Report 315

Evaluation of Ground-WaterResources in Dallam County, Texas

November 1989

Texas Water Development Board

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by
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ABSTRACT

The evaluation of ground-water conditions in Dallam County is in response to the 1985 passage of House Bill 2 by the Sixty-ninth Texas Legislature, which called for the identification and study of areas in the State that are experiencing or are expected to experience within the next 20 years, critical ground-water problems. Dallam County is located in the northwest corner of the Texas Panhandle and has a semi-arid climate characterized by low annual rainfall and high annual lake evaporation rates. The economy of the county is dominated by agriculture and ranching endeavors that depend heavily on the availability of ground water.

Almost all of Dallam County's water needs are supplied by the High Plains aquifer system which is defined stratigraphically in the near-surface Ogallala Formation of Tertiary age and, where connected hydrologically, in older formations of Cretaceous, Jurassic, and Triassic age. The aquifer system, which receives only a limited amount of natural recharge each year from precipitation, has diminished its ground-water reserve in recent times. In 1984, for example, 16 thousand acre-feet of natural recharge from precipitation is estimated to have entered the aquifer system, while more than 285 thousand acre-feet was pumped from it for irrigation purposes. Irrigation pumpage has lowered the water table in the High Plains aquifer system by as much as 80 feet under parts of Dallam County since the early 1930's.

Although total pumpage from the aquifer system is expected to decrease to about 192 thousand acre-feet annually in Dallam County by the year 2010, water in storage will continue to be depleted and water levels will continue to decline as long as discharge exceeds recharge. In fact, recent studies suggest that up to 21 percent of all usable water stored in the aquifer in 1980 will be depleted by the year 2010.

TABLE OF CONTENTS

TABLES

TABLE OF CONTENTS--(Continued)

FIGURES

INTRODUCTION

Purpose

In 1985, the Sixty-ninth Texas Legislature recognized that certain areas of the State were experiencing or were expected to experience within the next 20 years, critical ground-water problems. House Bill 2 was enacted, which in part, directed the state's water agencies to identify possible critical ground-water areas, conduct studies in the areas, and submit findings and recommendations on whether a ground-water district should be established in the respective areas to address the ground-water problems. For more information on the critical area process, see Subchapter C, Chapter 52, of the Texas Water Code. This study focuses on Dallam County, where the water levels in the High Plains aquifer have been steadily declining for several decades.

Location and Geographic Setting

Dallam County, located in the northwest corner of the Texas Panhandle, is bordered by the State of Oklahoma on the north, the State of New Mexico on the west, Sherman County on the east, and Hartley County on the south (Figure 1). The county is sparsely populated with the majority residing in the Cities of Dalhart and Texline. The Dallam County Underground Water Conservation District No. 1 (DCUWCD) is located in the north-central part of the county (Figure 1).

The northern Panhandle of Texas lies along the southern edge of the North American Central High Plains province, an elevated plateau region characterized by a gently undulating, treeless terrain. The plains slope gently to the southeast in Dallam County and are dissected by a few intermittent streams which provide local topographic relief.

Vegetation in Dallam County varies. In the northern part of the county, native grasses predominate and are protected in areas designated as Rita Blanca National Grassland (Figure 2). Elsewhere, farm crops are cultivated over large tracts of land, primarily during late spring and summer months.

The semi-arid climate in the region, as recorded by the National Weather Service, is characterized by low rainfall, high rate of evaporation, and wide temperature range. Average temperatures range from the low 90's (degrees F) in the summer to well below freezing during winter cold spells.

The average annual precipitation ranges from 13 to 17 inches, increasing in a southeast direction across the county (Larkin and Bomar, 1983). Most of the precipitation falls during thunderstorms between May and October.

Average annual gross lake evaporation is approximately 73 inches, an amount almost five times the average annual precipitation in the same region (Larkin and Bomar, 1983). Evaporation rates are highest in summer months when soil moisture demand by plants is also at its highest.

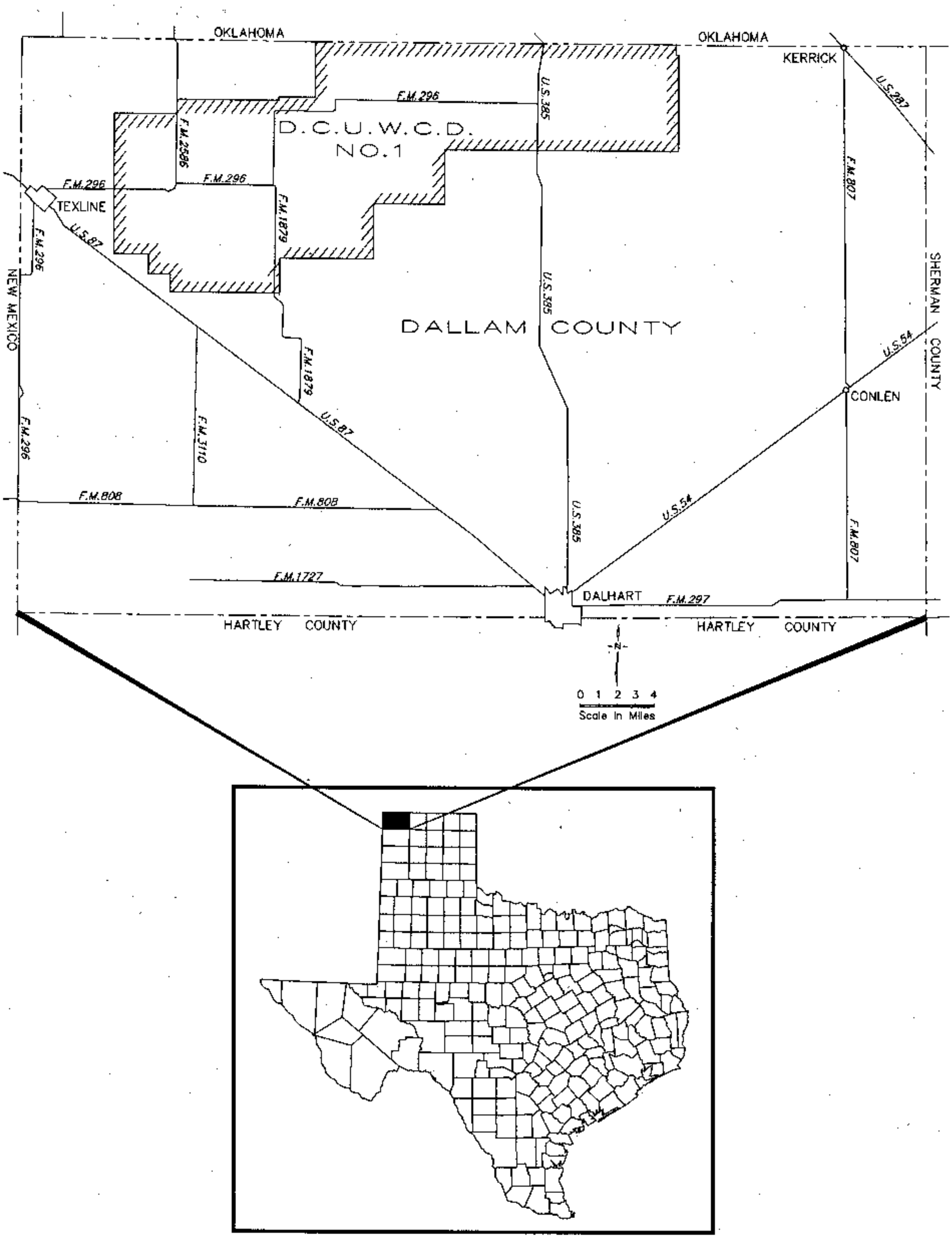


Figure 1

LOCATION OF STUDY AREA

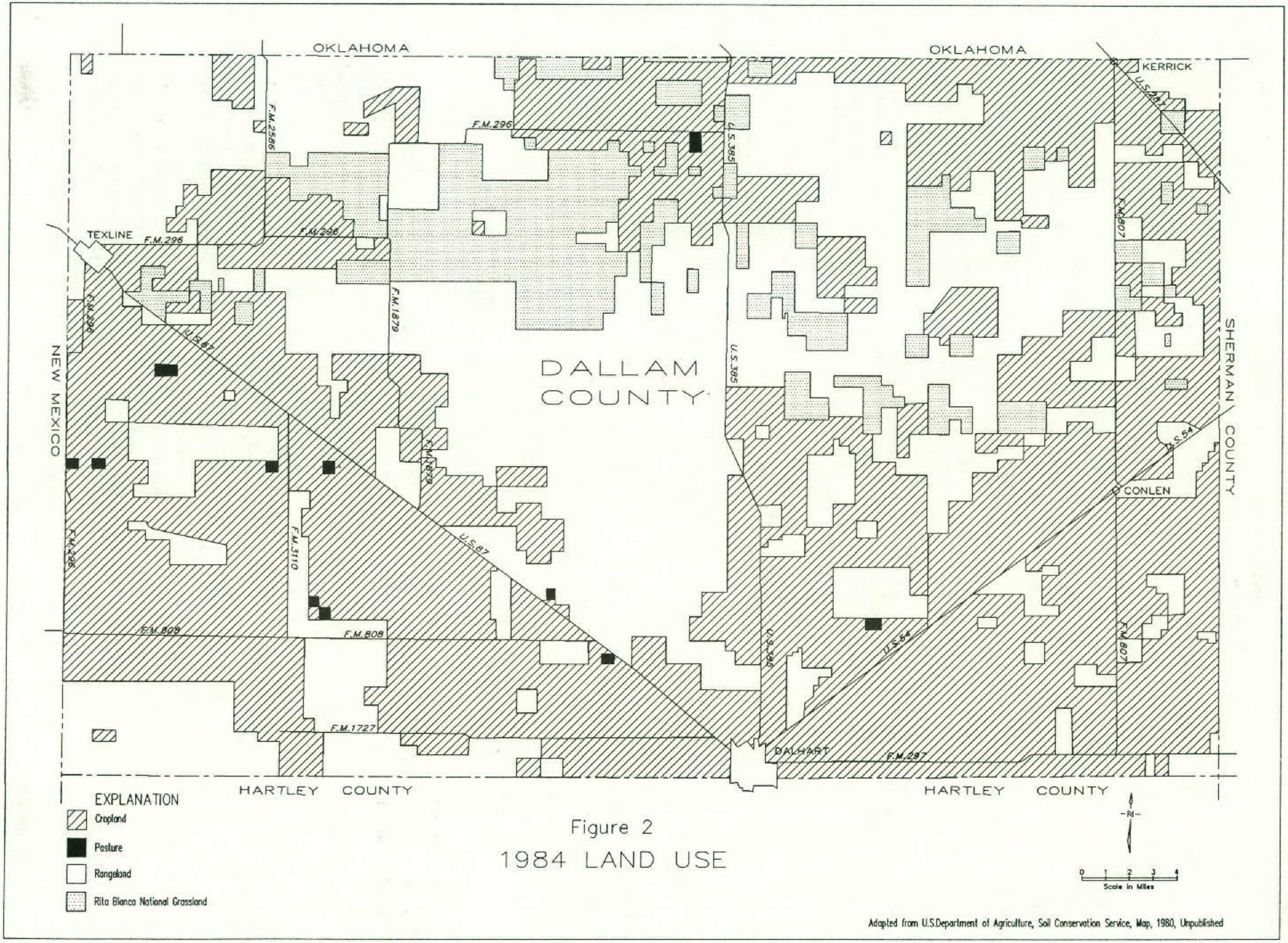


Figure 2
1984 LAND USE

The economy of Dallam County is based largely on agricultural development, with the community of Dalhart serving as an agribusiness and railhead center for a wide area in Texas, Oklahoma, and New Mexico. In 1984, the county had an average annual income of approximately $59 million derived mostly from raising and selling beef cattle, corn, wheat, grain, sorghum, and alfalfa (Texas Department of Agriculture and U.S. Department of Agriculture, 1985).

Economic growth in Dallam County can be traced directly to ground-water development in the region. Historically, water wells were first drilled in the study area in the late 1800's, primarily for watering livestock. Haley (1953) reports that by 1900, the XIT Ranch, which was headquartered in Dallam County and consisted of more than 3 million acres of land in the Texas Panhandle region, had 335 windmills in use. Irrigation well development followed, beginning slowly in the 1930's, then expanding more quickly as the efficiency of pumps and power units improved. In 1984 there were 1,200 active irrigation wells in Dallam County that were estimated to pump more than 285 thousand acre-feet of ground water from the High Plains aquifer to irrigate more than 213 thousand acres of cropland (Table 1).

Table 1. Irrigation Summary For Dallam County

Year	Total Acres Irrigated	Acre-Feet of Water Applied	Number of Irrigation Wells	Sprinkler Systems (Acres)
1958	42,225	49,874	271	660
1964	76,970	120,083	342	9,620
1969	128,600	160,985	712	49,920
1974	155,905	243,520	900	93,120
1979	220,515	323,345	1,200	148,950
1984	213,375	285,751	1,200	188,502

Source: Texas Water Development Board (1986).

Previous and Current Investigations

Early studies of the High Plains aquifer system under Dallam County included a 1937 publication by C. R. Follett, of the Texas State Board of Water Engineers, that listed records of wells, drillers' logs, and water analyses of wells sampled in the county. Also, several state and federal studies of the regional High Plains aquifer system have been made and reported on by such investigators as Weeks and Guttentag (1984), and Knowles, Nordstrom, and Klemt (1982). Hart, Hoffman, and Goemaat (1976) investigated and reported on the geohydrology of the Oklahoma Panhandle immediately north of the study area, and Baldwin and Bushman (1957) have outlined guides for the development of irrigation wells in the High Plains aquifer system to the west in Union County, New Mexico. Geologic mapping in the study area is best presented on the Dalhart geologic atlas sheet published by the University of Texas, Bureau of Economic Geology. Although no detailed studies focusing exclusively on the ground-water conditions of the High Plains aquifer system in Dallam County were found to exist, there is a detailed report in preparation for publication by the Texas Water Development Board.

Acknowledgements

The author wishes to thank the numerous individuals who provided information on the High Plains aquifer in Dallam County. More specifically, appreciation is extended to city officials who furnished information concerning their municipal water-supply systems, and to the many property owners who allowed Texas Water Development Board personnel access to their wells to measure water levels and collect water samples for analysis.

Finally, the author would like to acknowledge specific individuals at the Texas Water Development Board in Austin who have also contributed to this study including Henry Alvarez, Phil Nordstrom, John Ashworth, and Steve Gifford. Also portions of the report are drawn from a more comprehensive Dallam County report that is currently in draft by the Texas Water Development Board and authored by J. A. Tony Fallin.

GEOHYDROLOGY

Source and Occurrence

Ground water in Dallam County is drawn from the High Plains aquifer system which is defined within saturated intervals of the Ogallala Formation (Tertiary age) and underlying formations of Cretaceous, Jurassic, and Triassic age that are in hydraulic continuity and contain potable water (Knowles and others, 1982). The occurrence of ground water relative to the various formations in the High Plains aquifer is shown on the cross sections in Figures 3, 4, and 5.

The source of fresh ground water is primarily precipitation with an indeterminate amount derived from irrigation return flow. The direct infiltration of rainfall is minimal because most of the water is evaporated or transpired by plants. Water that escapes runoff and evapotranspiration migrates downward by gravity until it reaches the water table.

Ground water occurs in several different zones or horizons, with the greatest quantity stored in formations with the most porosity and permeability (Table 2). In the study area these zones are predominantly the sands and gravels deposited near the base of fluvial channels. These fluvial deposits are well developed in the Ogallala and are quite thick where they fill paleovalley courses that were scoured into the underlying Mesozoic strata (Figure 6). Cross-formational flow exists where the Ogallala is in contact with permeable and porous stratigraphic units of the Cretaceous in the northwest, Jurassic in the central, and Triassic in the eastern parts of the county (Figure 6).

Ground-water flow intervals in the Cretaceous section occur in the coarse-grained sands and gravels of the Mesa Rica and Lytle Sandstones, with small quantities of water produced from the tighter Romeroville Sandstone. Ground water in the Jurassic sediments occurs in small quantities in the Exeter Sandstone and sandy sections within the Morrison Formation. Small to moderate quantities of ground water occur in Triassic sediments, primarily the coarse-grained sands and gravels in the lower part of the Dockum Formation.

Ground-water flow is restricted in the High Plains aquifer system by the presence of relatively impermeable clay and shale intervals, or aquicludes, which function as upper and lower boundaries of the water-bearing units. In some locations, Cretaceous aquicludes overlying water-bearing zones create artesian pressures. Water filtering downward can be trapped by clay or shale layers above the water table resulting in perched water zones. Generally, these perched zones have limited yields and are susceptible to depletion during dry periods.

Ground-Water Movement

Ground water moves through porous and permeable sandstone, gravel, and conglomeratic beds in the High Plains aquifer in Dallam County. Direction of flow is perpendicular to the water-level contours shown on Figure 7, and is generally in an east-southeast direction in conformance with the regional structure. Exceptions occur where well

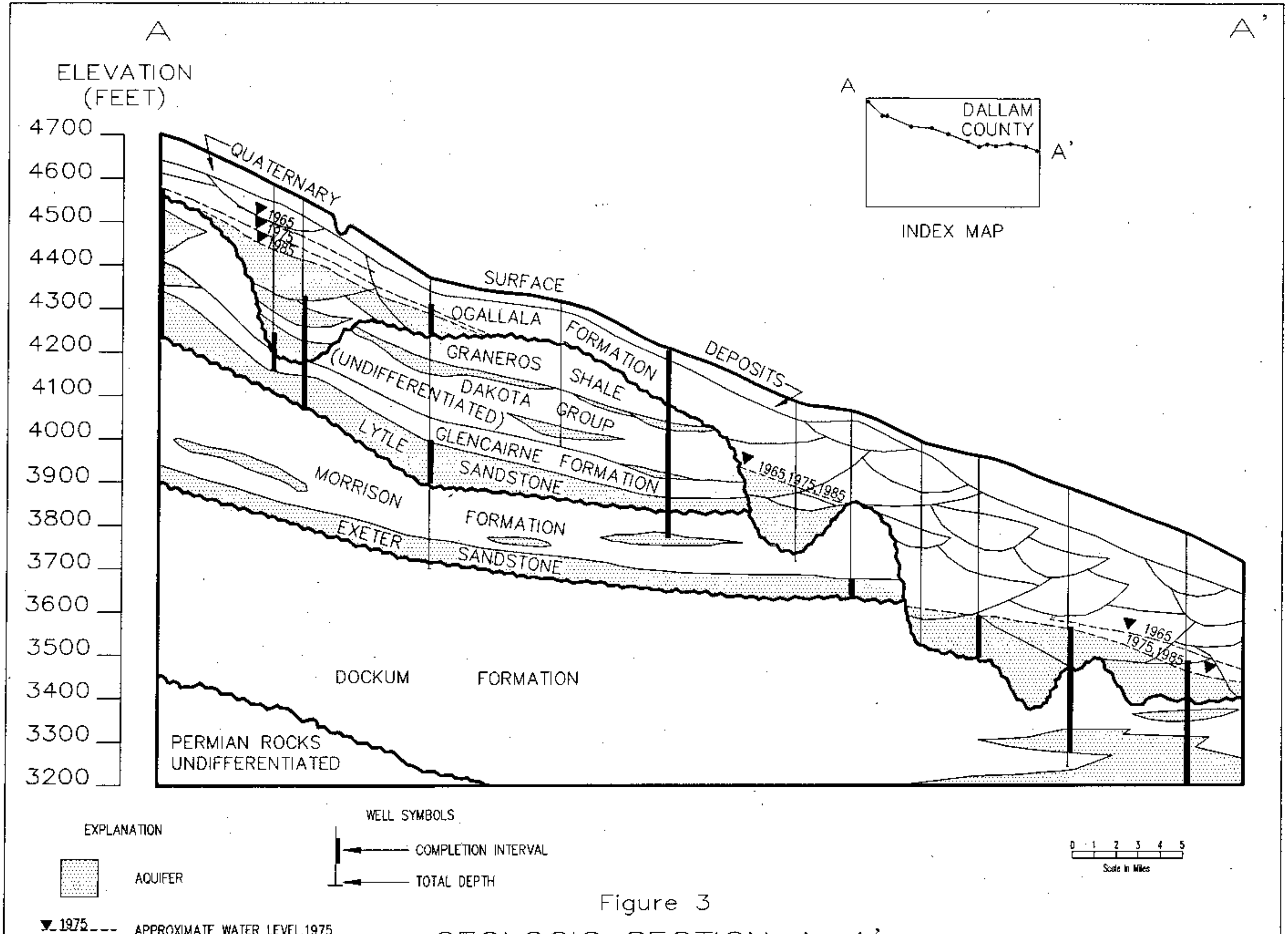


Figure 3

GEOLOGIC SECTION A—A'

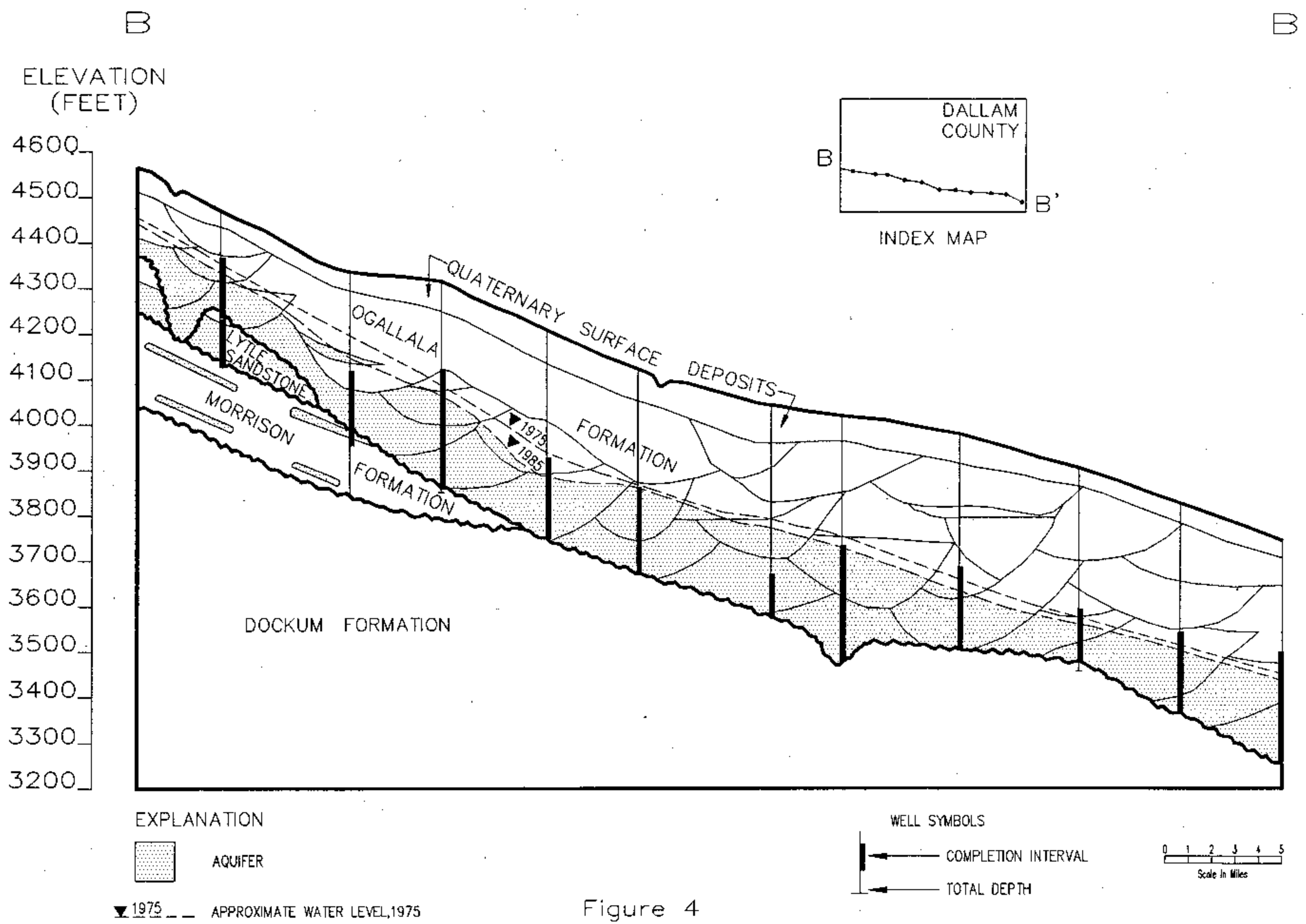


Figure 4

GEOLOGIC SECTION B—B'

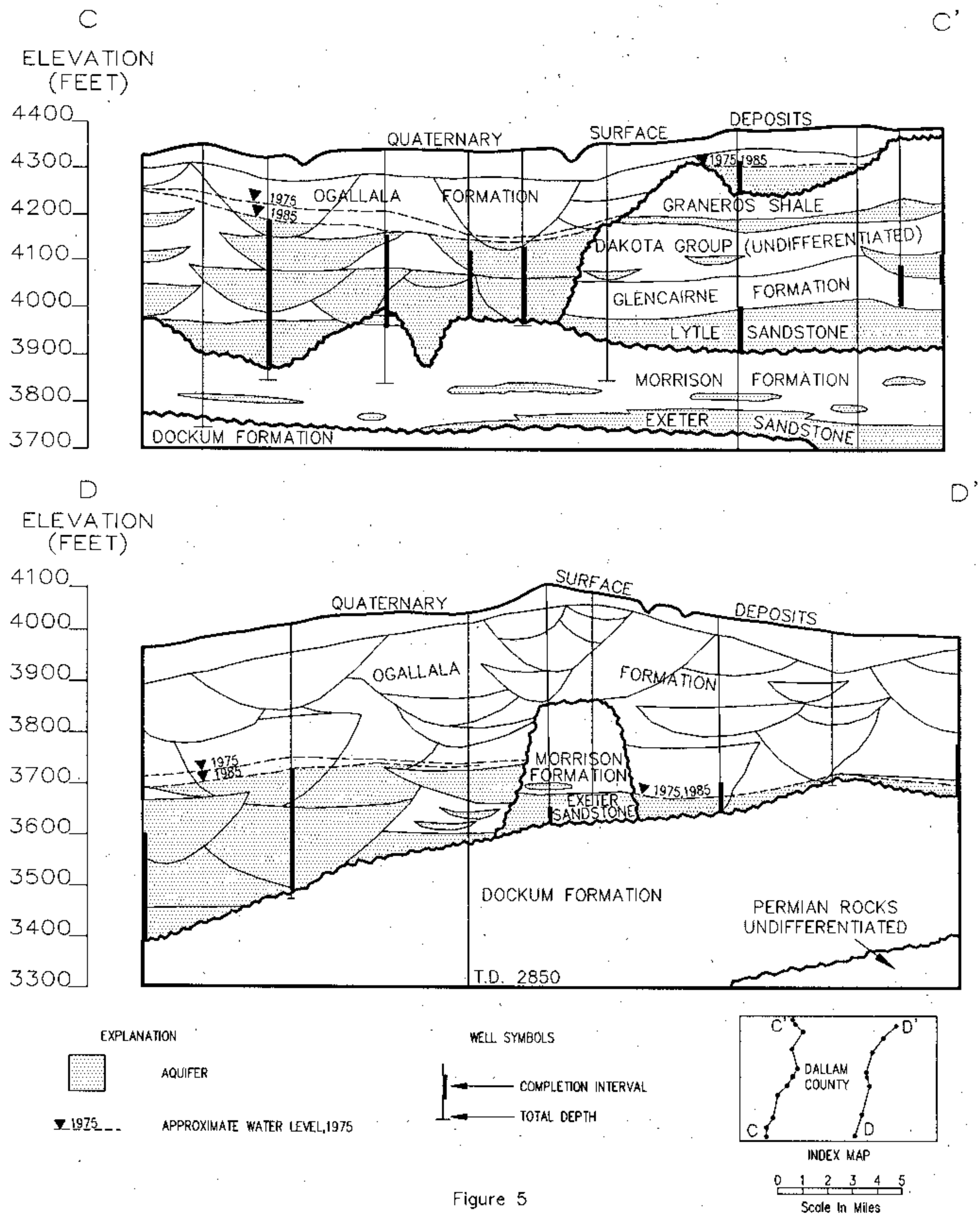
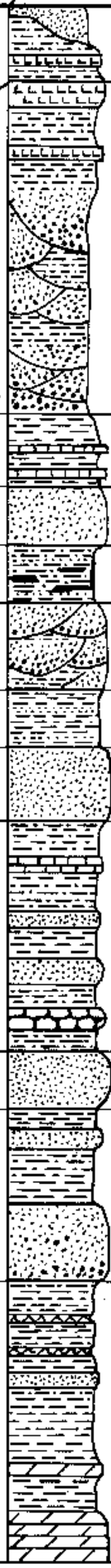


Figure 5

GEOLOGIC SECTIONS C–C' AND D–D'

Table 2. Geologic Units and Their Water-Bearing Characteristics

Era	System	Stratigraphic Unit	Generalized Lithologic Section	Approx. Maximum Thickness in Feet	Lithologic Description	Water-Bearing Properties *
CENOZOIC	Quaternary	Surface Deposits		90	Windblown sand and silt; clay, silt, sand, and gravel fluvial deposits; silt and clay playa lake deposits; and some caliche development.	Yields small quantities of fresh water along stream courses.
CENOZOIC	Quaternary / Tertiary	Ogallala Formation		500	Tan, yellow, reddish-brown clay, silt, sand, and gravel fluvial deposits. Caliche layers near the surface.	Yields moderate to large quantities of fresh water, with highest yields coming from coarse-grained sand and gravel deposits filling pre-Ogallala paleo-valley courses.
MESOZOIC	Cretaceous	Graneros Shale		100	Dark-gray, silty marine shale with limestone beds forming hard streaks 20 and 50 feet above its base locally.	Not known to yield water (aquiclude).
MESOZOIC	Cretaceous	Dakota Group: Romeroville Sandstone		50	Gray to yellow marine sandstone.	Yields small quantities of fresh water.
MESOZOIC	Cretaceous	Dakota Group: Pajarito Formation		50	Interbedded continental siltstone, sandstone and shale containing plant debris and lignite locally.	Not known to yield water (aquiclude).
MESOZOIC	Cretaceous	Dakota Group: Mesa Rica Sandstone		100	Massive, yellow to brown fluvial sandstone and shaly sandstone.	Yields small to moderate quantities of fresh water, especially from coarse-grained sand and gravel channel-fill facies.
MESOZOIC	Cretaceous	Glencairn Formation		60	Tidal-esturine deposit of dark-gray marine shales and thin sandstone interbeds.	Not known to yield water (aquiclude).
MESOZOIC	Cretaceous	Lytle Sandstone		90	Coastal plain deposit of light gray to white, cross bedded sand and sandstone. Conglomeratic locally.	Yields moderate to large quantities of fresh water.
MESOZOIC	Jurassic	Morrison Formation		300	Continental deposit, with green, gray, brown, red and maroon sandy shales and local interbeds of white sandstone and thin-bedded limestone in upper parts of the section. Lower 25 to 70 feet of the formation consists of thin-bedded, light-brown siltstone and sandstone with some reddish-brown mudstone. There are also from one to six thin nodular limestone beds ('agate beds') with an abundance of brown agate near the base of the formation.	Yields small quantities of fresh to slightly saline water from sandstone facies.
MESOZOIC	Jurassic	Exeter Sandstone		80	Light-colored sandstone.	Yields small quantities of fresh to slightly saline water.
MESOZOIC	Triassic	Dockum Formation		900	Continental deposit of red-brown mudstones and increasing light-colored sandstones and silt pebble conglomerate interbeds near the base of the formation.	Yields small to moderate quantities of fresh to moderately saline water, especially from sandstone and conglomerate facies near the base of the formation.
PALEOZOIC	Permian	Red Beds Undifferentiated		1,000+	Very fine to fine grained, red sandstone and shale; white to brown gypsum, anhydrite, and dolomite.	Yields small quantities of moderately saline to brine water.

* Yields of wells: small -- less than 50 gallons per minute (gpm); moderate -- 50 to 500 gpm; large -- more than 500 gpm.

* Chemical Quality of Water: slightly saline -- 1,000 to 3,000 milligrams per liter (mg/l); moderately saline -- 3,000 to 10,000 mg/l; very saline -- 10,000 to 35,000 mg/l; brine -- more than 35,000 mg/l.

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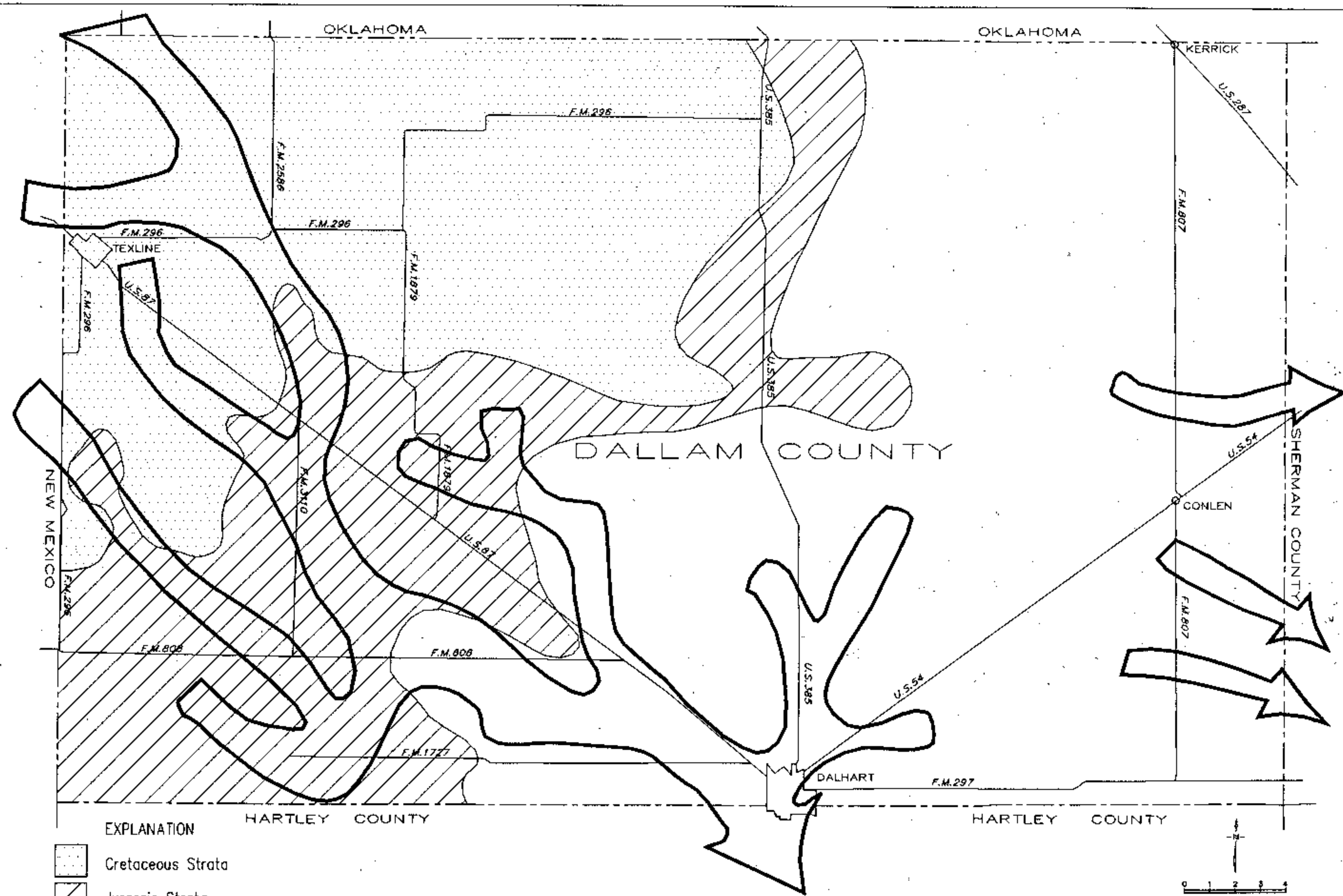


EXPLANATION

- Cretaceous Strata
- Jurassic Strata
- Triassic Strata
- Pre-Ogallala Drainage Courses

Figure 6

PALEOGEOGRAPHIC MAP SHOWING
PRE-OGALLALA TERRAIN AND DRAINAGE COURSES

pumpage has created local cones of depression and where pre-Ogallala topography defines local hydrologic divides in the High Plains aquifer system.

Flow rates in the aquifer system are generally greatest in the lower and middle parts of the Ogallala, where medium- to coarse-grained fluvial facies prevail, and in permeable layers of the Mesa Rica and Lytle Sandstones. Hydraulic conductivity values in the Ogallala exceed 67 feet per day in the southeast part of Dallam County, but average approximately 34 feet per day for the remainder of the county (Knowles and others, 1982). Actual flow rates through the aquifer are a function of saturated thickness, lithology, permeability, and hydraulic gradient. Knowles and others (1982) suggest an average estimated lateral flow of ground water for the High Plains aquifer of 7 inches per day. Underflow from updip parts of the aquifer system in New Mexico and Oklahoma moves into Dallam County through coarse-grained fluvial deposits in the Mesa Rica and Lytle Sandstones, and through channel-fill deposits in the Ogallala Formation.

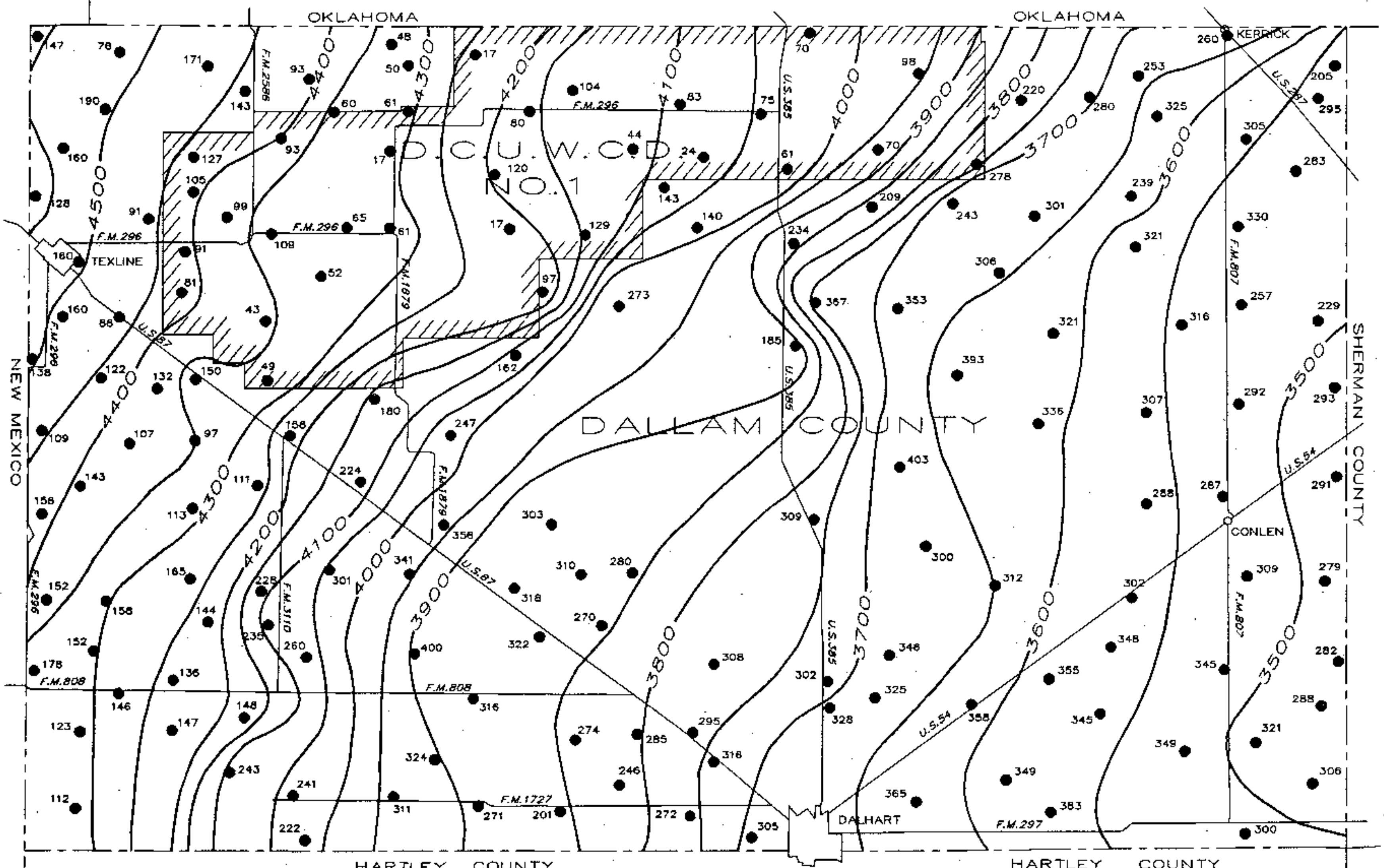
Recharge

Precipitation is the principal source of natural recharge to the High Plains aquifer. Approximately 2 percent of the 13 to 17 inches of annual precipitation that falls in Dallam County is estimated to enter the aquifer, an amount calculated to equal slightly more than 16 thousand acre-feet per year (Knowles and others, 1982).

Recharge is most effective where coarse-grained sands and gravels occur at the surface. Thick accumulations of wind-blown sand in the western part of the county, and coarse-grained sediments deposited in stream valleys, allow moisture to reach depths below the effects of evapotransporation.

Factors inhibiting recharge include the presence of semi-permeable soil zones that are at or near the surface over a large portion of the county. The fine-grained nature of silts and clays, and the cementation of caliche zones, reduce intergranular permeability and effective porosity in the sediments, thus retarding fluid flow. As a result, 98 percent of the precipitation that falls in Dallam County ponds in shallow playa lakes where it either quickly evaporates, flows out of the area in ephemeral streams, or is absorbed only to plant root depths before being returned to the atmosphere by evapotranspiration.

Recharge via irrigation return flow is similar to meteoric recharge in that excess water not used by plants or lost to the atmosphere by evaporation percolates downward toward the water table. Improved conservation methods such as monitoring soil moisture content, implementation of drip irrigation systems, and planting of drought resistant crops have reduced the amount of water applied thus limiting the amount of water available for recharge. Determining the actual amount of irrigation return flow that recharges the aquifer is beyond the scope of this study but as shown by water-level declines, this amount plus meteoric recharge is insufficient to offset water depletion due to pumpage.



EXPLANATION

● Current observation well

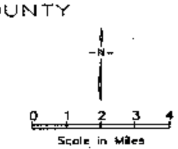
200 Depth to water from land surface

3600 Line showing approximate altitude of water levels, in feet

Contour interval 50 feet

Figure 7

APPROXIMATE ALTITUDE OF WATER LEVELS AND DEPTH TO WATER IN THE HIGH PLAINS AQUIFER, DECEMBER 1988



Discharge

Discharge from the High Plains aquifer in Dallam County by irrigation pumpage has exceeded 200 thousand acre-feet annually since the early 1970's. Current Texas Water Development Board data indicate that there are more than 1,200 irrigation wells presently operating in the county and that irrigation accounts for over 98 percent of the water used (Texas Water Development Board, 1988).

Well yields vary from one location to another and are dependent on specific geologic facies in the saturated zone. Highest yields in the study area range between 600 and 1,200 gallons per minute (gpm) and are from wells completed in the coarser grained fluvial sands and gravels of the Ogallala Formation, Mesa Rica Sandstone, and Lytle Sandstone. Wells producing from other parts of the aquifer system rarely exceed 500 gpm and are sometimes less than 10 gpm.

Springs in Dallam County were once a significant source of naturally occurring ground-water discharge. Although not as numerous, springs still emerge from the Ogallala Formation and various Cretaceous formations along Coldwater and Rita Blanca Creeks. Buffalo Springs, the largest and best known, flows from numerous openings in the Mesa Rica Sandstone into Rita Blanca Creek. On August 7, 1924, discharge was recorded as 1.2 cubic feet per second and Rita Blanca Creek flowed continuously. Flow from Buffalo Springs has steadily decreased as a result of declining water levels due to irrigation pumpage to the west. By June 22, 1971, discharge from the springs was recorded as 0.58 cubic foot per second (Brune, 1975). Other springs flowing into Rita Blanca Creek are Kimble, Horseshoe Bend, Potato, and Government Springs. Springs that currently flow into Coldwater Creek are Black Muley and Coldwater Springs (Brune, 1981).

Water Levels

The Texas Water Development Board currently monitors 167 wells annually to record water-level fluctuations in the High Plains aquifer in Dallam County. Figure 7 shows the approximate altitude of the water table during December 1988. As indicated, the water table is shallowest in north-central parts of the county where it ranges from less than 20 feet to slightly more than 125 feet below land surface. Further east and south, the water table drops to more than 400 feet below land surface. Water-level contours show a hydraulic gradient of approximately 20 feet per mile in a southeast direction across the county.

Water Quality

The chemical quality of the ground water in the High Plains aquifer in Dallam County varies slightly, depending on the lithology of the individual formations of the system. The quality of the water produced from the Ogallala Formation is virtually fresh, generally containing less than 500 milligrams per liter (mg/l) dissolved solids. It usually has a mixed cation-bicarbonate hydrochemical signature, and has a pH ranging between 7.3 and 8.5. Ogallala water is very hard, with equivalent concentrations of calcium carbonate exceeding 200 mg/l. It also presents a relatively low sodium and medium salinity hazard to plants and soils when used for irrigation, and is suitable for crops grown in the region.

Ground water in the Cretaceous formations is usually fresh, has a mixed cation-bicarbonate hydrochemical signature, and a pH ranging between 7.4 and 8.2. In contrast, solute concentrations of over 1,000 mg/l have been recorded in water from wells located just south and west of the community of Coldwater and about 60 to 200 feet below the land surface. This slightly saline Cretaceous water generally has either a sodium-mixed anion or sodium-bicarbonate hydrochemical signature, and a pH ranging between 7.8 and 8.3. This is the only water found in the High Plains aquifer that is unsuitable for irrigating most crops grown in the region. Cretaceous ground water in Dallam County is very hard, with equivalent concentrations of calcium carbonate measuring between 180 and 320 mg/l.

Ground water produced from wells completed in Jurassic formations is classified as fresh to slightly saline and generally contains dissolved solids concentrations ranging from about 400 to almost 1,100 mg/l. The water is considered moderately to very hard, containing concentrations of calcium carbonate ranging from 90 to over 300 mg/l. Values of pH generally range between 7.7 to 8.9.

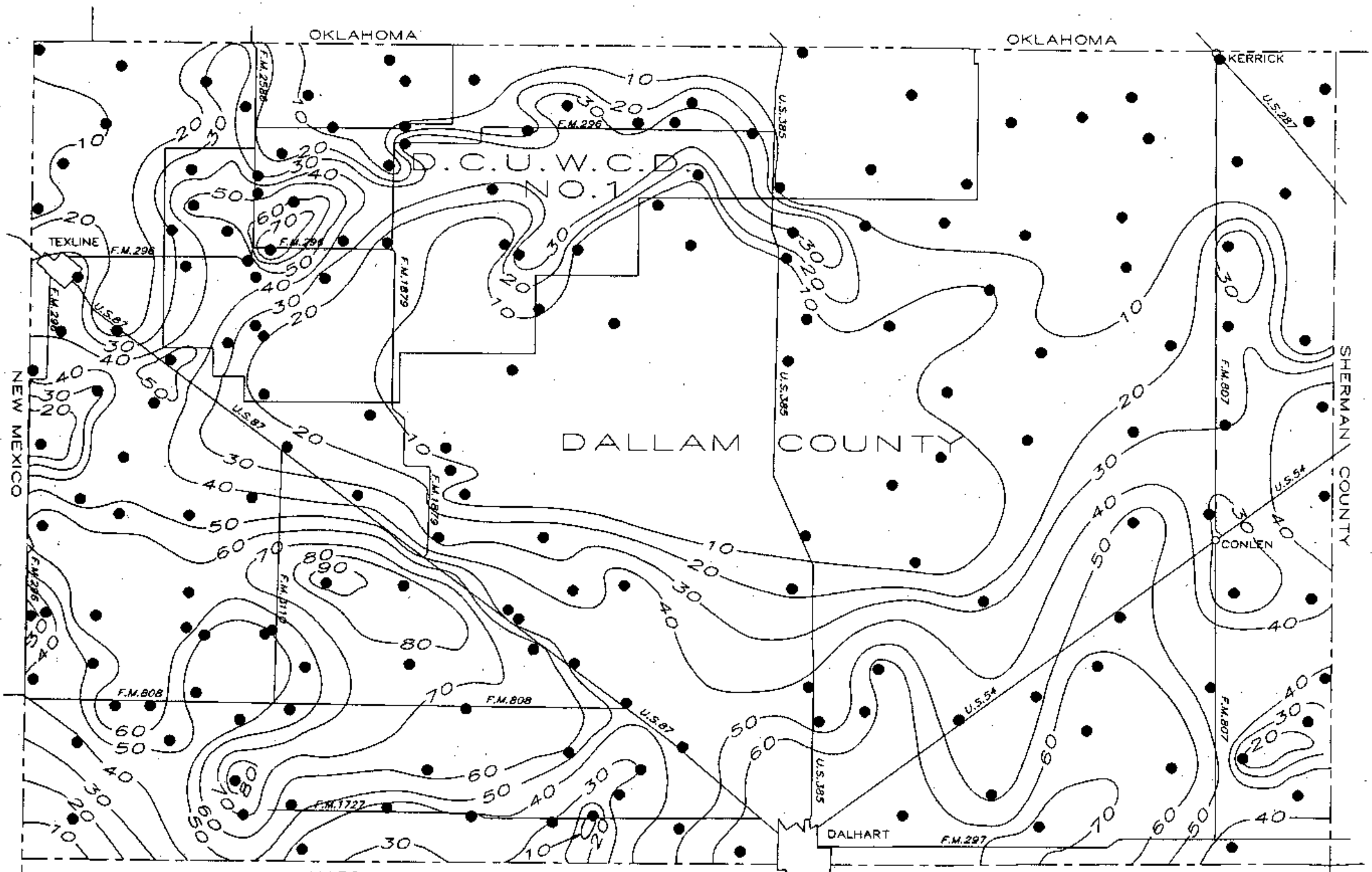
Water-quality data for wells completed in Triassic rocks in Dallam County is limited, with only one well completed solely within the Dockum Formation having been sampled to date. The Triassic well is located in the northeast part of the county where sandy facies prevail in the lower part of the Triassic section, and where hydraulic continuity exists between the Dockum and the overlying Ogallala. The water analysis from this well conforms to the results from the wells completed in the Ogallala Formation, reflecting the hydrologic continuity between the two formations in the northeast part of the county. Ground-water quality in the Dockum is expected to deteriorate westward as the formation dips further below ground surface and water-bearing facies in the Triassic deposits become more distant from fresh-water recharge zones.

Ground-Water Problems Due To Water-Level Declines

Water levels in wells completed in the High Plains aquifer have declined substantially since irrigation began in the early 1900's. The declines have been most prominent in the southern part of the county, with water levels in some wells dropping more than 80 feet (Figure 8). In the northern part of the county the impact of water-level declines is evident by the demise of the many springs that once contributed to the constant flow in various creeks that are now ephemeral (Brune, 1981).

Hydrographs of selected wells in the county show water-level declines in areas developed for irrigation (Figure 9). Irrigation development began in the late 1930's, and by the 50's, steady declines were evident. The greatest declines, as shown on the hydrographs, have occurred from the early 1970's to the middle 80's, when water levels in some wells dropped more than 50 feet. Water levels continue to drop as is indicated in Figure 10 which shows declines of greater than 30 feet occurring between 1980 and 1988.

If pumpage continues to exceed recharge in a manner similar to what has occurred in the past, the saturated thickness in the High Plains aquifer will continue to diminish. As the saturated thickness decreases, water levels drop and well yields decrease, requiring a greater expenditure of energy and money to produce water from the aquifer. Table 4 shows that by the year 2010 the annual demand of ground water for irrigation is projected to be about 41 thousand acre-feet less than the current annual irrigation demand. This amount still well exceeds the recharge rate and will result in a continued water level decline in the future.



EXPLANATION

—30— Line showing approximate equal water-level decline

Earliest recorded water-level measurement ranges from 1937 to 1975 based on well development in each area

● Data point used for control

Contour Interval 10 Feet

0 1 2 3 4
Scale in Miles

N

Figure 8

APPROXIMATE WATER-LEVEL DECLINE IN THE HIGH PLAINS AQUIFER FROM PRE-DEVELOPMENT TO 1988

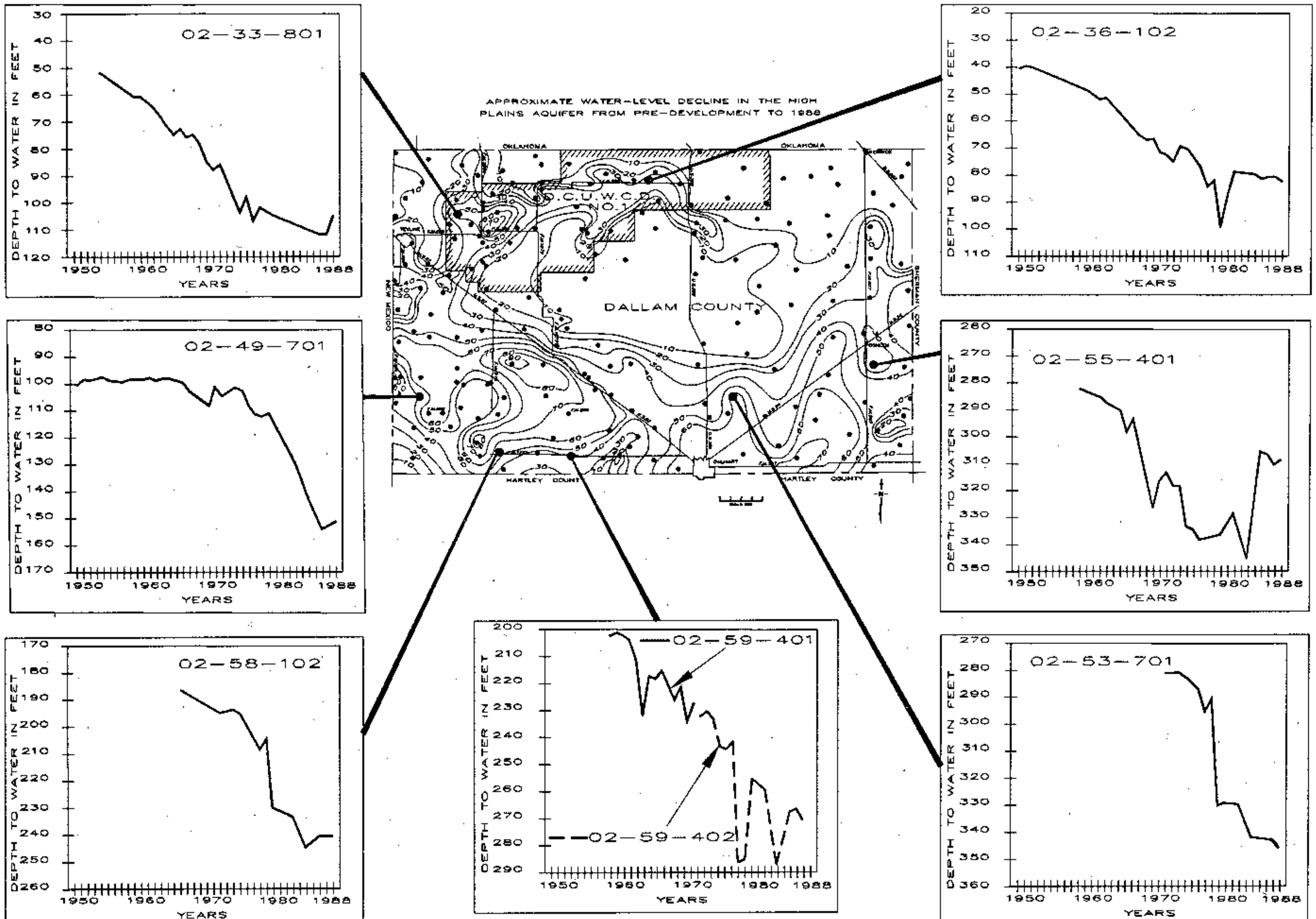
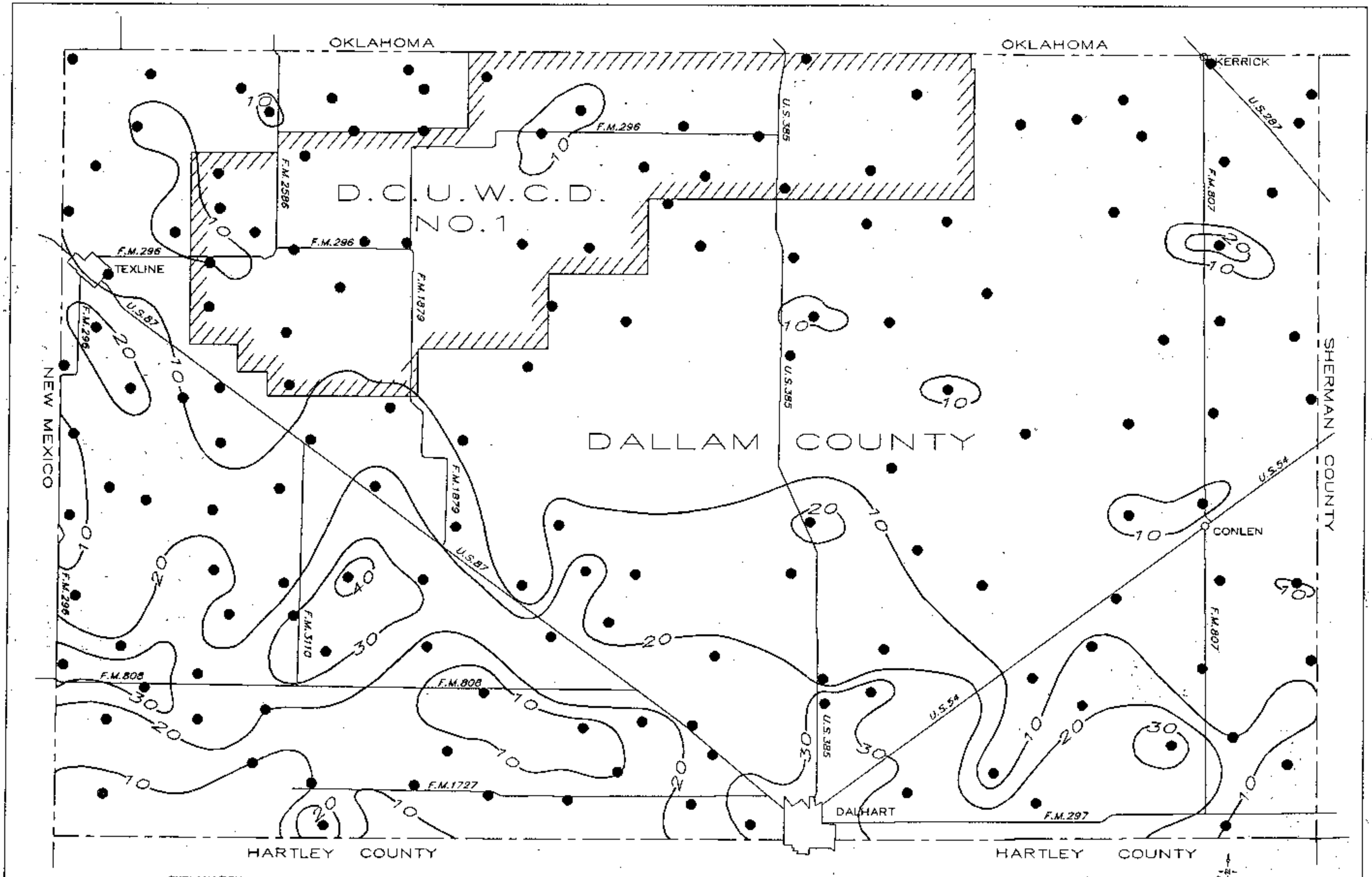


Figure 9

HYDROGRAPHS OF SELECTED WELLS COMPLETED IN THE HIGH PLAINS AQUIFER



EXPLANATION

● Current observation well

—10— Line of approximate equal water-level decline

Contour interval 10 feet

Figure 10

APPROXIMATE WATER-LEVEL DECLINE
IN THE HIGH PLAINS AQUIFER
FROM 1980 TO 1988

Projected Water Demands

Population

In 1985, the population of Dallam County was 8,628 of which 80 percent resided in the City of Dalhart. The remainder lived in rural settings such as farms, ranches, and small communities such as Texline and Kerrick.

Although part of Dalhart is located in Hartley County, the city's population is reported in Dallam County because the municipal water supply is located there. The population of Dalhart was 6,712 in 1985, which represents a decrease of approximately 2 percent from the 1980 census, and is projected to increase to 8,534 by the year 2010 thus placing an increased demand on the municipal water supply.

The rural population of Dallam County is generally sparse and is heavily dependent on agricultural economic conditions. Of the total 1,916 people residing in the rural area in 1985, 10 percent resided in the area encompassed by the Dallam County Underground Water Conservation District No. 1 (DCUWCD). By the year 2010, the county's total rural population is projected to increase to 2,036. The 1980 and 1985 population estimates for Dalhart and the rural areas in Dallam County along with projected estimates for the years 1990, 2000, and 2010 are shown in Table 3. Population projections for Dallam County were estimated by using the Texas Water Plan High Series population projection methodology (Texas Water Development Board, 1988). Population projections are shown with the DCUWCD separate from the county totals for the purpose of examining the area of the county that is not included within the district boundary.

Table 3. Current and Projected Population of Dallam County[1]

Year	1980	1985	1990	2000	2010
Dalhart[2]	6,854	6,712	6,770	7,677	8,534
Rural Area[3] Excluding DCUWCD[4]	1,763	1,723	1,494	1,662	1,814
DCUWCD	197	193	183	204	222
Total County	**8,814**	**8,628**	**8,447**	**9,543**	**10,570**

1 1980 and 1985 population is based on Bureau of Census statistics. 1990, 2000, and 2010 population is based on 1988 Texas Water Development Board Revised High Series population projection.

2 Dalhart is located in both Dallam and Hartley Counties. Values displayed represent the total city population.

3 The term "Rural" includes Texline, Kerrick, and all rural population.

4 Dallam County Underground Water Conservation District No. 1.

Water Use

In 1985, the total pumpage of ground water from the High Plains aquifer system in Dallam County was about 260 thousand acre-feet, or about 20 percent less than that pumped in 1980 (Table 4). Water use was estimated for that part of Dallam County not included in the DCUWCD as well as for the area in the district. Over 98 percent of the water was used for irrigation with the remaining 2 percent used for municipal, industrial, and livestock purposes.

Water Demands, 1990-2010

Current and projected water demands are listed by use and area on Table 4 in order to show their distribution by: 1) the total county, 2) the existing DCUWCD, and 3) the area in the county not included by the district. The table shows that, while water demand for public supply, domestic, industrial, and livestock use is projected to increase slightly by the year 2010, irrigation water demand is expected to decrease sufficiently to cause the total county water demand to decrease.

Projections for municipal requirements are based upon Texas Water Development Board Projected High Per-Capita with Conservation Series, apportioned by population where appropriate (Texas Water Development Board, 1988). Future projections of irrigation, industrial, and livestock use are based on the Board's High Series Preliminary Draft projected demands and the apportioned share of total county demands. High series projections take into account the demands that are likely to occur during drought conditions.

Table 4. Current and Projected Water Demand by Use in Dallam County[1] (Units in Acre-feet)

	Year	Dalhart[2]	Domestic[3]	Irrigation	Industrial[4]	Livestock[5]	Total
	1980	1,492	207	293,115	110	1,434	296,358
DALLAM COUNTY	1985	1,588	188	234,280	110	1,922	238,088
	1990	1,856	217	208,910	125	1,704	212,812
EXCLUDING	2000	1,996	229	186,272	156	1,976	190,629
DCUWCD[6]	2010	2,099	236	171,004	192	1,976	175,507
	1980	0	23	32,171	0	285	32,479
	1985	0	21	21,637	0	383	22,041
DCUWCD	1990	0	27	20,661	0	340	21,028
	2000	0	28	18,422	0	394	18,844
	2010	0	29	16,912	0	394	17,335
TOTAL	1980	1,492	230	325,286	110	1,719	328,837
	1985	1,588	209	255,917	110	2,305	260,129
DALLAM COUNTY	1990	1,856	244	229,571	125	2,044	233,840
	2000	1,996	257	204,694	156	2,370	209,473
	2010	2,099	265	187,916	192	2,370	192,842

1 1980 and 1985 water demand is based on reported and site-specific computed use. 1990, 2000, and 2010 water demand is based on 1988 Texas Water Development Board Revised High Series projections.

2 Dalhart is located in both Dallam and Hartley Counties. Values displayed represent the total city demand since the city's wells are located in Dallam County.

3 Domestic includes the communities of Texline, Kerrick, and all rural population use. In 1985, approximately 32 percent of water use reported as domestic was supplied by the City of Dalhart.

4 In 1985, approximately 45 percent of the industrial water use was supplied by the City of Dalhart.

5 Livestock includes a minor amount of surface water.

6 Dallam County Underground Water Conservation District No 1.

Availability of Water

Current Availability Of Ground Water

The recoverable volume of fresh to slightly saline ground water currently in storage within Dallam County is estimated at 28.5 million acre-feet which is 2.5 million less than the 1980 estimate. The estimated annual effective recharge to the aquifer remains constant at approximately 16 thousand acre-feet (Knowles and others, 1982). The current total ground-water pumpage of 233 thousand acre-feet continues to greatly exceed the sustainable annual yield (effective recharge), resulting in the net water-level declines shown in Figures 8 and 10. Available ground water in the DCUWCD is approximately one quarter of the county total.

Potential For Conjunctive Use Of Ground And Surface Water

The only surface water reportedly used in the study area is for the watering of livestock. In 1985, 461 acre-feet of the total 2,305 acre-feet of water used for livestock was derived from local surface sources which include creeks, stock tanks, playa lakes, pits, and other minor surface depressions capable of holding water.

No major surface water reservoir exists in Dallam County. However, Lake Rita Blanca is located 2 miles south of the City of Dalhart in Hartley County. Water samples from the lake have solute concentrations that measure less than 200 mg/l (Kunze and Lee, 1968), indicating that the water is of acceptable quality for municipal-supply use if water demand becomes critical. The lake is jointly managed by Dallam and Hartley Counties and contains about 12 thousand acre-feet of water allocated for recreational use (Texas Water Development Board, 1974).

Potential For Additional Ground-Water Development

The rate of ground-water use in Dallam County is presently depleting the aquifer, and additional well drilling in the region will only accelerate water-level declines. Still, some parts of the aquifer system appear to have potential for additional development.

Water in sand facies in the Dockum Formation in northeastern Dallam County have not been fully developed. Limited water-quality data shows that fresh to slightly saline water does exist in the Triassic section in this area, suggesting that additional study of the region is warranted.

The Lytle Sandstone also appears to have development potential under north-central and west-central Dallam County. Lying 350 to 400 feet below ground surface, the formation is known to produce up to 800 gpm locally, and yet only a few wells have been completed in it to date.

Potential Methods Of Increasing Aquifer Recharge

Recharge is the process by which water is absorbed and added to the zone of saturation, and can occur both naturally and artificially. As described earlier, natural recharge to the aquifer primarily occurs as precipitation percolates downward to the aquifer from the surface. Any activity by man, either intentional or unintentional, that increases or supplements the rate of replenishment to the aquifer, is referred to as artificial recharge.

Increased recharge to the aquifer system will benefit Dallam County by increasing the amount of water stored in the aquifer, especially where significant water-level declines have been experienced. Numerous methods of enhancing recharge have been studied and applied around the world (O'Hare and others, 1986). Potential methods for increasing aquifer recharge include such practices as the trenching of playa lakes, judicial placement of ditches and runoff control structures, and the use of recharge wells.

Water that collects in playa lakes and other shallow surface depressions tends to evaporate faster than water can percolate downward through the fine-grained sediments that line the bottom of these features. The vertical permeability, or infiltration capacity, of these shallow depressions can be improved by trenching, but generally must be repeated each time the basin dries due to the deposition of fine-grained sediments that are washed in with each rain. In addition to enhancing vertical permeability, trenching deepens these depressions thereby reducing the surface area of water exposed to evaporation.

Judicial placement of runoff control structures such as earthen dams and levees tends to maximize the recharge potential of the temporarily available surface water. These structures should be located so that water trapped between or behind them will cover the most permeable soils, thereby allowing for the highest infiltration rates. Structures can also be located upstream of recharge areas such that storm runoff can be released at a controlled rate comparable to the maximum potential recharge rate of the downstream areas. This minimizes storage detention time, thus reducing evaporation losses, and allows maximum storage availability for the next storm.

Surface water can be directly pumped into the aquifer via recharge wells. In areas where the impervious nature of the soils tend to retard or trap water at the surface, injecting water directly into the aquifer through injection wells enhances recharge while limiting the amount of water lost to evapotranspiration.

Projected Availability Through The Year 2010

Projections for future availability of ground water in the High Plains aquifer in Dallam County are dependent on the total usable amount of water stored in, removed from, and recharged to the aquifer. Aquifer recharge remains fairly constant while ground water pumped from storage changes annually. Based on the storage depletion rate shown below, average annual pumpage of ground water from the aquifer is projected to decrease from 328 thousand acre-feet in 1980 to 192 thousand acre-feet in 2010. The amount of water available from storage in the High Plains aquifer in Dallam County in 1980 was calculated by Knowles and others (1982) to be approximately 31 million acre-feet. Over the following 30 years ending in 2010, the available water in storage is projected to decrease to 24.6 million acre-feet. The amount of water available from the aquifer will continue to diminish in the future as long as recharge is exceeded by the withdrawal of water from the aquifer. Implementation of ground water conservation practices would serve the best interests for the future of all water users in Dallam County.

Year	Average Ground-Water Demand[1]	Annual Recharge	Storage Depletion[2]	Ground-Water Availability
1980	328,540	16,000	312,540	31,040,000
1985	259,668	16,000	243,668	29,649,480
1990	233,432	16,000	217,432	28,496,730
2000	208,999	16,000	192,999	26,444,575
2010	192,368	16,000	176,368	24,597,740

Water quantity in acre-feet.

[1] Derived from Table 4, by subtracting out the relativly small amount of surface water used for livestock.

[2] Demand minus recharge.

SUMMARY

The High Plains aquifer system is the sole source of water for public supply and irrigation use in Dallam County, with irrigation pumpage accounting for over 98 percent of all ground-water use. Current and projected demands are in excess of the natural recharge to the aquifer. In 1980, an estimated 31 million acre-feet of water was stored in the aquifer system. By 2010, it is estimated that 21 percent of this volume will be removed from storage, leaving a projected 24.6 million acre-feet. The 28.5 million acre-feet of water currently held in storage is about 40 percent of the amount that existed in the aquifer prior to irrigation development that started in the 1930's.

Although water supplies should be adequate through the year 2010, heavy pumpage will continue to result in declining water levels. In areas of heaviest pumpage, especially during drought periods, well yields can be expected to diminish as water must be produced from greater depths.

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