GROUNDWATER RELATIONSHIP BETWEEN NEW MEXICO AND TEXAS

ALONG THE STATE LINE IN THE SOUTHERN HIGH PLAINS

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Introduction

Concern has been continuously expressed that ground water flow across the state line in the Southern High Plains has increased substantially over the original flow and that New Mexico is losing its ground water resource to Texas. This loss has been attributed to differences in ground water management and water use between the states. Previous studies by the State Engineer Office (SEO) have shown that ground water pumping in Texas does effect water levels in New Mexico. However, these effects were found to be generally much less than the effects resulting from wells pumping in New Mexico.

Ground Water Policy

In New Mexico ground water is publicly owned. In declared underground water basins the landowner can only appropriate water underlaying his property by obtaining a permit from the State Engineer. The State Engineer has the power to grant permits in declared basins when there is unappropriated water and if the proposed appropriation would not cause impairment to other appropriators and is not contrary to the public welfare of the state or conservation of water within the state. The State Engineer has only limited regulatory authority over ground water in undeclared areas.

Since adoption of the groundwater code in 1931, it has been the policy of the SEO to permit development of the Ogallala Aquifer, reserving only a fraction of the resource for future generations. In 1966 the New Mexico Supreme Court upheld the State Engineer's policy allowing mining of the aquifer because the quantity of water in storage is large and there is no relationship to a fully appropriated stream (Mathers v. Texaco, Inc. 77 N.M. 239).

In Texas ground water belongs to the owner of the land above it who may take for use or sale all the water he can capture. Legislation passed in 1949 authorized the establishment of underground water conservation districts in Texas. These districts have the authority to promulgate rules for conserving, protecting, recharging, and preventing waste of ground water. Historically

these districts have been reluctant to regulate or limit the amount of water a landowner can pump.

Hydrology

The Ogallala Formation of eastern New Mexico and western Texas is the principal aquifer supplying practically all the water used by the area's irrigators, municipalities, industries and households. The formation generally consists of highly permeable unconsolidated sediments of Pliocene age, underlain by older consolidated, and less permeable rocks commonly referred to as "redbeds." The saturated thickness of the aquifer in New Mexico ranges from 0 feet to approximately 200 feet. The average saturated thickness, however is less than 100 feet becoming generally greater in Texas.

The only significant source of natural recharge to the Ogallala aquifer in New Mexico is precipitation on the overlying land surface. From a number of studies it has been concluded that the average annual recharge is only a fraction of an inch. Because the water table slopes to the southeast, the principal means of natural discharge for the New Mexico portion of the Ogallala is groundwater flow across the state line into Texas. Pumping in New Mexico intercepts flow that otherwise would ultimately reach Texas. Stateline flows represent only a small portion of the total recharge to the Texas portion of the Ogallala.

Summary of Water Development History

Irrigation in the Southern High Plains began in the 1930's on a significant scale in the Portales Valley, New Mexico and in the vicinity of Muleshoe, Texas. Development of irrigation in east-central Lea County and adjacent Gaines County, Texas began on a major scale about 1947. In Curry County large-scale development occurred after 1950.

Stateline Flow Calculations

Changes in water table gradients and groundwater flow across the New Mexico-Texas state line have been evaluated. Calculations were made to determine flow across the state line in 1991 in eastern Curry County, northeastern Roosevelt County and east-central Lea County (Figure 1). To determine the change in flow across the state line, the results were compared to flows calculated by this office[1], and presented in an SEO paper in 1977 by F.R. Allen[2], Chief of the Technical Division. Our calculations were performed in a manner consistent with the method used by Mr. Allen[3].

The rate of movement of ground water across the state line is controlled by the gradient of the water table and the conductivity of the aquifer. The Darcy equation, used to calculate this flow,

may be expressed as:

$$Q = K \times I \times A$$

where:

Q = rate of flow across the state line,

K = hydraulic conductivity of the aquifer,

I = slope (gradient) of the water table,

A = cross-sectional area of the aquifer through which the water moves.

In a relatively homogeneous aquifer such as the Ogallala (constant K is assumed), the rate of flow through a cross section of the aquifer would be sensitive to changes in the rate of ground water pumping on either side of the state line. Increased pumping in Texas would increase the gradient (I) across the state line, thus increasing the rate of flow (Q) across the state line. Increased pumping in either New Mexico or Texas causes the water table to decline, reducing the cross-sectional area (A) of the aquifer through which the water (Q) can move across the state line. Changes in flow across the state line are caused by changes in the water table slope, changes in the aquifer's area, or a combination of these.

Our calculations and analysis of the results are presented in the following sections by area.

Eastern Curry County and Northeastern Roosevelt County

Groundwater levels along the state line in eastern Curry County and in the sandhills area of northeastern Roosevelt County have declined by as much as 125 feet since 1950. New Mexico irrigators in the area along the Curry-Roosevelt county line, southeast of Clovis, have been particularly affected by the large declines in area water levels. Well hydrographs from this area show that water levels in both New Mexico and Texas wells located near the state line began to decline in 1955. This was at a time when the rate of ground water development was rapidly increasing on both sides of the state line.

The pattern of water level declines in Figure 2 shows local cones of depression centered around both New Mexico and Texas wells. The water level declines in New Mexico are primarily due to the use of wells in New Mexico.

Figure 3 is a typical cross-section of the aquifer representing water level changes in New Mexico in the area of maximum declines. A large decline in saturated thickness over time can be seen.

Localized pumping depressions can be seen in both the 1977 and 1991 profiles (Range 36 East). Calculations have shown that after 40 years of pumping a well located in this area derives about 80 percent of its water from within one mile of the well. Only six percent of the well's supply is obtained from areas beyond five miles. Drawdowns west of Range 37 East are primarily due to New Mexico wells.

In 1956 the estimated stateline flow, using the Darcy equation, was 53,000 acre-feet (af) and by 1972 large scale pumping in Texas caused the estimated flow to increase to 69,000 af. However, by 1977 the total estimated flow across the state line had significantly decreased because declining water levels on both sides of the state line had reduced the cross-sectional area of the aquifer through which the water flows. Results of calculations for this area show that the estimated 1991 flow across the state line was about 34,000 af. This represents a substantial decrease in groundwater flow across the stateline.

If it is assumed that the 1956 rate of stateline flow approximates conditions prior to the period of large groundwater withdrawals, then the calculations indicate that New Mexico pumping has reduced stateline flows by as much as 40 percent. The 1991 stateline flow of about 34,000 af represents only 6 percent of the estimated 550,000 af of ground water pumped for agricultural use during 1991 in Curry and Roosevelt counties.

The Texas Water Development Board has reported that irrigated acreage in Bailey and Parmer counties, the Texas counties contiguous to Curry and Roosevelt counties, declined 28 percent between 1979 and 1989, from 600,000 to 431,000 acres (county totals). During this same period, irrigated acreage in New Mexico remained relatively constant at 255,000 acres (county totals).

Ground water basins in portions of northeastern Roosevelt County (Portales Valley) were declared successively in 1950, 1953 and 1955 (Figure 1). In the administration of the Ogallala aquifer, the State Engineer has developed a system that provides a measure of protection to existing rights without unduly restricting the full use of the groundwater resource. This policy provides for de-watering of all but the bottom 20 feet of the aquifer by 1996. As a result, the appropriation of ground water for an additional 90,000 acres of irrigated land have been permitted in the Portales Underground Water Basin between 1950 and 1991. Groundwater development in Curry County remained unregulated until the Curry County Underground Water Basin was declared in 1989. No policy has been adopted for the Curry County basin by the SEO. Applications to appropriate water or drill new wells are evaluated on a case-by-case basis.

Across the state line from Curry County and northeastern Roosevelt County, in West Texas, the High Plains Underground Water

Conservation District No. 1 regulates ground water development. Established in 1951, the district regulates well spacing and otherwise directs its efforts toward data collection, recharge studies, waste prevention and water conservation education. The district does not control or limit well production. The district's programs have reduced wasteful irrigation practices.

East-Central Lea County

Groundwater levels along the state line in Lea County have generally declined between 10 and 70 feet from 1947 to 1991. The pattern of water level declines in Figure 4 shows localized cones of depression centered around wells located both in New Mexico and Texas. The water level declines in Lea County are caused primarily by wells located within the state.

Figure 5 is a cross-section of the aquifer representing areas in eastern Lea County with historically moderate to large water level declines. The gradient across the state line increased significantly between 1977 and 1991. However, results of the calculations for Lea County show that in 1991 the estimated flow across the state line was about 35,000 af, only slightly larger than the 1976 estimated flow of 32,000 af, and approximately the same as the estimated pre-development stateline flow of 34,000 af.

Between 1979 and 1991 irrigated acreage in Lea County declined by more than 50 percent from 68,000 acres to 31,000 acres. During this same period, the Texas Water Development Board reported a decline of 37 percent in irrigated acreage in contiguous Gaines and Yoakum counties, from 480,000 to 304,000 acres. Recent aerial photographs of the area show that the amount of irrigated acreage located on the Texas side of the stateline has remained stable while it has declined on the New Mexico side. The increase in the water table gradient across the state line is probably due to the more rapid reduction of irrigated acreage in Lea County in the vicinity of the stateline rather than increased pumping in Texas. The increase in stateline flow of about 3,000 af from 1976 to 1991 represents only 3 percent of total 1991 Lea County withdrawals.

Shortly after adoption of the state's ground water appropriation act, the Lea County underground water basin was declared in 1931 and expanded in 1952 (Figure 1). The SEO adopted a policy permitting the mining of the aquifer, reserving the bottom one-third for use beyond 1992. In 1931 approximately 2,000 acres were under irrigation in Lea County. Subsequently the State Engineer has permitted irrigation on an additional 118,000 acres.

Yoakum County, Texas, across the state line from Lea County constitutes the Sandy Land Underground Water Conservation District (Figure 1). The district, established in 1989, regulates well

spacing and limits irrigation pumping rates to 5 gpm per acre owned. The district also manages a water level and water quality monitoring program. Gaines County, also located opposite of Lea County, is not located within the jurisdiction of an underground water conservation district. Ground water use is unregulated.

Summary

Calculations were made to estimate the change in groundwater flow across the New Mexico-Texas state line in the Southern High Plains. It was determined that pumping in Texas has caused water table gradients to increase along the state line in Curry County, northeastern Roosevelt County and east-central Lea County. However, diversions in both New Mexico and Texas have caused water levels to decline, reducing the cross-sectional area of the aquifer through which the water moves. The observed reduction in saturated thickness in New Mexico is primarily due to well withdrawals in New Mexico and has reduced flows from New Mexico to Texas in Curry and Roosevelt Counties, while stateline flows in Lea County are near predevelopment levels.

The historic pattern of water level declines shown in Figure 6 represents the coalescing of local cones of depression centered around both New Mexico and Texas wells (Figures 2 and 4). Irrigated acreage estimates show that the total amount of irrigated acreage within all Texas counties located in the study area, while significantly greater than New Mexico's acreage, has declined 28 to 37 percent since 1979, while in New Mexico, irrigated acreage has declined only in Lea County.

There is no evidence to suggest that differences in groundwater management between New Mexico and Texas have resulted in different patterns of either agricultural development or water use. Since declaration of the Lea and Portales underground water basins the State Engineer has permitted the development of approximately 200,000 acres of additional irrigated land in these administrative areas. The Curry County Underground Water Basin was not declared until 1989 and other areas with ground water development in the Southern High Plains have not been declared, including the Causey-Lingo area of Roosevelt County and eastern Union County (Figure 7).

Pumping in Texas does lower water levels in New Mexico. Most of these effects, however, are confined to a radius of less than five miles of the pumping wells. Large withdrawals in Texas along the state line, adjacent to areas in New Mexico with significantly less groundwater development will continue to impact New Mexico. Regardless of the amount of pumping in Texas, water levels in New Mexico will continue to decline so long as diversions in New Mexico continue to exceed the natural rate of recharge.

Groundwater models currently under development in the SEO will be useful in quantifying future water level declines in New Mexico due

to groundwater pumping in New Mexico and Texas. These models will provide an improved method of evaluating stateline flows, and for developing and implementing new ground water basin policies for the Ogallala aquifer in New Mexico.

To better address the water management issues facing the High Plains region of New Mexico, it is important for the current efforts to collect and analyze hydrologic and water use data be continued, expanded and improved. This effort should include continuation of the water level monitoring program and its possible expansion to include water quality. Agriculture is the biggest water user in the High Plains region, yet very few irrigation wells are metered. Well metering is a proven catalyst to better ground water management and conservation. Geologic formations associated with the Ogallala may also be important sources of water. Better characterization of these formations is necessary to evaluate their potential as additional sources of supply. All of these additional sources of information may be continually assembled into the new models now being developed. Ultimately, these models will assist the water users in making informed decisions with respect to their limited resource.

This report only addresses the changes in ground water flows across the state line resulting from groundwater depletions in the Southern High Plains, and the effect of Texas diversions on New Mexico's ground water reserves. Other areas of significant, if different interstate ground water concerns, include the Hueco Bolson and Mesilla Bolson of southern New Mexico and the Rio Grande Valley along the New Mexico-Colorado state line. Finally, because these aquifers underlay more than one state, mutual cooperation between the states is required to address these issues. The possibility of data sharing, joint model development, cooperative investigations and negotiating agreements with neighboring states to manage ground water development in these aquifers deserves attention. This report, and suggestions from its reviewers, is intended to initiate development of a plan to explore this possibility.

References

1. F.R. Allen. Changes in water-table gradients and ground-water flow along the New Mexico-Texas border in east-central Lea County from 1952 to 1976. Memorandum to S.E. Reynolds, October 27, 1976.

2. F.R. Allen. Ground-Water Relationship Between New Mexico and Texas Along the State Line in the Southern High Plains. SEO report, January, 1977.

3. Mustafa Chudnoff and Linda Logan. Analysis of groundwater flow across the New Mexico-Texas stateline in the Southern High Plains. Memorandum to Eluid Martinez, September 21, 1994.

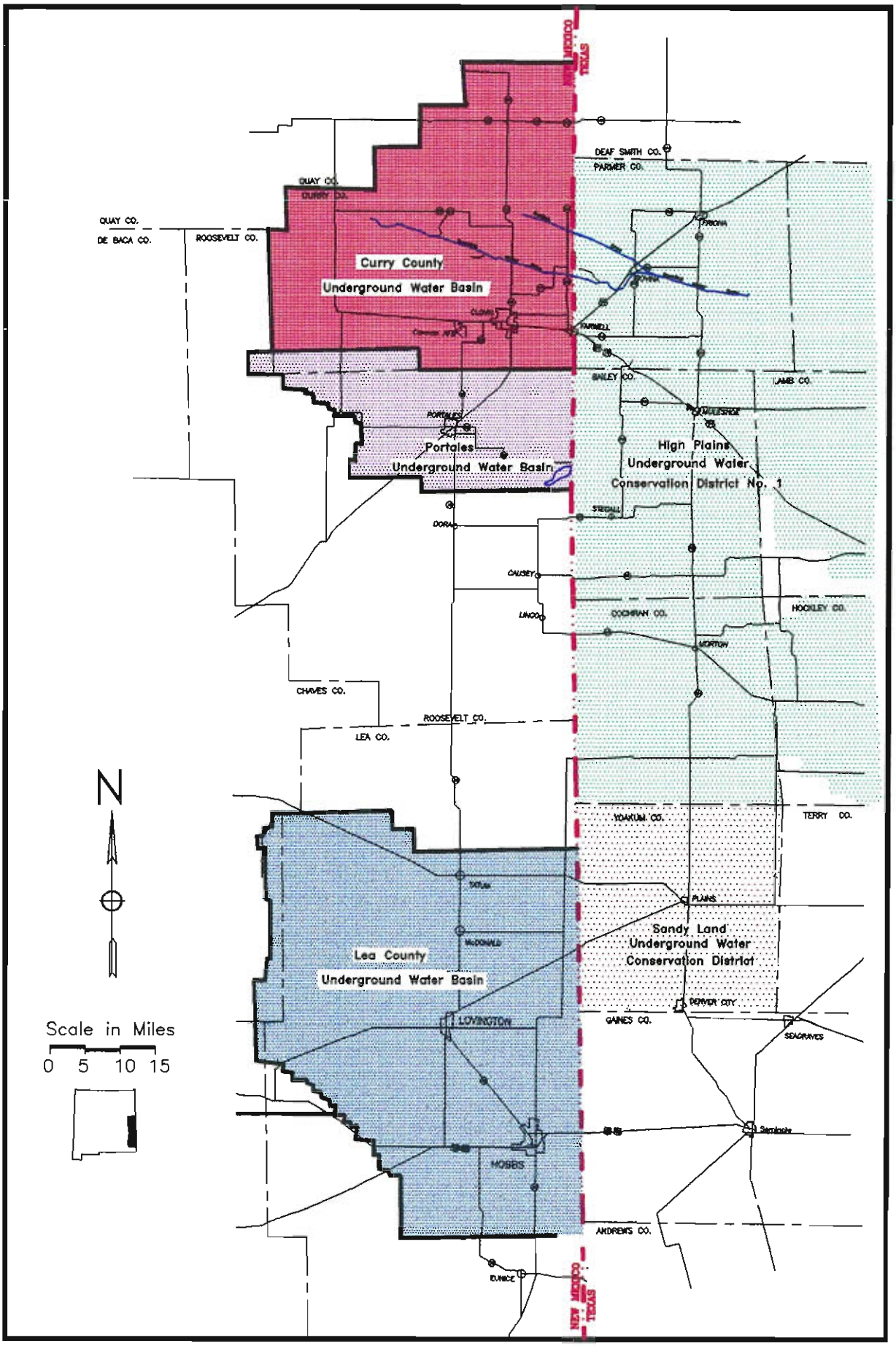

Figure 1 Study Area Location Map

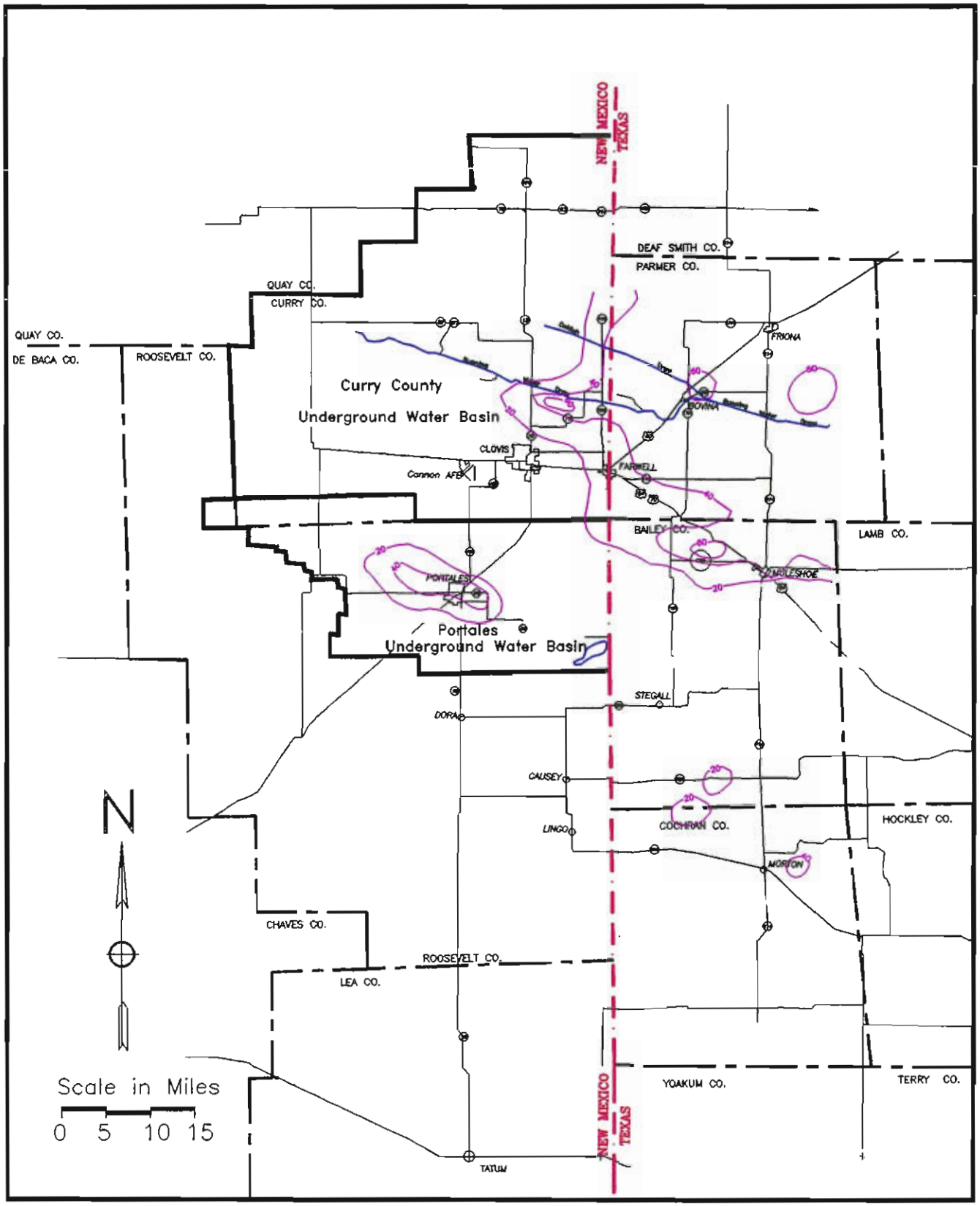

Figure 2. Decline in the Water Table 1937 to 1967 Roosevelt and Curry Counties, New Mexico and adjacent areas, Texas

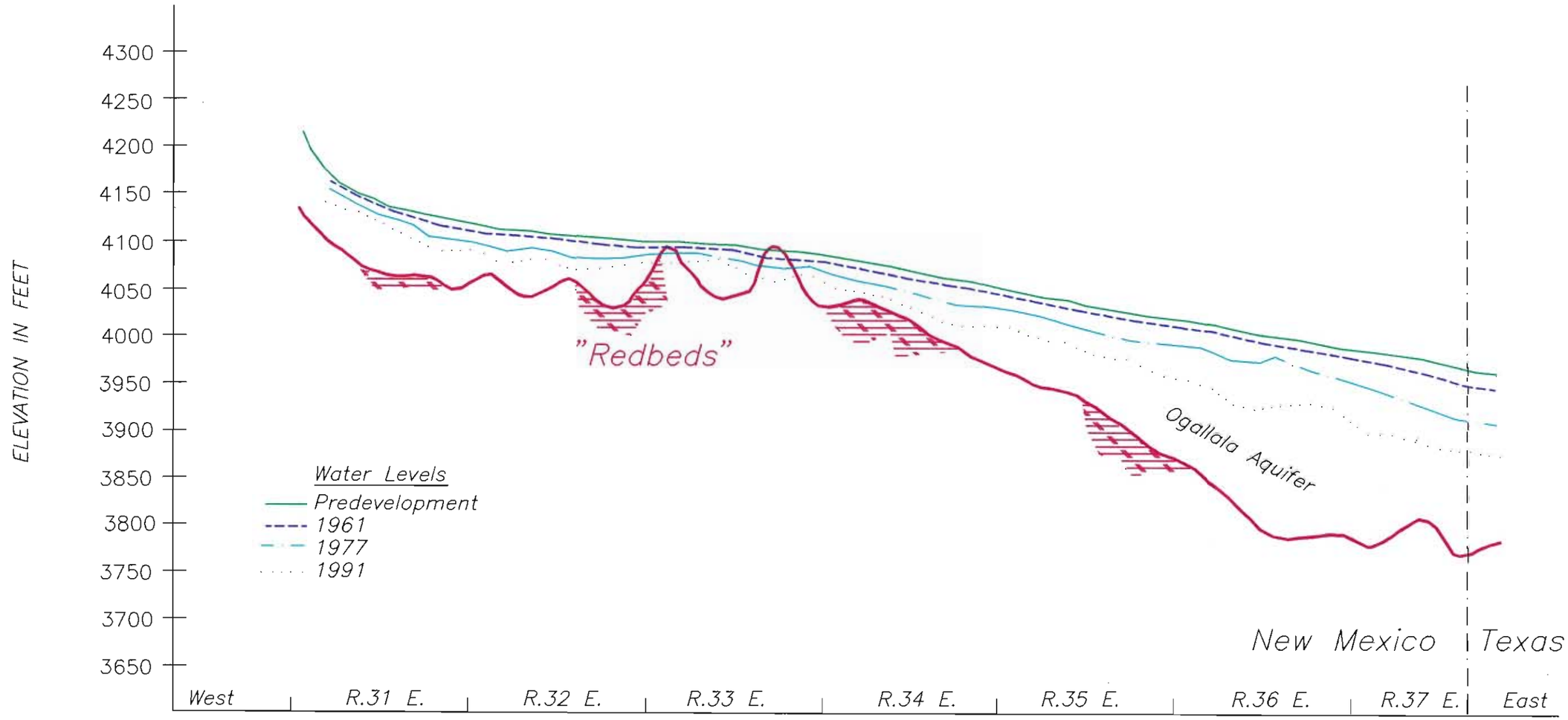

Figure 3. Water Table Profile through Township 1 North

Roosevelt County, New Mexico

0 1 2 3 — 50 feet

Scale in miles

Vertical exaggeration 1:100

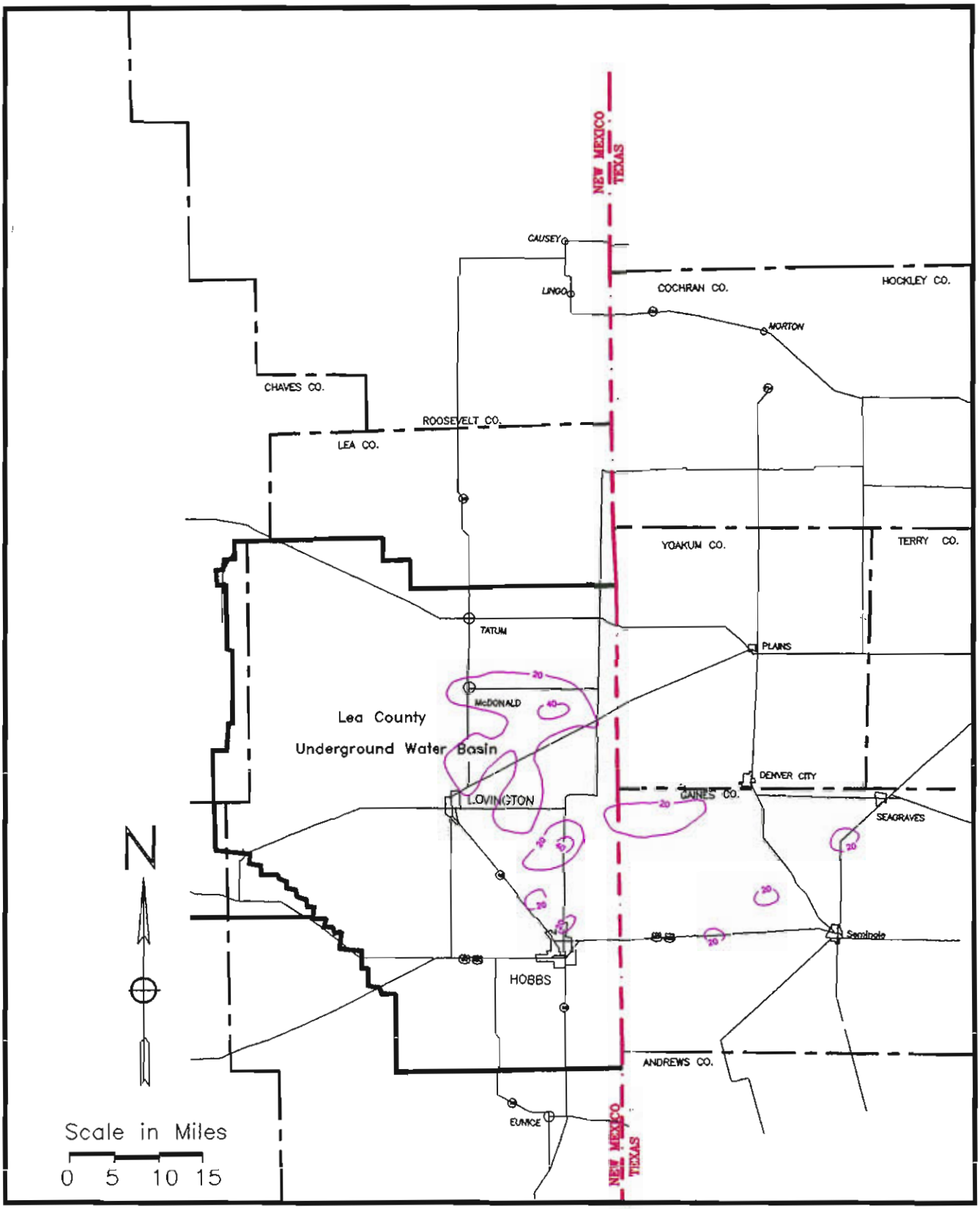

Figure 4. Decline in the Water Table 1937 to 1967 Lea County, New Mexico and adjacent areas, Texas

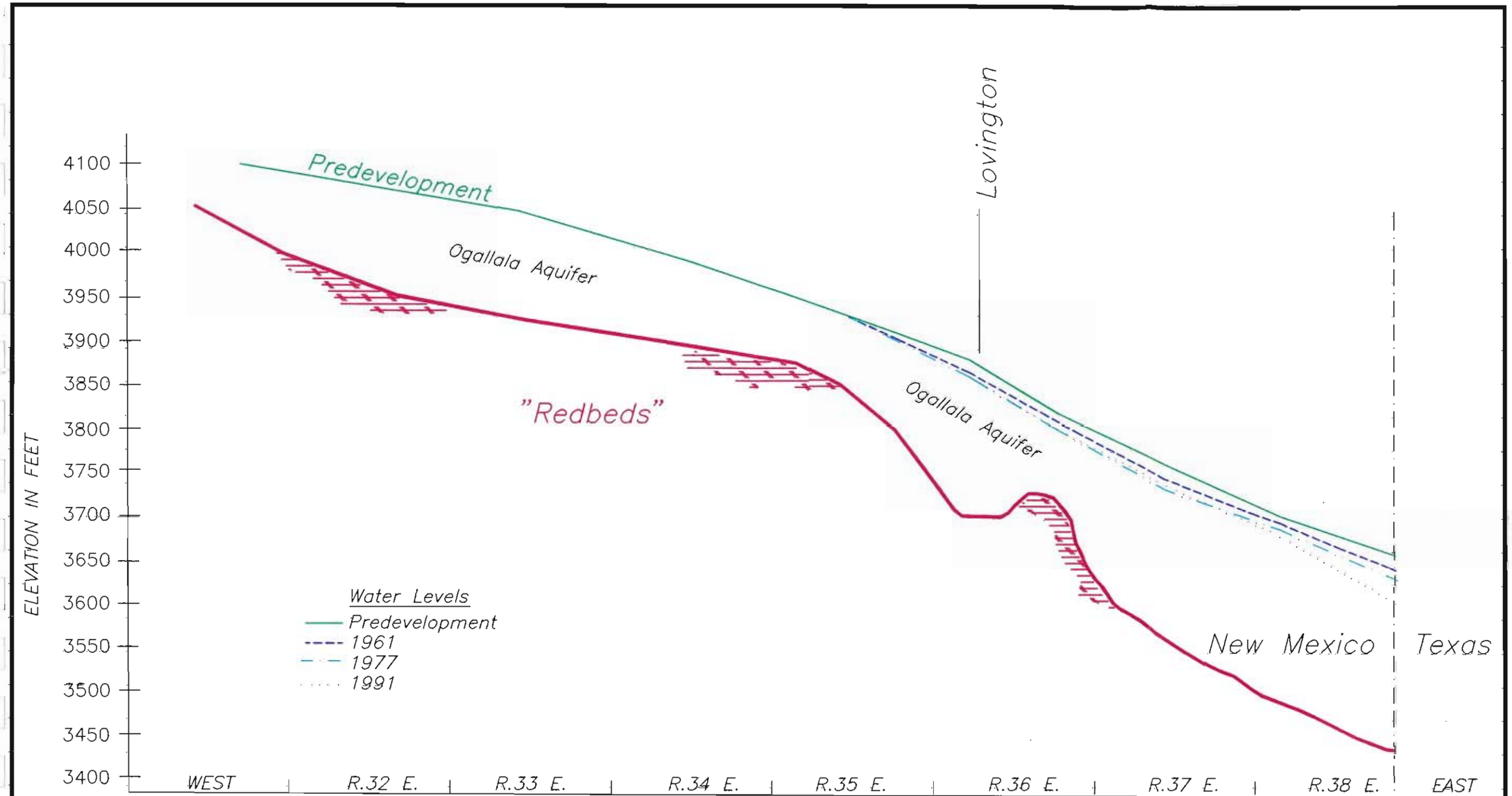

Figure 5. Water Table Profile through Township 16 South

Lea County, New Mexico

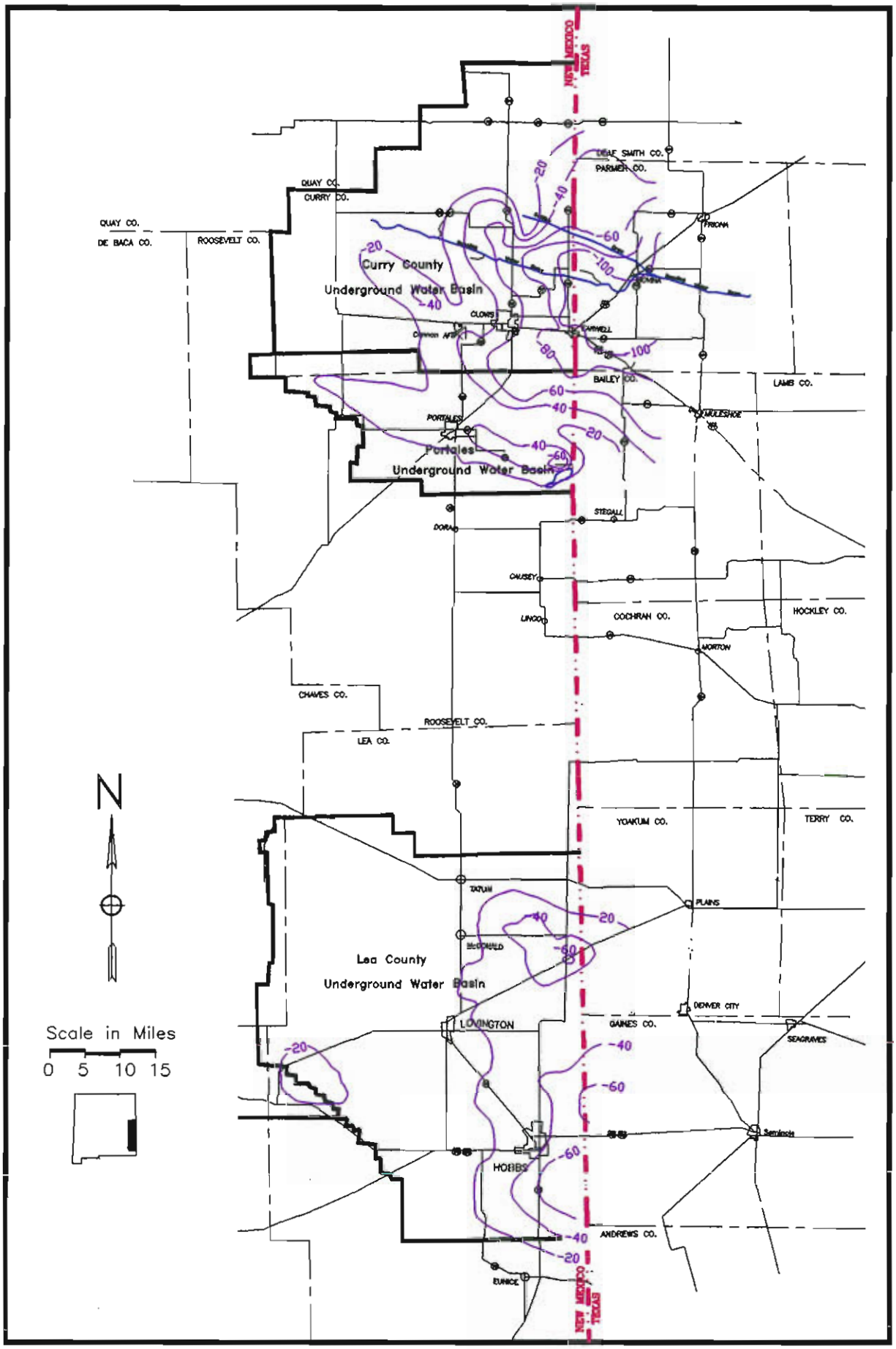

Figure 6. Decline in the Water Table Predevelopment to 1991

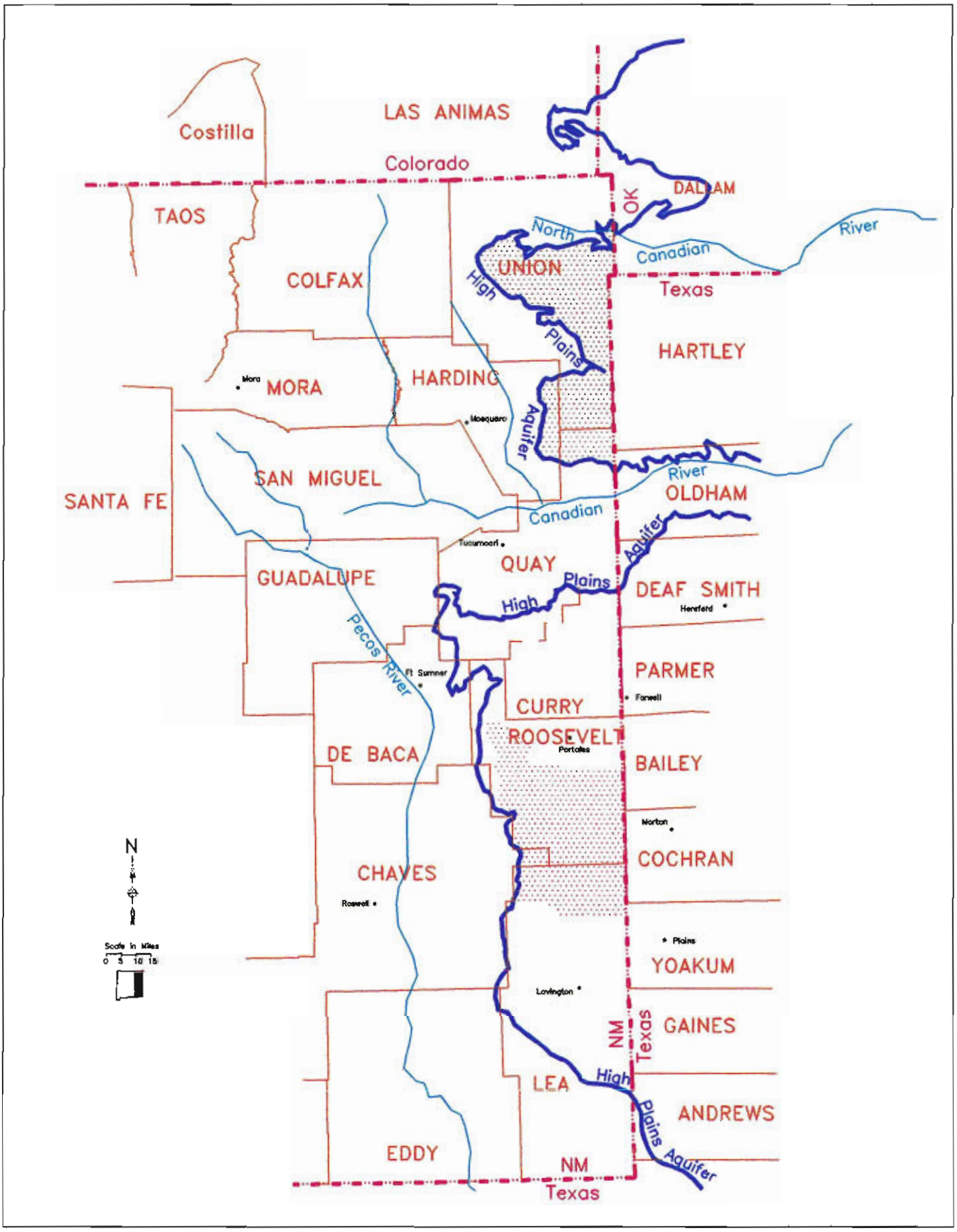

Figure 7. Undeclared areas within the High Plains Aquifer, NM.

Indicates undeclared area