HIGH PLAINS-OGALLALA AQUIFER STUDY

CURRY COUNTY, NEW MEXICO*

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DISCLAIMER

ABSTRACT

New Mexico participated with five High Plains states and the High Plains Associates in the Six-State High Plains-Ogallala Aquifer Area Study. The purpose of the study was to estimate the economic impacts over a 40-year planning horizon resulting from rapidly rising energy costs and the declining Ogallala aquifer water tables in Curry County.

Four management strategies including a baseline, voluntary water conservation, mandatory irrigation water supply reduction, and interstate importation were evaluated.

The total gross output of all goods and services for Curry County was about $406 million in 1977. It is projected to be $516 million in 1985, $654 million in 1990, $756 million in 2000, and $832 million in 2020 for the baseline. The differences in gross output among the management strategies are due primarily to changes in the agricultural sectors.

The important sectors are agriculture and manufacturing. The agricultural sectors are projected to have a major economic impact. In 1977, they accounted for about $208 million of the total output, and by 1985 they are projected to account for $270 million. In 1985, they are expected to account for $283 million in 1990, $286 million in 2000, and $296 million in 2020. The manufacturing sectors are expected to expand throughout the period. The Finance, Insurance, and Real Estate (FIRE) sectors were next in importance and generally showed an increase (from $44 million in 1977 to $93 million in 2020).

Output under the voluntary strategy is projected to be about $25,000 more than the baseline output in 2020. This is due to $42,000 more output in the agricultural sectors and $17,000 less in the construction sectors. The mandatory strategy resulted in $4.24 million more output in 2020 than the baseline and the importation strategy resulted in $8.527 million more than the baseline.

The total employment in Curry County in 1977 was 12,594 and is expected to increase to 19,199 by 1990 then decrease to 14,325 by 2020. Government was the largest employer throughout the period accounting for about 53 percent in 1977 and 42 percent in 2020.

KEYWORDS: *High Plains, *Ogallala Aquifer, *Curry County, *New Mexico, *management strategies, energy, water resources, on-farm impacts, regional impacts, gross output, employment, population, economic projections, resources, interdisciplinary.

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INTRODUCTION

A large part of eastern New Mexico is situated in the High Plains, a somewhat homogenous region extending over large areas of Colorado, Kansas, Nebraska, New Mexico, Oklahoma and Texas (Figure 1). Discovery and subsequent exploitation of extensive ground water resources in the region, primarily from the Ogallala Formation, have generated dramatic economic growth. This growth has exerted greater and greater demands on ground water supplies. Water levels have declined and some irrigated areas have gone out of production. As a result, the area's economic activities that depend on irrigated agriculture are threatened due to the rapidly rising energy costs and the declining water tables. If significant areas were to be forced out of irrigated production in the New Mexico High Plains, the economy of the entire state could be adversely affected. In response to these concerns, New Mexico, five other High Plains states, and the High Plains Associates (general contractor) participated in the Six-State High Plains-Ogallala Aquifer Area Study.

The general purpose of this study was to estimate the economic impacts over a 40-year planning horizon on regional income and employment, population, irrigated and dryland cropping patterns, agricultural output, and farm income. The impacts were measured under alternative sets of assumptions regarding public policy, water and energy costs and availability, and irrigation management practices.

The ground water irrigated acreage of the High Plains region represents about 35 percent of the irrigated acreage in New Mexico (Lansford et al., November 1981) and accounts for about one-third of the cash receipts from crop sales in the state.

Irrigation has been a fairly recent development in Curry County. For example, in Curry County irrigated cropland increased from 3,010 to 222,080 acres from 1950 to 1980 (Lansford et al., September 1982). However, parts of Curry County already have felt the effects of a declining water supply and rising energy costs. As a result, some irrigated cropland has been abandoned.

This report presents an in-depth look at the water, energy, and related resources in Curry County, New Mexico, which is a part of the High Plains-Ogallala Aquifer study region in New Mexico. Other reports

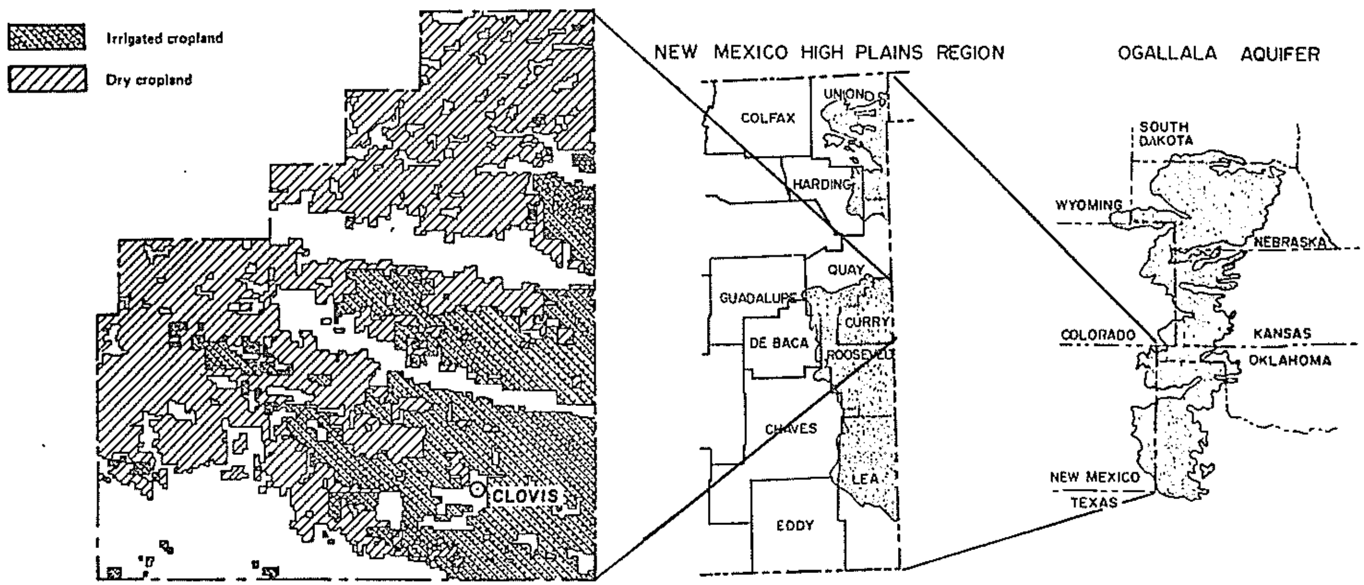

Figure 1. Ogallala Aquifer Region and New Mexico.

have been prepared for Roosevelt County, Lea County, Quay County, Union and Harding counties, and for the New Mexico region (WRRI Reports 147 through 151).

MANAGEMENT STRATEGIES

Four management strategies including a baseline were evaluated: voluntary water conservation (Alternative Management Strategy 1); mandatory irrigation water supply reduction (Alternative Management Strategy 2); and importation, supply augmentation for those areas that physically exhaust their water supply under Alternative Strategy 1 (Alternative Management Strategy 5A). Management Strategy 3, local supply augmentation, and Management Strategy 4, intrastate transfers, were not evaluated for New Mexico.

Baseline

The baseline is defined as "no new public action or deliberate change--continuation of current trends in water and agricultural management in both public and private sectors." It has been consistently assumed that under the baseline neither states nor the federal government will initiate new policies or programs to reduce demands on the Ogallala aquifer or other resources. Neither would they augment the water supply during the study period. It is further assumed that current trends in public and private sector resource demand and supply management would continue throughout the study period. Only those changes in resource management already underway and anticipated to continue as rational economic behavior would be considered to influence long-term baseline projections. Under the baseline, the continuation of present trends in water conservation is expected to result in water savings of about 10 percent on sprinkler-irrigated lands over the study period. It was assumed that there would be no reduction in water applications for furrow irrigated cropland.

Voluntary Irrigation Water Conservation

This alternative adds to the baseline by assuming incentives will be provided for technological change and improved water and agricultural management practices at the farm level. This alternative assumes an accelerated adoption rate of new and promising technologies. The changes in irrigation water and farm management practices are expected to occur through research and development, extension and education, and finally adoption of improved technology, improved farming practices, and improved plant varieties. The area of improved technology probably would include improved water conveyance and application systems. Improved farming practices would include techniques such as irrigation scheduling and evaporation reduction farming methods. Plant varieties might be adapted, through genetic research, to produce the same amount, only requiring less water. Operationally, this strategy is defined for two major irrigation systems: sprinkler and furrow.

Sprinkler water applications would be decreased by an additional 1.2 percent in 1985. There would be a 3 percent reduction in water applications in 1990, an additional 4 percent reduction in 2000, and an additional 5 percent reduction in 2020 for a total reduction of 12 percent from 1990 through 2020.

There would be a 4 percent reduction in water applications for furrow irrigation in 1985, an additional 5 percent reduction in 1990, an additional 6 percent reduction in 2000, and an additional 6 percent reduction in 2020 due to incentive programs and expanded research.

Mandatory Irrigation Water Supply Reduction

The mandatory strategy builds upon the voluntary strategy by adding mandatory water supply management. This strategy encompasses institutional/regulatory changes requiring water conservation, improved water and agricultural management practices at the farm level, and/or restrictions on new irrigated agricultural developments.

This strategy requires the supply of irrigation water to be reduced below what would be available under the voluntary strategy. Water supplies would be required to be reduced by 10 percent below the irrigation water applications in the voluntary strategy by 1985, by 20 percent by 1990, and by 30 percent by 2000.

Importation (Supply Augmentation)

Irrigation water would be imported to fully supply those lands that physically exhaust their natural water supply. The irrigation water would be available in the year 2000 and be applied in a manner consistent with the voluntary strategy technology.

GENERAL DESCRIPTION

Curry County, New Mexico, lies in eastern New Mexico on the Southern High Plains adjacent to Texas (Figure 1). Nearly all of the county lies in the Southern High Plains (Figure 1) and forms a part of the Llano Estacado in New Mexico. The topography of Curry County consists of relatively flat grassland, interspersed with some rolling hills and numerous playa lakes occupying potholes that have weathered into the landscape. Surface drainage is not well defined, except to Frio and Running Water draws which flow intermittently east into Texas. In the extreme northern part, the caprock is exposed and drainage is towards the Canadian River in Quay County. Elevations range from about 4,600 feet (MSL) in the northern part to about 4,200 feet near the southern boundary.

Curry County lies partly in three major river basins: Arkansas-White-Red, 441 square miles; Pecos Basin, 62 square miles; and the Texas Gulf, 910 square miles, for a total land area of 1,413 square miles.

There is only one Life Zone in the county; namely, the Upper Sonoran. Some pinon-juniper woodland follows the edge of the caprock; otherwise, vegetation consists of grassland and extensive areas of dry and irrigated farmland.

Climate

Curry County experiences a semiarid climate characterized by clear and sunny days, large diurnal temperatural ranges, low humidity, and moderately low rainfall. The mean annual precipitation averages about 17.5 inches. The hot summer months are normally the wettest. Occasionally, thunderstorms are accompanied by hail which may damage crops and property. The average snowfall is light and the snows usually melt within a few days after occurrence. Moderate winds prevail most of the year and strong winds are common from January to May.

Temperatures in the area average about 58 degrees Fahrenheit. Winters are usually mild and dry, and temperatures above 100 degrees Fahrenheit are not uncommon in the summer months. The growing season usually begins in early April and lasts 193 days, ending in late October.

Land

Curry County consists of approximately 898,500 acres of land. Less than 1 percent of the land is under federal ownership, about 7 percent under state ownership, and 93 percent is privately owned. Approximately 31 percent of the land in Curry County is rangeland used for grazing and 65 percent is cropland (25 percent is irrigated and 40 percent dryland). Urban and urban fringe areas comprise about 2 percent of the county land, and road systems account for 1 percent. The remainder of the land includes 100 acres of inland water and 3,471 acres used for defense purposes.

Hydrology

The Ogallala Formation is the principal source of ground water in Curry County. The extent of the Ogallala Formation in the Southern High Plains is outlined in Figure 1. The Ogallala is of the Tertiary age and overlies older rocks of Cretaceous, Jurassic, Triassic, and Permian ages. The group of older formations yield comparatively small quantities of usable fresh water, but in places contain considerable saline water in storage.

The first successful wells were drilled in about 1948 in Curry County. Irrigation by ground water in the Clovis area has developed rapidly since 1953. The principal aquifer is the Ogallala which overlies the red beds in most of Curry County. Measurements of water levels were begun in the Clovis area in 1954 to determine effects of pumping and precipitation on the ground water stored in the Ogallala Formation.

As of January 1976, the depth-to-water in this area ranged from 200 to over 400 feet, with an average of 300 feet from the land surface. The saturated thickness of the Ogallala ranged from 45 to 150 feet, with an average of approximately 90 feet. The typical irrigation well in this region will yield up to 1,000 gallons per minute with a specific well yield of 40 gallons per minute per foot of drawdown. The pumping head is comprised of the depth-to-water from the land surface, plus the drawdown, plus any head that is to be delivered to the irrigation system, such as a sprinkler. Presently, the pumping head for a typical gravity flow system is approximately 325 feet in this area.

Water level measurements have been maintained in this area by the U.S. Geological Survey since 1954 and reported by the State Engineer in the report series, "Water Levels in New Mexico." Irrigation well 2N 37E 7.211 was selected as being representative of the ground water response in this general area. In 1954, the depth-to-water in this well was reported as 230.34 feet and in 1975 the depth-to-water was 298.34 feet, with a general decline over the intervening years. The general rate of decline is approximately 3.0 feet per year.

The principle source of recharge to the Ogallala Formation is precipitation and infiltration into the aquifer. There is some discharge of ground water by natural means, such as through springs and seeps along the escarpments and by evaporation and transpiration; however, these are probably quite small in relation to the amount of water removed from the aquifer by pumping.

The amount and rate of recharge from precipitation depends on the amount, distribution, and intensity of the precipitation; the amount of moisture in the soil when rain or snowmelt begins; and the temperature, vegetative cover, and permeability of the materials at the site of infiltration. Because of the wide variations in these factors and because of the lack of data, it is difficult to estimate the amount of recharge to the ground water reservoir. An unknown amount of water pumped from the Ogallala Formation for irrigation percolates back to the aquifer. This does not constitute an addition to the water supply, but only a reduction in net discharge. The average annual recharge is estimated to be only a fraction of an inch.

Water Quality

The water is typically hard and has an objectionably high concentration of fluoride in many areas. The hardness, in addition to a high concentration of silica, makes it somewhat objectionable for domestic and many industrial uses. Except possibly in the vicinity of the playa lakes and in local areas where the ground water may have been contaminated by seepage from brine disposal pits (Ash, 1961, 1963, sheet 3), the water is satisfactory for irrigation. Only the excessive fluoride content makes it objectionable for public supply.

Water Use

Ground water from the Ogallala Formation in Curry County is used for irrigation, public supply, industrial supply, and domestic and stock purposes.

Water Rights Administration

A small portion of the county in the southwest corner is within the Portales Underground Water Basin as declared by the State Engineer (Figure 2). Permits from the State Engineer are necessary prior to drilling wells within the boundaries of the declared basin. No permit is required to drill wells in the portion of the county outside the declared basin.

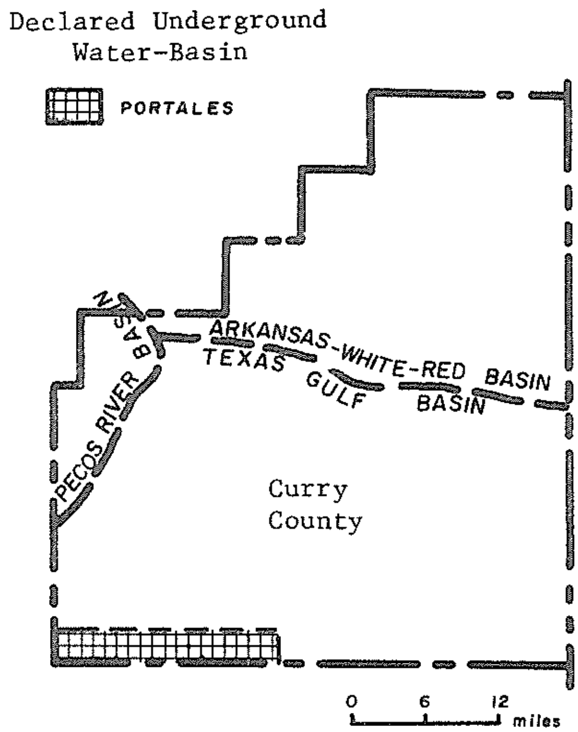

Figure 2. Declared Underground Water Basin, Curry County, New Mexico.

Energy

There is no energy production in Curry County.

Agriculture

Curry County is an important agricultural area in New Mexico. In 1977, it accounted for about 15 percent of the total irrigated acreage, about 29 percent of the total dryland crop acreage, and 11.6 percent of the cash receipts from crop sales. The important irrigated crops in Curry County were corn, grain sorghum, and wheat. According to 1977 published data, these three crops accounted for 86 percent of the irrigated acreage and 72 percent of the total cash receipts from crops in Curry County (New Mexico Crop and Livestock Reporting Service, 1978). The important dryland crops in 1977 were grain sorghum, other sorghum, and wheat (Lansford, 1980). These three crops accounted for about 97 percent of the dry cropland acreage and 19 percent of the total cash receipts from crops in 1977.

OGALLALA HIGH PLAINS MODEL AND COMPONENTS

The purpose of this study was to estimate the economic impacts over a 40-year planning horizon on regional income, employment, population, irrigated and dryland cropping patterns, agricultural output, farm income, and energy production. The impacts were measured under alternative sets of assumptions regarding public policy, water and energy costs and availability, and irrigation management practices.

An interdisciplinary approach to the solution of the water resource problems of the High Plains region in New Mexico was made possible by integrating hydrology, geology, and engineering with economics. Research procedures developed to carry out this study were closely coordinated by the investigators to achieve the stated objectives. Inputs into the economic models were obtained from separate studies covering the hydrological, agricultural, and energy areas.

Assumptions concerning regional economic impacts, employment, population, crop yields, commodity prices, energy prices, input prices, and energy production were developed cooperatively among the six states and the general contractor. All states used basically the same assumptions for compatibility. A detailed description and discussion of the methodology for the separate area studies are presented in WRRI Report 151.

RESULTS

Results are presented for the Curry County economic impacts and key resources by management strategy for selected years (1977, 1985, 1990, 2000, and 2020).

Water Resources

Projected withdrawals for irrigation, urban, rural, manufacturing, minerals, power, livestock, and recreation uses are presented in Table 1. Table 1 also shows projections for depth-to-water (ground surface to water table), and the remaining saturated thickness of the Ogallala Formation for the years 1977, 1985, 1990, 2000, and 2020 in Curry County. The base year for all projections is 1977.

Other than areas of future agricultural and urban uses, there is little possibility of reducing water demand in Curry County through voluntary or mandatory strategies. This does not mean conservation should be abandoned in all areas of water use. However, the use of water by irrigated agriculture (about 97 percent of the total ground water withdrawals) overshadows all other uses.

For these reasons, the only changes in the voluntary strategy projection and in the mandatory strategy projection (Table 1) from quantities shown in the baseline projection are for "irrigation" and "urban." Water requirements for other water-use categories are the same in all projections.

Other than irrigation and urban, the only significant increases in water demand are the amounts projected for "minerals." Most of this water is now used for secondary oil recovery and is expected to increase in the future. The projected amounts were reviewed and concurred with by personnel of the New Mexico Energy and Minerals Division.

The voluntary projections for "urban" were estimated by reducing baseline projections by 10 percent. Mandatory projections were estimated by reducing voluntary projections by an additional 15 percent (a total of 25 percent with respect to the baseline quantities).

In the High Plains area of New Mexico, it was assumed that when the saturated thickness of the Ogallala aquifer in a given area becomes 25 feet or less, the water is no longer economically recoverable for irrigated agriculture and pumping for this purpose would cease. However, even though the water in the lower 25 feet of the aquifer is no longer economically extractable for irrigation use, many widely spaced wells producing small amounts of water could continue to produce sufficient supplies for urban and most other nonirrigation needs.

Table 1. Estimated Withdrawals, Depth-to-Water, and Remaining Saturated Thickness of Ogallala Aquifer, Curry County, New Mexico, 1977-2020.

Strategy and Category	Year				
	1977	1985	1990	2000	2020
Baseline					
Withdrawals (1,000 acre-ft.)					
Irrigation	(313.2)	(312.3)	(237.4)	(107.9)	(0.0)
Saturated Thickness/Less than 50 ft.	64.9	65.4	0.0	0.0	0.0
Saturated Thickness/50 to 100 ft.	133.7	133.1	124.0	0.0	0.0
Saturated Thickness/More than 100 ft.	114.6	113.8	113.4	107.9	0.0
Urban	6.2	7.0	9.0	10.5	13.7
Rural	0.6	0.6	0.6	0.6	0.6
Manufacturing	0.2	0.2	0.3	0.4	0.6
Mining	<0.1	<0.1	1.0	2.2	3.9
Military	1.8	1.8	1.8	1.8	1.8
Livestock*	1.3	1.4	1.6	1.8	1.9
Recreation, Fish & Wildlife	<0.1	<0.1	0.2	0.2	0.4
Total Withdrawals	323.5	323.5	251.9	125.4	22.9
Depth-to-water (ft.)					
Saturated Thickness/Less than 50 ft.	325.0	350.0	>350.0	>350.0	>350.0
Saturated Thickness/50 to 100 ft.	350.0	375.4	391.4	>395.0	>395.0
Saturated Thickness/More than 100 ft.	270.0	294.0	309.0	339.0	>370.0
Remaining saturated thickness (ft.)**					
Saturated Thickness/Less than 50 ft.	50.0	25.0	<25.0	<25.0	<25.0
Saturated Thickness/50 to 100 ft.	70.0	44.6	28.6	<25.0	<25.0
Saturated Thickness/More than 100 ft.	125.0	101.0	86.0	56.0	<25.0
Voluntary Strategy					
Withdrawals (1,000 acre-ft.)					
Irrigation	(313.2)	(308.3)	(231.2)	(99.7)	(0.0)
Saturated Thickness/Less than 50 ft.	64.9	63.8	0.0	0.0	0.0
Saturated Thickness/50 to 100 ft.	133.7	134.0	125.0	0.0	0.0
Saturated Thickness/More than 100 ft.	114.6	110.5	106.2	99.7	0.0
Urban	6.2	6.3	8.1	9.4	12.3
Rural	0.6	0.6	0.6	0.6	0.6
Manufacturing	0.2	0.2	0.3	0.4	0.6
Mining	<0.1	<0.1	1.0	2.2	3.9
Military	1.8	1.8	1.8	1.8	1.8
Livestock*	1.3	1.4	1.6	1.8	1.9
Recreation, Fish & Wildlife	<0.1	<0.1	0.2	0.2	0.4
Total Withdrawals	323.5	318.8	244.8	116.1	21.5
Depth-to-water (ft.)					
Saturated Thickness/Less than 50 ft.	325.0	350.0	>350.0	>350.0	>350.0
Saturated Thickness/50 to 100 ft.	350.0	375.2	391.9	>395.0	>395.0
Saturated Thickness/More than 100 ft.	270.0	294.0	309.0	337.0	>370.0
Remaining saturated thickness (ft.)**					
Saturated Thickness/Less than 50 ft.	50.0	25.0	<25.0	<25.0	<25.0
Saturated Thickness/50 to 100 ft.	70.0	44.8	28.9	<25.0	<25.0
Saturated Thickness/More than 100 ft.	125.0	101.0	86.0	58.0	<25.0

* Includes surface water.

** Saturated thickness is defined as the thickness of a lens of saturated porous material existing below the water table, capable of yielding significant quantities of ground water to wells. The remaining saturated thickness reflects the impact of all ground water withdrawals on the quantity of water stored in the porous medium and, thus, the thickness of the lens.

Table 1 cont.

Strategy and Category	1977	1985	Year 1990	2000	2020
Mandatory Strategy					
Withdrawals (1,000 acre-ft.)					
Irrigation	(313.2)	(273.9)	(185.0)	(69.9)	(65.8)
Saturated Thickness/Less than 50 ft.	64.9	57.4	0.0	0.0	0.0
Saturated Thickness/50 to 100 ft.	133.7	117.0	100.0	0.0	0.0
Saturated Thickness/More than 100 ft.	114.6	99.5	85.0	69.9	65.8
Urban	6.2	5.3	6.8	7.9	10.3
Rural	0.6	0.6	0.6	0.6	0.6
Manufacturing	0.2	0.2	0.3	0.4	0.6
Mining	<0.1	<0.1	1.0	2.2	3.9
Military	1.8	1.8	1.8	1.8	1.8
Livestock*	1.3	1.4	1.6	1.8	1.9
Recreation, Fish & Wildlife	<0.1	<0.1	0.2	0.2	0.4
Total Withdrawals	323.5	283.4	197.3	84.8	85.3
Depth-to-water (ft.)					
Saturated Thickness/Less than 50 ft.	325.0	350.0	>350.0	>350.0	>350.0
Saturated Thickness/50 to 100 ft.	350.0	375.2	389.1	>395.0	>395.0
Saturated Thickness/More than 100 ft.	270.0	294.0	307.0	330.0	365.0
Remaining saturated thickness (ft.)**					
Saturated Thickness/Less than 50 ft.	50.0	25.0	<25.0	<25.0	<25.0
Saturated Thickness/50 to 100 ft.	70.0	44.8	30.9	<25.0	<25.0
Saturated Thickness/More than 100 ft.	125.0	101.0	88.0	65.0	30.0

* Includes surface water.

** Saturated thickness is defined as the thickness of a lens of saturated porous material existing below the water table, capable of yielding significant quantities of ground water to wells. The remaining saturated thickness reflects the impact of all ground water withdrawals on the quantity of water stored in the porous medium and, thus, the thickness of the lens.

The estimated hydrologic conditions, well characteristics, irrigation system, and fuel for the baseline conditions for the Ogallala in Curry County are presented in Appendix Table A-1.

The estimated remaining saturated thickness resulting from irrigation is presented in Table 2. Except for 1977 conditions, the estimated remaining saturated thickness shown in these tables does not reflect the impact of withdrawals for uses other than irrigation.

To estimate the total effect of all uses upon the saturated thickness, the values shown in Table 2 were modified and are presented in Table 1. A linear analysis was used to determine the necessary adjustments for uses other than irrigation in Curry County. This was done on the basis of the 1975 Water-Use Inventory (Sorensen), and the location of uses as shown on Point Source Maps produced by the New Mexico Environmental Improvement Division (see selected references).

On-Farm Impacts

The on-farm impacts for Curry County include a discussion by management strategy of the on-farm economic impacts (irrigated and total value of production as well as returns to land and management); land resource--including cropland and cropping patterns (irrigated, dry cropland, and rangeland); and the utilization of ground water for irrigation (see Appendix Table B-1 for a summary of baseline). Supporting tables, describing the land, water, and economic impacts by the selected years, can be found in WRRI Report 151. A sensitivity analysis of the on-farm impacts to demonstrate the effect of both higher and lower crop prices, crop yield, and energy costs on the irrigated agricultural economy of New Mexico is also presented in WRRI Report 151.

Because of the varying thickness of the Ogallala aquifer and depths of pumping, the irrigated cropland in Curry County is divided into three areas: Ogallala aquifer saturated thickness less than 50 feet; 50 to 100 feet; and greater than 100 feet. The area with less than 50 feet of saturated thickness has about 33,600 acres of irrigated cropland; the area with a saturated thickness between 50 and 100 feet encompasses about 67,200 acres of irrigated cropland; and the area with an aquifer saturated thickness of more than 100 feet includes the remaining 57,100

Table 2. The Projected Effect of Irrigation on Remaining Saturated Thickness, Curry County, New Mexico, 1977-2020.

Strategy and Category	1977	1985	1990	2000	2010	2020
	(ft. of remaining saturated thickness)					
Baseline						
Saturated Thickness/Less than 50 ft.	50.0	26.0	<25.0	<25.0	<25.0	<25.0
Saturated Thickness/50 to 100 ft.	70.0	46.0	31.0	<25.0	<25.0	<25.0
Saturated Thickness/More than 100 ft.	125.0	101.0	86.0	56.0	28.0	<25.0
Voluntary Strategy						
Saturated Thickness/Less than 50 ft.	50.0	26.0	<25.0	<25.0	<25.0	<25.0
Saturated Thickness/50 to 100 ft.	70.0	46.0	31.0	<25.0	<25.0	<25.0
Saturated Thickness/More than 100 ft.	125.0	101.0	86.0	58.0	32.0	<25.0
Mandatory Strategy						
Saturated Thickness/Less than 50 ft.	50.0	26.0	<25.0	<25.0	<25.0	<25.0
Saturated Thickness/50 to 100 ft.	70.0	46.0	33.0	<25.0	<25.0	<25.0
Saturated Thickness/More than 100 ft.	125.0	101.0	88.0	65.0	47.0	30.0

acres of irrigated cropland. Also, a summary of the dry cropland and rangeland is presented in Appendix B.

For purposes of this section, only the total Curry County on-farm impacts will be discussed. In Appendix B, tables are presented for each of the three saturated thicknesses showing value of production, returns to land and management by period, acreage irrigated, total water withdrawals, irrigation energy source, and similar information by crops.

Value of Production

The 1977 total agricultural value of production (TVP) in Curry County (irrigated crops, dryland crops, and rangeland) was about $43.1 million (Figure 3). Under all the management strategies, the total value of production is expected to increase significantly until 1990 due to increasing crop yields and prices. After 1990, significant decreases are expected under the baseline and voluntary strategies, slight declines under the mandatory strategy, and significant increases under the importation strategy. The net result over the study period under both the baseline and voluntary strategies was a decline (0.8 percent) of $344,000 (Table 3). However, it must be noted that the change from a primarily irrigated agricultural economy to a dryland agricultural economy will induce increased variance in the county's agricultural TVP and income. Under the mandatory strategy, the TVP is projected to increase $17.7 million (41 percent), primarily due to the retention of some irrigated agriculture. The largest increase, 146 percent ($62.9 million), is expected to occur under the importation strategy due to expansion of the value of production provided by the irrigated agriculture sector from imported water (Table 3).

The 1977 value of production for irrigated crops was about $29.5 million (69 percent of total agricultural value of production) in Curry County (Figure 3). Under all the management strategies, the irrigated value of production is expected to follow the same general trend as TVP--initially increasing due to increasing crop yields and prices, then declining under all strategies but importation. Under the baseline and the voluntary strategies, the irrigated value of production drops to zero in 2020 due to aquifer exhaustion. Under the mandatory strategy,

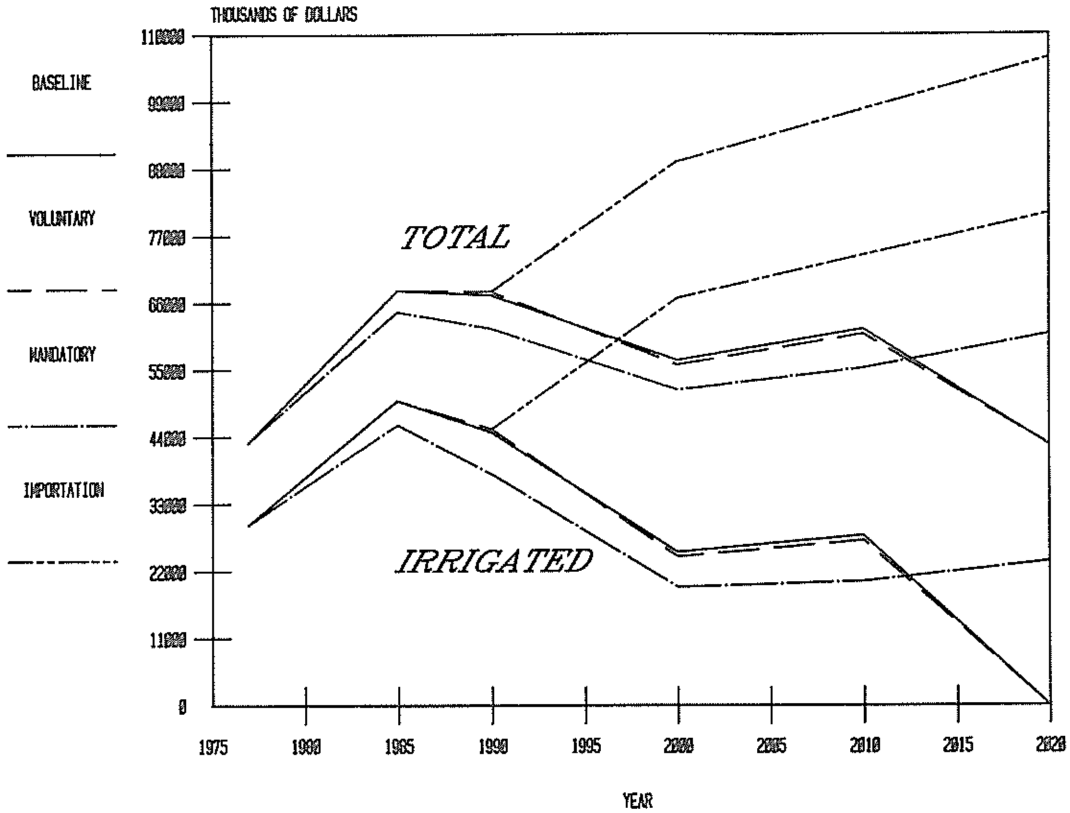

Figure 3. Total and Irrigated Value of Production for Curry County, New Mexico, 1977-2020.

TVP is expected to decline 21 percent ($6 million) over the study period from partial aquifer exhaustion. With importation, the irrigated value of production increased by 172 percent ($51 million) by 2020. This increase is due to the full restoration of irrigated lands in Curry County with imported water.

Returns to Land and Management

The total 1977 returns to land and management (irrigated crops, dryland crops, and rangeland) in Curry County were about $6.7 million (Figure 4). There are significant increases in the county's returns to land and management under all strategies in all time periods. This is due to increasing value of production from increasing crop yields and higher crop prices. Under all the strategies except importation, the increasing returns from the dry cropland sector contribute a great per-

Table 3. Value of Production and Returns to Land and Management by Management Strategy for Selected Years, Curry County, 1977-2020.

Strategy and Item	1977	1985	1990	2000	2010	2020
	(1,000 dollars)					
			Value of Production			
Baseline	43,109	68,025	67,231	56,584	61,796	42,765
Irrigated Cropland	29,542	49,898	44,652	25,109	27,842	0
Dry Cropland	6,952	10,124	14,378	23,008	25,488	34,298
Rangeland	6,615	8,004	8,202	8,467	8,467	8,467
Voluntary	43,109	67,964	67,723	55,789	60,884	42,765
Irrigated Cropland	29,542	49,837	45,143	24,314	26,930	0
Dry Cropland	6,952	10,124	14,378	23,008	25,488	34,298
Rangeland	6,615	8,004	8,202	8,467	8,467	8,467
Mandatory	43,109	64,468	61,656	51,634	55,284	60,853
Irrigated Cropland	29,542	45,846	37,760	19,302	20,200	23,539
Dry Cropland	6,952	10,619	15,694	23,865	26,617	28,848
Rangeland	6,615	8,004	8,202	8,467	8,467	8,467
Importation	43,109	67,964	67,723	89,058	97,558	106,070
Irrigated Cropland	29,542	49,837	45,143	66,659	73,651	80,561
Dry Cropland	6,952	10,124	14,378	13,932	15,441	17,041
Rangeland	6,615	8,004	8,202	8,467	8,467	8,467
			Returns to Land and Management*			
Baseline	6,724	20,305	20,711	22,703	26,887	22,165
Irrigated Cropland	4,160	15,071	12,660	8,961	10,840	0
Dry Cropland	1,341	3,569	6,309	11,928	14,250	20,393
Rangeland	1,223	1,664	1,741	1,815	1,797	1,772
Voluntary	6,724	20,613	22,204	22,983	27,071	22,165
Irrigated Cropland	4,160	15,379	14,153	9,241	11,025	0
Dry Cropland	1,341	3,569	6,309	11,928	14,250	20,393
Rangeland	1,223	1,664	1,741	1,815	1,797	1,772
Mandatory	6,724	19,577	21,001	21,076	25,195	29,649
Irrigated Cropland	4,160	14,164	12,363	7,524	8,524	10,762
Dry Cropland	1,341	3,748	6,896	12,368	14,874	17,116
Rangeland	1,223	1,668	1,741	1,815	1,797	1,772
Importation	6,724	20,613	22,204	40,947	47,201	59,034
Irrigated Cropland	4,160	15,379	14,153	31,933	36,792	47,134
Dry Cropland	1,341	3,569	6,309	7,199	8,612	10,129
Rangeland	1,223	1,664	1,741	1,815	1,797	1,772

* A charge for imported water was not included in the importation strategy. Therefore, the returns are to land, management, and imported water for the years 2000, 2010, and 2020.

centage of the increase in total returns to land and management. The dry cropland sector exhibits increased returns from both the increased crop yields and prices as well as increased acreage from the conversion of previously irrigated lands to dryland.

The greatest expected increase of $52.3 million (678 percent) is expected to occur under the importation strategy (Table 3). This significant increase in 2020 is due to the full restoration of irrigated lands in Curry County at higher crop yields and prices with no charge for the imported water. Under the mandatory strategy, the returns to land and management increase by $22.9 million (241 percent). Under both the baseline and the voluntary strategies, the returns are expected to peak in 2010 and then decline in 2020 due to aquifer exhaustion. In 2020, the returns are expected to be $22.2 million for an increase in returns of 229 percent.

The 1977 returns to land and management for irrigated crops in Curry County were about $4.2 million (Figure 4). Significant increases in returns are expected for all strategies through 2010. After 2010, under the baseline and voluntary strategies, irrigated returns drop to zero from aquifer exhaustion. Under the mandatory strategy, some irrigated land is expected to be retained in 2020 with resulting returns of $10.8 million (Table 3). However, irrigated returns under the importation strategy are expected to increase by 10-fold from the restoration of irrigated lands with no-cost water at higher crop yields and prices.

The projected baseline and voluntary strategies increases of more than 225 percent in total returns to land and management compared to the total value of production decreases of about 1 percent imply that returns to land and management capture a greater portion of the value of production in the future. However, under these strategies, there will be increased variability in income from the greater reliance on dryland farming.

The greatest increase in both irrigated value of production and returns to land and management occurs under the importation strategy. This is because irrigated lands are fully restored at projected higher crop yields and prices while no cost is assessed for the imported water. The adoption of the mandatory strategy in Curry County results in the

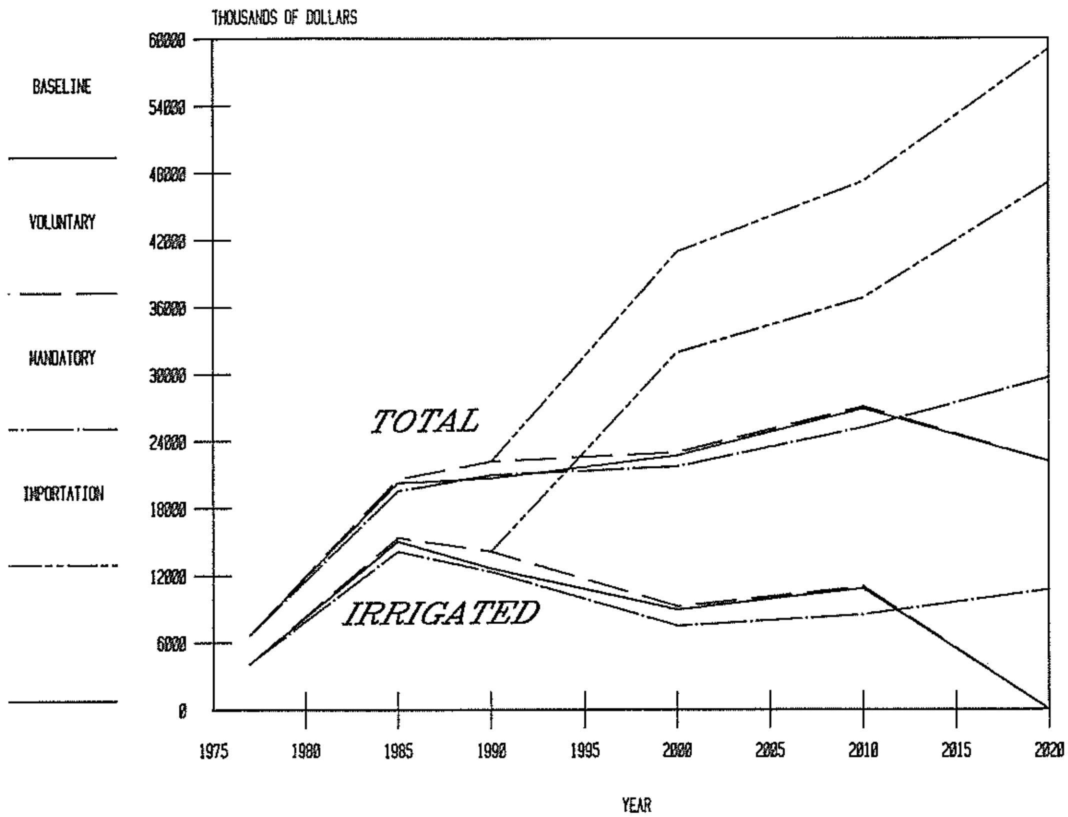

Figure 4. Total and Irrigated Returns to Land, Management, and Risk for Curry County, New Mexico, 1977-2020.

greatest total and irrigated value of production and returns to land and management from the natural water supply in 2020. However, the sum over the 43 years examined in the study indicates that the total irrigated value of production under the mandatory strategy is less than both the baseline and voluntary strategies by $246 and $262 million, respectively. This means that the mandatory strategy has the greatest irrigated value of production in 2020 but not over the period of the study. The sum of the irrigated returns to land and management over the 43 years of the study indicates that the mandatory strategy has the greatest returns over the study period with $9.9 million more than the voluntary and $11.5 million more than the baseline.

Any future increase in land value above the inflation rate will result in reduction in the returns to land and management.

Irrigation Water

The quantity of irrigation water diverted is expected to decline from 313,167 acre-feet in 1977 to 0 acre-feet in 2020 under the baseline with most of the decrease occurring before 2000 (Table 4). Under the voluntary strategy, the quantity of irrigation water diverted is expected to be only slightly less than under the baseline (Figure 5). Under the voluntary strategy, as is the case under the baseline, aquifer exhaustion occurs before 2020. Under the mandatory strategy, the water used for irrigation is a fixed percentage of that used under the voluntary and, as a result, the lowest water diversions are expected. However, under the mandatory strategy, in Curry County enough water is conserved to support irrigation where the aquifer was initially the thickest through the year 2020.

Under the importation strategy, water will be imported to allow full irrigation of those lands that exhaust their natural water supply under the voluntary strategy. In Curry County, it is estimated that 176,140 acre-feet will be imported in 2000, 165,776 acre-feet in 2010, and 243,013 acre-feet in 2020. Costs of this water delivered to the farm in Curry County ranged from $500 to $800 per acre-foot. It is estimated that farmers could afford to pay $125 per acre-foot in 2000 and $150 per acre-foot in 2020 to have the same profit levels as dryland producers.

Cropland and Cropping Pattern

The irrigated cropland in Curry County is expected to decrease from 157,900 acres in 1977 to 57,100 acres by 2010, then decline to zero after 2010 for both the baseline and voluntary strategies (Table 5). Under the mandatory strategy, the irrigated acreage is expected to decline to 2010, then increase slightly to about 49,100 acres in 2020. Under importation, the irrigated acreage is expected to decline to 1990, then increase to about the 1977 level in 2000 where it remains through 2020.

The dry cropland acreage in 1977 was about 156,100 acres. It varies greatly across management strategies and time periods. As irrigation water stocks are depleted, acreage reverts to dryland. Thus,

Table 4. Quantity of Irrigation Water Diverted by Management Strategy for Selected Years, Curry County, New Mexico, 1977-2020.

	1977	1985	1990	2000	2010	2020
	(acre-feet)					
Baseline	313,167	312,291	237,371	107,834	103,721	0
Voluntary	313,167	304,346	231,159	99,656	94,061	0
Mandatory	313,167	273,915	184,952	70,044	65,769	65,760
Importation	313,167	304,345	231,159	275,796	259,837	243,013

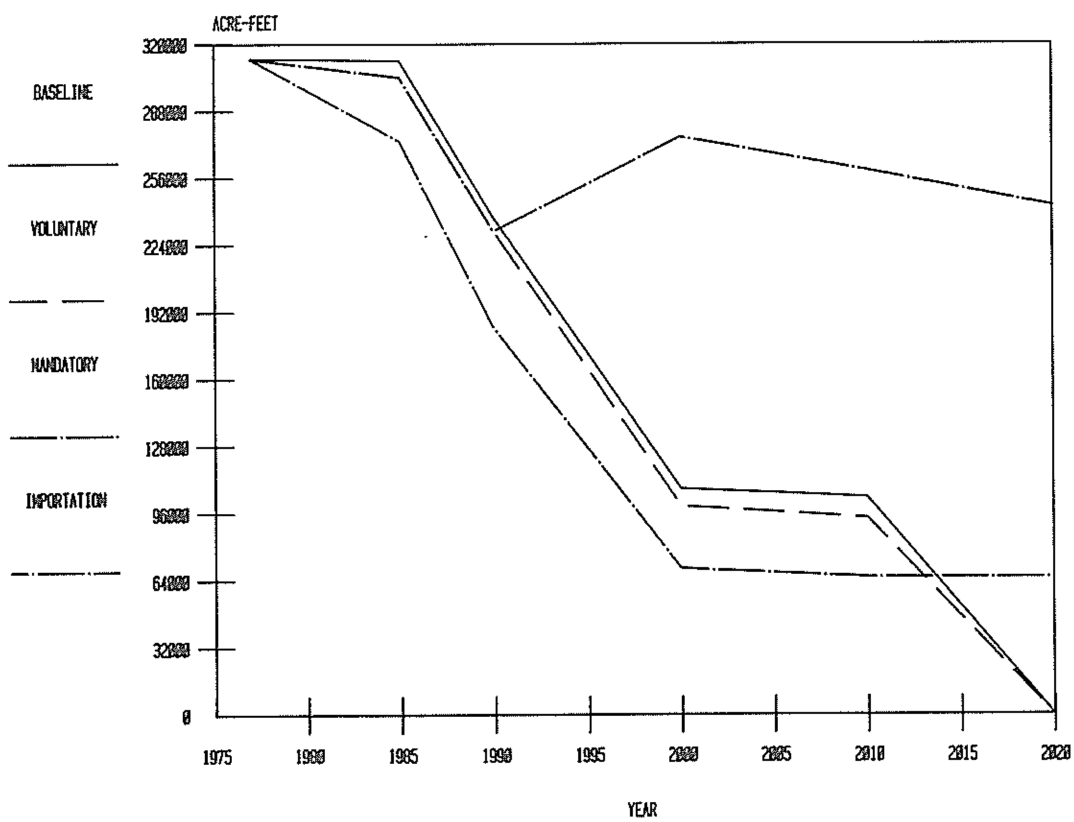

Figure 5. Quantity of Irrigation Applied, Curry County, 1977-2020.

Table 5. Irrigated Cropland Acreages by Crop by Management Strategy for Selected Years, Curry County, New Mexico, 1977-2020.

Strategy and Crop	1977	1985	1990	2000	2010	2020
	(irrigated acres)					
Baseline	157,900	157,900	124,300	57,100	57,100	0
Alfalfa	3,158	11,053	5,710	5,710	5,710	0
Corn (grain)	50,528	58,432	49,720	22,840	22,840	0
Corn (silage)	1,579	0	0	0	0	0
Grain Sorghum	36,317	52,107	49,720	22,840	22,840	0
Wheat	66,318	36,317	19,150	5,710	5,710	0
Voluntary	157,900	157,900	124,300	57,100	57,100	0
Alfalfa	3,158	11,053	11,790	5,070	4,464	0
Corn (grain)	50,528	58,432	49,080	22,200	21,594	0
Corn (silage)	1,579	0	0	0	0	0
Grain Sorghum	36,317	52,107	48,226	21,346	19,933	0
Wheat	66,318	36,317	15,205	8,485	11,109	0
Mandatory	157,900	150,357	107,156	47,428	45,560	49,069
Alfalfa	3,158	8,302	0	0	0	0
Corn (grain)	50,528	55,632	42,262	18,003	17,293	18,624
Corn (silage)	1,579	0	0	0	0	0
Grain Sorghum	36,317	49,618	41,462	16,713	16,051	17,285
Wheat	66,318	36,806	23,432	12,712	12,216	13,160
Importation	157,900	157,900	124,300	157,900	157,900	158,875
Alfalfa	3,158	11,053	11,790	14,041	12,327	12,327
Corn (grain)	50,528	58,432	49,080	61,410	59,697	59,697
Corn (silage)	1,579	0	0	0	0	0
Grain Sorghum	36,317	52,107	48,226	58,945	55,111	56,086
Wheat	66,318	36,317	15,205	23,505	30,765	30,765

the dryland acreage in each period is the base acreage plus the change in irrigated acreage. The rangeland acreage in Curry County is expected to remain constant over time for all the management strategies at about 548,900 acres.

Under the baseline through 1990, a significant increase in the acreage of the more profitable crops of corn, grain sorghum, and alfalfa is expected over time due to reductions in wheat acreage (Table 5). After 1990, significant reductions occur in the acreages of corn, grain sorghum, and wheat as aquifer exhaustion occurs. Under the voluntary strategy, the same situation occurs as under the baseline, except for an increase in the relatively low water using crop, wheat, in 2010.

Under the mandatory strategy, significant shifts are expected in the cropping pattern over time (Table 5). The alfalfa acreage is expected to decline to zero by 1990 and corn is expected to first increase then decrease after 1985. Grain sorghum is expected to follow the same pattern as corn, and wheat exhibits a steady decline through 2010. The most important aspect of the mandatory strategy's cropping pattern is the continuation of irrigation through 2020.

Under the importation strategy, there are projected increases in alfalfa, corn, and grain sorghum acreages and decreases in corn for silage and wheat acreages (Table 5).

Sensitivity Analysis

Sensitivity analyses were performed on three key on-farm variables. Analyses were performed on the variable crop prices, crop yields, and energy prices to determine the effects of increases or decreases in these variables upon irrigated acreage, irrigation water usage, value of production (VOP), and returns to land and management (Table 6).

Crop prices, crop yields, and energy prices were increased and decreased over the length of the study period for a total of six alternatives. Production in Curry County is projected to have ceased by the year 2020. Therefore, this analysis extends only to the year 2010.

Higher or lower crop prices, higher or lower crop yields, and lower energy prices indicate through this analysis that they will have no impact upon irrigated cropland or upon irrigation water usage.

Irrigation water usage does show some sensitivity to higher energy prices. The analysis indicates that higher energy prices will cause a minor increase in water usage. Higher energy prices make dryland farming less profitable. This, in turn, causes irrigated farming to be more attractive and thus increases water usage.

Higher or lower crop yields, higher or lower crop prices, and higher or lower energy prices are projected to have a significant impact upon TVP and net returns to land and management (see Table 6).

Analysis indicates that crop yields will have the most significant impact, followed by crop prices and energy prices. With changing yields and crop prices, there was almost a dollar-for-dollar impact on returns

Table 6. Effect of Sensitivity Analysis on Irrigated Value of Production and Returns to Land and Management, Curry County, New Mexico.

Item	Changes From Baseline Irrigated Value of Production		Changes From Baseline Irrigated Returns to Land and Management	
	($million)	(percent)	($million)	(percent)
Crop Prices				
Increased	+1,146	+ 2	+1,162	+10.7
Decreased	-1,265	- 2	-1,265	-11.7
Crop Yields				
Increased	+4,071	+14.6	+4,073	+38
Decreased	-4,081	-14.7	-4,029	-37.2
Energy Costs				
Increased	+ 85	+.003	-1,803	-16.6
Decreased	--	--	+1,486	+13.7

when the TVP was changed. This indicates that farmers have almost no room to adjust cropping patterns to lessen the impact of price or yield declines.

Regional Impacts

Baseline

The baseline assumes the continuation of current trends and no new public agricultural policies or programs. Under the baseline, the continuation of present trends in water conservation is expected to result in water savings of about 10 percent on sprinkler-irrigated lands over the study period. The on-farm impact results and the energy impact results were incorporated into the county impacts analysis.

Gross Output

The total gross output of all goods and services projected for the Curry County economy is reported in Table 7. It was about $406 million

Table 7. Gross Output by Major Sector for Each of the Alternative Management Strategies, Curry County, New Mexico, 1977-2020.

Sector	Gross Output ($1977)				
	1977	1985	1990	2000	2020
	(millions of dollars)				
Baseline					
Agriculture	207.758	270.190	283.460	285.817	296.064
Mining	1.963	4.914	7.865	13.749	16.206
Manufacturing	62.976	78.824	126.160	157.569	176.333
TCU*	19.076	23.876	38.215	47.729	53.413
Construction	10.863	13.597	21.762	27.180	30.416
FIRE**	44.335	49.655	57.636	75.370	93.104
Trade	28.965	36.254	58.026	72.472	81.102
Services	30.542	38.228	61.185	76.418	85.518
Total	406.478	515.538	654.309	756.304	832.156
Voluntary					
Agriculture	207.758	270.187	283.960	285.461	296.106
Mining	1.963	4.914	7.865	13.749	16.206
Manufacturing	62.976	78.824	126.160	157.569	176.333
TCU*	19.076	23.876	38.215	47.729	53.413
Construction	10.863	13.597	21.762	27.180	30.399
FIRE**	44.335	49.655	57.636	75.370	93.104
Trade	28.965	36.254	58.026	72.472	81.102
Services	30.542	38.228	61.185	76.418	85.518
Total	406.478	515.535	654.809	755.948	832.181
Mandatory					
Agriculture	207.758	270.246	284.057	286.295	296.709
Mining	1.963	4.914	7.865	13.749	16.208
Manufacturing	62.976	78.826	126.175	157.610	176.458
TCU*	19.076	23.905	38.295	48.149	54.411
Construction	10.863	13.597	21.769	27.207	30.554
FIRE**	44.335	49.675	57.681	75.619	94.070
Trade	28.965	36.259	58.059	72.612	81.674
Services	30.542	38.237	61.220	76.594	86.312
Total	406.478	515.659	655.121	757.835	836.396
Importation					
Agriculture	207.758	270.187	283.960	285.958	296.377
Mining	1.963	4.914	7.865	13.750	16.211
Manufacturing	62.976	78.824	126.160	157.651	176.593
TCU*	19.076	23.876	38.215	48.176	54.743
Construction	10.863	13.597	21.762	27.354	30.949
FIRE**	44.335	49.655	57.636	75.863	95.613
Trade	28.965	36.254	58.026	72.877	82.768
Services	30.542	38.228	61.185	76.824	87.429
Total	406.478	515.535	654.809	758.453	840.683

* Transportation, Communication, and Utilities.
** Finance, Insurance, and Real Estate.

in 1977. It is projected to be $516 million in 1985, $654 million in 1990, $756 million in 2000, and $832 million in 2020.

Agricultural. The agricultural sectors are a major source of output in Curry County. They accounted for over 51 percent of the total gross output in 1977, and are projected to be over 52 percent in 1985, 43 percent in 1990, 38 percent in 2000, and 36 percent in 2020. The agricultural sectors are expected to be a driving force in the local economy with the other sectors responding to growth in the agricultural sectors and activity in other sectors in adjacent counties. The agricultural sectors are expected to increase between 1977 and 2020 with about $208 million in 1977 and $296 million in 2020 (Table 7). This growth is projected to be relatively stable over the period (Figure 6).

Mining. The mining sectors are projected to have a minor impact on the local economy (Figure 6). In 1977, the mining sectors accounted for only about $2 million, or less than 0.5 percent of the total. By 1985, they are projected to account for almost $5 million. The mining activity is expected to increase to about $8 million in 1990, $14 million in 2000, and $16 million in 2020. There is no oil or gas production in Curry County and none is expected through 2020.

Electrical Production. There is no electrical energy production in Curry County.

Manufacturing. The manufacturing sectors are projected to increase from $63 million in 1977 to about $176 million in 2020. The contribution of the manufacturing sectors to the total was 15 percent in 1977 and 1985, 19 percent in 1990, and 21 percent in 2000 and 2020 (Table 7).

Transportation, Communication, and Utilities (TCU). The TCU sectors, taken together, generally show an increase over the period. These sectors are projected to increase from $19 million in 1977 to $53 million in 2020 (Table 7). The contribution of these sectors to the total was about 5 percent in 1977 and is expected to remain about 5 to 6 percent through 2020.

Construction. The construction sectors are projected to increase over the period. These sectors accounted for about $11 million in 1977. They are projected to be about $14 million in 1985, $22 million in 1990, $27 million in 2000, and $30 million in 2020.

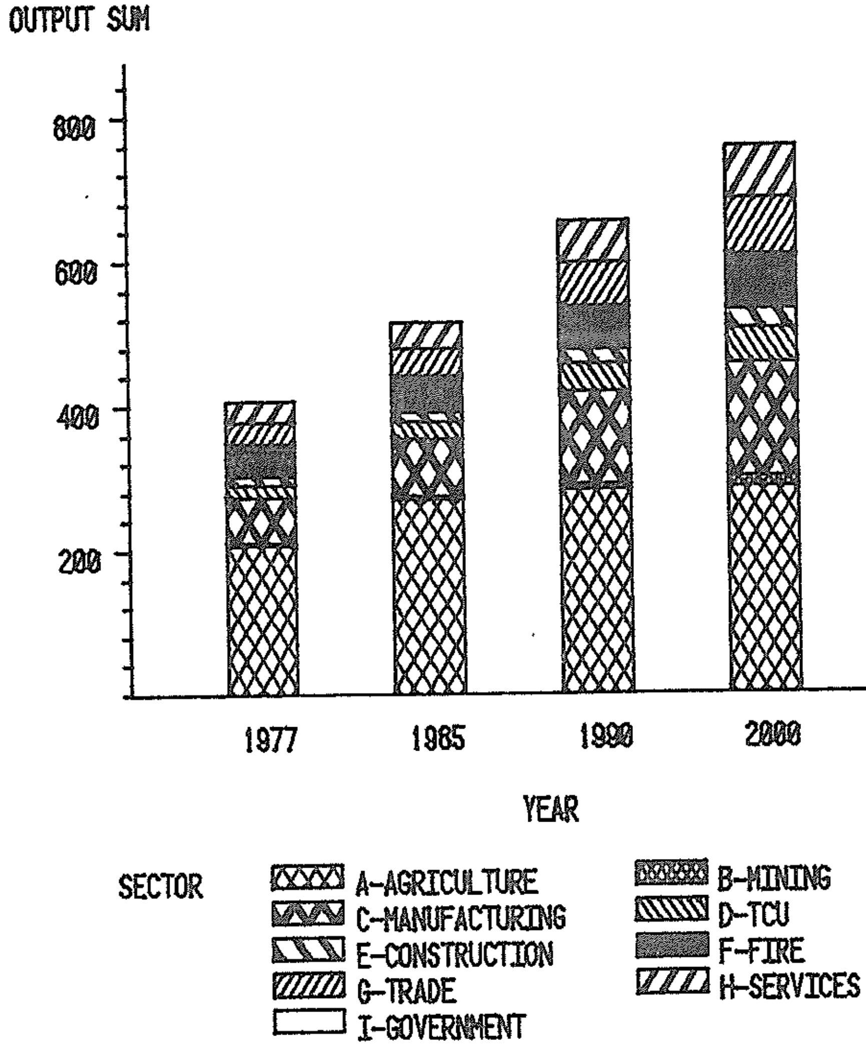

Figure 6. Projected Gross Output for Curry County, Baseline Conditions, 1977-2020.

Finance, Insurance, and Real Estate (FIRE). The FIRE sectors are also projected to increase between 1977 and 2020, and contribute about 9 to 11 percent of the total output (Table 7).

Trade. The trade sector is also expected to expand between 1977 and 2020 (Figure 6). In 1977, it accounted for about 7 percent of the total and by 2020 it is projected to reach almost 10 percent.

Service. The service sectors are also projected to expand between 1977 and 2020 (Figure 6). In 1977, they accounted for about 8 percent of the total and by 2020 they are projected to contribute over 10 percent.

Employment

Total employment in the form of jobs for each alternative for each sector by year is reported in Table 8. Employment projected for the baseline is summarized by major sector in Figure 7. The total jobs were 12,594 in 1977; and are expected to increase to 16,714 in 1985; 19,199 in 1990; then decrease to 17,359 in 2000; and 14,325 in 2020. Government is the largest employer, accounting for over half of the total employment through 1990. In 2000, it contributes 43 percent and in 2020 42 percent. Most of this is expected to be associated with military activity in the county. Services employed about 8 percent in 1977 and 1985, 10 percent in 1990, 14 percent in 2000, and 17 percent in 2020. The trade sector employed 14 percent in 1977 and is expected to employ 13 percent in 1985. It is expected to increase to 16 percent in 1990, 17 percent in 2000, and then decline to 12 percent in 2020. The agricultural sector accounted for about 9 percent of the jobs in 1977, almost 7 percent in 1985, 5 percent in 1990, about 6 percent in 2000, and about 6 percent in 2020. Construction provided about 2 percent of the jobs in 1977, and in 1985 is expected to contribute almost 3 percent, then increase to 4 percent in 1990, 5 percent in 2000, and then increase to 6 percent in 2020 (Table 8).

Population

The total population for Curry County for the baseline and each of the alternative management strategies is presented in Table 9. The county had about 46,078 people in 1977. Between 1977 and 2000, the population is projected to increase by 12,856, or about 28 percent. In 2020, the population is projected to decrease by 10,696 and to be about 105 percent of the 1977 level.

Alternative Management Strategies

Gross Output

The gross output by major sector for each of the alternative management strategies is also summarized in Table 7. For 1977, all of

Table 8. Employment by Major Sector for Each of the Alternative Management Strategies, Curry County, New Mexico, 1977-2020.

Sector	Jobs 1977	1985	1990	2000	2020
	--------	--------	(number of jobs)	--------	--------
Baseline					
Agriculture	1,093	1,129	1,048	988	837
Mining	8	24	37	58	40
Manufacturing	681	942	1,156	946	606
TCU*	295	411	600	556	336
Construction	306	434	684	837	911
FIRE**	736	832	942	1,157	1,287
Trade	1,803	2,208	3,140	2,890	1,774
Services	960	1,258	1,998	2,405	2,495
Government	6,712	9,476	9,594	7,522	6,039
Total	12,594	16,714	19,199	17,359	14,325
Voluntary					
Agriculture	1,093	1,179	1,104	1,010	915
Mining	8	24	37	58	40
Manufacturing	681	942	1,161	949	606
TCU*	295	418	604	563	337
Construction	306	432	687	845	914
FIRE**	736	837	945	1,169	1,292
Trade	1,803	2,215	3,167	2,920	1,784
Services	960	1,264	2,010	2,425	2,509
Government	6,712	9,531	9,640	7,571	6,063
Total	12,594	16,842	19,355	17,510	14,460
Mandatory					
Agriculture	1,093	1,138	1,065	959	865
Mining	8	24	37	58	40
Manufacturing	681	942	1,161	950	608
TCU*	295	415	605	568	344
Construction	306	432	687	846	919
FIRE**	736	837	944	1,172	1,306
Trade	1,803	2,215	3,168	2,925	1,797
Services	960	1,263	2,010	2,430	2,531
Government	6,712	9,532	9,643	7,579	6,086
Total	12,594	16,798	19,320	17,487	14,496
Importation					
Agriculture	1,093	1,179	1,101	1,083	996
Mining	8	24	37	58	40
Manufacturing	681	942	1,161	951	609
TCU*	295	418	604	567	347
Construction	306	432	687	851	930
FIRE**	736	837	945	1,176	1,327
Trade	1,803	2,215	3,167	2,936	1,821
Services	960	1,264	2,010	2,437	2,562
Government	6,712	9,531	9,640	7,603	6,144
Total	12,594	16,842	19,352	17,662	14,776

* Transportation, Communication, and Utilities.
** Finance, Insurance, and Real Estate.

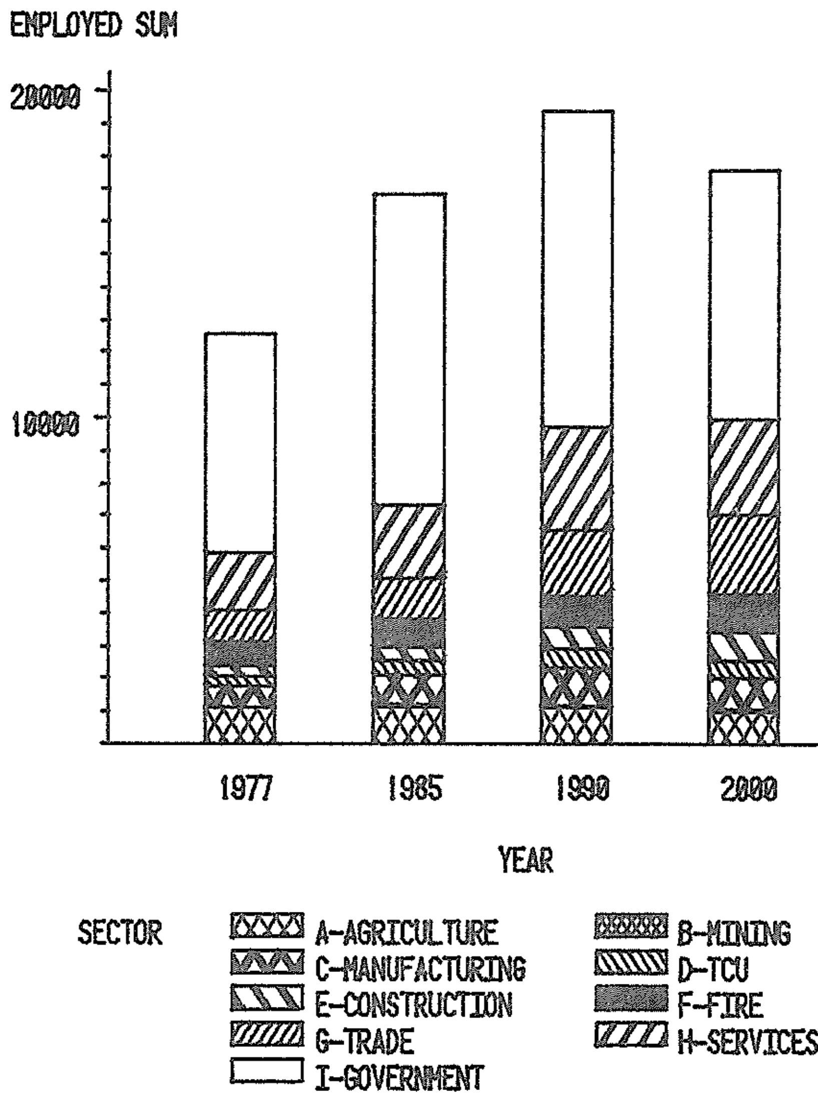

Figure 7. Projected Employment for Curry County.

the output estimates for the management strategies were the same as the baseline.

The differences in gross output among the management strategies came about basically because of changes in the agricultural sectors. By 2020, output under the voluntary management strategy is expected to be $25,000 more than the baseline. Output is projected to increase $42,000 in the agricultural sectors, and decrease $17,000 in the construction sectors. The projected output in 2020 under the mandatory management strategy is $4.24 million more than under the baseline. Agriculture is projected to increase $645,000.

Table 9. Summary of Population Projections for Curry County for Each of the Management Strategies, 1977-2020.

Strategy	Population Projection 1977	1985	1990	2000	2020
Baseline	46,078	48,450	58,425	58,934	48,238
Voluntary	46,078	48,761	58,880	59,330	48,715
Mandatory	46,078	48,635	58,784	59,225	48,784
Importation	46,078	48,761	58,879	59,736	49,582

By 2020, output under the importation strategy is projected to be $8.527 million more than under the baseline. Agricultural output is projected to have $313,000 more than the baseline. Output for all other sectors is projected to be $8.214 million more than under the baseline.

Employment

Employment in the form of jobs for each of the alternative management strategies is also summarized in Table 8 by major sector. The number of jobs were the same for all management strategies in 1977.

In 2020, voluntary is projected to result in 135 more jobs than the baseline. By sector, agriculture is expected to result in 78 more; TCU, 1 more; construction, 3 more; FIRE, 5 more; trade, 10 more; services, 14 more; and government, 24 more. Mandatory is expected to result in 171 more jobs than the baseline in 2020. Agriculture accounted for 28 of these; manufacturing, 2; TCU, 8; construction, 8; FIRE, 19; trade, 23; services, 36; and government, 41. Importation is projected to result in 451 more jobs than under the baseline. Agriculture is projected to have 159 more jobs under the importation strategy than baseline as a result of the imported water.

Population

The total population for each of the management strategies is also summarized in Table 9. For 1977, all of the projections for the management strategies were the same. For 1985, population under the voluntary strategy and importation strategy is projected to be 311 more than under the baseline. The mandatory strategy is projected to result in 186 more people than the baseline in 1985. In 1990, voluntary is projected to result in 455 more people than the baseline, and importation is 454 more than baseline. In 2020, voluntary is expected to result in 477 more people than the baseline, and mandatory is projected to result in 546 more people than the baseline. The importation strategy is expected to result in the greatest population in 2020 in Curry County with 49,582 people. However, this is only 1,344 more than the baseline which has a 48,238 projected population.

SUMMARY

The general purpose of this report was to estimate the economic impacts over a 40-year planning horizon on regional income and employment, population, irrigated and dryland cropping patterns, agricultural output, and farm income resulting from rapidly rising energy costs and the declining water tables. If significant areas were to be forced out of irrigated production in the New Mexico High Plains, the economy of the entire state could be adversely affected. In response to these concerns, New Mexico, five other High Plains states, and the High Plains Associates (General Contractor) participated in the Six-State High Plains-Ogallala Aquifer Area Study. The impacts were measured under alternative sets of assumptions regarding public policy, water and energy costs and availability, and irrigation management practices.

Four management strategies including a baseline were evaluated: voluntary water conservation; mandatory irrigation water supply reduction; and importation, supply augmentation for those areas that physically exhaust their water supply.

The total gross output of all goods and services produced in Curry County was about $406 million in 1977. It is projected to be $516 mil-

lion in 1985, $654 million in 1990, $756 million in 2000, and $832 million in 2020 for the baseline.

The differences in gross output among the management strategies are due to changes in the agricultural and manufacturing sectors. Changes such as the increased output in agriculture and manufacturing result in higher levels of output in the rest of the economy.

In all strategies, the output levels are only slightly different from the baseline. By 2020, the voluntary strategy is only $25,000 greater than the baseline, mandatory is $4.24 million more than the baseline, and the importation strategy is $8.53 million more than the baseline. The agricultural sectors account for the majority of the output through 2020 increasing throughout the period. Manufacturing also increases significantly over the study period. The level of economic activity as measured by output in the county is estimated to increase to about 205 percent of the 1977 level for the baseline, voluntary, and mandatory strategies. The increase under the importation strategy is almost 207 percent of the 1977 level in 2020.

The employment levels projected for the baseline and each management strategy are summarized by major sector in Table 5. These levels follow a similar pattern as the output with essentially minor differences between the strategies and baseline. The voluntary strategy is estimated to have 135 more jobs than baseline in 2020. The mandatory strategy is projected to have 171 more jobs than baseline, and the importation strategy is projected to have 451 more jobs than baseline. These levels are insignificant when compared to the change in employment over the period. The 1985 employment level of about 17,000 jobs is projected to decline to about 14,000 jobs.

The population of Curry County is projected to follow a similar pattern as output and employment, with about 46,000 in 1977, increasing to about 48,000 in 1985; 58,000 in 1990; 59,000 in 2000; and dropping to about 48,000 in 2020. The management strategies are projected to be slightly higher than the baseline throughout the period, but do not amount to enough to offset the general decline projected over time. The importation strategy results in the highest level with about 1,344 more than baseline in 2020.

In Curry County, a continuation of a "business as usual" (baseline) policy is estimated to result in the largest (in the early years of the study) irrigated acreage, the least reduction in irrigation water diversions, the greatest increases in the value of production, and significant increases in returns to land and management of any of the management strategies examined. However, a continuation of "business as usual" will result in exhaustion of the Ogallala in Curry County. If voluntary water demand reduction policies are implemented, the same irrigated acreage, decreased water diversions, reductions in the value of production, and increases in returns over the study period are expected. However, as under baseline, voluntary measures will result in exhaustion of the aquifer.

The implementation of a mandatory water supply reduction policy in Curry County is expected to result in a change of the acreage irrigated. However, this would be accomplished only with the greatest reduction in water diversions. There are also significant reductions in irrigated value of production and returns to land and management in the early years of the study when compared to the baseline. This is due to changes in cropping patterns and levels of irrigation water applications which reduce crops. Mandatory reductions will extend the life of the aquifer and of irrigated agriculture.

If the natural water supply in the High Plains is augmented with imported water from adjacent areas during the last half of the study period, it is anticipated that this policy would result in positive impacts in Curry County. Land will be restored to irrigation and the acreage irrigated will be greater than under the other strategies.

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APPENDIX A
HYDROLOGIC AND IRRIGATION SYSTEMS

Table A-1. Baseline Conditions--Hydrologic and Irrigation Systems Information, Curry County, New Mexico, 1977.

Item	Unit of Measure	1977 Estimate: Less than 50 ft.	50-100 ft.	More than 100 ft.
Hydrologic Information				
Saturated thickness	feet	50	70	125
Maximum irrigated acreage	acres	33,000	66,000	56,000
Depth-to-water	feet	325	350	270
Average water withdrawals (1977 base)	acre-feet	64,400	132,300	112,900
Average water decline	ft./yr.	3.0	3.0	3.0
Gallons per minute (gpm)				
flood	gpm	800*	650	850
sprinkler	gpm	400	550	850
Specific capacity	gpm/ft. drawdown	40	40	40
Irrigation Systems				
Type				
flood	percent	50	73	80
sprinkler	percent	50	27	20
Pumping plant fuels				
natural gas	percent	92	92	92
electricity	percent	8	8	8
diesel	percent	--	--	--
LPG	percent	--	--	--
Average pumping plant efficiencies**				
natural gas	percent	7.8	7.8	7.8
electricity	percent	37.4	37.4	37.4
diesel	percent	--	--	--
LPG	percent	--	--	--

* Two 400 gpm wells together.

** Good efficiencies were considered to be 13.8 percent for natural gas; 66.1 percent for electricity; 19.9 percent for diesel; and 18.6 percent for LPG.

APPENDIX B
SUBAREA ANALYSIS

SATURATED THICKNESS LESS THAN 50 FEET

Value of Production

The 1977 irrigated agricultural value of production was about $6.2 million (Table B-1). The irrigated agricultural value of production is expected to almost double by 1985 and decrease to zero after 1985 because the Ogallala aquifer will become dewatered.

Returns to Land and Management

The 1977 irrigated returns to land and management (RLM) were about $989,500 (Table B-1). Under the baseline, the RLM is expected to increase over 200 percent by 1985 and then drop to zero after 1985.

Irrigation Water

The quantity of irrigation water diverted is expected to increase from 64,900 acre-feet in 1977 to 65,400 acre-feet in 1985 and then drop to zero (Table B-1).

Cropland

The irrigated cropland is expected to remain constant at 33,600 acres from 1977 to 1985 and then decrease to zero (Table B-1).

Table B-1. Summary of On-Farm Impacts, Saturated Thickness Less Than 50 Feet, Curry County, New Mexico, 1977-2020--Baseline.

Item	Unit	1977	1985	1990	2000	2010	2020
Value of Production	$1,000	6,365	10,696				
Irrigated Cropland	$1,000	6,365	10,696	0	0	0	0
Returns to Land & Management	dollars	989,458	3,223,156	0	0	0	0
Irrigated Cropland	dollars	989,458	3,223,156	0	0	0	0
Irrigation Water							
Quantity	acre-ft	64,906	65,390	0	0	0	0
Cost	dollars	1,563,748	2,269,576	0	0	0	0
Land Use							
Irrigated Cropland	acres	33,600	33,600	0	0	0	0
Irrigation Energy							
Natural Gas	mcf	1,020,644	406,476	0	0	0	0
Electricity	1000 kwh	5,697	19,728	0	0	0	0
Irrigated Crops							
Alfalfa							
Acreage	acres	672	2,352	0	0	0	0
Production	ton	3,226	13,321	0	0	0	0
Irrigation Water	acre-ft	2,145	7,507	0	0	0	0
Irrigation Water Cost	dollars	51,552	233,236	0	0	0	0
Value of Production	dollars	199,987	846,301	0	0	0	0
Returns to Land & Mgt.	dollars	37,534	145,256	0	0	0	0
Corn for Grain							
Acreage	acres	10,752	12,432	0	0	0	0
Production	bu	1,290,240	1,864,554	0	0	0	0
Irrigation Water	acre-ft	25,052	28,184	0	0	0	0
Irrigation Water Cost	dollars	602,148	925,307	0	0	0	0
Value of Production	dollars	2,806,272	5,223,526	0	0	0	0
Returns to Land & Mgt.	dollars	521,113	1,903,365	0	0	0	0
Corn Silage							
Acreage	acres	336	0	0	0	0	0
Production	ton	6,048	0	0	0	0	0
Irrigation Water	acre-ft	588	0	0	0	0	0
Irrigation Water Cost	dollars	14,212	0	0	0	0	0
Value of Production	dollars	78,624	0	0	0	0	0
Returns to Land & Mgt.	dollars	22,073	0	0	0	0	0
Grain Sorghum							
Acreage	acres	7,728	11,088	0	0	0	0
Production	cwt	386,400	673,749	0	0	0	0
Irrigation Water	acre-ft	12,210	17,101	0	0	0	0
Irrigation Water Cost	dollars	295,122	639,749	0	0	0	0
Value of Production	dollars	1,363,992	2,952,213	0	0	0	0
Returns to Land & Mgt.	dollars	307,972	854,583	0	0	0	0
Wheat							
Acreage	acres	14,112	7,728	0	0	0	0
Production	bu	678,720	469,358	0	0	0	0
Irrigation Water	acre-ft	24,911	12,598	0	0	0	0
Irrigation Water Cost	dollars	600,714	471,284	0	0	0	0
Value of Production	dollars	1,916,544	1,673,794	0	0	0	0
Returns to Land & Mgt.	dollars	100,766	319,952	0	0	0	0

SATURATED THICKNESS 50 TO 100 FEET

Value of Production

The 1977 irrigated agricultural value of production was about $12.6 million (Table B-2). The irrigated agricultural value of production is expected to more than double by 1990 and then decrease to zero because the Ogallala aquifer will become dewatered.

Returns to Land and Management

The 1977 irrigated returns to land and management (RLM) were about $1.5 million (Table B-2). Under the baseline, the RLM is expected to increase 300 percent by 1990 and then decrease to zero as the Ogallala aquifer is dewatered.

Irrigation Water

The quantity of irrigation water diverted is expected to decrease from 133,700 acre-feet in 1977 to 124,000 acre-feet in 1990 and then decrease to zero (Table B-2).

Cropland and Cropping Pattern

The irrigated cropland is expected to remain constant at 67,200 acres from 1977 to 1990 and then decrease to zero (Table B-2).

Irrigated corn and grain sorghum acreages are expected to increase from 1977 to 1990 (Table B-2). Irrigated alfalfa, corn silage, and wheat acreages are expected to decrease from 1977 to 1990.

Table B-2. Summary of On-Farm Impacts, Saturated Thickness 50 to 100 Feet, Curry County, New Mexico, 1977-2020--Baseline.

Item	Unit	1977	1985	1990	2000	2010	2020
Value of Production	$1,000	12,561	21,217	23,730	0	0	0
Irrigated Cropland	$1,000	12,561	21,217	23,730	0	0	0
Returns to Land & Management	dollars	1,494,008	6,068,294	6,415,358	0	0	0
Irrigated Cropland	dollars	1,494,008	6,068,294	6,415,358	0	0	0
Irrigation Water							
Quantity	acre-ft	133,676	133,124	123,961	0	0	0
Cost	dollars	3,321,830	4,723,285	5,754,704	0	0	0
Land Use							
Irrigated Cropland	acres	67,200	67,200	67,200	0	0	0
Irrigation Energy							
Natural Gas	mcf	2,158,735	826,831	534,191	0	0	0
Electricity	1000 kwh	12,427	42,396	57,769	0	0	0
Irrigated Crops							
Alfalfa							
Acreage	acres	1,344	4,704	0	0	0	0
Production	ton	6,451	26,643	0	0	0	0
Irrigation Water	acre-ft	4,290	15,014	0	0	0	0
Irrigation Water Cost	dollars	105,966	492,296	0	0	0	0
Value of Production	dollars	399,974	1,692,603	0	0	0	0
Returns to Land & Mgt.	dollars	72,205	264,689	0	0	0	0
Corn for Grain							
Acreage	acres	21,504	24,864	26,880	0	0	0
Production	bu	2,580,480	3,683,479	4,302,139	0	0	0
Irrigation Water	acre-ft	50,104	57,933	61,355	0	0	0
Irrigation Water Cost	dollars	1,237,733	1,899,627	2,937,366	0	0	0
Value of Production	$1,000	5,613	10,322	12,256	0	0	0
Returns to Land & Mgt.	$1,000	1,009	3,618	3,589	0	0	0
Corn Silage							
Acreage	acres	672	0	0	0	0	0
Production	ton	12,096	0	0	0	0	0
Irrigation Water	acre-ft	1,176	0	0	0	0	0
Irrigation Water Cost	dollars	29,847	0	0	0	0	0
Value of Production	dollars	157,248	0	0	0	0	0
Returns to Land & Mgt.	dollars	42,722	0	0	0	0	0
Grain Sorghum							
Acreage	acres	15,456	22,176	26,880	0	0	0
Production	cwt	772,800	1,347,499	1,796,665	0	0	0
Irrigation Water	acre-ft	24,420	34,202	40,960	0	0	0
Irrigation Water Cost	dollars	619,792	1,344,148	1,843,227	0	0	0
Value of Production	dollars	2,727,984	5,904,426	7,978,949	0	0	0
Returns to Land & Mgt.	dollars	586,394	1,644,517	2,063,771	0	0	0
Wheat							
Acreage	acres	28,224	15,456	13,440	0	0	0
Production	bu	1,280,160	922,390	997,667	0	0	0
Irrigation Water	acre-ft	53,686	25,975	21,646	0	0	0
Irrigation Water Cost	dollars	1,328,492	987,214	974,111	0	0	0
Value of Production	dollars	3,663,072	3,297,632	3,494,966	0	0	0
Returns to Land & Mgt.	dollars	-216,103	541,566	762,968	0	0	0

SATURATED THICKNESS MORE THAN 100 FEET

Value of Production

The 1977 irrigated agricultural value of production was about $10.6 million (Table B-3). The total and irrigated agricultural value of production is expected to increase 160 percent by 2010 and drop to zero as the Ogallala becomes dewatered.

Returns to Land and Management

The 1977 irrigated returns to land and management (RLM) were about $1.7 million (Table B-3). Under the baseline, the RLM is expected to increase 550 percent by 2010 and then drop to zero as the Ogallala aquifer becomes dewatered.

Irrigation Water

The quantity of irrigation water diverted is expected to decrease from 114,600 acre-feet in 1977 to 103,700 acre-feet in 2010 and then decrease to zero by 2020 (Table B-3).

Cropland and Cropping Pattern

The irrigated cropland is expected to remain constant at 57,100 acres from 1977 to 2010 and then decrease to zero by 2020 (Table B-3).

Irrigated pasture acreages are expected to increase from 1977 to 2010 (Table B-3). Irrigated corn silage and wheat acreages are expected to decrease from 1977 to 2010.

Table B-3. Summary of On-Farm Impacts, Saturated Thickness More Than 100 Feet, Curry County, New Mexico, 1977-2020--Baseline.

Item	Unit	1977	1985	1990	2000	2010	2020
Value of Production	$1,000	10,616	17,985	20,921	25,109	27,842	0
Irrigated Cropland	$1,000	10,616	17,985	20,921	25,109	27,842	0
Returns to Land & Management	$1,000	1,677	5,780	6,245	8,961	10,840	0
Irrigated Cropland	$1,000	1,677	5,780	6,245	8,961	10,840	0
Irrigation Water							
Quantity	acre-ft	114,584	113,778	113,411	107,834	103,721	0
Cost	dollars	2,312,729	3,344,234	4,392,746	5,011,070	5,381,831	0
Land Use							
Irrigated Cropland	acres	57,100	57,100	57,100	57,100	57,100	0
Irrigation Energy							
Natural Gas	mcf	1,497,596	571,537	398,571	56,016	63,849	0
Electricity	1000 kwh	8,839	30,999	44,917	68,896	69,402	0
Irrigated Crops							
Alfalfa							
Acreage	acres	1,142	3,997	5,710	5,710	5,710	0
Production	ton	5,482	22,638	33,418	36,652	44,378	0
Irrigation Water	acre-ft	3,645	12,757	18,224	18,224	16,249	0
Irrigation Water Cost	dollars	72,527	342,251	720,210	768,037	843,123	0
Value of Production	dollars	339,859	1,438,209	2,168,846	2,511,413	3,211,608	0
Returns to Land & Mgt.	dollars	78,866	300,961	255,140	508,505	910,811	0
Corn for Grain							
Acreage	acres	18,272	21,127	22,840	22,840	22,840	0
Production	bu	2,192,640	3,129,861	3,681,972	4,153,992	4,405,729	0
Irrigation Water	acre-ft	42,574	49,226	51,186	46,660	45,546	0
Irrigation Water Cost	dollars	847,149	1,320,646	1,997,012	2,209,330	2,363,286	0
Value of Production	$1,000	4,769	8,771	10,488	12,606	13,722	0
Returns to Land & Mgt.	$1,000	1,062	3,367	3,607	5,069	5,900	0
Corn Silage							
Acreage	acres	571	0	0	0	0	0
Production	ton	10,278	0	0	0	0	0
Irrigation Water	acre-ft	999	0	0	0	0	0
Irrigation Water Cost	dollars	21,684	0	0	0	0	0
Value of Production	dollars	133,614	0	0	0	0	0
Returns to Land & Mgt.	dollars	39,979	0	0	0	0	0
Grain Sorghum							
Acreage	acres	13,133	18,843	22,840	22,840	22,840	0
Production	cwt	645,230	1,144,973	1,526,630	1,734,808	1,845,840	0
Irrigation Water	acre-ft	21,321	29,062	34,804	33,973	33,163	0
Irrigation Water Cost	dollars	455,139	976,764	1,325,321	1,608,636	1,720,734	0
Value of Production	dollars	2,279,717	5,017,005	6,779,732	8,224,610	8,933,933	0
Returns to Land & Mgt.	dollars	499,391	1,562,712	1,994,465	2,859,600	3,349,639	0
Wheat							
Acreage	acres	23,982	13,133	5,710	5,710	5,710	0
Production	bu	1,079,190	769,886	423,860	500,920	539,455	0
Irrigation Water	acre-ft	46,045	22,733	9,197	8,977	8,763	0
Irrigation Water Cost	dollars	916,230	704,573	350,203	425,067	454,688	0
Value of Production	dollars	3,093,678	2,759,559	1,484,840	1,767,184	1,974,827	0
Returns to Land & Mgt.	dollars	-3,235	548,813	387,796	523,863	679,839	0

DRY CROPLAND AND RANGELAND

Value of Production

The 1977 total dry cropland agricultural value of production in Curry County was about $7.0 million (Table B-4). The dry cropland agricultural value of production is expected to increase to $34.3 million by 2020. This is primarily due to increased dry cropland acreage prices and yields. The 1977 TVP for rangeland was about $6.6 million. The TVP for rangeland is expected to increase by 28 percent by 2020 (Table B-4).

Returns to Land and Management

The 1977 dry cropland returns to land and management (RLM) in Curry County were about $1.3 million (Table B-4). Under the baseline, the RLM is expected to increase to $20.4 million by 2020. Rangeland is expected to increase from $1.2 million in 1977 to $1.8 million in 2010 and then decline slightly by 2020.

Cropland and Cropping Pattern

The dry cropland acreage is expected to increase from 156,100 acres in 1977 to 314,000 acres by 2020 (Table B-4). The rangeland acreage is expected to remain constant at 548,900 acres.

Both dryland grain sorghum and wheat acreages are expected to increase over time (Table B-4).

Table B-4. Summary of On-Farm Impacts, Dry Cropland and Rangeland, Curry County, New Mexico, 1977-2020--Baseline.

Item	Unit	1977	1985	1990	2000	2010	2020
Value of Production	$1,000	43,109	68,025	67,231	56,584	61,796	42,765
Dry Cropland	$1,000	6,952	10,124	14,378	23,008	25,488	34,298
Rangeland	$1,000	6,615	8,004	8,202	8,467	8,467	8,467
Returns to Land & Management	$1,000	6,724	20,305	20,711	22,703	26,887	22,165
Dry Cropland	$1,000	1,341	3,569	6,309	11,928	14,250	20,393
Rangeland	$1,000	1,223	1,664	1,741	1,815	1,797	1,772
Land Use							
Dry Cropland	acres	156,100	156,100	189,700	256,900	256,900	314,000
Rangeland	acres	548,900	548,900	548,900	548,900	548,900	548,900
Dryland Crops							
Grain Sorghum							
Acreage	acres	32,781	23,415	28,455	38,535	38,535	47,100
Production	cwt	426,153	369,924	494,504	760,999	809,705	1,041,754
Value of Production	$1,000	1,575	1,673	2,260	3,700	4,016	5,282
Returns to Land & Mgt.	$1,000	45	333	545	1,326	1,590	2,257
Wheat							
Acreage	acres	123,319	132,685	161,245	218,365	218,365	266,900
Production	bu	1,603,147	2,095,233	3,112,047	4,980,679	5,363,833	7,024,328
Value of Production	$1,000	5,377	8,451	12,117	19,309	21,472	29,016
Returns to Land & Mgt.	$1,000	1,296	3,236	5,765	10,601	12,660	18,136
Rangeland							
Steers							
Acreage	acres	340,318	340,318	340,318	340,318	340,318	340,318
Production	1977 $	5,540,377	15,540,377	15,540,377	15,540,377	15,540,377	15,540,377
Value of Production	$1,000	5,540	6,704	6,870	7,092	7,092	7,092
Returns to Land & Mgt.	$1,000	762	1,048	1,096	1,143	1,133	1,115
Cows							
Acreage	acres	208,582	208,582	208,582	208,582	208,582	208,582
Production	1977 $	1,074,197	1,074,197	1,074,197	1,074,197	1,074,197	1,074,197
Value of Production	$1,000	1,074	1,300	1,332	1,375	1,375	1,375
Returns to Land & Mgt.	$1,000	461	617	645	672	664	656