level in 1952.

## Table 5-21. Change in Water Levels in USGS-Monitored Wells near Logan

| Aquifer | Well ID | Change in Water Level | | | |
|---|---|---|---|---|---|
| | | Period of Record | | Amount [a] (feet) | Average Rate [a] (ft/yr) |
| | | Dates | No. of Years | | |
| Santa Rosa Sandstone | 351844103254001 | 1983-1998 | 15 | +12.95 | +0.81 |
| | 352307103274401 | 1967-1978<br>1967-1998 | 11<br>31 | –6.38<br>+5.00 [b] | |
| | 352149103284001 | 1965-1998 | 33 | +46.54 | |
| | 352149103264101 | 1967-1978<br>1967-1998 | 11<br>31 | –24.46<br>–1.66 [b] | –0.05 |
| Chinle Formation | 351654103260701 | 1983-1998 | 15 | +0.71 | +0.10 |
| | 352106103202401 | 1988-1998 | 10 | +1.5 | |
| | 351937103263102 | 1960-1998 | 38 | –61.71 | –1.62 |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed December 12, 2005.

[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

[b] Water level fell between 1967 and 1978, but has increased since then.

Village of San Jon water supply wells are completed in the alluvial aquifer or the Chinle Formation. Water levels are not monitored by the Village, and so water level data for municipal wells are unavailable. The Village of San Jon is no longer using these wells and instead receives its water from Logan. Water level data for all USGS monitoring wells within 4 miles of San Jon are summarized in Table 5-22.

**Table 5-22. Change in Water Levels in USGS-Monitored Wells near San Jon**

| Aquifer | Well ID | Change in Water Level |  |  |  |
|---|---|---|---|---|---|
|  |  | Period of Record |  | Amount[a] (feet) | Average Rate[a] (ft/yr) |
|  |  | Dates | No. of Years |  |  |
| Alluvial | 350303103212301 | 1988-2003 | 15 | –6.25 | –0.29 |
|  | 350347103173001 | 1988-1998 | 10 | –1.43 |  |
|  | 350808103224701 | 1988-2003 | 15 | –2.44 |  |
|  | 350833103230101 | 1988-2003 | 15 | –6.66 |  |
| Chinle Formation | 350821103184201 | 1988-1998 | 10 | –5.23 | –0.52 |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed December 12, 2005.

[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

Water levels in USGS-monitored wells have declined in all four wells completed in the alluvial aquifer, as well as in the one well completed in the Chinle Formation. Water levels in the four USGS-monitored wells completed in the alluvial aquifer show an average decrease of 0.29 ft/yr, while the well completed in the Chinle Formation has shown an average decrease of 0.52 ft/yr.

The Village of House is supplied by groundwater pumped from the Ogallala aquifer. Water levels are not monitored by the Village, and so municipal well water level data are unavailable. Data for the one USGS-monitored well within 4 miles of House, which is completed in the Ogallala aquifer, are summarized in Table 5-23. This well has shown an average decrease of 0.078 ft/yr.

**Table 5-23. Change in Water Levels in USGS-Monitored Wells near House**

| Aquifer | Well ID | Change in Water Level |  |  |  |
|---|---|---|---|---|---|
|  |  | Period of Record |  | Amount[a] (feet) | Average Rate[a] (ft/yr) |
|  |  | Dates | No. of Years |  |  |
| Ogallala | 343848103555801 | 1968-2005 | 37 | –2.88 | –0.078 |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed December 12, 2005.

[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

Major irrigated areas in Quay County are located near Tucumcari (Arch Hurley) and House. Arch Hurley irrigation near Tucumcari stretches 9.1 miles north, 6.8 miles south, 14.4 miles east, and 4.4 miles west of town. Change in depth to water for all wells monitored by the USGS within this area are summarized in Table 5-24. (Some of the USGS-monitored wells are located both within the Arch Hurley irrigated area and within 4 miles of the City of Tucumcari, in which case they appear on both Tables 5-20 and 5-24.)

**Table 5-24. Change in Water Levels in USGS Monitored Wells near Arch Hurley Irrigated Area**

| | | Change in Water Level | | | |
|---|---|---|---|---|---|
| | | Period of Record | | Amount[a] (feet) | Average Rate (ft/yr) |
| Aquifer | Well ID | Dates | No. of Years | | |
| Alluvial | 350252103333501 | 1983-1998 | 15 | +0.2 | +0.19 |
| | 350507103334101 | 1988-2003 | 15 | +0.09 | |
| | 350916103380401 | 1948-2003 | 55 | +4.34 | |
| | 351041103442201 | 1983-2003 | 20 | +12.88 | |
| | 351126103423201 | 1985-1998 | 13 | +3.66 | |
| | 351231103421001 | 1983-1998 | 15 | +1.51 | |
| Chinle Formation | 350609103382401 | 1988-2003 | 15 | –2.86 | –0.24 |
| | 350857103343401 | 1988-2003 | 15 | –4.84 | |
| | 350930103302801 | 1983-2003 | 20 | –13.79 | |
| | 351010103315201 | 1983-1998 | 15 | –2.67 | |
| | 351041103461901 | 1952-1998 | 46 | –0.97 | |
| | 351332103413501 | 1988-1998 | 10 | –0.50 | |
| | 350557103364501 | 1945-1983 | 38 | +17.35 | +0.48 |
| | 350744103312301 | 1983-1998 | 15 | +7.96 | |
| | 351012103341101 | 1983-1998 | 15 | +5.28 | |
| | 351149103343201 | 1983-1998 | 15 | +8.59 | |
| | 351537103302202 | 1988-1998 | 10 | +2.37 | |
| | 351652103373901 | 1988-1998 | 10 | +7.66 | |
| | 351654103260701 | 1983-1998 | 15 | +0.71 | |
| | 351755103345201 | 1988-1998 | 10 | +8.42 | |
| Morrison Formation | 350950103481701 | 1988-1998 | 10 | +5.01 | +0.36 |
| | 351158103455201 | 1988-1998 | 10 | +2.18 | |
| Entrada Sandstone | 351040103433602 | 1952-2006 | 54 | +71.17 | +1.32 |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed June 10, 2006.

[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

Water levels have increased in all six wells completed in the alluvial aquifer, possibly as a result of agricultural return flow. The average rate of increase has been 0.19 ft/yr. Water levels in the wells completed in the Chinle Formation aquifer have decreased in six wells and increased in eight wells. The average rate of decrease has been 0.24 ft/yr, and the average rate of increase has been 0.48 ft/yr. Water levels in both of the wells completed in the Morrison Formation aquifer have increased, at an average rate of 0.36 ft/yr. The water level in the well completed in the Entrada Sandstone aquifer has increased at an average rate of 1.32 ft/yr.

Agricultural irrigation started in the House area in 1936, and while appreciable declines in groundwater level were seen in the 1950s, long-term hydrographs in the House area indicate that groundwater levels have remained relatively stable since 1980 (Woodward, 1998). All of the irrigation near House occurs within a perimeter of 4 miles around town (Lavender, 2006), an area analyzed in Table 5-23.

#### *5.3.5.4 Curry County*

Village of Grady water supply wells are completed in the Ogallala aquifer. Although the Village does not monitor water levels in their municipal wells, change in depth to water has been tabulated for the three USGS-monitored wells within 4 miles of Grady, all of which are also completed in the Ogallala aquifer (Table 5-25). Water levels in all these wells have increased, at an average rate of 0.11 ft/yr. However, these wells only represent trends in their immediate local area; modeling studies indicate that decline of the Ogallala in Curry County is expected.

**Table 5-25. Change in Water Levels in USGS-Monitored Wells near Grady**

| Aquifer | Well ID | Change in Water Level: Period of Record: Dates | Change in Water Level: Period of Record: No. of Years | Change in Water Level: Amount[a] (feet) | Change in Water Level: Average Rate (ft/yr) |
|---|---|---|---|---|---|
| Ogallala | 344902103182601 | 1962-1997 | 35 | +2.48 | +0.11 |
| | 345125103155101 | 1962-1997 | 35 | +0.86 | |
| | 344952103232501 | 1955-2002 | 47 | +11.12 | |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed December 12, 2005.

[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

Village of Melrose water supply wells are completed in the Ogallala aquifer; however, the Village does not monitor water levels in their municipal wells. Change in depth to water has been tabulated for the three USGS-monitored wells within 4 miles of Melrose, two of which are completed in the Ogallala aquifer and one in the alluvial aquifer (Table 5-26).

**Table 5-26. Change in Water Levels in USGS-Monitored Wells near Melrose**

| | | Change in Water Level | | | |
|---|---|---|---|---|---|
| | | Period of Record | | Amount [a] (feet) | Average Rate (ft/yr) |
| Aquifer | Well ID | Dates | No. of Years | | |
| Ogallala | 342356103415501 | 1987-1997 | 10 | –0.77 | –0.077 |
| | 342414103365201 | 1977-1997 | 20 | +0.62 | +0.038 |
| | 342556103382101 | 1956-2005 | 49 | +2.19 [b] | |
| Alluvial | 342406103390501 | 1962-1997 | 35 | –1.80 | –0.05 |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed December 12, 2005.

[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

[b] Water level in this well decreased through the 1970s, but has rebounded since then.

Water levels in the Ogallala aquifer wells, the aquifer that the Village of Melrose draws its water supply from, have increased in two wells, at an average rate of 0.038 ft/yr, and decreased in one, at an average rate of 0.077 ft/yr over 10 years. However, these wells only represent trends in their immediate local area; modeling studies indicate that decline of the Ogallala in Curry County is expected. The USGS-monitored well completed in the alluvial aquifer has declined at an average rate of 0.052 ft/yr over 35 years. According to CH2MHill's assessment of existing ENMRWS member water facilities, production well levels are steadily declining in Melrose (CH2MHill, 2005c).

City of Clovis water supply wells are completed in the Ogallala aquifer; and water levels are measured quarterly. Change in depth to water has been tabulated for all the USGS-monitored wells within 4 miles of Clovis, including those completed in other aquifers (Table 5-27). (Some USGS-monitored wells are within 4 miles of both Cannon AFB and Clovis or Clovis and Texico; in these cases, wells appear on tables for both locations.)

Water levels in all 40 USGS-monitored wells completed within 4 miles of Clovis are declining. The average rate of decline for these wells is 1.86 ft/yr.

## Table 5-27. Change in Water Levels in USGS Monitoring Wells near Clovis
### Page 1 of 2

| | | Change in Water Level | | | |
|---|---|---|---|---|---|
| | | Period of Record | | Amount [a] (feet) | Average Rate (ft/yr) |
| Aquifer | Well ID | Dates | No. of Years | | |
| Ogallala | 341941103121901 | 1978-2002 | 24 | –77.51 | –1.86<br>(all 40 wells) |
| | 341944103141001 | 1994-1997 | 3 | –17.16 | |
| | 342006103134201 | 1954-2005 | 51 | –164.77 | |
| | 342025103090701 | 1975-1997 | 22 | –78.72 | |
| | 342031103111301 | 1954-1998 | 44 | –98.23 | |
| | 342033103155801 | 1969-2004 | 35 | –81.21 | |
| | 342103103072601 | 1975-2002 | 27 | –96.59 | |
| | 342121103142301 | 1962-2005 | 43 | –100.16 | |
| | 342126103164501 | 1975-1998 | 23 | –45.78 | |
| | 342158103180601 | 1994-1999 | 5 | –20.06 | |
| | 342200103181001 | 1994-1998 | 4 | –10.40 | |
| | 342201103180901 | 1992-1997 | 5 | –14.74 | |
| | 342203103101201 | 1982-1997 | 15 | –21.39 | |
| | 342211103053901 | 1954-2005 | 51 | –148.95 | |
| | 342214103091301 | 1954-2004 | 50 | –86.80 | |
| | 342216103073301 | 1980-1997 | 17 | –56.28 | |
| | 342305103111501 | 1979-1997 | 18 | –11.81 | |
| | 342309103180601 | 1995-1996 | 1 | –2.20 | |
| | 342310103165901 | 1954-2005 | 51 | –61.93 | |
| | 342313103180801 | 1994-2005 | 11 | –18.02 | |
| | 342321103181001 | 1994-2005 | 11 | –17.65 | |
| | 342328103182401 | 1994-2005 | 11 | –17.44 | |
| | 342358103093601 | 1974-2005 | 31 | –28.91 | |
| | 342502103083301 | 1977-1998 | 21 | –23.66 | |
| | 342505103151801 | 1962-1998 | 36 | –40.90 | |
| | 342532103180501 | 1982-1997 | 15 | –1.78 | |
| | 342541103065801 | 1973-2005 | 32 | –57.20 | |
| | 342633103155301 | 1971-2005 | 34 | –19.27 | |
| | 342651103090701 | 1979-1998 | 19 | –5.96 | |
| | 342655103114001 | 1954-1998 | 44 | –67.03 | |
| | 342728103123901 | 1972-1995 | 23 | –5.53 | |
| | 342729103103801 | 1954-2004 | 50 | –99.09 | |
| | 342729103141901 | 1969-1997 | 28 | –1.35 | |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed December 12, 2005.

[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

## Table 5-27. Change in Water Levels in USGS Monitoring Wells near Clovis
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| Aquifer | Well ID | Change in Water Level | | | Average Rate (ft/yr) |
|---|---|---|---|---|---|
| | | Period of Record | | Amount [a] (feet) | |
| | | Dates | No. of Years | | |
| Ogallala (cont.) | 342744103055701 | 1979-2003 | 24 | –14.90 | –1.86 (all 40 wells) |
| | 342753103083201 | 1962-1997 | 35 | –78.51 | |
| | 342824103124301 | 1975-1997 | 22 | –8.16 | |
| | 342907103093501 | 1963-1997 | 34 | –28.58 | |
| | 342910103080001 | 1954-2005 | 51 | –84.42 | |
| | 342912103103801 | 1954-1995 | 41 | –77.83 | |
| | 343022103104301 | 1982-1997 | 15 | –12.44 | |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed December 12, 2005.

[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

Adequacy of future water supply for Clovis will depend upon the purchase of additional water rights and the development of additional production wells (NMAW, 2004) unless or until Ute Reservoir water becomes available through the ENMRWS. Newly drilled wells produce only a third to half the amount of water that new wells did a few decades ago, and existing production wells are showing declines of 3 to 5 feet per year (CH2M Hill, 2005d). New Mexico American Water (NMAW) currently adds 5 wells per year (CH2M Hill, 2005c) and assumes that new wells have an initial yield of 300 gpm and that yield declines by 25 gpm each year (CH2M Hill, 2005b). Based on these assumptions, NMAW estimated that to meet demand through 2040, Clovis will need to drill 185 new wells (CH2M Hill, 2005d).

Village of Texico water supply wells are completed in the Ogallala aquifer. Change in depth to water has been tabulated for USGS-monitored wells located within 4 miles of Texico, all of which are also completed in the Ogallala aquifer (Table 5-28). The Village of Texico does not monitor water levels in their municipal wells; however, according to CH2M Hill's assessment of existing ENMRWS member water facilities, production well levels are steadily declining in Texico (CH2M Hill, 2005c).

**Table 5-28. Change in Water Levels in USGS-Monitored Wells near Texico**

| | | Change in Water Level | | | |
|---|---|---|---|---|---|
| | | Period of Record | | | |
| Aquifer | Well ID | Dates | No. of Years | Amount [a] (feet) | Average Rate (ft/yr) |
| Ogallala | 341936103034601 | 1972-1995 | 23 | –64.23 | –2.39 |
| | 342017103055401 | 1954-1997 | 43 | –133.02 | |
| | 342032103021601 | 1954-1997 | 43 | –85.18 | |
| | 342054103040301 | 1954-1997 | 43 | –91.49 | |
| | 342059103052201 | 1954-2005 | 51 | –167.68 | |
| | 342211103053901 | 1954-2005 | 51 | –148.95 | |
| | 342216103073301 | 1980-1997 | 17 | –56.28 | |
| | 342255103035501 | 1982-1997 | 15 | –53.39 | |
| | 342502103083301 | 1977-1998 | 21 | –23.66 | |
| | 342541103065801 | 1973-2005 | 32 | –57.20 | |
| | 342615103045501 | 1981-2004 | 23 | –6.29 | |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed December 12, 2005.
[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

Water levels in all 11 USGS-monitored wells completed within 4 miles of Texico are declining, at an average rate of 2.39 ft/yr.

No water supply information was received for Cannon AFB; however, the Base most likely derives its water from wells completed in the Ogallala aquifer (Cannon AFB also has water reserved in Ute Reservoir). Change in depth to water has been tabulated for the 27 USGS-monitored wells within 4 miles of Cannon AFB, all of which are also completed in the Ogallala aquifer (Table 5-29). Water levels in these wells have increased in 2 wells, at an average rate of 0.035 ft/yr, and decreased in 25 wells, at an average rate of 1.76 ft/yr.

Major irrigated areas in Curry County are located around Clovis, where dryland farming dominated prior to 1948 (Woodward, 1998). Irrigation near Clovis stretches approximately 12 miles north, 20 miles west, and extends east to the border with Texas and south to the Curry-Roosevelt County line (Minton, 2006). Change in depth to water for all wells monitored by the USGS within this area are summarized in Table 5-30. (Some USGS monitored wells are within this irrigated area and within 4 miles of the City of Clovis, in which case wells appear on both Tables 5-27 and 5-30.) Groundwater levels generally declined in the Clovis area during 1987-1992 (Woodward, 1998).

In the irrigated area around Clovis, water levels in both wells completed in the alluvial aquifer have decreased, at an average rate of 0.18 ft/yr. Water levels in wells completed in the Ogallala aquifer have decreased in 107 wells and increased in 10 wells. The average rate of decrease for these wells has been 1.74 ft/yr.

#### *5.3.5.5 Roosevelt County*

City of Portales water supply wells are completed in the Ogallala aquifer, and water level data are collected annually. Change in depth to water has been tabulated for USGS-monitored wells within 4 miles of Portales, 31 of which are completed in the alluvial aquifer and 2 in the Ogallala aquifer (Table 5-31).

Water levels in the alluvial aquifer wells have increased in 6 wells, at an average rate of 0.21 ft/yr, and decreased in 25, at an average rate of 0.86 ft/yr. Water levels in the two USGS-monitored wells completed in the Ogallala aquifer have decreased in both wells, at an average rate of 0.82 ft/yr.

## Table 5-29. Change in Water Levels in USGS Monitoring Wells near Cannon Air Force Base

| | | Change in Water Level | | | |
|---|---|---|---|---|---|
| | | Period of Record | | Amount[a] (feet) | Average Rate (ft/yr) |
| Aquifer | Well ID | Dates | No. of Years | | |
| Ogallala | 342011103191701 | 1977-1997 | 20 | –29.86 | –1.76 |
| | 342033103155801 | 1969-2004 | 35 | –81.21 | |
| | 342036103220001 | 1967-2003 | 36 | –33.51 | |
| | 342121103142301 | 1962-2005 | 43 | –100.16 | |
| | 342126103164501 | 1975-1998 | 23 | –45.78 | |
| | 342140103190501 | 1954-2005 | 51 | –67.93 | |
| | 342158103180601 | 1994-1999 | 5 | –20.06 | |
| | 342200103181001 | 1994-1998 | 4 | –10.40 | |
| | 342201103180901 | 1992-1997 | 5 | –14.74 | |
| | 342218103182601 | 1994-2005 | 11 | –27.06 | |
| | 342219103183101 | 1996-2003 | 7 | –20.79 | |
| | 342307103181601 | 1993-2005 | 12 | –18.65 | |
| | 342309103180601 | 1995-1996 | 1 | –2.20 | |
| | 342310103165901 | 1954-2005 | 51 | –61.93 | |
| | 342313103180801 | 1994-2005 | 11 | –18.02 | |
| | 342321103181001 | 1994-2005 | 11 | –17.65 | |
| | 342328103182401 | 1994-2005 | 11 | –17.44 | |
| | 342338103203701 | 1967-2005 | 38 | –52.66 | |
| | 342418103180601 | 1995-1996 | 1 | –2.20 | |
| | 342419103232301 | 1977-1997 | 20 | –3.99 | |
| | 342457103213901 | 1972-1997 | 25 | –32.25 | |
| | 342505103151801 | 1962-1998 | 36 | –40.90 | |
| | 342532103180501 | 1982-1997 | 15 | –1.78 | |
| | 342615103220701 | 1962-2005 | 43 | –89.55 | |
| | 342633103155301 | 1971-2005 | 34 | –19.27 | |
| | 342142103221201 | 1982-2002 | 20 | +0.43 | +0.035 |
| | 342248103241401 | 1967-2005 | 38 | +1.81 | |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed December 12, 2005.

[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

## Table 5-30. Change in Water Levels in USGS Monitored Wells in the Irrigated Area near Clovis
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| Aquifer | Well ID | Change in Water Level | | | Average Rate (ft/yr) |
|---|---|---|---|---|---|
| | | Period of Record | | Amount [a] (feet) | |
| | | Dates | No. of Years | | |
| Alluvial | 341842103272401 | 1977–1997 | 20 | –4.73 | –0.17 |
| | 341903103303501 | 1962–1997 | 35 | –3.73 | |
| Ogallala | 341808103082901 | 1972–2005 | 33 | –161.32 | –1.74<br>(107 wells) |
| | 341809103163502 | 1977–1997 | 20 | –43.15 | |
| | 341823103135501 | 1980–2005 | 25 | –93.19 | |
| | 341825103031301 | 1954–1994 | 40 | –99.84 | |
| | 341836103052001 | 1972–2005 | 33 | –147.59 | |
| | 341849103122301 | 1982–1997 | 15 | –65.59 | |
| | 341902103072801 | 1954–1997 | 43 | –130.47 | |
| | 341917103110501 | 1982–1997 | 15 | –65.28 | |
| | 341931103265501 | 1982–1997 | 15 | –0.43 | |
| | 341936103034601 | 1972–1995 | 23 | –64.23 | |
| | 341941103121901 | 1978–2002 | 24 | –77.51 | |
| | 341944103141001 | 1994–1997 | 3 | –17.16 | |
| | 341954103080901 | 1982–2003 | 21 | –99.54 | |
| | 342006103134201 | 1954–2005 | 51 | –164.77 | |
| | 342011103191701 | 1976–1997 | 21 | –29.86 | |
| | 342017103055401 | 1954–1997 | 43 | –133.02 | |
| | 342025103090701 | 1975–1997 | 22 | –78.72 | |
| | 342031103111301 | 1954–1998 | 44 | –98.23 | |
| | 342032103021601 | 1954–1997 | 43 | –85.18 | |
| | 342033103155801 | 1969–2004 | 35 | –81.21 | |
| | 342036103220001 | 1967–2005 | 38 | –20.94 | |
| | 342054103040301 | 1954–1997 | 43 | –91.49 | |
| | 342059103052201 | 1954–2005 | 51 | –167.68 | |
| | 342103103072601 | 1975–2002 | 27 | –96.59 | |
| | 342121103142301 | 1962–2005 | 43 | –100.16 | |
| | 342126103164501 | 1975–1998 | 23 | –45.78 | |
| | 342140103190501 | 1954–2005 | 51 | –67.93 | |
| | 342158103180601 | 1994–1999 | 5 | –20.06 | |
| | 342200103181001 | 1994–1998 | 4 | –10.40 | |
| | 342201103180901 | 1992–1997 | 5 | –15.34 | |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed June 13, 2006.

[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

### Table 5-30. Change in Water Levels in USGS Monitored Wells in the Irrigated Area near Clovis
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| | | Change in Water Level | | | |
|---|---|---|---|---|---|
| | | Period of Record | | Amount [a] (feet) | Average Rate (ft/yr) |
| Aquifer | Well ID | Dates | No. of Years | | |
| Ogallala (cont.) | 342203103101201 | 1982–1997 | 15 | –21.39 | –1.74 (107 wells) |
| | 342211103053901 | 1954–2005 | 51 | –148.95 | |
| | 342214103091301 | 1954–2004 | 50 | –86.80 | |
| | 342216103073301 | 1980–1997 | 17 | –56.28 | |
| | 342218103182601 | 1994–2005 | 11 | –27.06 | |
| | 342219103183101 | 1996–2003 | 7 | –20.79 | |
| | 342255103035501 | 1982–1997 | 15 | –53.39 | |
| | 342305103111501 | 1979–1997 | 18 | –11.81 | |
| | 342307103181601 | 1993–2005 | 12 | –18.65 | |
| | 342309103180601 | 1995–1996 | 1 | –2.20 | |
| | 342310103165901 | 1954–2005 | 51 | –61.93 | |
| | 342313103180801 | 1994–2005 | 11 | –18.02 | |
| | 342321103181001 | 1994–2005 | 11 | –17.65 | |
| | 342328103182401 | 1994–2005 | 11 | –17.44 | |
| | 342338103203701 | 1967–2005 | 38 | –52.66 | |
| | 342358103093601 | 1974–2005 | 31 | –36.89 | |
| | 342418103180601 | 1982–1997 | 15 | –10.89 | |
| | 342419103232301 | 1977–1997 | 20 | –3.99 | |
| | 342457103213901 | 1972–1997 | 25 | –32.25 | |
| | 342502103083301 | 1977–1998 | 21 | –23.66 | |
| | 342505103151801 | 1962–1998 | 36 | –40.90 | |
| | 342532103180501 | 1982–1997 | 15 | –1.78 | |
| | 342541103065801 | 1973–2005 | 32 | –57.20 | |
| | 342615103045501 | 1981–2004 | 23 | –6.29 | |
| | 342615103220701 | 1962–2005 | 43 | –89.55 | |
| | 342633103155301 | 1971–2005 | 34 | –19.27 | |
| | 342651103090701 | 1979–1998 | 19 | –5.96 | |
| | 342655103114001 | 1954–1998 | 44 | –67.03 | |
| | 342729103103801 | 1954–2004 | 50 | –99.09 | |
| | 342729103141901 | 1969–1997 | 28 | –1.35 | |
| | 342735103262701 | 1977–2005 | 28 | –8.94 | |
| | 342736103203701 | 1954–2005 | 51 | –21.60 | |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed June 13, 2006.

[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

## Table 5-30. Change in Water Levels in USGS Monitored Wells in the Irrigated Area near Clovis
### Page 3 of 4

| Aquifer | Well ID | Change in Water Level | | | Average Rate (ft/yr) |
|---|---|---|---|---|---|
| | | Period of Record | | Amount [a] (feet) | |
| | | Dates | No. of Years | | |
| Ogallala (cont.) | 342744103055701 | 1979–2003 | 24 | –14.90 | –1.74<br>(107 wells) |
| | 342753103083201 | 1962–1997 | 35 | –78.51 | |
| | 342824103124301 | 1975–1997 | 22 | –8.16 | |
| | 342837103192201 | 1967–2004 | 37 | –25.02 | |
| | 342858103235101 | 1982–1997 | 15 | –5.14 | |
| | 342907103093501 | 1967–1997 | 30 | –27.18 | |
| | 342910103080001 | 1954–2005 | 51 | –84.42 | |
| | 342912103103801 | 1954–2005 | 51 | –84.42 | |
| | 342913103045101 | 1975–1997 | 22 | –48.33 | |
| | 342914103062601 | 1962–2005 | 43 | –97.30 | |
| | 342943103220001 | 1972–1997 | 25 | –6.53 | |
| | 342955103262101 | 1971–2002 | 31 | –17.03 | |
| | 343022103104301 | 1982–1997 | 15 | –12.44 | |
| | 343023103273201 | 1980–1997 | 17 | –5.08 | |
| | 343044103162401 | 1962–1997 | 35 | –21.50 | |
| | 343057103034701 | 1954–2005 | 51 | –137.40 | |
| | 343057103062601 | 1977–1998 | 21 | –46.76 | |
| | 343100103190201 | 1962–2005 | 43 | –15.50 | |
| | 343104103275601 | 1977–1997 | 20 | –10.92 | |
| | 343117103231601 | 1967–1997 | 30 | –2.59 | |
| | 343131103310801 | 1973–2005 | 32 | –25.05 | |
| | 343140103045601 | 1982–1997 | 15 | –29.63 | |
| | 343142103080301 | 1982–1997 | 15 | –28.69 | |
| | 343230103140301 | 1975–2005 | 30 | –52.01 | |
| | 343232103291601 | 1980–1997 | 17 | –7.77 | |
| | 343242103055401 | 1975–2005 | 30 | –64.08 | |
| | 343242103114201 | 1975–1998 | 23 | –26.29 | |
| | 343252103324001 | 1954–2005 | 51 | –29.74 | |
| | 343255103093401 | 1954–2005 | 51 | –116.38 | |
| | 343336103145001 | 1974–2002 | 28 | –29.51 | |
| | 343337103064201 | 1969–1996 | 27 | –52.57 | |
| | 343405103193501 | 1982–1997 | 15 | –5.13 | |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed June 13, 2006.

[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

## Table 5-30. Change in Water Levels in USGS Monitored Wells in the Irrigated Area near Clovis

### Page 4 of 4

| Aquifer | Well ID | Change in Water Level | | | Average Rate (ft/yr) |
|---|---|---|---|---|---|
| | | Period of Record | | Amount [a] (feet) | |
| | | Dates | No. of Years | | |
| Ogallala (cont.) | 343407103024301 | 1977–1997 | 20 | –28.02 | –1.74 (107 wells) |
| | 343427103024201 | 1962–2005 | 43 | –92.62 | |
| | 343427103154301 | 1962–1997 | 35 | –44.22 | |
| | 343428103141201 | 1962–2005 | 43 | –72.51 | |
| | 343520103054001 | 1971–1998 | 27 | –22.59 | |
| | 343520103083801 | 1977–2005 | 28 | –7.26 | |
| | 343521103093401 | 1969–1998 | 29 | –25.99 | |
| | 343558103071301 | 1972–1997 | 25 | –12.95 | |
| | 343613103144401 | 1973–2002 | 29 | –38.20 | |
| | 343615103111701 | 1982–1997 | 15 | –14.78 | |
| | 343615103123801 | 1969–2005 | 36 | –51.57 | |
| | 343626103054101 | 1962–2005 | 43 | –38.30 | |
| | 343646103200501 | 1954–2005 | 51 | –20.41 | |
| | 342142103221201 | 1982–2002 | 20 | +0.43 | +0.15 (10 wells) |
| | 342248103241401 | 1967–2005 | 38 | +1.81 | |
| | 342728103123901 | 1972–1995 | 23 | +5.53 | |
| | 342908103155201 | 1975–1997 | 22 | +3.97 | |
| | 343021103153401 | 1982–1997 | 15 | +6.50 | |
| | 343205103200601 | 1982–1997 | 15 | +0.74 | |
| | 343552103221501 | 1982–2002 | 20 | +1.49 | |
| | 343637103180001 | 1975–2002 | 27 | +2.75 | |
| | 343641103282301 | 1982–1997 | 15 | +0.33 | |
| | 343542103361901 | 1977–1997 | 20 | +6.18 | |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed June 13, 2006.

[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

## Table 5-31. Change in Water Levels in USGS Monitoring Wells near Portales

| Aquifer | Well ID | Change in Water Level | | | Average Rate (ft/yr) |
|---|---|---|---|---|---|
| | | Period of Record | | Amount [a] (feet) | |
| | | Dates | No. of Years | | |
| Alluvial | 340742103202201 | 1955-1997 | 42 | –22.16 | –0.86 |
| | 340831103190102 | 1964-2002 | 38 | –20.20 | |
| | 340832103165801 | 1945-1995 | 50 | –44.79 | |
| | 340909103162001 | 1971-2005 | 34 | –40.58 | |
| | 340915103190001 | 1954-2005 | 51 | –43.21 | |
| | 340937103174202 | 1966-2002 | 36 | –32.04 | |
| | 341003103160801 | 1972-1998 | 26 | –46.95 | |
| | 341011103250601 | 1958-1997 | 39 | –30.10 | |
| | 341037103254501 | 1952-2005 | 53 | –58.94 | |
| | 341042103152001 | 1961-2005 | 44 | –68.12 | |
| | 341052103214501 | 1955-2005 | 50 | –23.70 | |
| | 341111103205401 | 1975-1997 | 22 | –23.07 | |
| | 341118103241501 | 1949-2005 | 56 | –57.42 | |
| | 341135103184301 | 1977-1997 | 20 | –31.04 | |
| | 341146103234201 | 1957-1997 | 40 | –14.57 | |
| | 341157103251501 | 1953-1997 | 44 | –36.71 | |
| | 341215103232201 | 1977-1997 | 20 | –10.81 | |
| | 341230103212001 | 1957-1997 | 40 | –19.02 | |
| | 341235103182201 | 1959-1995 | 36 | –31.00 | |
| | 341320103183001 | 1961-2005 | 44 | –40.87 | |
| | 341322103233001 | 1937-2005 | 68 | –42.80 | |
| | 341357103251301 | 1976-2002 | 26 | –3.82 | |
| | 341404103155802 | 1977-2005 | 28 | –20.27 | |
| | 341511103201701 | 1972-1997 | 25 | –24.14 | |
| | 342310103101201 | 1950-1994 | 44 | –47.17 | |
| | 340620103210601 | 1977-1997 | 20 | +3.08 | +0.21 |
| | 340808103245101 | 1963-2002 | 39 | +12.12 | |
| | 340834103213501 | 1974-1997 | 23 | +2.30 | |
| | 341014103245701 | 1980-1997 | 17 | +2.58 | |
| | 341224103240202 | 1972-1997 | 25 | +9.71 | |
| | 341308103231501 | 1964-2002 | 38 | +5.07 | |
| Ogallala | 341014103264401 | 1996-2005 | 9 | –2.76 | –0.82 |
| | 341041103184201 | 1971-1997 | 26 | –34.81 | |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed December 12, 2005.

[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

Declining water levels and decreasing saturated thickness has prompted Portales to purchase additional water rights and drill new wells. However, as in Clovis, newly drilled wells produce a third to a half the water that new wells a few decades ago produced (CH2M Hill, 2005d), and City production wells show water level declines of 2 to 7 feet per year (CH2M Hill, 2005b). Studies by Wilson (2001, 2004) indicate that to meet demand through 2040, Portales will need to drill 276 new wells, with projected saturated thicknesses as small as 15 feet (CH2M Hill, 2005d).

Village of Dora water supply wells are completed in the Ogallala aquifer; however, water level data have been collected only twice in the last 20 years. Change in depth to water has been tabulated for 14 USGS-monitored wells within 4 miles of Dora, 4 of which are completed in a local Cretaceous system aquifer and 10 in the Ogallala aquifer (Table 5-32).

**Table 5-32. Change in Water Levels in USGS-Monitored Wells near Dora**

| Aquifer | Well ID | Change in Water Level: Period of Record: Dates | No. of Years | Amount [a] (feet) | Average Rate (ft/yr) |
|---|---|---|---|---|---|
| Cretaceous system | 335204103175701 | 1964-1995 | 31 | +5.47 | +0.14 |
| | 335436103145401 | 1970-1995 | 25 | +1.73 | |
| | 335627103145802 | 1970-1995 | 25 | +5.20 | |
| | 335843103155801 | 1975-1995 | 20 | +1.65 | |
| Ogallala | 335247103221301 | 1975-1995 | 20 | +5.10 | +0.79 |
| | 335327103180201 | 1970-1995 | 25 | +1.33 | |
| | 335352103234801 | 1975-1995 | 20 | +8.92 | |
| | 335407103190301 | 1975-1995 | 20 | +1.71 | |
| | 335420103203001 | 1964-1995 | 31 | +12.47 | |
| | 335421103224101 | 1985-1995 | 10 | +43.94 | |
| | 335616103200901 | 1956-1995 | 39 | +12.53 | |
| | 335659103200201 | 1964-1995 | 31 | +13.08 | |
| | 335749103190401 | 1975-2005 | 30 | +8.10 | |
| | 335843103211301 | 1975-2005 | 30 | +36.45 | |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed December 12, 2005.

[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

Water levels have increased in all 14 USGS-monitored wells completed within 4 miles of Dora. The average rate of increase for the 4 wells completed in the Cretaceous system aquifer has been 0.135 ft/yr, while the average rate of increase for the 10 wells completed in the Ogallala aquifer has been 0.787 ft/yr.

Village of Causey water supply wells are completed in the Ogallala aquifer; however, the Causey Water Association does not monitor water levels in their wells. Change in depth to water has been tabulated for 37 USGS-monitored wells within 4 miles of Causey, 27 of which are completed in a local Cretaceous system aquifer and 10 in the Ogallala aquifer (Table 5-33).

Water levels in the local Cretaceous system aquifer wells have increased in 13 wells, at an average rate of 0.15 ft/yr, and decreased in 14 wells, at an average rate of 0.32 ft/yr. Water levels in the Ogallala aquifer wells have increased in 7 wells, at an average 0.2 ft/yr, and decreased in 3 wells at an average rate of 0.05 ft/yr.

The Village of Elida is supplied by wells completed in the Ogallala aquifer. The Village does not monitor water levels in its wells, and no wells within 4 miles of Elida are monitored by the USGS.

Major irrigated areas in Roosevelt County are located around Portales and in the Causey Lingo area. Extensive use of groundwater for irrigation began in 1910 in the Portales Valley and in 1954 in the Causey Lingo area (Woodward, 1998). Regionally speaking, groundwater levels generally increased in the Causey Lingo area and adjacent to the City of Portales in the Portales Valley area during 1987 through 1992 (Woodward, 1998).

Irrigation near Portales stretches approximately 15 miles west, 15 miles south, east to the border with Texas, and north to the Curry-Roosevelt county line (Whitehead, 2006). The perimeter of the newly declared Causey Lingo groundwater basin was used to define the area of irrigation for the Causey Lingo area. Changes in depth to water for all wells monitored by the USGS within the irrigated areas near Portales and Causey Lingo are summarized in Tables 5-34 and 5-35. (Some USGS monitored wells fall into multiple categories [within 4 miles of Portales, within the irrigated area near Portales, within the Causey Lingo groundwater basin] in which case those wells appear on tables for multiple locations.)

## Table 5-33. Change in Water Levels in USGS Monitoring Wells near Causey

| Aquifer | Well ID | Change in Water Level | | | Average Rate (ft/yr) |
|---|---|---|---|---|---|
| | | Period of Record | | Amount [a] (feet) | |
| | | Dates | No. of Years | | |
| Cretaceous system | 334700103030601 | 1956-2005 | 49 | –7.97 | –0.32 |
| | 334704103041101 | 1956-2005 | 49 | –18.47 | |
| | 334734103043701 | 1956-2005 | 49 | –21.49 | |
| | 334745103033001 | 1956-2005 | 49 | –26.03 | |
| | 334745103043501 | 1956-2005 | 49 | –19.07 | |
| | 334754103033801 | 1956-2005 | 49 | –15.11 | |
| | 334831103055701 | 1964-1995 | 31 | –6.68 | |
| | 334905103071001 | 1948-2005 | 57 | –2.06 | |
| | 334915103034501 | 1956-2005 | 49 | –26.90 | |
| | 334945103051501 | 1956-2005 | 49 | –11.55 | |
| | 334954103032301 | 1975-1995 | 20 | –3.14 | |
| | 335002103040501 | 1956-2005 | 49 | –21.97 | |
| | 335045103052801 | 1956-2005 | 49 | –9.03 | |
| | 335234103080501 | 1955-1995 | 40 | –15.00 | |
| | 334630103093201 | 1956-1995 | 39 | +3.73 | +0.15 |
| | 334635103072001 | 1956-1995 | 39 | +5.76 | |
| | 334635103081701 | 1956-1995 | 39 | +5.25 | |
| | 334720103052801 | 1956-1995 | 39 | +6.74 | |
| | 335204103084701 | 1975-1995 | 20 | +3.09 | |
| | 335230103112201 | 1970-1995 | 25 | +5.73 | |
| | 335236103123301 | 1956-2005 | 49 | +31.85 | |
| | 335245103094101 | 1980-1995 | 15 | +0.52 | |
| | 335304103042901 | 1956-2005 | 49 | +2.87 | |
| | 335311103083201 | 1957-2005 | 48 | +1.69 | |
| | 335325103031501 | 1964-2005 | 41 | +2.38 | |
| | 335529103104101 | 1956-1995 | 39 | +4.42 | |
| | 335653103111001 | 1964-1995 | 31 | +2.01 | |
| Ogallala | 334954103114601 | 1975-2005 | 30 | –1.94 | –0.05 |
| | 335408103030601 | 1980-2000 | 20 | –1.34 | |
| | 335416103073001 | 1956-2005 | 49 | –0.27 | |
| | 334657103095601 | 1975-2005 | 30 | +13.88 | +0.20 |
| | 335013103104301 | 1964-2005 | 41 | +9.27 | |
| | 335044103032301 | 1975-1995 | 20 | +3.14 | |
| | 335048103093801 | 1956-2005 | 49 | +17.89 | |
| | 335438103025901 | 1965-2000 | 35 | +2.40 | |
| | 335518103043101 | 1965-1995 | 30 | +3.58 | |
| | 335604103084201 | 1956-2000 | 44 | +0.11 | |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed December 12, 2005.

[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

## Table 5-34. Change in Water Levels in USGS-Monitored Wells in the Irrigated Area near Portales
### Page 1 of 4

| Aquifer | Well ID | Change in Water Level | | | Average Rate (ft/yr) |
|---|---|---|---|---|---|
| | | Period of Record | | Amount [a] (feet) | |
| | | Dates | No. of Years | | |
| Cretaceous system | 335653103111001 | 1964–1995 | 31 | +2.01 | +0.27 |
| | 335836103133301 | 1956–1995 | 39 | +25.98 | |
| | 335843103155801 | 1975–1995 | 20 | +1.65 | |
| Ogallala | 340844103055001 | 1992–2005 | 13 | –39.27 | –3.44 |
| | 341012103024701 | 1977–1997 | 20 | –65.28 | |
| | 341014103264401 | 1996–2005 | 9 | –3.25 | |
| | 341016103084801 | 1977–1997 | 20 | –72.18 | |
| | 341041103184201 | 1971–1997 | 26 | –34.81 | |
| | 341042103074501 | 1972–1997 | 25 | –84.04 | |
| | 341108103095201 | 1977–1997 | 20 | –79.36 | |
| | 341140103053701 | 1975–2005 | 30 | –140.86 | |
| | 341143103032101 | 1972–1998 | 26 | –84.95 | |
| | 341203103102201 | 1972–1997 | 25 | –102.31 | |
| | 341217103122301 | 1977–1997 | 20 | –91.27 | |
| | 341232103051901 | 1975–1998 | 23 | –100.56 | |
| | 341241103073001 | 1972–1997 | 25 | –103.01 | |
| | 341626103045001 | 1979–1997 | 18 | –75.10 | |
| | 335659103200201 | 1956–1995 | 30 | +13.08 | +0.49 |
| | 335749103190401 | 1975–2005 | 30 | +8.10 | |
| | 335759103112501 | 1975–2000 | 25 | +7.06 | |
| | 335840103105701 | 1956–1995 | 39 | +10.33 | |
| | 335843103211301 | 1975–2005 | 30 | +36.45 | |
| Alluvial | 340503103173101 | 1956–1997 | 41 | –12.79 | –1.24<br>(96 wells) |
| | 340551103074901 | 1956–1997 | 41 | –29.11 | |
| | 340553103063001 | 1953–1997 | 44 | –37.44 | |
| | 340608103124401 | 1982–1997 | 15 | –8.84 | |
| | 340631103062601 | 1978–2002 | 24 | –53.75 | |
| | 340641103072101 | 1958–2005 | 47 | –84.35 | |
| | 340641103072102 | 1978–2003 | 25 | –48.44 | |
| | 340641103093702 | 1979–1997 | 18 | –5.86 | |
| | 340656103114601 | 1979–2005 | 26 | –27.32 | |
| | 340712103041401 | 1954–1993 | 39 | –67.38 | |
| | 340716103124401 | 1980–2005 | 25 | –32.46 | |
| | 340732103145001 | 1949–1997 | 48 | –31.36 | |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed June 12, 2006.

[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

# Table 5-34. Change in Water Levels in USGS-Monitored Wells in the Irrigated Area near Portales
### Page 2 of 4

| | | Change in Water Level | | | |
|---|---|---|---|---|---|
| | | Period of Record | | | |
| Aquifer | Well ID | Dates | No. of Years | Amount [a] (feet) | Average Rate (ft/yr) |
| Alluvial (cont.) | 340737103061301 | 1972–1997 | 25 | –79.07 | –1.24<br>(96 wells) |
| | 340742103202201 | 1955–1997 | 42 | –22.16 | |
| | 340753103083101 | 1975–2005 | 30 | –94.27 | |
| | 340754103034501 | 1977–1997 | 20 | –37.90 | |
| | 340808103082301 | 1963–1997 | 34 | –64.67 | |
| | 340825103024201 | 1980–1998 | 18 | –20.77 | |
| | 340831103190102 | 1964–2002 | 38 | –20.20 | |
| | 340832103165801 | 1945–1994 | 49 | –44.79 | |
| | 340833103093501 | 1955–1997 | 42 | –61.56 | |
| | 340839103073101 | 1977–1997 | 20 | –49.99 | |
| | 340842103123101 | 1944–2005 | 61 | –96.02 | |
| | 340845103105801 | 1963–1997 | 34 | –32.75 | |
| | 340846103055901 | 1980–1998 | 18 | –47.16 | |
| | 340857103293201 | 1956–1997 | 41 | –10.39 | |
| | 340909103162001 | 1971–2005 | 34 | –40.58 | |
| | 340915103190001 | 1954–2005 | 51 | –43.21 | |
| | 340923103071401 | 1976–1997 | 21 | –39.73 | |
| | 340924103081801 | 1977–1997 | 20 | –40.25 | |
| | 340933103051301 | 1982–1997 | 15 | –23.47 | |
| | 340937103174202 | 1966–2002 | 36 | –32.04 | |
| | 340946103275701 | 1956–1997 | 41 | –16.66 | |
| | 340950103140601 | 1961–1997 | 36 | –45.41 | |
| | 341002103303001 | 1945–2005 | 60 | –22.60 | |
| | 341003103160801 | 1972–1998 | 26 | –46.95 | |
| | 341011103250601 | 1958–1997 | 39 | –30.10 | |
| | 341013103305901 | 1962–1997 | 35 | –29.53 | |
| | 341024103364901 | 1976–2002 | 26 | –32.25 | |
| | 341037103254501 | 1952–2005 | 53 | –62.77 | |
| | 341042103152001 | 1961–2005 | 44 | –68.12 | |
| | 341050103293501 | 1971–2005 | 34 | –22.26 | |
| | 341052103214501 | 1955–2005 | 50 | –23.70 | |
| | 341109103071301 | 1977–1997 | 20 | –33.17 | |
| | 341111103202201 | 1974–1998 | 24 | –29.39 | |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed June 12, 2006.

[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

## Table 5-34. Change in Water Levels in USGS-Monitored Wells in the Irrigated Area near Portales

### Page 3 of 4

| Aquifer | Well ID | Change in Water Level | | | Average Rate (ft/yr) |
|---|---|---|---|---|---|
| | | Period of Record | | Amount [a] (feet) | |
| | | Dates | No. of Years | | |
| Alluvial (cont.) | 341111103205401 | 1975–1983 | 8 | –10.72 | –1.24<br>(96 wells) |
| | 341114103124601 | 1956–1997 | 41 | –40.49 | |
| | 341117103092801 | 1977–2005 | 28 | –18.17 | |
| | 341118103241501 | 1949–2005 | 56 | –57.42 | |
| | 341127103354701 | 1965–1997 | 32 | –35.93 | |
| | 341135103184301 | 1977–1997 | 20 | –31.04 | |
| | 341146103234201 | 1957–1997 | 40 | –14.57 | |
| | 341147103373301 | 1965–1997 | 32 | –28.65 | |
| | 341150103124301 | 1977–1997 | 20 | –29.42 | |
| | 341157103251501 | 1953–1997 | 44 | –36.71 | |
| | 341200103040301 | 1977–1997 | 20 | –25.23 | |
| | 341200103262201 | 1953–1995 | 42 | –32.03 | |
| | 341209103100201 | 1977–1997 | 20 | –38.27 | |
| | 341212103324001 | 1972–2005 | 33 | –5.70 | |
| | 341215103232201 | 1977–1997 | 20 | –10.81 | |
| | 341230103212001 | 1957–1997 | 40 | –19.02 | |
| | 341231103282301 | 1974–1997 | 23 | –9.10 | |
| | 341235103182201 | 1959–1995 | 36 | –31.00 | |
| | 341241103360401 | 1977–1998 | 21 | –20.47 | |
| | 341256103054001 | 1967–1997 | 30 | –41.14 | |
| | 341304103272101 | 1956–2002 | 46 | –26.79 | |
| | 341308103231501 | 1964–2002 | 38 | –5.07 | |
| | 341309103092001 | 1977–1997 | 20 | –42.18 | |
| | 341315103300001 | 1945–2005 | 60 | –67.81 | |
| | 341319103074402 | 1979–1997 | 18 | –40.63 | |
| | 341320103183001 | 1961–2005 | 44 | –40.87 | |
| | 341322103233001 | 1937–2005 | 68 | –42.80 | |
| | 341336103124401 | 1980–2005 | 25 | –45.51 | |
| | 341352103042201 | 1982–1997 | 15 | –32.31 | |
| | 341357103251301 | 1976–2002 | 26 | –3.82 | |
| | 341404103112001 | 1977–1997 | 20 | –54.69 | |
| | 341404103155802 | 1977–2005 | 28 | –20.27 | |
| | 341419103053501 | 1975–2005 | 30 | –92.72 | |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed June 12, 2006.

[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

# Table 5-34. Change in Water Levels in USGS-Monitored Wells in the Irrigated Area near Portales

## Page 4 of 4

| Aquifer | Well ID | Change in Water Level | | | Average Rate (ft/yr) |
|---|---|---|---|---|---|
| | | Period of Record | | Amount [a] (feet) | |
| | | Dates | No. of Years | | |
| Alluvial (cont.) | 341420103325001 | 1982–2002 | 20 | –13.64 | –1.24<br>(96 wells) |
| | 341427103272301 | 1973–2002 | 29 | –12.30 | |
| | 341431103261901 | 1981–1995 | 14 | –3.60 | |
| | 341432103134002 | 1982–1997 | 15 | –28.64 | |
| | 341433103292802 | 1971–2002 | 31 | –12.50 | |
| | 341438103354601 | 1956–2005 | 49 | –65.03 | |
| | 341445103310001 | 1944–2005 | 61 | –65.40 | |
| | 341446103094701 | 1975–2005 | 30 | –92.69 | |
| | 341511103043301 | 1982–1997 | 15 | –50.50 | |
| | 341511103201701 | 1972–1997 | 25 | –24.14 | |
| | 341523103325101 | 1982–2002 | 20 | –11.60 | |
| | 341535103345401 | 1948–1997 | 49 | –52.82 | |
| | 341642103112401 | 1980–1998 | 18 | –78.80 | |
| | 341725103221901 | 1993–1997 | 4 | –2.09 | |
| | 341725103250501 | 1977–1997 | 20 | –18.05 | |
| | 341756103375101 | 1965–1988 | 23 | –19.04 | |
| | 341759103215701 | 1980–1997 | 17 | –31.68 | |
| | 342310103101201 | 1950–2002 | 52 | –47.17 | |
| | 340205103230101 | 1967–1997 | 30 | +15.01 | +0.35 |
| | 340435103184401 | 1959–1995 | 36 | +5.06 | |
| | 340620103210601 | 1977–1997 | 20 | +3.08 | |
| | 340808103245101 | 1963–2002 | 39 | +12.12 | |
| | 340816103342801 | 1972–2005 | 33 | +19.88 | |
| | 340834103213501 | 1974–1997 | 23 | +2.30 | |
| | 341014103245701 | 1980–1997 | 17 | +2.58 | |
| | 341143103354801 | 1956–1997 | 41 | +33.09 | |
| | 341224103240202 | 1972–1997 | 25 | +9.71 | |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed June 12, 2006.

[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

## Table 5-35. Change in Water Levels in USGS Monitored Wells in the Causey Lingo Groundwater Basin
### Page 1 of 3

| Aquifer | Well ID | Change in Water Level | | | Average Rate (ft/yr) |
|---|---|---|---|---|---|
| | | Period of Record | | Amount [a] (feet) | |
| | | Dates | No. of Years | | |
| Alluvial | 341127103354701 | 1965–1997 | 32 | –35.93 | –1.01 |
| | 341147103373301 | 1965–1997 | 32 | –28.65 | |
| | 340205103230101 | 1967–1997 | 30 | +15.01 | +0.32 |
| | 340923103410701 | 1977–2005 | 28 | +4.06 | |
| | 341013103402801 | 1977–1997 | 20 | +5.96 | |
| | 341143103354801 | 1956–1997 | 41 | +33.09 | |
| | 341711103442101 | 1975–1997 | 22 | +2.09 | |
| | 341717103480801 | 1975–1997 | 22 | +0.98 | |
| Ogallala | 333745103281801 | 1980–1995 | 15 | –1.64 | –0.09 |
| | 333828103272101 | 1980–1995 | 15 | –0.99 | |
| | 335048103093801 | 1956–2005 | 49 | –9.03 | |
| | 335408103030601 | 1980–2000 | 20 | –1.34 | |
| | 335416103073001 | 1956–2005 | 49 | –0.27 | |
| | 334024103200901 | 1980–2005 | 25 | +2.35 | +0.35 |
| | 334105103165701 | 1980–2000 | 20 | +3.86 | |
| | 334610103252701 | 1975–1995 | 20 | +3.20 | |
| | 334657103095601 | 1975–2005 | 30 | +0.46 | |
| | 335013103104301 | 1964–2005 | 41 | +9.27 | |
| | 335044103032301 | 1975–1995 | 20 | +3.14 | |
| | 335051103152601 | 1956–1995 | 39 | +10.08 | |
| | 335141103142801 | 1972–1995 | 23 | +7.97 | |
| | 335230103145101 | 1975–1990 | 15 | +8.87 | |
| | 335247103221301 | 1975–1995 | 20 | +5.10 | |
| | 335352103234801 | 1975–1995 | 20 | +8.92 | |
| | 335420103203001 | 1964–1995 | 31 | +12.47 | |
| | 335438103025901 | 1965–2000 | 35 | +2.40 | |
| | 335518103043101 | 1965–1995 | 30 | +3.58 | |
| | 335604103084201 | 1956–2000 | 44 | +0.11 | |
| | 335616103200901 | 1956–1995 | 39 | +12.53 | |
| | 335659103200201 | 1964–1995 | 31 | +13.08 | |
| | 335749103190401 | 1975–2005 | 30 | +8.10 | |
| | 335759103112501 | 1975–2000 | 25 | +7.06 | |
| | 335840103105701 | 1956–1995 | 39 | +10.33 | |
| | 335843103211301 | 1975–2005 | 30 | +36.45 | |
| | 341743103470801 | 2002–2005 | 3 | +4.52 | |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed June 10, 2006.

[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

## Table 5-35. Change in Water Levels in USGS Monitored Wells in the Causey Lingo Groundwater Basin
### Page 2 of 3

| Aquifer | Well ID | Change in Water Level | | | Average Rate (ft/yr) |
|---|---|---|---|---|---|
| | | Period of Record | | Amount [a] (feet) | |
| | | Dates | No. of Years | | |
| Cretaceous | 333648103113801 | 1980–2005 | 25 | –2.99 | –0.29 |
| | 333716103161101 | 1980–2000 | 20 | –4.08 | |
| | 333840103140501 | 1980–2000 | 20 | –2.28 | |
| | 333920103155001 | 1956–2005 | 49 | –2.76 | |
| | 334226103064401 | 1975–2005 | 30 | –2.46 | |
| | 334700103030601 | 1956–2005 | 49 | –8.43 | |
| | 334704103041101 | 1956–2005 | 49 | –18.47 | |
| | 334710103134901 | 1956–1995 | 39 | –15.53 | |
| | 334720103052801 | 1956–1995 | 39 | –6.74 | |
| | 334734103043701 | 1956–2005 | 49 | –21.49 | |
| | 334740103150001 | 1956–1995 | 39 | –32.83 | |
| | 334745103033001 | 1956–2005 | 49 | –26.03 | |
| | 334745103043501 | 1956–2005 | 49 | –19.07 | |
| | 334754103033801 | 1956–2005 | 49 | –15.11 | |
| | 334831103055701 | 1964–1995 | 31 | –6.68 | |
| | 334835103161501 | 1956–1995 | 39 | –5.12 | |
| | 334905103071001 | 1948–2005 | 57 | –2.06 | |
| | 334915103034501 | 1956–2005 | 49 | –26.90 | |
| | 334945103051501 | 1956–2005 | 49 | –11.55 | |
| | 334954103032301 | 1956–2005 | 49 | –18.09 | |
| | 335002103040501 | 1956–2005 | 49 | –21.97 | |
| | 335045103052801 | 1956–2005 | 49 | –9.03 | |
| | 333622103264501 | 1980–1995 | 15 | +0.82 | +0.27<br>(44 wells) |
| | 333706103143801 | 1980–2005 | 25 | +0.15 | |
| | 333716103252301 | 1980–2005 | 25 | +3.81 | |
| | 333735103114601 | 1980–1995 | 15 | +4.54 | |
| | 333741103085901 | 1980–2005 | 25 | +3.21 | |
| | 333747103102601 | 1980–1995 | 15 | +4.73 | |
| | 333756103044301 | 1980–2005 | 25 | +12.57 | |
| | 333803103081701 | 1980–1995 | 15 | +2.82 | |
| | 333847103102001 | 1985–1995 | 10 | +15.16 | |
| | 334022103290401 | 1980–1995 | 15 | +0.63 | |
| | 334308103284001 | 1973–1995 | 22 | +5.87 | |
| | 334331103191401 | 1975–1995 | 20 | +5.73 | |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed June 10, 2006.

[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

## Table 5-35. Change in Water Levels in USGS Monitored Wells in the Causey Lingo Groundwater Basin

### Page 3 of 3

| | | Change in Water Level | | | |
|---|---|---|---|---|---|
| | | Period of Record | | Amount[a] (feet) | Average Rate (ft/yr) |
| Aquifer | Well ID | Dates | No. of Years | | |
| Cretaceous (cont.) | 334332103201101 | 1980–1995 | 15 | +4.44 | +0.27<br>(44 wells) |
| | 334534103201001 | 1980–1989 | 9 | +3.33 | |
| | 334539103153701 | 1964–2005 | 41 | +6.52 | |
| | 334622103043301 | 1975–2000 | 25 | +2.02 | |
| | 334630103093201 | 1956–1995 | 39 | +3.73 | |
| | 334635103072001 | 1956–1995 | 39 | +5.76 | |
| | 334635103081701 | 1956–1995 | 39 | +5.25 | |
| | 334637103174001 | 1964–1995 | 31 | +7.14 | |
| | 334704103223201 | 1964–1995 | 31 | +2.81 | |
| | 334731103184901 | 1964–1995 | 31 | +19.85 | |
| | 334739103165801 | 1970–1995 | 25 | +9.29 | |
| | 334741103133101 | 1980–1995 | 15 | +11.30 | |
| | 334750103132101 | 1970–1995 | 25 | +2.84 | |
| | 334755103201901 | 1964–1995 | 31 | +9.76 | |
| | 334805103183701 | 1956–1995 | 39 | +20.12 | |
| | 334806103114101 | 1970–2005 | 35 | +2.01 | |
| | 334931103170801 | 1956–2005 | 49 | +10.99 | |
| | 335204103084701 | 1975–1995 | 20 | +3.09 | |
| | 335204103175701 | 1964–1995 | 31 | +5.47 | |
| | 335230103112201 | 1970–1995 | 25 | +5.73 | |
| | 335236103123301 | 1956–2005 | 49 | +31.85 | |
| | 335245103094101 | 1980–1995 | 15 | +0.52 | |
| | 335304103042901 | 1956–2005 | 49 | +2.87 | |
| | 335311103083201 | 1957–2005 | 48 | +1.69 | |
| | 335325103031501 | 1964–2005 | 41 | +2.38 | |
| | 335339103124701 | 1956–1995 | 39 | +50.38 | |
| | 335435103131101 | 1964–1995 | 31 | +5.72 | |
| | 335436103145401 | 1970–1995 | 25 | +1.73 | |
| | 335529103104101 | 1956–1995 | 39 | +4.42 | |
| | 335653103111001 | 1964–1995 | 31 | +2.01 | |
| | 335836103133301 | 1956–1995 | 39 | +25.98 | |
| | 335843103155801 | 1975–1995 | 20 | +1.65 | |

Source: Data available at http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels, accessed June 10, 2006.

[a] Positive numbers signify a rise in water levels; negative numbers signify a drop in water levels.

In the irrigated area around Portales, water levels in all 3 wells completed in the Cretaceous system aquifers increased, at an average rate of 0.27 ft/yr. Water levels in wells completed in the Ogallala aquifer have decreased in 14 wells and increased in 5 wells. The average rate of decrease for wells completed in the Ogallala aquifer has been 3.44 ft/yr, and the average rate of increase has been 0.49 ft/yr. Water levels in wells completed in the alluvial aquifer have decreased in 95 wells and increased in 10 wells. The average rate of decrease for wells completed in the alluvial aquifer has been 1.24 ft/yr, and the average rate of increase has been 0.35 ft/yr.

Water level changes in irrigation wells in the Causey Lingo area (which is quite large) have been variable:

- In the Causey Lingo groundwater basin, water levels in the wells completed in the alluvial aquifer have decreased in 2 wells and increased in 6 wells. The average rate of decrease in the alluvial aquifer wells has been 1.01 ft/yr, and the average rate of increase has been 0.32 ft/yr.

- Water levels in the wells completed in the Ogallala aquifer have decreased in 5 wells and increased in 22 wells. The average rate of decrease in these wells has been 0.09 ft/yr, and the average rate of increase has been 0.35 ft/yr.

- Water levels in the wells completed in the Cretaceous system aquifers have decreased in 22 wells and increased in 44 wells. The average rate of decrease for these wells has been 0.29 ft/yr, and the average rate of increase has been 0.27 ft/yr.

### *5.3.6 Aquifer Sustainability*

While no quantitative estimates of sustainable yields have been developed specifically for any of the groundwater basins in the Northeast Region, water level measurement trends over time, as discussed in Section 5.3.5, provide some indication of the sustainability of these aquifers. Based on these trends, the following concerns were identified:

- Aquifer sustainability concerns for Union County include the Dakota aquifer near Clayton and Sedan and the Entrada Sandstone aquifer near Sedan, all locations where water levels decline at rates greater than 1 ft/yr (Section 5.3.5.1). Water levels in the Ogallala aquifer near Clayton and Sedan and the Dakota aquifer near Grenville appear to be stable, but modeling studies project declines with increasing agricultural pumping in the future.

- In Harding County, groundwater levels appear to be stable in the Ogallala aquifer near Roy and slowly declining (at a rate of approximately 1 ft/yr) in the Dakota aquifer near Mosquero (Section 5.3.5.2). (Although one Dakota Sandstone well showed an 11-foot drop in water level between 2004 and 2005, this measurement sharply contrasts with the long-term average rate of decline and may be an error.) Given the relatively stable water levels, aquifer sustainability does not appear to be an issue in Harding County.

- In Quay County, water levels are consistently either stable or increasing in the Entrada Sandstone, Morrison Formation, and Santa Rosa Sandstone (Section 5.3.5.3). The Chinle Formation and alluvial aquifer water levels have risen in some areas and declined slightly (<1 ft/yr) in others. The Ogallala aquifer is the only Quay County aquifer to have exhibited consistently declining water levels, but those declines have been less than 1 ft/yr. As water levels are increasing in many of the formations and only slowly decreasing slowly in others, aquifer sustainability does not appear to be an issue in Quay County.

- In Curry County, water levels in the Ogallala aquifer are declining in most areas, at rates close to 2 ft/yr. Slightly declining water levels are also seen in alluvial aquifer irrigation wells (Section 5.3.5.4). Consequently, aquifer sustainability, especially with regard to the Ogallala aquifer, is of concern in Curry County.

- In Roosevelt County, while water levels in the Cretaceous system aquifer are relatively stable, the alluvial aquifer and Ogallala aquifer have exhibited significant declines (Section 5.3.5.5), particularly in the Ogallala aquifer around Portales, where average declines are 2 to 10 ft/yr, and in the alluvial aquifer around Portales and in the Causey Lingo area, where average declines are about 1 ft/yr (other aquifers in the Causey Lingo area, including the Ogallala, have more stable water levels). Accordingly, aquifer sustainability is a major issue in Roosevelt County.

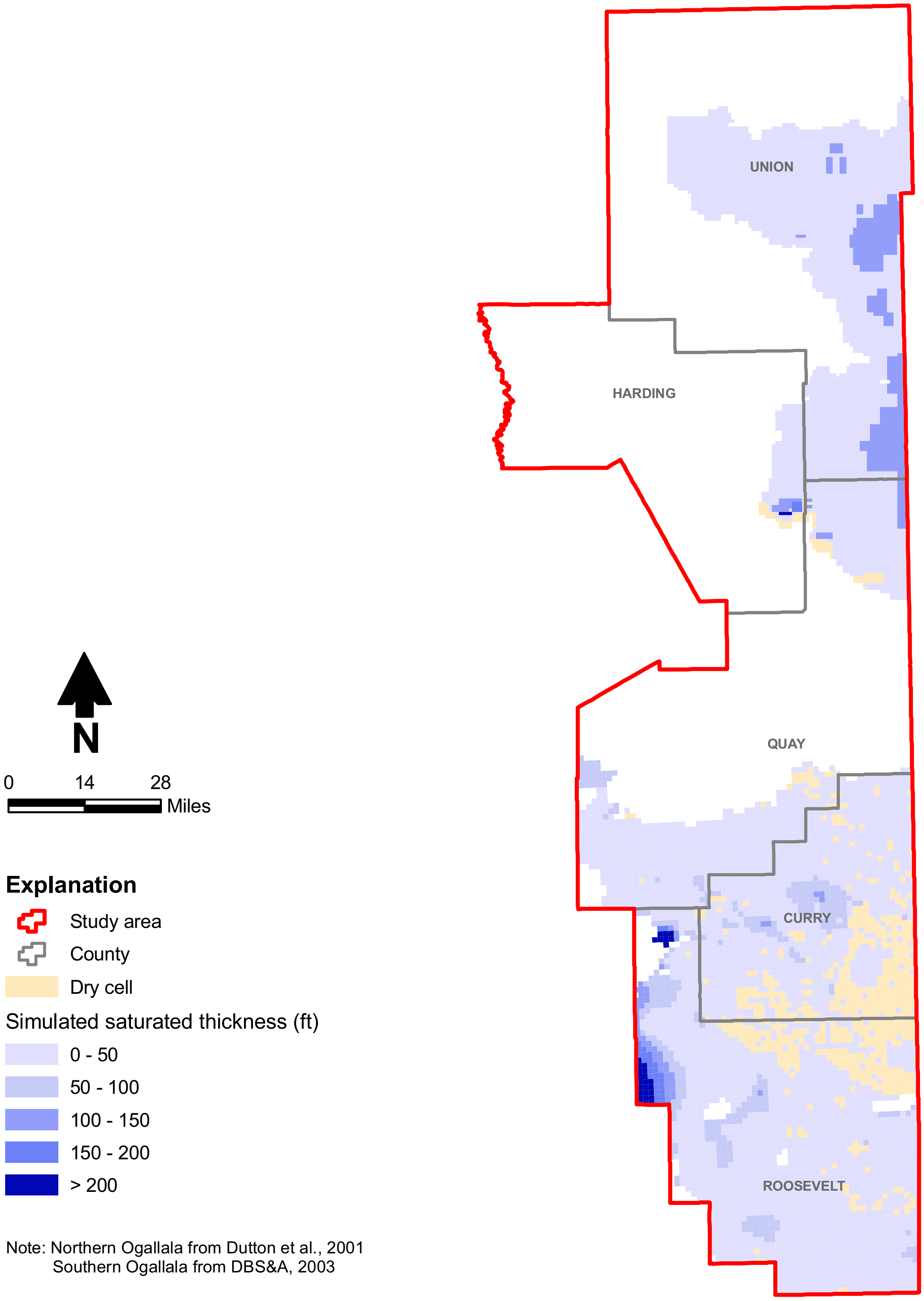
In summary, aquifer sustainability is of concern for the Dakota aquifer and the Entrada Sandstone in parts of Union County and for the Ogallala and alluvial aquifers in parts of Curry and Roosevelt Counties. Aquifer sustainability is less of an issue in Harding and Quay Counties, where water levels appear to be stable. However, if increased demands (high growth projection described in Section 6) are realized, aquifer sustainability issues will need to be addressed.

Groundwater sustainability concerns are centered on areas supplied by the Ogallala aquifer, as it supplies the bulk of groundwater use in the Northeast Region yet exhibits the most significant water level declines. The use of groundwater from other aquifers in Northeast New Mexico is limited, and continued withdrawals from these aquifers at their current level will not lead to resource depletion (Wilson, 1998). The water level declines seen in the Ogallala aquifer, however, indicate that it is being mined and will eventually be depleted in most of the area (Wilson, 1998). Based on current pumping rates for those communities supplied by the Ogallala aquifer in the overall Southern High Plains, and assuming that all groundwater can be recovered, projections are that the amount of water remaining can provide supply for only another 40 years (CH2M Hill, 2005b). The projected saturated thickness of the Ogallala in New Mexico is illustrated in Figure 5-19

Although the saturated thickness of the overall Ogallala Formation ranges from nearly 0 to about 1,000 feet, the thicker portions of the aquifer do not occur in New Mexico (Luckey et al., 1988). In 2000, the maximum saturated thickness of the Ogallala aquifer in New Mexico was 200 feet (McGuire et al., 2003).

The three modeling efforts discussed in Section 5.3.3.2 simulated changes in water levels. Results of the water level modeling that are applicable to the Northeast Region include:

- The USGS RASA evaluated the historical and future effects of groundwater development in the High Plains aquifer (Weeks et al., 1988). Assuming that current



Note: Northern Ogallala from Dutton et al., 2001
Southern Ogallala from DBS&A, 2003

NORTHEAST NEW MEXICO REGIONAL WATER PLAN

## Projected Ogallala Saturated Thickness in 2050
## Average Conditions

*Daniel B. Stephens & Associates, Inc.*
03/22/2007
WR04.0147

Figure 5-19

M:/PROJECTS/WR04.0147_NE_NM_REGIONAL_WATER_PLAN/GIS/MXDS/REPORT_FINAL/FIG5-19_OGALLALA_SATURATED_THICKNESS.MXD 702230 economic trends continue and current governmental policies are maintained, the RASA models predicted the following:

- For the Southern High Plains aquifer, (1) water levels in the entire aquifer (including the portion present in southern Quay, Curry, and Roosevelt Counties) will decline by more than 150 feet between 1980 and 2020 and (2) by 2020, more than one-half of the aquifer will have a saturated thickness of less than 25 feet. Although RASA conclusions are not divided by state, much of the New Mexico portion of the Southern High Plains aquifer will presumably fall into this half, as these are the areas that had the smallest saturated thicknesses to start and are on the edge of the extent of the aquifer; significantly more water is stored in the Southern High Plains aquifer in Texas than in New Mexico. The RASA models further predict well yields of less than 250 gpm throughout 80 percent of the Southern High Plains by 2020 (Luckey et al., 1988).

- For the Central High Plains aquifer, (1) water levels in the aquifer (including the portion in Union, Harding, and northern Quay Counties) will decline by more than 100 feet between 1980 and 2020, and (2) by 2020, the average saturated thickness will be 100 feet. Probable well yields are predicted to decrease to less than 25 percent from 1980 to 2020 (Luckey et al., 1988). The New Mexico portion of the Central High Plains are expected to see more significant declines, as multiple areas are already defined by RASA maps as having little or no saturated thickness and significantly more water in the Central High Plains aquifer is stored east of New Mexico than in New Mexico.

- *Central High Plains Aquifer GAM.* The results of this GAM developed by the Texas BEG indicate that water levels will continue to decline from 2000 to 2050 and that areas with 50 feet or less of saturated thickness will increase, leading to large dewatered areas. The authors note that it is difficult to predict which areas will be dewatered, as pumping may decrease or shift to other locations as the water levels fall (Dutton et al., 2001a).

- *Southern Ogallala Aquifer GAM:* In this GAM developed by DBS&A for TWDB, results of modeling average conditions predict that regions of the Southern Ogallala aquifer will continue to be progressively dewatered through time and that, within each decade of the simulation, approximately 10 percent of total pumping will be lost due to dry areas at the edge of the aquifer. Modeling results indicate that the bulk of the dewatered cells in New Mexico are clustered around Clovis and Portales (DBS&A, 2003). These results suggest that estimated withdrawals for a number of counties in the Southern High Plains (including Curry and Roosevelt Counties) will not be sustainable over the 50-year planning horizon (DBS&A, 2003). For the overall Southern High Plains, a simulation run to model the effects of reducing pumping by 45 to 55 percent showed significant saturated thickness remaining in 2050, at the end of the simulation (DBS&A, 2003). If pumping of the Ogallala aquifer were to be significantly decreased, the resource could be expected to last significantly longer.

Given these studies and observed water level declines, the fact that the Ogallala aquifer is being mined in New Mexico is widely established. When the saturated thickness of the aquifer can no longer support pumping for irrigation, agriculture is expected to revert to dryland and pasture farming, while municipalities rely on water from Ute Reservoir and continued pumping (Wilson, 1998).

## 5.4 Water Quality Assessment

Ability to meet future water demands requires not only sufficient quantity of water, but also water that is of sufficient quality for the intended use. In order to meet drinking water quality standards, most water supplies require at least a minimal amount of treatment. Should the quality of the drinking water supply become significantly degraded, additional and costly treatment must be provided or additional water supplies located. Thus, where drinking water supply options are limited, water quality impairment can be a significant and expensive problem. Although water quality standards are generally not as high for other uses as for drinking water, water quality must meet applicable standards for those uses, or expensive treatment will be required.

Water quality for the Northeast Region was assessed through existing documents and databases. Surface water studies that were especially helpful were two documents prepared pursuant to Section 305(b) of the Federal Clean Water Act: (1) *2004-2006 State of New Mexico Integrated Clean Water Act §303(d)/§305(b) Report* (NMED, 2004c), and (2) *Record of Decision for the 2004-2006 State of New Mexico Integrated Clean Water Act §303(d)/§305(b) Report* (NMED, 2004b). Information regarding groundwater quality was obtained primarily from the first document, and information on specific sites and facilities that may potentially impact groundwater quality was obtained from various NMED and EPA databases, as cited in the discussions of surface water quality, groundwater quality, and water quality by county in Sections 5.4.1 through 5.4.3.

### *5.4.1 Surface Water*

Potential sources of contamination and measured impacts to surface water bodies are described in Sections 5.4.1.1 and 5.4.1.2, respectively.

#### *5.4.1.1 Potential Sources of Contamination*

Sources of contamination are considered point sources if they originate from a single location, or nonpoint sources if they originate over a more widespread or unspecified location. Potential point source discharges must comply with the Clean Water Act and the New Mexico Water Quality Standards by obtaining a permit to discharge. These permits are referred to as National Pollutant Discharge Elimination System (NPDES) permits. Only two NPDES-permitted discharges are located in the Northeast Region (Table 5-36): (1) the City of Tucumcari discharges to Breen's Pond, which in turn drains to an un-named creek before flowing into Pajarito Creek in the Canadian River Basin, and (2) Cannon AFB discharges to North Playa Lake and to a golf course pond (NMED, 2006a).

**Table 5-36. Northeast New Mexico Municipal and Industrial NPDES Permittees**

| Permit No. | Municipality/Industry | County |
|---|---|---|
| *Municipalities:* | | |
| NM0020711 | Tucumcari | Quay |
| *Industries:* | | |
| NM0030236 | Cannon AFB | Curry |

Source: NMED, 2006a

Nonpoint sources of pollutants are also a concern for surface water in the Northeast Region. The probable nonpoint sources of pollutants are grazing, cultivated agriculture, recreation, hydromodification, road and highway maintenance, silvicultural activities, resource extraction, road runoff, nutrient-enriched waters, and natural and unknown sources (NMED, 2004c). Specific pollutants or threats to surface water quality resulting from these nonpoint sources are turbidity, stream bottom deposits, metals, problematic pH, dissolved oxygen, temperature extremes, pathogens, plant nutrients, streambank destabilization, conductivity, and forest management such as fire suppression (NMED, 2004c). Additional nonpoint source contamination is a concern around Ute Reservoir because of the recent and projected development in this area.

#### *5.4.1.2 Existing Surface Water Quality*

Surface water of the Northeast Region originates primarily in mountains to the northwest in Colfax County and to the north in Colorado. Surface water flows east and south to the Canadian and Dry Cimarron Rivers of the Arkansas River Basin, and these rivers continue flowing east out of the planning region. There are no surface water features in the region south of the start of the Caprock, in southwestern Quay, southern Curry, and Roosevelt Counties.

Surface water quality concerns in the Arkansas River Basin are largely due to nonpoint sources. River reaches that do not fully support their designated uses fail to do so because of turbidity, stream bottom deposits, nutrients, metals, pathogens, temperature, and total dissolved solids (TDS). The sources for these pollutants include agriculture, recreation, road runoff, road construction, and municipal point sources (NMED, 2004c).

No perennial streams are present in the southern half of the planning region. Surface water quality concerns in this area are centered on playa lakes, which are the primary source of recharge for the High Plains aquifer (Wood, 2000). Playa lake contamination is caused by municipal sewage effluents, stormwater runoff, hypersaline brines from potash refinement, petroleum industry waste products, agricultural chemicals, stockyard wastes, and deteriorating watershed conditions (NMED, 2004c).

River reaches within the planning region from the Cimarron Headwaters, Upper Canadian, Ute, Revuelto, Upper Beaver, Yellow Horse Draw, Blackwater Draw, and Running Water Draw watersheds (Figure 5-6) have been included on the New Mexico 303(d) list of impaired waters (NMED, 2004c). This list is prepared by NMED to comply with Section 303(d) of the federal Clean Water Act, which requires each state to identify surface waters within its boundaries that are not meeting or are not expected to meet water quality standards. Table 5-37 lists each of the reaches in the planning region that are on the 303(d) list; the locations of these reaches are shown on Figure 5-20.

Section 303(d) further requires the states to prioritize their listed waters for development of total maximum daily load (TMDL) management plans. A TMDL plan documents the amount of a pollutant that a water body can assimilate without violating a state water quality standard. It also allocates that load capacity to known point sources and nonpoint sources at a given flow. As shown on Table 5-37, numerous TMDL management plans have been developed for streams in the planning region.

In addition to the 303(d) listings, the State of New Mexico has listed the Ute Reservoir and Clayton Lake on the impaired lakes list and has issued fish consumption advisories for these reservoirs. These advisories were issued because mercury has been found in some fish at concentrations that could lead to significant adverse human health effects. Although the levels of mercury in the water of these lakes are moderate, very low levels of elemental mercury found in bottom sediments bioaccumulate in fish, resulting in elevated levels in larger and older fish that absorb mercury through the gills or through diet. The probable source of this mercury is atmospheric deposition (NMED, 2004c).

In evaluating the impacts of the 303(d) list on the regional water planning process, it is important to consider the nature of impairment and its effect on potential use. Problems such as stream bottom deposits and turbidity will not necessarily make the water unusable for irrigation or even for domestic water supply (if the water is treated prior to use). However, the presence of the impaired reaches illustrates the degradation that has occurred in the water supply.

## Table 5-37. Total Maximum Daily Load Status of Streams, Lakes, and Reservoirs in the Northeast Region
## Page 1 of 4

| Waterbody Name (Basin, Segment) Evaluated or Monitored Support Status Assessment Unit ID | Affected Reach (mi or ac) | Probable Sources of Impairment | TMDL Schedule Date | Probable Causes of Impairment | TMDL Assessed Date | NPDES Permits on the Reach | Uses Not Fully Supported [a] | Acute Public Health Concern |
|---|---|---|---|---|---|---|---|---|
| Carrizozo Creek<br>(Dry Cimarron to headwaters)<br>Monitored<br>Fully supported<br>NM-2701_40 | 44.79 | --- | --- | --- | 010/1/2001 | None | --- | No |
| Dry Cimarron River<br>(Oak Creek to headwaters)<br>Monitored<br>Fully supported<br>NM-2701_01 | 15.16 | --- | --- | --- | 01/01/2001 | None | --- | No |
| Dry Cimarron River<br>(Perennial reaches OK border to Oak Creek)<br>Monitored<br>Partially supported<br>NM-2701_00 | 77.65 | Loss of riparian habitat<br>Rangeland grazing<br>Natural sources<br>Streambank modifications/ destabilization | 2004 | Temperature<br>Total dissolved solids | 01/01/2001 | None | CWF | No |
| Long Canyon<br>(Perennial reaches above Dry Cimarron)<br>Monitored<br>Partially supported<br>NM-2701_20 | 8.21 | Loss of riparian habitat<br>Rangeland grazing<br>Natural sources | 2004 | Temperature, water | 01/01/2001 | None | CWF | No |
| Oak Creek<br>(Dry Cimarron to headwaters)<br>Monitored<br>Fully supported<br>NM-2701_10 | 11.72 | --- | --- | --- | 01/01/2001 | None | --- | No |

Sources: NMED, 2004b
NMED, 2004a
NMED, 2002

[a] CWF = Cold water fishery
MCWF = Marginal coldwater fishery
WWF = Warmwater fishery

mi = Miles (used for streams)
ac = Acres (used for lakes and reservoirs)
TMDL = Total maximum daily load

NPDES = National Pollutant Discharge Elimination System
--- = No data available
DO = Dissolved oxygen

## Table 5-37. Total Maximum Daily Load Status of Streams, Lakes, and Reservoirs in the Northeast Region
### Page 2 of 4

| Waterbody Name (Basin, Segment) Evaluated or Monitored Support Status Assessment Unit ID | Affected Reach (mi or ac) | Probable Sources of Impairment | TMDL Schedule Date | Probable Causes of Impairment | TMDL Assessed Date | NPDES Permits on the Reach | Uses Not Fully Supported [a] | Acute Public Health Concern |
|---|---|---|---|---|---|---|---|---|
| Canadian River<br>(Texas border to Ute Reservoir)<br>Monitored<br>Fully supported<br>NM-2301_00 | 40.45 | --- | --- | --- | 01/01/1998 | None | --- | No |
| Pajarito Creek<br>(Ute Reservoir to headwaters)<br>Monitored<br>Fully supported<br>NM-2303_10 | 55.88 | --- | --- | --- | 01/01/1998 | Tucumcari (NM0020711) | --- | No |
| Tucumcari Lake<br>Monitored<br>Fully supported<br>NM-9000.B_103 | 349.43 | --- | --- | --- | 01/01/1998 | None | --- | No |
| Ute Reservoir<br>Monitored<br>Partially supported<br>NM-2302_00 | 3760.75 | Atmospheric deposition<br>Highway/road/bridge runoff (non-construction related)<br>Impervious surface/parking lot runoff | 2017 | Aluminum<br>Mercury in fish tissue<br>Sedimentation/ siltation | 01/01/2003 | None | WWF | No |
| Chicosa Lake<br>Monitored<br>Fully supported<br>NM-9000.B_029 | 40 | --- | --- | --- | 01/01/1998 | None | --- | No |

Sources: NMED, 2004b
NMED, 2004a
NMED, 2002

[a] CWF = Cold water fishery
MCWF = Marginal coldwater fishery
WWF = Warmwater fishery

mi = Miles (used for streams)
ac = Acres (used for lakes and reservoirs)
TMDL = Total maximum daily load

NPDES = National Pollutant Discharge Elimination System
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## Table 5-37. Total Maximum Daily Load Status of Streams, Lakes, and Reservoirs in the Northeast Region
## Page 3 of 4

| Waterbody Name (Basin, Segment) Evaluated or Monitored Support Status Assessment Unit ID | Affected Reach (mi or ac) | Probable Sources of Impairment | TMDL Schedule Date | Probable Causes of Impairment | TMDL Assessed Date | NPDES Permits on the Reach | Uses Not Fully Supported [a] | Acute Public Health Concern |
|---|---|---|---|---|---|---|---|---|
| Ute Creek<br>(Ute Reservoir to headwaters)<br>Monitored<br>Fully supported<br>NM-2303_20 | 148.01 | --- | --- | --- | 01/01/1998 | None | --- | No |
| Revuelto Creek<br>(Canadian River to headwaters)<br>Monitored<br>Fully supported<br>NM-2301_10 | 20.8 | --- | --- | --- | 01/01/1998 | None | --- | No |
| Clayton Lake<br>Monitored<br>Partially supported<br>NM-9000.B_030 | 147.76 | Atmospheric deposition | 2017 | Mercury in fish tissue | 01/01/1998 | None | WWF | No |
| Corrumpa Creek<br>(OK border to headwaters)<br>Monitored<br>Fully supported<br>NM-2701_30 | 73.78 | --- | --- | --- | 01/01/1998 | None | --- | No |
| Little Tule Lake<br>Monitored<br>Fully supported<br>NM-9000.B_076 | 7.62 | --- | --- | --- | 01/01/1998 | None | --- | No |
| Oasis Park Lake<br>Monitored<br>Not assessed<br>NM-9000.B_092 | 2 | --- | --- | --- | 01/01/1998 | None | --- | No |

Sources: NMED, 2004b
NMED, 2004a
NMED, 2002

[a] CWF = Cold water fishery
MCWF = Marginal coldwater fishery
WWF = Warmwater fishery

mi = Miles (used for streams)
ac = Acres (used for lakes and reservoirs)
TMDL = Total maximum daily load

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DO = Dissolved oxygen

## Table 5-37. Total Maximum Daily Load Status of Streams, Lakes, and Reservoirs in the Northeast Region
## Page 4 of 4

| Waterbody Name (Basin, Segment) Evaluated or Monitored Support Status Assessment Unit ID | Affected Reach (mi or ac) | Probable Sources of Impairment | TMDL Schedule Date | Probable Causes of Impairment | TMDL Assessed Date | NPDES Permits on the Reach | Uses Not Fully Supported[a] | Acute Public Health Concern |
|---|---|---|---|---|---|---|---|---|
| Tule Lake<br>Monitored<br>Fully supported<br>NM-9000.B_104 | 45.65 | --- | --- | --- | 01/01/1998 | None | --- | No |
| Dennis Chavez Lake (Curry)<br>Monitored<br>Fully supported<br>NM-9000.B_036 | 4 | --- | --- | --- | 01/01/1998 | None | --- | No |
| Green Acres Lake<br>Monitored<br>Partially supported<br>NM-9000.B_046 | 10.94 | Impervious surface/ parking lot runoff<br>Natural sources | 2017 | Nutrient/ eutrophication Biological indicators | 01/01/1998 | None | MCWF<br>WWF | No |
| Ingram Lake<br>Monitored<br>Fully supported<br>NM-9000.B_050 | 11.59 | Urban runoff/storm sewers<br>Natural sources | --- | Organic enrichment/low DO<br>Nutrients | 01/01/1998 | None | --- | No |
| Williams Playa (Curry)<br>Monitored<br>Fully supported<br>NM-9000.B_108 | 15 | --- | --- | --- | 01/01/1998 | None | --- | No |
| Ned Houk Lakes<br>Monitored<br>Not assessed<br>NM-9000.B_089 | 4 | --- | --- | --- | 01/01/1998 | None | --- | No |

Sources: NMED, 2004b
NMED, 2004a
NMED, 2002

[a] CWF = Cold water fishery
MCWF = Marginal coldwater fishery
WWF = Warmwater fishery

mi = Miles (used for streams)
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NPDES = National Pollutant Discharge Elimination System
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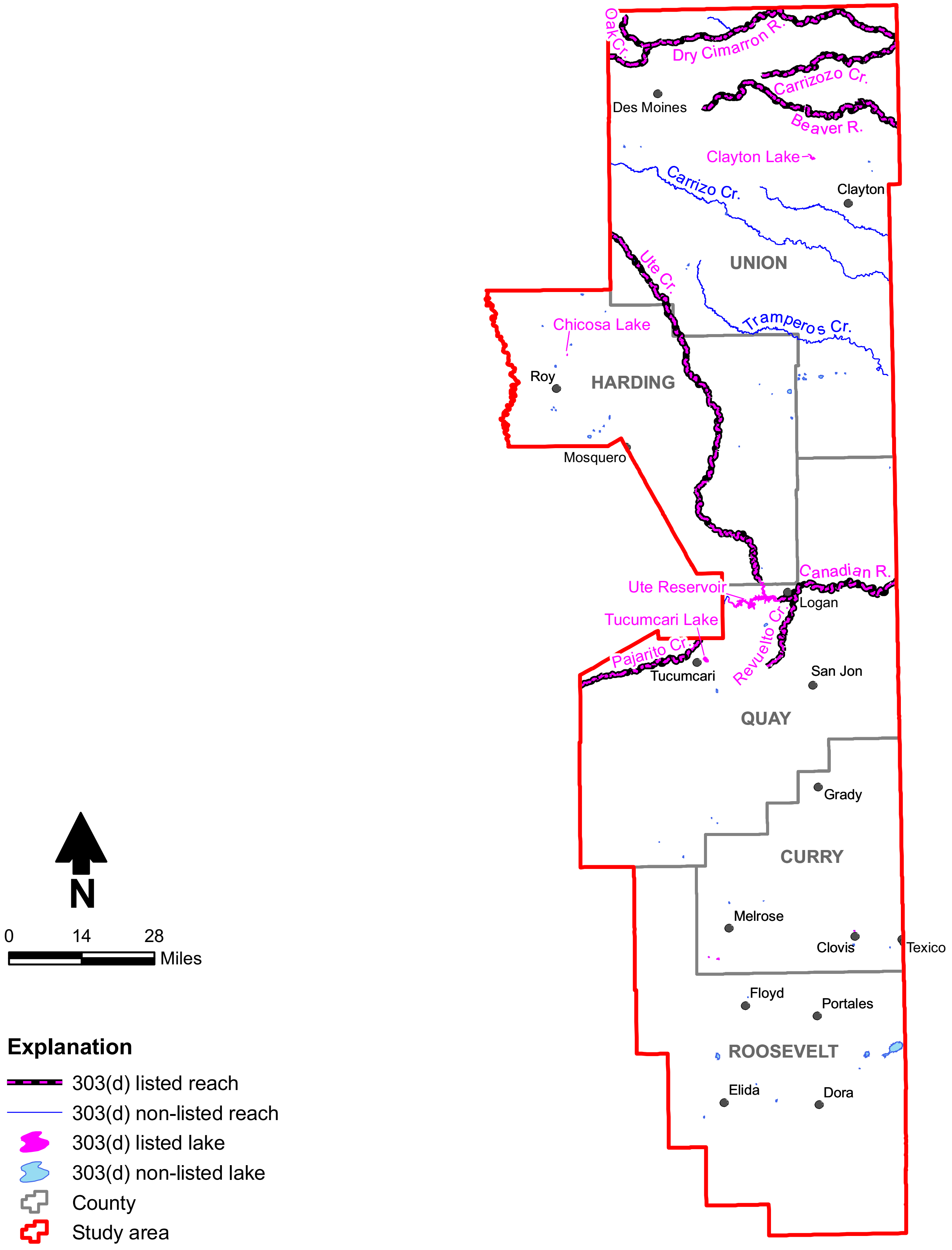

**Explanation**

- ▬ 303(d) listed reach
- — 303(d) non-listed reach
- 303(d) listed lake
- 303(d) non-listed lake
- County
- Study area

M:/PROJECTS/WR04.0147_NE_NM_REGIONAL_WATER_PLAN/GIS/MXDS/REPORT_FINAL/FIG5-20_TMDL_REACHES.MXD 702230

NORTHEAST NEW MEXICO REGIONAL WATER PLAN

## Water Quality-Impaired Reaches

*Daniel B. Stephens & Associates, Inc.*
03/22/2007
WR04.0147

Figure 5-20

### 5.4.2 Groundwater

Groundwater in the planning region is generally of high quality. It is suitable for agricultural and private domestic consumption and can easily be treated for public water supply system use. Groundwater contamination has, however, occurred in some areas of the planning region from both point and nonpoint sources, and prevention of future groundwater contamination can be key to protecting finite groundwater resources for future use.

#### *5.4.2.1 Existing Groundwater Quality*

Groundwater quality concerns in the northern half of the planning region are largely due to leaking underground storage tanks (USTs), septic systems, and grain silos that were fumigated using carbon tetrachloride (NMED, 2004c). Groundwater quality concerns in the southern half of the planning region include leaking USTs, nitrates from agricultural activity, dairy operations, septic tanks, and public and private sewage treatment plants, and petroleum, methane, and TDS contamination from oil and gas field operations (NMED, 2004c). Water quality for the municipal supply in Clovis, Portales, Melrose, and Texico is good, and disinfection is the only required treatment in those communities (CH2M Hill, 2005b).

#### *5.4.2.2 Potential Contamination Sources*

*5.4.2.2.1 Underground Storage Tanks.* Leaking USTs are one of the most significant point source contaminant threats, with most of the contamination centered near Tucumcari and Clovis (NMED, 2004c). As of January 2005, NMED had reported 103 leaking USTs in the Northeast Region, 54 of which are active cases in either the pre-investigation, investigation, cleanup, or monitoring phases (NMED, 2005a). Information on the status of all UST sites in the planning region is summarized in Table 5-38.

In the northern half of the planning region, groundwater contamination due to UST leaks includes oil, gasoline, jet fuel, diesel, gasoline additives, petroleum constituents such as benzene, toluene, ethylbenzene and xylene, and solvents. In the southern half of the planning region, groundwater contamination due to UST leaks includes oil, gas, diesel, gasoline additives, and petroleum byproducts. Details regarding whether specific underground storage tank leaks have impacted groundwater and the status of site investigation and cleanup efforts can be obtained from the NMED database, at www.nmenv.state.nm.us/ust/leakcity.html (current data are summarized in Table 5-38).

## Table 5-38. Leaking Underground Storage Tanks in the Northeast Region
### Page 1 of 6

| Name | Facility ID | Contact | Physical Address | County | Status [a] | Water Supply Impacts [b] |
|---|---|---|---|---|---|---|
| Phillips 66 Service | 1635 | Unknown | 1st and Chestnut St, Clayton, 88415 | Union | NFA | N |
| Bottle Neck Inc | 27023 | Susan Von Gonten | Hwy 87 S, Clayton, 88415 | Union | M-R | N |
| Ww Parts & Supply | 31516 | Lorena Goerger | 320 N First, Clayton, 88415 | Union | C-R | N |
| Allsups #208 | 897 | Unknown | 321 Main St, Clayton, 88415 | Union | NFA | N |
| Army Ng Clay | 29556 | Unknown | 304 Second Ave, Clayton, 88415 | Union | NFA | N |
| Hiway Grocery | 28545 | Unknown | 801 S First St, Clayton, 88415 | Union | NFA | N |
| Adee Truck Barn | 26396 | Unknown | W Avenue, Clayton, 88415 | Union | NFA | N |
| Former Texaco | 27928 | Lorena Goerger | 623 S 1st St, Clayton, 88415 | Union | PI-S | U |
| Luv's Country Store | 29167 | Susan Von Gonten | 703 S First St, Clayton, 88415 | Union | NFA | N |
| Kears Exxon | 28829 | Lorena Goerger | 601 S First St, Clayton, 88415 | Union | I-R | N |
| Pats Service Station | 29879 | Susan Von Gonten | 3rd and Main<br>Hwy 39, Mosquero, 87733 | Harding | C-R | N |
| Airco Gases | 31450 | Unknown | 13 and One Half Miles E<br>Mosquero NM on Hwy 102<br>Mosquero, 87733 | Harding | NFA | N |
| Enmr | 1213 | TC (Thomas) Shapard | N Hwy 54, Logan, 88426 | Quay | NFA | N |
| Nmshtd Nara Visa | 29535 | Unknown | SR 54 MP 35 0, Nara Visa, 88430 | Quay | NFA | N |
| Nmshtd Ragland | 30123 | Unknown | NM 209 MP 59 9, Ragland, 88443 | Quay | NFA | N |
| Halls Well | 28453 | George Beaumont | NM 66 E of Town, San Jon, 88434 | Quay | M-CAF | N |
| Bryants Conoco | 998 | TC (Thomas) Shapard | State Rd 39, San Jon, 88434 | Quay | PI-C | U |
| Drivers Travel | 28016 | Susan Rhoades | I 40 and Hwy 469 Exit 356<br>San Jon, 88434 | Quay | PI-C | N |
| Rigdon Texaco | 1720 | TC (Thomas) Shapard | 123 E Tucumcari Blvd<br>Tucumcari, 88401 | Quay | PI-S | U |

Source: NMED web site (http://www.nmenv.state.nm.us/ust/leakcity.html)

[a] ACCR = Aggr Cleanup Completed, Responsible Party
C-F = Cleanup, Federal Facility
C-R = Cleanup, Responsible Party
GWQB = Referred to the Groundwater Quality Bureau
I-R = Investigation, Responsible Party
M-CAF = Monitoring, State Lead, CAF
M-R = Monitoring, Responsible Party
NFA = No Further Action Required
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[b] N = No
U = Unknown
Y = Yes

## Table 5-38. Leaking Underground Storage Tanks in the Northeast Region
### Page 2 of 6

| Name | Facility ID | Contact | Physical Address | County | Status [a] | Water Supply Impacts [b] |
|---|---|---|---|---|---|---|
| Ramada Exxon | 28845 | Dulce (Renee) Romero | 1124 W Tucumcari Blvd<br>Tucumcari, 88401 | Quay | C-R | U |
| Quay County Butane | 30083 | Unknown | E Tucumcari Blvd<br>Tucumcari, 88401 | Quay | NFA | N |
| Kmart Exxon 2 | 1446 | TC (Thomas) Shapard | 1819 E Tucumcari Blvd<br>Tucumcari, 88401 | Quay | PI-C | N |
| Davids Conoco | 27639 | Dulce (Renee) Romero | 801 E Main, Tucumcari, 88401 | Quay | I-R | N |
| Worley Mills | 31672 | George Beaumont | 702 W Cambell, Tucumcari, 88401 | Quay | M-CAF | N |
| Martinez Plumbing | 29281 | George Beaumont | 1019 E Main, Tucumcari, 88401 | Quay | C-R | N |
| Nmshtd Tucumcari | 31249 | Danny Valenzuela | US 54 MP 305, Tucumcari, 88401 | Quay | M-R | N |
| Holiday Conoco | 28571 | George Beaumont | I 40 and Tucumcari Blvd E<br>Tucumcari, 88401 | Quay | ACC-R | N |
| K-Mart Station | 1446 | TC (Thomas) Shapard | 1819 E Tucumcari Blvd<br>Tucumcari, 88401 | Quay | NFA | N |
| K & C Texaco | 1436 | Christopher Holmes | 902 W Tucumcari Blvd<br>Tucumcari, 88401 | Quay | NFA | N |
| Bar F 11 | 29238 | George Beaumont | 701 E Main St, Tucumcari, 88401 | Quay | C-R | N |
| Tucumcari Muni | 31241 | George Beaumont | 6253 Quay Rd<br>State Hwy 88, Tucumcari, 88401 | Quay | M-CAF | N |
| Circle K 839 | 1144 | Dulce (Renee) Romero | 601 E Tucumcari, Tucumcari, 88401 | Quay | C-R | N |
| Tucumcari Truck | 31248 | George Beaumont | Exit 329 I 40, Tucumcari, 88401 | Quay | C-R | N |
| Fire Station | 28036 | Unknown | 123 N Adams St, Tucumcari, 88401 | Quay | NFA | N |
| Chevron 75762 | 27328 | George Beaumont | E Hwy 66, Tucumcari, 88401 | Quay | M-R | N |

Source: NMED web site (http://www.nmenv.state.nm.us/ust/leakcity.html)

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## Table 5-38. Leaking Underground Storage Tanks in the Northeast Region
## Page 3 of 6

| Name | Facility ID | Contact | Physical Address | County | Status [a] | Water Supply Impacts [b] |
|---|---|---|---|---|---|---|
| Beacon Station 654 | 28285 | George Beaumont | I 40 Exit 321 Palomas Interc,<br>Tucumcari, 88401 | Quay | I-R | N |
| Yocums Texaco | 2034 | George Beaumont | 1823 E Tucumcari Blvd<br>Tucumcari, 88401 | Quay | I-R | U |
| Ups Tucumcari | 31315 | Unknown | 524 Tucumcari St<br>Tucumcari, 88401 | Quay | NFA | N |
| Tucumcari City Of B | 31235 | TC (Thomas) Shapard | 202 N Monroe, Tucumcari, 88401 | Quay | ACC-R | U |
| Town & Ctry Food 148 | 1161 | TC (Thomas) Shapard | 201 E Tucumcari Blvd<br>Tucumcari, 88401 | Quay | M-R | N |
| Tucumcari Chevron | 31234 | TC (Thomas) Shapard | 300 W Tucumcari Blvd<br>Tucumcari, 88401 | Quay | I-R | U |
| Transcon | 31174 | Unknown | 701 Eleventh St, Tucumcari, 88401 | Quay | NFA | N |
| Dan C Trigg Mem | 27751 | George Beaumont | 301 E Miel De Luna Ave<br>Tucumcari, 88401 | Quay | NFA | N |
| Loves Country Store 262 | 29170 | Dulce (Renee) Romero | 1900 Mountain Rd<br>Tucumcari, 88401 | Quay | PI-C | N |
| Conway Oil Bulk Plnt | 1162 | George Beaumont | 412 Railroad Avenue<br>Tucumcari, 88401 | Quay | PI-C | U |
| Conway Oil Bulk Plant | 1162 | George Beaumont | 412 Railroad Avenue<br>Tucumcari, 88401 | Quay | NFA | N |
| Conservancy District | 26630 | Unknown | 705 W Campbell St<br>Tucumcari, 88401 | Quay | NFA | N |
| Sw Public Serv | 30710 | TC (Thomas) Shapard | 301 W Railroad Ave<br>Tucumcari, 88401 | Quay | GWQB | U |
| Conchas North Dock 9002 | 31246 | George Beaumont | 809 E Main, Tucumcari, 88401 | Quay | I-R | U |

Source: NMED web site (http://www.nmenv.state.nm.us/ust/leakcity.html)

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## Table 5-38. Leaking Underground Storage Tanks in the Northeast Region
Page 4 of 6

| Name | Facility ID | Contact | Physical Address | County | Status [a] | Water Supply Impacts [b] |
|---|---|---|---|---|---|---|
| Stuckeys 112 A | 30795 | Jeffery Mills | I 40 at Palomas Exit<br>Exit 321, Tucumcari, 88401 | Quay | NFA | N |
| Stuckey'S | 30795 | Jeffery Mills | I 40 At Palomas Exit<br>Exit 321, Tucumcari, 88401 | Quay | NFA | N |
| Second St Exxon Station | 1787 | George Beaumont | 101 E Tucumcari Blvd<br>Tucumcari, 88401 | Quay | PI-C | U |
| Bar F 13 | 1238 | George Beaumont | 401 W Tucumcari Blvd<br>Tucumcari, 88401 | Quay | M-R | N |
| Whiting Bros Tucumcari | 31628 | George Beaumont | E Tucumcari Blvd<br>Tucumcari, 88401 | Quay | M-R | N |
| Sandia Tucumcari Fina 34 | 30436 | Lane Andress | 702 E Tucumcari Blvd<br>Tucumcari, 88401 | Quay | PI-C | U |
| Travis Stovall | 30790 | Steven Jetter | E One Half Section 31 N<br>R 36 E, Broadview, 88112 | Curry | NFA | N |
| Bldg 368 | 30970 | TC (Thomas) Shapard | Facility 368 A, Cannon AFB, 88103 | Curry | PI-C | U |
| Bldg 2285 | 30953 | TC (Thomas) Shapard | Facility 2285, Cannon AFB, 88103 | Curry | PI-C | U |
| Bldg 10 | 30933 | TC (Thomas) Shapard | Facility 10, Cannon AFB, 88103 | Curry | C-F | U |
| Facility 130 | 30935 | TC (Thomas) Shapard | Facility 130, Cannon AFB, 88103 | Curry | PI-C | U |
| Facility 728 | 30990 | TC (Thomas) Shapard | Facility 728, Cannon AFB, 88103 | Curry | PI-C | U |
| Facility 392 | 30977 | Unknown | Facility 392 A, Cannon AFB, 88103 | Curry | NFA | N |
| Facility #3060 | 30964 | TC (Thomas) Shapard | Facility 3060, Cannon AFB, 88103 | Curry | PI-C | U |
| Facility #1400-Hospital | 30940 | TC (Thomas) Shapard | Facility 1402, Cannon AFB, 88103 | Curry | PI-C | U |
| 1402 Sewage Lift Sta | 30940 | TC (Thomas) Shapard | Facility 1402, Cannon AFB, 88103 | Curry | GWQB | U |
| Bldg 600 | 30989 | TC (Thomas) Shapard | Facility 600, Cannon AFB, 88103 | Curry | PI-C | U |

Source: NMED web site (http://www.nmenv.state.nm.us/ust/leakcity.html)

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## Table 5-38. Leaking Underground Storage Tanks in the Northeast Region
### Page 5 of 6

| Name | Facility ID | Contact | Physical Address | County | Status [a] | Water Supply Impacts [b] |
|---|---|---|---|---|---|---|
| Bldg/Fac 2110 | 30948 | TC (Thomas) Shapard | Facility 2110<br>Cannon AFB, 881035260 | Curry | C-F | U |
| Rierson Motors | 30231 | TC (Thomas) Shapard | 3500 Mabry Dr, Clovis, 88101 | Curry | PI-C | U |
| Red Rock Oil Co A | 30182 | Stephen Reuter | 1321 N Prince St, Clovis, 88101 | Curry | PI-C | U |
| Woodies Trk Stp | 27190 | TC (Thomas) Shapard | Star Rte<br>PO Box 25, Clovis, 88101 | Curry | NFA | N |
| Target Gas 7 | 31013 | TC (Thomas) Shapard | 2021 N Prince St, Clovis, 88101 | Curry | I-R | N |
| K Barnett & Sons | 28812 | Unknown | 2405 W Seventh St, Clovis, 88101 | Curry | NFA | N |
| Mountain Bell | 27444 | Unknown | 512 E Llano Estacado<br>Clovis, 88101 | Curry | NFA | N |
| Merrill Dairy | 29376 | TC (Thomas) Shapard | Rte 1, Box 265 B, Clovis, 88101 | Curry | NFA | N |
| Westside Sheet Metal | 2013 | Unknown | W Llano Estacada, Clovis, 88101 | Curry | NFA | N |
| York Tire Co | 31738 | Unknown | 1121 W Seventh St, Clovis, 88101 | Curry | NFA | N |
| At&Sf Rail Yard | 27439 | Unknown | Main St, Clovis, 88101 | Curry | NFA | N |
| Prince Street Sixty Six | 1682 | Dulce (Renee) Romero | Prince and 21st, Clovis, 88101 | Curry | NFA | N |
| Giant 104 | 30817 | Unknown | 710 E First St, Clovis, 88101 | Curry | NFA | N |
| Aei Ethanol | 26799 | Delbert Utz | Humphrey Rd<br>Rt 2 Box 307 A, Clovis, 88101 | Curry | NFA | N |
| Adair Bus | 26389 | Unknown | Po Box 337, Clovis, 88101 | Curry | NFA | N |
| Target Gas 6 | 31012 | TC (Thomas) Shapard | 720 E 1st St, Clovis, 88101 | Curry | PI-C | U |
| ADOC Oil, Clovis 1220 W. 21st St. | 26320 | Jeffery Mills | 1220 W Twenty First, Clovis, 88101 | Curry | PI-C | U |
| 7th & Hull Gulf | 26272 | TC (Thomas) Shapard | 7th and Hull, Clovis, 88101 | Curry | NFA | N |
| Circle K 644 | 1109 | Unknown | 1201 Thomas, Clovis, 88101 | Curry | NFA | N |

Source: NMED web site (http://www.nmenv.state.nm.us/ust/leakcity.html)

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# Table 5-38. Leaking Underground Storage Tanks in the Northeast Region
## Page 6 of 6

| Name | Facility ID | Contact | Physical Address | County | Status [a] | Water Supply Impacts [b] |
|---|---|---|---|---|---|---|
| Clovis Fina | 30817 | Unknown | 710 E First St, Clovis, 88101 | Curry | NFA | N |
| Quickstop | 30093 | Unknown | 1400 Thorton St, Clovis, 88101 | Curry | NFA | N |
| Colonial One Stop | 27461 | Unknown | 1400 Prince St, Clovis, 88101 | Curry | NFA | N |
| Colonial Chevron | 27461 | Unknown | 1400 Prince St, Clovis, 88101 | Curry | NFA | N |
| Sps Clovis Svc | 27442 | Unknown | 401 S Norris St<br>PO Box 1568, Clovis, 88101 | Curry | NFA | N |
| Main Street Conoco | 29236 | Danny Valenzuela | 117 Main, Clovis, 88101 | Curry | NFA | N |
| Circle K 710 | 28111 | Unknown | 905 N Prince, Clovis, 88101 | Curry | NFA | N |
| Crown Electric | 27578 | Unknown | 120 N Oak, Clovis, 88101 | Curry | NFA | N |
| Grady Keylock | 1145 | Unknown | Hwy 18 At Grady, Grady, 88120 | Curry | NFA | N |
| Ryder Truck | 30367 | Unknown | 2309 W 18th, Portales, 88130 | Roosevelt | NFA | N |
| Poynors Home/Auto | 26797 | Unknown | 420 S Ave C, Portales, 88130 | Roosevelt | NFA | N |
| Portales Chevron | 1677 | Dulce (Renee) Romero | 321 W 2nd, Portales, 88130 | Roosevelt | I-R | U |
| C And S Oil Co Inc | 1013 | Norman Pricer | 222 N Main, Portales, 88130 | Roosevelt | M-R | N |
| Hwy 70 Truckstop | 28532 | TC (Thomas) Shapard | 1601 W 2nd, Portales, 88130 | Roosevelt | C-R | U |
| University Gulf | 31290 | TC (Thomas) Shapard | 619 W 2nd St, Portales, 88130 | Roosevelt | NFA | N |
| C&S Card Lock | 1281 | TC (Thomas) Shapard | 100 S Chicago, Portales, 88130 | Roosevelt | I-R | N |
| Cardlock Station | 1021 | Dulce (Renee) Romero | 108 N Ave B, Portales, 88130 | Roosevelt | M-R | N |
| Serve-U-Right | 30533 | Unknown | 1131 W Second St, Portales, 88130 | Roosevelt | NFA | N |

Source: NMED web site (http://www.nmenv.state.nm.us/ust/leakcity.html)

[a] ACCR = Aggr cleanup completed, responsible party
C-F = Cleanup, federal facility
C-R = Cleanup, responsible party
GWQB = Referred to the Groundwater Quality Bureau
I-R = Investigation, responsible party
M-CAF = Monitoring, state lead, CAF
M-R = Monitoring, responsible party
NFA = No further action required
PI-C = Pre-investigation, confirmed release
PI-S = Pre-investigation, suspected release

[b] N = No
U = Unknown
Y = Yes

*5.4.2.2.2 Groundwater Discharge Plans.* The NMED Ground Water Quality Bureau regulates facilities with wastewater discharges that have a potential to impact groundwater quality and therefore the quantity and availability of the usable water supply. These facilities must comply with the New Mexico Water Quality Control Commission (NMWQCC) regulations and obtain approval of a discharge plan, which provides for measures needed to prevent and detect groundwater contamination. Each discharge plan includes requirements for ongoing monitoring, and NMWQCC regulations require cleanup of any groundwater contamination detected by such monitoring.

A variety of facilities fall under the discharge plan requirements, including mines, sewage dischargers, dairies, food processors, sludge and septage disposal operations, and other industries. The discharge plans in the Northeast Region are listed in Table 5-39.

*5.4.2.2.3 CERCLA Superfund Sites.* The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as Superfund, was enacted by the U.S. Congress on December 11, 1980. This law created the Superfund program to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment.

AT&SF Clovis (Santa Fe Lake) is the only U.S. EPA Superfund listed site in the Northeast Region (U.S. EPA, 2004). Santa Fe Lake is a playa lake, located approximately 1 mile south of the Burlington Northern Santa Fe (BNSF) railroad yard in Clovis, New Mexico. Wastewater from the yard was discharged into the lake beginning in the early 1900s when the yard was first constructed. Preliminary reports from an EPA investigation in the late 1970s indicated that heavy metals, total petroleum hydrocarbons, and cyanide were present on the site. Consequently, Santa Fe Lake, listed as "AT&SF Clovis," was one of the first six sites in New Mexico to be added to the National Priorities List (NPL) in 1983.

This site was deleted from the final NPL on March 17, 2003, after approximately 187,000 cubic yards of total petroleum hydrocarbon-contaminated soil and sediment were treated and the site was planted with native grasses. Contaminants of concern included boron, fluoride, chloride, total phenolics, sulfate, petroleum hydrocarbons, total dissolved solids, and total organic carbon.

# Table 5-39. Groundwater Discharge Permits in the Northeast Region
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| County | City | Facility Name | Waste Type |
|---|---|---|---|
| Union | Capulin | Capulin Volcano National Monument | Domestic |
| | Clayton | Clayton (Village of) Wastewater Treatment Plant | Domestic |
| | Clayton | Clayton (Village of) Municipal Airport | Domestic |
| | Clayton | Clayton (Village of) Municipal Airport | Domestic |
| | Clayton | Nightingale Dairy | Agricultural |
| Harding | Mosquero | Mosquero (Village of) Wastewater Treatment Plant | Domestic |
| | Roy | Roy (Village of) Wastewater Treatment Plant | Domestic |
| Quay | Nara Visa | Stull Trailer Wash | Agricultural |
| | San Jon | San Jon (Village of) Wastewater Treatment Plant | Domestic |
| | Sanford | Lake Meredith Salinity Control Project | Industrial |
| | Tucumcari | Tucumcari Dairy | Agricultural |
| | Tucumcari | Quail Hill Farm | Domestic |
| | Tucumcari | Grain Power Tucumcari Ltd | Industrial |
| | Tucumcari | Sixty Six Packing Company | Agricultural |
| | Tucumcari | Tucumcari Mountain Cheese Factory | Agricultural |
| Curry | Cannon AFB | Cannon Air Force Base | Domestic |
| | Clovis | Southern Draw Dairy | Agricultural |
| | Clovis | James Idsinga & Sons Dairy | Agricultural |
| | Clovis | T & J Dairy | Agricultural |
| | Clovis | Bigger And Better Septic Tank | Domestic |
| | Clovis | Barnes Farms II | Agricultural |
| | Clovis | Squanderosa Dairy | Agricultural |
| | Clovis | Desperado Dairy | Agricultural |
| | Clovis | Running M Land And Cattle | Agricultural |
| | Clovis | Three County Farms Inc | Agricultural |
| | Clovis | Mighty Vac | Industrial |
| | Clovis | Clovis (City of) - Inngram Lake Storm Water | Industrial |
| | Clovis | Rocket Industries | Agricultural |
| | Clovis | North Point Dairy | Agricultural |
| | Clovis | Clovis (City of) - Wastewater Treatment Plant | Domestic |
| | Clovis | Clovis (City of) - Wastewater Treatment Plant | Domestic |
| | Clovis | Mid Frisian Dairy | Agricultural |
| | Clovis | South Slope Dairy | Agricultural |
| | Clovis | Ideal Mobile Home Park | Domestic |
| | Clovis | Nelson Hart-D and A Chem Fuels | Industrial |
| | Clovis | Southwest Cheese Company | Agricultural |
| | Clovis | West Texas Ethanol - Ethanol Plant | Industrial |

Source: NMED, 2005

## Table 5-39. Groundwater Discharge Permits in the Northeast Region
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| County | City | Facility Name | Waste Type |
|---|---|---|---|
| Curry (cont.) | Clovis | Myrick Property Dairy | Agricultural |
| | Clovis | T and T Farms | Agricultural |
| | Clovis | Ford Dairy | Agricultural |
| | Clovis | Boersma's A and T Dairy | Agricultural |
| | Clovis | Rio Leche Dairy | Agricultural |
| | Clovis | Highway 288 Dairy | Agricultural |
| | Clovis | El Dorado Dairy | Agricultural |
| | Clovis | Frozfruit Corporation | Agricultural |
| | Clovis | Frozfruit Corporation | Agricultural |
| | Clovis | Rajen Dairy | Agricultural |
| | Clovis | Restaurant at Fox Run | Domestic |
| | Clovis | Sams Mobile Home Park | Domestic |
| | Clovis | Clovis (City of) - Sludge | Domestic |
| | Clovis | Highland Dairy II | Agricultural |
| | Clovis | Heritage Dairy 2 | Agricultural |
| | Clovis | Palla Dairy | Agricultural |
| | Clovis | Day Star Dairy | Agricultural |
| | Clovis | SAS Dairy | Agricultural |
| | Clovis | Highland Dairy | Agricultural |
| | Clovis | Stark Dairy | Agricultural |
| | Clovis | Clovis Energy Facility | Industrial |
| | Clovis | Palla Dairy II | Agricultural |
| | Clovis | Palla Dairy III | Agricultural |
| | Clovis | Burlington Northern Santa Fe - Clovis | Industrial |
| | Clovis | Three County Farms 2 | Agricultural |
| | Clovis | Jorde Dairy Ii | Agricultural |
| | Clovis | Valley Rendering Company | Industrial |
| | Clovis | Valley View Dairy | Agricultural |
| | Clovis | Powerline Dairy | Agricultural |
| | Clovis | Do-Rene Dairy 2Do-rene Dairy 2 | Agricultural |
| | Clovis | Providence Dairy | Agricultural |
| | Clovis | Opportunity Dairy | Agricultural |
| | Grady | Grady School | Domestic |
| | Melrose | Outback Dairy | Agricultural |
| | Melrose | Melrose (Village of) Wastewater Treatment Plant | Domestic |
| | Melrose | Anderson Dairy | Agricultural |
| | Texico | Ridgecrest Dairy | Agricultural |

Source: NMED, 2005

## Table 5-39. Groundwater Discharge Permits in the Northeast Region
## Page 3 of 4

| County | City | Facility Name | Waste Type |
|---|---|---|---|
| Curry (cont.) | Texico | Martin Grain | Agricultural |
| | Texico | Bouziden Cattle Co 1 | Agricultural |
| | Texico | Bouziden Cattle Co 1 | Agricultural |
| | Texico | Barnes Farms | Agricultural |
| | Texico | Desert Star Dairy | Agricultural |
| Roosevelt | Causey | Mariposa Farms Dairy | Agricultural |
| | Causey | Bright Horizon Dairy | Agricultural |
| | Dora | Gaines Dairy | Agricultural |
| | Elida | Elida Municipal Schools | Domestic |
| | Elida | Allsups - No287 | Domestic |
| | Elida | Danbom Dairy | Agricultural |
| | Floyd | Floyd Municipal Schools | Domestic |
| | Floyd | SunnyVale Dairy | Agricultural |
| | Portales | Midway Dairy | Agricultural |
| | Portales | Pleasant Valley Dairy | Agricultural |
| | Portales | Mitchell Dairy | Agricultural |
| | Portales | Terry Dairy | Agricultural |
| | Portales | Carter's Milk Factory | Agricultural |
| | Portales | Portales (City of) - Wastewater Treatment Plant | Domestic |
| | Portales | J-Lu Dairy 2 | Agricultural |
| | Portales | Cameo Dairy | Agricultural |
| | Portales | Abarca Miguel Dairy | Agricultural |
| | Portales | J-Lu Dairy #2 | Agricultural |
| | Portales | Abengoa Bioenergy Corporation | Industrial |
| | Portales | Red Roof Dairy | Agricultural |
| | Portales | Sanders Dairy | Agricultural |
| | Portales | Jorde Dairy V | Agricultural |
| | Portales | Jorde Dairy III | Agricultural |
| | Portales | R and L Farm Service, Inc 1 | Agricultural |
| | Portales | Rising Hills Dairy | Agricultural |
| | Portales | Sloping Hills Dairy | Agricultural |
| | Portales | Portales National Guard Armory | Domestic |
| | Portales | Milagro Dairy | Agricultural |
| | Portales | Ponderosa Dairy | Agricultural |
| | Portales | E and C Dairy | Agricultural |
| | Portales | Anderson Dairy 2 | Agricultural |
| | Portales | Bonestroo Dairy, LLC | Agricultural |

Source: NMED, 2005

## Table 5-39. Groundwater Discharge Permits in the Northeast Region
## Page 4 of 4

| County | City | Facility Name | Waste Type |
|---|---|---|---|
| Roosevelt (cont.) | Portales | Dependence Dairy | Agricultural |
| | Portales | High Plains Dairy | Agricultural |
| | Portales | Sandy Land Dairy | Agricultural |
| | Portales | Lajolla Dairy | Agricultural |
| | Portales | Lajolla Dairy | Agricultural |
| | Portales | Jones and Allen LLC | Agricultural |
| | Portales | Campbell Dairy | Agricultural |
| | Portales | Back Nine Dairy | Agricultural |
| | Portales | DairiConcepts | Agricultural |
| | Portales | New Mexico Christian Children's Home | Domestic |
| | Portales | Launchpad Dairy II | Agricultural |
| | Portales | West Farms Dairy 3 | Agricultural |
| | Portales | West Farms Dairy 2 | Agricultural |
| | Portales | West Farms Dairy 1 | Agricultural |
| | Portales | Lake View Dairy | Agricultural |
| | Portales | Philmar Dairy | Agricultural |
| | Portales | Portales National Guard Armory | Domestic |
| | Portales | Andy Schaap Dairy | Agricultural |
| | Portales | Outlaw Dairy | Agricultural |
| | Portales | Crosswinds Dairy | Agricultural |
| | Portales | Hide-A-Way Dairy | Agricultural |
| | Portales | Mirage Dairy | Agricultural |
| | Portales | Milk Flow Dairy | Agricultural |
| | Portales | Six Arrows Dairy | Agricultural |
| | Portales | Cooper-Legacy Dairy | Agricultural |
| | Portales | Idsinga Brothers Dairy | Agricultural |
| | Portales | Jorde Dairy VI | Agricultural |
| | Portales | Pork Packers, Inc | Agricultural |
| | Portales | 4-Way Dairy | Agricultural |
| | Portales | Bonestroo Dairy, LLC | Agricultural |
| | Portales | Western Star Dairy | Agricultural |
| | Portales | W-Diamond Dairy | Agricultural |
| | Portales | West View Dairy | Agricultural |
| | Rogers | D and J Dairy | Agricultural |

Source: NMED, 2005

Groundwater monitoring continues to be conducted by the BNSF Railroad (U.S. EPA, 2006). Further details about the site and its current status are available on EPA's web site (http://www.epa.gov/earth1r6/6sf/pdffiles/0600827.pdf).

*5.4.2.2.4 Landfills.* Landfills used for disposal of municipal and industrial solid waste can contain a variety of potential contaminants that may impact groundwater quality. To prevent such impacts, landfills operated since 1989 are regulated under the New Mexico Solid Waste Management Regulations. Many small landfills throughout New Mexico, including landfills in the planning region, closed before the 1989 deadline in order to avoid more stringent final closure requirements. Seven landfills are currently operating within the planning region (Table 5-40).

**Table 5-40. Landfills in the Northeast Region**

| Landfill Name | County | Operating Status |
|---|---|---|
| City of Clayton | Union | Active |
| Clayton C&D | Union | Closed |
| Village of Mosquero | Harding | Active |
| Mosquero C&D | Harding | Closed |
| Roy | Harding | Closure plan approved in 1999 |
| Roy C&D | Harding | Active |
| San Jon | Quay | In process of closure |
| San Jon C&D | Quay | Closed |
| Logan | Quay | Closed |
| Logan C&D | Quay | Active |
| City of Tucumcari | Quay | Active |
| Tucumcari C&D | Quay | Closed |
| Cannon AFB (asbestos) | Curry | Active |
| Clovis Regional | Curry | Active |
| Texico C&D | Curry | Closed |
| Elida C&D | Roosevelt | Closed |
| City of Portales | Roosevelt | Closed |

Sources: NMED, 2000a and 2000b

NA = Not applicable (landfill is still operating)
C&D = Construction and demolition

*5.4.2.2.5 Septic Systems.* A significant water quality concern for the planning region is groundwater contamination due to septic tanks. In areas with a shallow water table, septic system discharges can percolate rapidly to the underlying aquifer and increase concentrations of several contaminants, including TDS, nitrate, potentially toxic organic chemicals, iron, manganese, and sulfides (anoxic contamination), and bacteria, viruses, and parasites (microbiological contamination) (NMED, 2004c). Because septic systems are generally spread out in rural areas, they are considered a nonpoint source. Collectively, septic tanks and other on-site domestic wastewater disposal systems constitute the single largest known source of groundwater contamination in New Mexico (NMED, 2004c).

Of particular concern in the Northeast Region are septic tanks that serve the bulk of the Village of Logan population near Ute Reservoir. Because of their proximity to the reservoir, these septic systems may be a source of contamination to surface water as well as to groundwater. Additional septic systems will be used to treat wastewater from the homes built during Phase 1 of the Ute Lake Ranch development on the south side of the reservoir, increasing the input of septic system effluent.

#### *5.4.2.3 Dairies*

Although septic tanks and other on-site domestic wastewater disposal methods are the largest known source of groundwater contamination in New Mexico, contamination due to dairies is also a concern. Groundwater under about half of the dairies in New Mexico is contaminated with nitrate (Hartz, 2006b). Lagoon failures that resulted in contamination of groundwater have occurred at four dairies in Curry County, and nitrate levels in groundwater are increasing beneath an additional five dairies in the county (Hartz, 2006b). In Roosevelt County nitrate levels in groundwater beneath 16 dairies exceed the state standard of 10 mg/L (Hartz, 2006b).

Curry and Roosevelt Counties together have 64 dairies housing approximately 120,000 dairy cows, at an average of 1,900 to 2,000 cows per dairy (Bradley, 2006). While the current concentration of dairies in Curry and Roosevelt Counties is approaching saturation, more significant increases continue in west Texas where environmental regulations are less stringent (Bradley, 2006). Although feedlots (which unlike dairies do not have daily discharges) are not regulated by NMED (Hartz, 2006b), they are also a potential source of nitrate contamination. Future development of public water supplies in areas with concentrations of dairies must carefully consider water quality issues.

### 5.4.3 Summary of Water Quality by County

Sections 5.4.3.1 through 5.4.3.5 summarize the overall water quality for each of the counties in the Northeast Region, beginning with Union County in the north and moving generally southward. Water quality in the region is illustrated in Figures A-9a/A-9b through A-11a/A-11b (Appendix A).

#### 5.4.3.1 Union County

The NMED Surface Water Quality Bureau (SWQB) conducted a water quality survey for the Dry Cimarron River Watershed in 2000. The survey found that headwaters of the watershed had no water quality impairments. However, in other parts of the watershed, applicable water quality standards were exceeded for the following parameters:

- Dissolved oxygen and dissolved aluminum in Carrizozo Creek (Figure 5-20)
- Dissolved oxygen, pH, TDS, and temperature in the Dry Cimarron River (Figure 5-20)
- Temperature in Long Canyon

The SWQB survey noted that while the Dry Cimarron River and Long Canyon reaches are classified as coldwater fisheries, there is no evidence that coldwater fish have ever lived in these reaches (NMED, 2004a). Water quality standards for the coldwater fishery designated use are more stringent than standards for other designated uses, and standards might not be exceeded if the reaches were classified by some alternate designated use.

Responses to DBS&A's water system surveys were received from Clayton, Grenville, and Des Moines. These responses indicate that Grenville has no water quality concerns, while Clayton and Des Moines are concerned about naturally occurring radon concentrations. One Clayton well (well 10) has elevated levels of radon; consequently, this well is used only for backup.

The NMED Drinking Water Bureau gathers information on drinking water quality for each county in New Mexico (available at http://eidea.state.nm.us/SDWIS/Maps/Map_Template.jsp). The most recent Union County data for basic parameters show excellent water quality for three communities in the county (Table 5-41). All constituents are well below State and EPA aesthetic standards, although the water in each of the three communities can be characterized as hard, indicating that minerals will precipitate on fixtures.

### Table 5-41. Water Quality for Union County

| Water Quality Parameter | Concentration (mg/L[a]) NMWQCC Standard | Clayton[b] | Des Moines[c] | Grenville[d] |
|---|---|---|---|---|
| Calcium | NS | 39.7 | 55.6 | 34.2 |
| Chloride | NS | 6.6 | 18.2 | 5.6 |
| Hardness | NS[e] | 181 | 148[f] | 142 |
| Magnesium | NS | 20 | 21.2 | 13.7 |
| MBAS (surfactant) | NS | 0.025 | 0.01 | 0.025 |
| Nitrate+nitrite (as N) | 10 | 1.2[g] | 1.58[h] | 1.7[i] |
| Odor (TON) | NS | 1 | 0 | 1 |
| pH (s.u.) | Between 6 and 9 | 7.51 | 7.54 | 7.7 |
| Potassium | NS | 3.8 | < 1 | 2.7 |
| Radium-226/-228 (pCi/L) | 5[j] | 3.10[k] | 3.86[k] | 0.55[m] |
| Sulfate | 600 | 19 | 44.6 | 11 |
| Total alkalinity | NS | 190.9 | 215 | 136.9 |
| Total dissolved solids | 1,000 | 226 | 376 | 185 |
| Turbidity (NTU) | NS | 0.02 | 0.36[f] | 0.18 |

Source: NMED, 2005c

[a] Unless otherwise noted

[b] Sample collected 7/25/2000 from well 11 (unless otherwise noted)

[c] Sample collected 9/10/2002 from well 2 (unless otherwise noted)

[d] Sample collected 3/26/1997 from well 2 (unless otherwise noted)

[e] Water with more than 60 mg/L total hardness is considered hard.

[f] Sample collected 3/26/1997 from well B

[g] Sample collected 5/05/2005 from entry point 1

[h] Sample collected 10/21/2004 from well 1

[i] Sample collected 9/13/2005 from well 3

[j] EPA MCL

[k] Sample collected 11/8/05 from entry point 1

[l] Sample collected 11/9/05 from well A

[m] Sample collected 11/9/05 from well 2

NMWQCC = New Mexico Water Quality Control Commission
mg/L = Milligrams per liter
NS = No standard set
MBAS = Methylene-blue active substances
TON = Threshold odor number
s.u. = Standard units
pCi/L = PicoCuries per liter
NTU = Nephelometric turbidity units

While no water quality violations are listed on the NMED Drinking Water Bureau web site for Clayton, Des Moines and Grenville have had total coliform violations. The online data list one violation in Des Moines (March 1998) and five violations in Grenville for five monthly samples collected between 1999 and 2005, the most recent of which was in August 2005. Total coliforms were absent in all samples collected more recently for both communities (NMED, 2006b).

### *5.4.3.2 Harding County*

Responses to DBS&A's water system survey were received from Roy and Mosquero. According to these responses, neither community has any water quality concerns.

The most recent NMED Drinking Water Bureau information basic parameter data for Harding County are summarized in Table 5-42. The water in both communities is of excellent quality, although considered hard.

**Table 5-42. Water Quality for Harding County**

| Water Quality Parameter | Concentration (mg/L [a]) | | |
|---|---|---|---|
| | NMWQCC Standard | Mosquero [b] | Roy [c] |
| Calcium | NS | 48.1 | 47.6 |
| Chloride | NS | 10.4 | 71.5 |
| Hardness | NS [d] | 233 | 222 |
| Magnesium | NS | 27.4 | 25.1 |
| MBAS (surfactant) | NS | 0.025 | 0.01 |
| Nitrate+nitrite (as N) | 10 | 1 [e] | 2 [r] |
| Odor (TON) | NS | 1 | 0 |
| pH (s.u.) | Between 6 and 9 | 7.27 | 8.12 |
| Potassium | NS | 3.4 | 5 |
| Sulfate | 600 | 48 | 60.2 |
| Total alkalinity | NS | 183.5 | 187 |
| Total dissolved solids | 1,000 | 243 | 418 |
| Turbidity (NTU) | NS | 0.38 | 0.13 |

Source: NMED, 2005c

[a] Unless otherwise noted

[b] Sample collected 8/12/1997 from well 1 (unless otherwise noted)

[c] Sample collected 9/30/1997 from well 2 (unless otherwise noted)

[d] Water with more than 60 mg/L total hardness is considered hard.

[e] Sample collected 8/23/2005 from entry point 1

[f] Sample collected 8/25/2005 from entry point 1

NMWQCC = New Mexico Water Quality Control Commission
mg/L = Milligrams per liter
NS = No standard set
MBAS = Methylene-blue active substances
TON = Threshold odor number
s.u. = Standard units
NTU = Nephelometric turbidity units

The NMED Drinking Water Bureau web site lists total coliform violations for both Roy and Mosquero. The online data include two violations in the Village of Roy: for total coliforms in August 2002 and for total coliforms plus E. coli and fecal coliform in November 2000. The online data include four total coliform violations for the Village of Mosquero: for total coliforms plus E. coli and fecal coliform in February 2001 and for total coliforms in three monthly samples collected between 1992 and 1995. Total coliforms were absent in all samples collected more recently for both communities (NMED, 2006b).

The Village of Roy also received a violation for failure to sample for nitrate+nitrite in well 5 during 2004. The most current online result for this well was 1.56 mg/L, in a sample collected on October 23, 2003. This result is below the maximum contaminant level of 10 mg/L, indicating that the nitrate+nitrite level in this well is in compliance with current standards (NMED, 2006b).

#### *5.4.3.3 Quay County*

In Quay County, known groundwater contaminants include nitrate, chlorinated solvents, and halogenated aliphatic compounds. Contamination in Tucumcari includes chlorinated solvents (NMED, 2000a) and halogenated aliphatic compounds. Sources of chlorinated solvents include dry cleaning fluids, and sources of halogenated aliphatic compound contamination include grain fumigants and degreasing solvents (NMED, 2004c). Nitrate contamination is prevalent where there are high densities of septic systems and has been detected in Tucumcari, San Jon, and Logan. In addition to septic systems, other sources of nitrate contamination include meat packing and processing plants, dairies, feedlots, sewage treatment plants, and explosives manufacturing plants (NMED, 2004c).

Responses to DBS&A's water system surveys were received from San Jon, Tucumcari, House, and Logan. These responses indicate that Tucumcari and House have no water quality concerns. San Jon previously had issues with arsenic (28.2 µg/L in 2003) and fluoride (3.39 mg/L in 2003); however, San Jon began purchasing water from Logan in 2004, and so current supply does not reflect these past concentrations. Logan is concerned about the potential impacts of septic tanks to water quality, especially along the shores of Ute Reservoir. Wastewater from Village of Logan homes near the reservoir is treated by septic systems, and additional septic systems will be used to treat wastewater from homes built as part of Phase 1 of the Ute Lake Ranch development.

The most recent NMED Drinking Water Bureau information basic parameter data for Quay County are summarized in Table 5-43. Water for the communities in Quay County is also of excellent quality, with the exception of being relatively hard.

**Table 5-43. Water Quality for Quay County**

| Water Quality Parameter | Concentration (mg/L [a]) | | | | |
|---|---|---|---|---|---|
| | NMWQCC Standard | San Jon [b] | Tucumcari [c] | House [d] | Logan [e] |
| Calcium | NS | --- | 35.3 | --- | 48.8 |
| Chloride | NS | --- | 12.5 | --- | 48.4 |
| Hardness | NS [f] | --- | 202 | --- | 201 |
| Magnesium | NS | --- | 27.6 | --- | 19.3 |
| MBAS (surfactant) | NS | --- | 0.25 [g] | --- | 0.025 |
| Nitrate+nitrite (as N) | 10 | 4.2 [h] | 0.99 [i] | 3.51 [j] | 0 [k] |
| Odor (TON) | NS | --- | 1 | --- | 1 |
| pH (s.u.) | Between 6 and 9 | --- | 8.22 | --- | 7.49 |
| Potassium | NS | --- | 3 | --- | 3.9 |
| Sulfate | 600 | 73 | 85 | 141 | 104 |
| Total alkalinity | NS | --- | 221.4 | --- | 221.4 |
| Total dissolved solids | 1,000 | --- | 352 | --- | 400 |
| Turbidity (NTU) | NS | --- | 4.65 | --- | 4.5 |

Source: NMED, 2005c

[a] Unless otherwise noted

[b] Sample collected 1/20/1998 from well 23 (unless otherwise noted)

[c] Sample collected 6/4/2003 from Metro Well 10A (unless otherwise noted)

[d] Sample collected 3/11/1996 from Village Well (unless otherwise noted)

[e] Sample collected 3/20/2000 from Goggins Well (unless otherwise noted)

[f] Water with more than 60 mg/L hardness is considered hard.

[g] Sample collected 12/04/2001 from well 12A

[h] Sample collected 4/27/2004 from entry point

[i] Sample collected 10/21/2005 from the Hoover entry point

[j] Sample collected 2/12/2003 from Village Well

[k] Sample collected 3/17/2004 from well 6

NMWQCC = New Mexico Water Quality Control Commission
mg/L = Milligrams per liter
NS = No standard set
--- = No information available on the NMED web site
MBAS = Methylene-blue active substances
TON = Threshold odor number
s.u. = Standard units
NTU = Nephelometric turbidity units

The NMED Drinking Water Bureau web site lists fluoride and total coliform violations for San Jon. The online data include 18 fluoride violations in the Village of San Jon, the most recent of which was for a sample with a fluoride concentration of 4.04 mg/L, slightly exceeding the current federal primary drinking water standard of 4.0 mg/L. This concentration also exceeds the secondary drinking water standard of 2.0 mg/L, which was set because fluoride causes tooth discoloration (dental fluorosis) in children. The other 17 fluoride violations occurred in monthly samples collected between 1999 and 2004. The Village of San Jon water supply now comes completely from the Village of Logan via pipeline, and so these high levels of fluoride are not a major concern.

The Village of San Jon also received a violation for failing to sample for total coliforms during the July to September 2003 compliance period, and total coliforms were present in a sample collected in March 2006, although notice of a violation had not been posted as of June 2006 (NMED, 2006b).

No recent major violations have been received by other communities in Quay County:

- No water quality violations are listed on the NMED Drinking Water Bureau web site for Tucumcari (NMED, 2006b).
- The Village of House received a violation for failing to collect all of the required lead and copper samples between 1996 and 2004, but there is no record of any water quality exceedances (NMED, 2006b).
- The Village of Logan has received three violations for total coliform (June 1999, October 1995, and November 1993); however, total coliforms were absent in all samples collected more recently (NMED, 2006b).

#### *5.4.3.4 Curry County*

In Curry County, known groundwater contaminants include nitrate, chlorinated solvents, and halogenated aliphatic compounds. Contamination in Clovis includes chlorinated solvents (NMED, 2000a) and nitrate (NMED, 2004c); halogenated aliphatic compounds have been detected in Texico and Clovis (NMED, 2004c).

Responses to DBS&A's water system surveys were received from Clovis, Grady, Melrose, and Texico. These responses indicate that Grady has no water quality concerns. Radon has been detected in Melrose and Texico, and Texico detected a fluoride concentration greater than

2.0 mg/L (2.01 mg/L) in 2003. (Although the EPA primary water quality standard for fluoride is 4.0 mg/L, communities must report any detections between 2.0 and 4.0 mg/L due to the increased risk of dental fluorosis [discoloration of permanent teeth] in children younger than 9 years old). Clovis has had issues with nitrates and tetrachloroethylene (PCE) around their landfill and with fluoride (highest detection in 2004 was 2.1 mg/L) and barium (highest detection in 2004 was 143 µg/L). Radon is also an issue in Clovis, where the range in radon concentrations in 2004 was 200 to 530 pCi/L (Barnes, 2005) (the EPA's proposed MCL for radon is 300 pCi/L [U.S. EPA, 2000]).

One of the technical memorandums prepared as a part of the ENMRWS project states that water quality for the municipal supplies in Clovis, Melrose, and Texico is good, and chlorination is the only required treatment in those communities (CH2M Hill, 2005b). The most recent NMED Drinking Water Bureau basic parameter data for Curry County are summarized in Table 5-44. The water quality is very hard in Clovis and in some of the Cannon AFB wells. TDS has exceeded the aesthetic standard of 1,000 mg/L in 6 of the 16 Cannon AFB wells sampled.

The City of Clovis (whose municipal supply is provided by New Mexico American Water Company) received a violation for fluoride for the compliance period of 2001 to 2003. The sample had a concentration of 2.31 mg/L fluoride, which exceeds the NMWQCC secondary drinking water standard of 1.6 mg/L and EPA standard of 2 mg/L. This concentration required that a public notice be mailed, and public notification continues with discussion of elevated fluoride in the annual water quality reports that are sent to consumers (NMAW, 2004).

The most recent City of Clovis sample analyzed for nitrate+nitrite and posted online was collected February 28, 2005 from the distribution system. The concentration of nitrate+nitrite in this sample is listed as 18 mg/L, which exceeds the current standard of 10 mg/L. Comparison with previous sample concentrations suggests that this value may have been entered incorrectly.

## Table 5-44. Water Quality for Curry County

| Water Quality Parameter | Concentration (mg/L [a]) | | | | | |
|---|---|---|---|---|---|---|
| | NMWQCC Standard | Clovis [b] | Grady [c] | Melrose [d] | Texico [e] | Cannon Air Force Base [f] |
| Calcium | NS | 52.7 | --- | --- | --- | 24.4-339 |
| Chloride | NS | 113.0 | --- | --- | --- | 13.0-3,630 |
| Fluoride | 1.6 (2 [g]) | 2.31 | 0.84 [h] | 1.98 [i] | 2.47 [j] | 0.07-4.70 |
| Hardness | NS [k] | 324 | --- | --- | --- | 135-2,191 |
| Magnesium) | NS | 46.9 | --- | --- | --- | 18.0-327 |
| MBAS (surfactant) | NS | 0.025 | --- | --- | --- | NA |
| Nitrate+nitrite (as N) | 10 | 1.4 [l] | 3.3 [m] | 4.1 [n] | 2.0 [o] | 0.01-12.0 |
| Odor (TON) | NS | 1 | --- | --- | --- | NA |
| pH (s.u.) | Between 6 and 9 | 7.88 | --- | --- | --- | 6.9-8.2 |
| Potassium | NS | 9.1 | --- | --- | --- | 1.97-17.00 |
| Sulfate | 600 | 154 | 34 | 291 | 26 | 7.6-2,020 |
| Total alkalinity | NS | 164 | --- | --- | --- | 40-550 |
| Total dissolved solids | 1,000 | 590 | --- | --- | --- | 545-7,700 |
| Turbidity (NTU) | NS | 0.12 | --- | --- | --- | NA |

Source: NMED, 2005c, unless otherwise noted

[a] Unless otherwise noted

[b] Sample collected 6/09/2003 from well 51, New Mexico American Water Company (unless otherwise noted)

[c] Sample collected 6/01/1997 from well 1 (unless otherwise noted)

[d] Sample collected 4/01/1996 after treatment (unless otherwise noted)

[e] Sample collected 4/01/1996 from entry point after treatment (unless otherwise noted)

[f] Source: Langman et al., 2004. Data are from samples collected June 2002 to March 2003 in 16 wells.

[g] EPA MCL

[h] Sample collected 6/17/2003 from well 1

[i] Sample collected 6/17/2003 after treatment

[j] Sample collected 12/08/2004 from Brown well

[k] Water with more than 60 mg/L hardness is considered hard.

[l] Sample collected 3/09/2004 from well 49

[m] Sample collected 9/21/2005 from well 1

[n] Sample collected 1/28/2004 after treatment

[o] Sample collected 10/17/2005 from KKR well

NMWQCC = New Mexico Water Quality Control Commission
mg/L = Milligrams per liter
NS = No standard set
--- = No information available on the NMED web site
MBAS = Methylene-blue active substances
TON = Threshold odor number
s.u. = Standard units
NTU = Nephelometric turbidity units

No recent major violations have been received by other communities in Curry County:

- No water quality violations are listed on the NMED Drinking Water Bureau web site for Grady (NMED, 2006b).

- The Village of Melrose has received four violations for failing to collect total coliform samples (July 2005, August 2002, October 2000, and September 2000), but has not received any water quality violations (NMED, 2006b).

- The Village of Texico received a violation for failing to collect all of the required lead and copper samples between 1996 and 2004, but there is no record of any water quality exceedances (NMED, 2006b).

- Cannon AFB received a violation for failing to collect all of the required total coliform samples (2003), but has not received any water quality violations (NMED, 2006b).

#### *5.4.3.5 Roosevelt County*

Responses to DBS&A's water system surveys were received for Dora, Causey, Elida, and Portales. Based on these responses, neither Dora nor Causey have water quality concerns. Elida is concerned about the concentration of arsenic in their water, which was 12.0 µg/L on September 11, 2002 and ranged from 10.6 to 17.5 µg/L in the three Elida wells as of June 2006 (Monks, 2006). Portales is concerned about the concentrations of fluoride (1.71 to 2.85 mg/L in 2003) and arsenic (3.1 to 7.0 µg/L in 2003). In addition, Portales is concerned about radon contamination, as well as the impact of dairies on water quality.

One of the technical memorandums prepared as a part of the ENMRWS project states that water quality for the municipal supply in Portales is good, and chlorination is the only required treatment (CH2M Hill, 2005b). NMED Drinking Water Bureau basic parameter data for Roosevelt County are summarized in Table 5-45.

The Village of Dora has received two violations for total coliform (June 2005, August 2000); however, total coliforms were absent in recent samples (NMED, 2006b). The Village has also received violations for failing to collect all of the required total coliform samples (September

2005, December 1998, and July 1996) and for failing to collect all of the required lead and copper samples (1997 through 1999) (NMED, 2006b).

### Table 5-45. Water Quality for Roosevelt County

| Water Quality Parameter | Concentration (mg/L [a]) | | | | |
|---|---|---|---|---|---|
| | NMWQCC Standard | Dora [b] | Causey [c] | Elida [d] | Portales [e] |
| Arsenic | 0.1 (.01[f]) | 4.4[g] | 4.0[h] | 12[i] | 0.0077 |
| Calcium | NS | --- | --- | --- | 34.9 |
| Chloride | NS | --- | --- | --- | 9.8 |
| Fluoride | 1.6 (2[j]) | | | | |
| Hardness | NS[g] | --- | --- | --- | 172 |
| Magnesium | NS | --- | --- | --- | 20.7 |
| MBAS (surfactant) | NS | --- | --- | --- | 0.025 |
| Nitrate+nitrite (as N) | 10 | 2.1[k] | 2.5[l] | 0.93[m] | 2.2[n] |
| Odor (TON) | NS | --- | --- | --- | 1 |
| pH (s.u.) | Between 6 and 9 | --- | --- | --- | 7.7 |
| Potassium | NS | --- | --- | --- | 4.7 |
| Sulfate | 600 | 150 | 86 | 419 | 55 |
| Total alkalinity | NS | --- | --- | --- | 194.4 |
| Total dissolved solids | 1,000 | --- | --- | --- | 292 |
| Turbidity (NTU) | NS | --- | --- | --- | 0.11 |

Source: NMED, 2005c

[a] Unless otherwise noted

[b] Sample collected 1/17/1996 from entry point 1 (unless otherwise noted)

[c] Sample collected 1/08/1996 from well 1 (unless otherwise noted)

[d] Sample collected 1/08/1996 from entry point 1 (unless otherwise noted)

[e] Sample collected 4/14/2003 from Blackwater well 17 (unless otherwise noted)

[f] EPA MCL

[g] Sample collected 3/3/2003 from entry point 1

[h] Sample collected 3/3/2003 from well 1

[i] Data provided by Elida (Barnes, 2005)

[j] Water with more than 60 mg/L hardness is considered hard.

[k] Sample collected 9/15/2005 from entry point 2

[l] Sample collected 9/15/2005 from well 1

[m] Sample collected 9/15/2005 from entry point 1

[n] Sample collected 10/12/2005 from Hill entry point

NMWQCC = New Mexico Water Quality Control Commission
mg/L = Milligrams per liter
NS = No standard set
--- = No information available on the NMED web site
MBAS = Methylene-blue active substances
TON = Threshold odor number
s.u. = Standard units
NTU = Nephelometric turbidity units

The Causey Water Association received a violation for fluoride for the compliance period of 2001 to 2003. The sample had a concentration of 2.08 mg/L, which exceeds the secondary drinking water standard of 2.0 mg/L, requiring that a public notice be mailed. The water association received a violation for failing to collect all of the required total coliform samples in September 1995 and, since that time, has received four violations for total coliform (August 2002, July 2000, September 1999, and February 1999); however, total coliforms were absent in recent samples (NMED, 2006b).

The Village of Elida has received violations for failing to collect total coliform samples (May 2005), failing to collect all of the required lead and copper samples (1997–2004), and failing to repeat coliform analyses on all necessary samples (December 1997) (NMED, 2006b). Although the Village in the past has received three violations for total coliform (December 1997, October 1992, June 1992), total coliforms were absent in recent samples (NMED, 2006b).

The City of Portales has received violations for failing to collect all of the required total coliform samples (November 1998) and failing to collect all of the required lead and copper samples (2004) (NMED, 2006b). The City has also received one violation for total coliform (August 1999); however, total coliforms were absent in recent samples (NMED, 2006b).