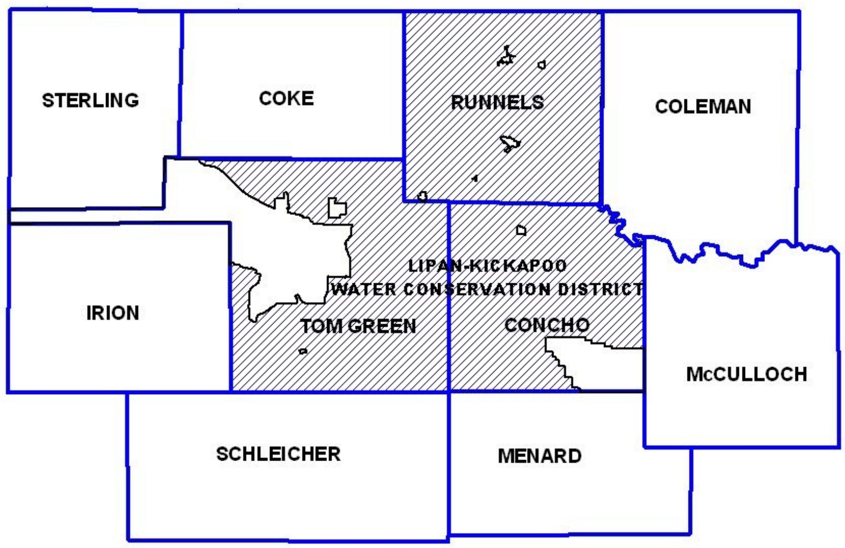
LIPAN-KICKAPOO WATER CONSERVATION DISTRICT



MANAGEMENT PLAN

2008-2018

Adopted: August 6, 2008

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TABLE OF CONTENTS

List of Figures

List of Tables

DISTRICT MISSION

The Lipan-Kickapoo Water Conservation District strives to develop, promote and implement water conservation and management strategies to conserve, preserve, and protect the groundwater supplies of the District, to protect and enhance recharge, prevent waste and pollution, and to effect the efficient, beneficial and wise use of water for the benefit of the citizens and economy of the District. The District seeks to protect the owners of water rights within the District from impairment of their groundwater quality and quantity within the District, pursuant to the powers and duties granted under Chapter 36, Subchapter D of the Texas Water Code.

TIME PERIOD FOR THIS PLAN

This plan becomes effective upon adoption by the Board of Directors and approval by the Texas Water Development Board executive administrator. This plan remains in effect for a ten-year period, or until such time as a revised or amended plan is approved.

STATEMENT OF GUIDING PRINCIPLES

The District recognizes that its groundwater resources are of utmost importance to the economy and environment, first to the residents of the District and then to the region. Also recognized is the importance of understanding the aquifers and aquifer characteristics for proper management of these resources. In addition, the integrity and ownership of groundwater play an important role in the management of this precious resource. One of the primary goals of the District is to preserve the integrity of the groundwater in the district from all potential contamination sources. This is accomplished as the District sets objectives to provide for the conservation, preservation, protection, recharge, prevention of waste and pollution, and efficient use of water including:

- Acquiring, understanding and beneficially employing scientific data on the District's aquifers and their hydrogeologic qualities and identifying the extent and location of water supplies within the District, for the purpose of developing sound management procedures;
- Protecting the private property rights of landowners in groundwater by ensuring that such landowners continue to have the opportunity to use the groundwater underlying their land;
- Promulgating rules for permitting and regulation of spacing of wells and transportation of groundwater resources in the District to protect the quantity and quality of the resource;
- Educating the public and managing for the conservation and beneficial use of the water;
- Educating the public and managing to prevent pollution of groundwater resources;
- Cooperating and coordinating with other groundwater conservation districts with which the District shares aquifer resources.

These objectives are best achieved through guidance from the locally elected board members who understand the local conditions and can manage the resource for the benefit of the citizens of the district and region.

Since a basic understanding of the aquifers and their hydrogeologic properties, as well as a quantification of resources is the foundation from which to build prudent planning measures, this management plan is intended as a tool to focus the thoughts and actions of those given the responsibility for the execution of district activities.

GENERAL DESCRIPTION OF THE DISTRICT

History

The primary concern of the residents of this area of the State regarding groundwater is the potential contamination of the groundwater from leaking oil and gas wells. For this reason, the residents introduced legislation in the 70th Regular Legislative Session (1987) for creation of the District. In November 1987, the residents confirmed the district and also voted to fund the district operations through local property taxes. It became an active district on November 1, 1988. On January 2, 1989, the district adopted a 10-year Management Plan and in February 1989 adopted Rules and By-Laws which became effective March 6, 1989. This 10-year Management Plan was replaced in 1998 by a new 10-year Management Plan that complied with the new mandates of Chapter 36 of the Texas Water Code. One of the new mandates is that management plans are required to be reviewed at least every 5 years. This new plan was reviewed and amended on July 9, 2003 to comply with this statute. Since 1989, the District rules were amended four times: March 6, 2000, August 4, 2004, November 1, 2006, and September 5, 2007.

The District is governed by a seven member locally elected Board of Directors - two members from Concho County, two members from Runnels County, two members from Tom Green County, and one member-at-large from the District as a whole. Elections are held every two years. The directors serve staggered four year terms - the directors from Concho and Runnels Counties are elected in one election and the directors from Tom Green County and the director at-large are elected in another. By having a local board of directors, the District is very responsive to voters' approval or disapproval of the local management of their groundwater and/or the services provided by the District.

Location and Extent

The Lipan-Kickapoo WCD has an areal extent of approximately 2,262,464 acres or 3,535 square miles and is located in the center of the State of Texas. The USGS geographic center of Texas monument is located within the District and is approximately 13 miles southeast of Vancourt, Texas where the District office is located.

The District's economy is based primarily on agriculture with some oil and gas production. The agricultural income is derived primarily from cotton, grain sorghum, wheat, corn, alfalfa as well as sheep, goats, and beef cattle production. Income is also obtained from cattle and sheep feedlots and dairies. Recreational hunting leases also contribute to the income of the area.

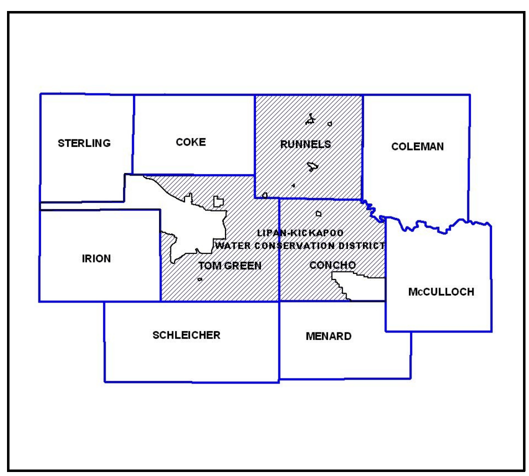

Figure 1. Location of the Lipan-Kickapoo Water Conservation District showing excluded areas.

The boundaries of the water district generally include: All of Tom Green, Runnels, and Concho counties not currently within the boundaries of the Hickory Underground Water Conservation District. The cities/towns of Winters, Ballinger, Rowena, Miles, Paint Rock, San Angelo, Christoval, Grape Creek, the Red Creek Municipal Utility District, and the area northwest of San Angelo north of the Middle Concho River and south and west of US Highway 87 north to the Coke County line are excluded from the district (Fig. 1). Most of these towns and cities within these counties were excluded because they get their water supply from surface water that belongs to and is regulated by the state. Therefore, there are no major municipalities within the District boundaries.

Tom Green County

The total population of the county is approximately 103,938.[1] The largest city in Tom Green county is San Angelo (also the county seat) with a population of approximately 88,300 people. It is not a part of the District and is located northwest of the District. Other communities in Tom Green County not in the District are: Christoval, Grape Creek, Water Valley, and the Red Creek MUD with a combined population of approximately 10,460. There are 7 small communities within the District in Tom Green county: Vancourt, Wall, Veribest, Mereta, Carlsbad, Knickerbocker, and Harriet. The total estimated population within the District in Tom Green County is 5,178.

The largest single land use in the county is agriculture with a total of 844,695 acres of which 212,464 acres is crop or farm land and the balance of 632,231 acres is range land.[2] The crop land is located primarily in the center of the county over the Lipan aquifer while the range land is located on the north, west, and south portions of the county over the Edwards-Trinity aquifer. Irrigation covers approximately 48,308 acres of the county's crop land.[3] Pivot irrigation systems have been the primary method of applying irrigation water, but in the last few years a considerable number of drip irrigation systems have been installed replacing other methods of irrigation.

Concho County

The total population of the county is approximately 3,654.[4] The largest city in Concho county is Eden with a population of approximately 2,407. It is located within the Hickory UWCD boundaries. Paint Rock, the county seat, has a population of approximately 284 and is not a part of the District. There are several other small communities within the District in Concho county: Eola, Vick, Lowake, Live Oak, and Millersview. The total estimated population within the District in Concho county is 938.

The largest single land use in the county is agriculture with a total of 544,312 acres of which 142,138 acres is crop or farm land and the balance of 402,174 acres is range land.[5] The crop land is located primarily in the west central portion of the county over the Lipan aquifer while the range land is located on the north, east, and south portions of the county over the Edwards-Trinity and Hickory aquifers. Irrigation covers approximately 4,933 acres of the county's crop land. The principle method of irrigation is through pivot irrigation systems with some drip irrigation.

Runnels County

The total population of the county is approximately 10,724.[6] The largest city in Runnels county is Ballinger (also the county seat) with a population of approximately 3,918 people. This town is not a part of the District. Other communities with larger populations not in the District are: Winters with approximately 2,662 people, Miles with approximately 796 people, and Rowena with approximately 387. Other small communities in the District include: Olfen, Norton, Hatchel, Crews, and Wingate. The total estimated population within the District in Runnels county is 2,961.

The largest single land use in the county is agriculture with a total of 584,878 acres of which 299,223 acres is crop or farm land and the balance of 285,655 acres is range land.[7] The crop land is located primarily in the west central and southwestern portion of the county over the Lipan aquifer while the range land is located on the north and east portions of the county. Irrigation covers approximately 3,351 acres of the county's crop land. The principle methods of irrigation are furrow irrigation, pivot irrigation, and drip irrigation.

The total estimated population of these three counties is 118,316.[8] However, since the District covers the area generally outside the cities and towns, the total estimated population in the District is 9,077.

Overall land use in the District is for agricultural purposes of which approximately 653,825 acres are crop or farm land and 1,320,060 acres are range land. The crop land is located primarily in the central portion of the District over the Lipan aquifer while the range land is located along the boundaries of the District over the Edwards-Trinity and Hickory aquifers. Irrigation covers approximately 56,592 acres of the District's crop land.[9] The principle method of irrigation has been furrow irrigation. However, within the last 10 years there has been a large scale change to more highly efficient pivot and drip irrigation. Drip irrigation is now being installed to replace both furrow irrigation and pivot irrigation.

Topography and Drainage

The District lies within the Colorado River Basin with much of the area known as the Concho Valley of Texas. Two major rivers, the Colorado-with its headwaters beginning on the South Plains and the Concho-with its headwaters located in the counties to the north, west, and south of Tom Green county, traverse the District and converge at the O.H. Ivie Reservoir on the Concho-Runnels-Coleman County lines. There are numerous creeks which are tributaries of these two rivers. Drainage is generally in an eastward direction. Springs flowing from the Edwards-Trinity aquifer form the headwaters of the South Concho river, Lipan Creek, and the Kickapoo Creek. Topographically, the District consists of the Lipan Flats in the center of the District southeast of the city of San Angelo to rolling plains in the remainder of the District in Concho, Runnels, and Tom Green Counties.

REGIONAL COOPERATION AND COORDINATION

West Texas Regional Groundwater Alliance

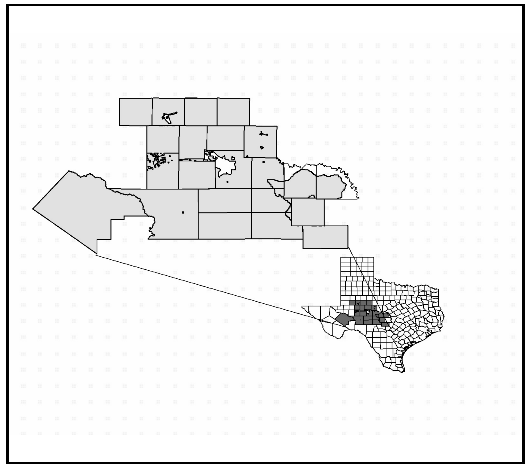

Figure 2. Territory in the West Texas Regional Alliance.

The District is a member of the West Texas Regional Groundwater Alliance (WTRGA). This regional alliance consists of seventeen (17) locally created and locally funded districts that encompass approximately eighteen (18.2) million acres or twenty eight thousand three hundred sixty eight (28,368) square miles of West Texas (Fig 2). To put this in perspective, this area is larger than many individual states including Rhode Island (1,045 sq mi), Delaware (1,954 sq mi), Puerto Rico (3,425 sq mi), Connecticut (4,845 sq mi), Hawaii (6,423 sq mi), New Jersey (7,417 sq mi), Massachusetts (7,840 sq mi), New Hampshire (8,968 sq mi), Vermont (9,250 sq mi), Maryland (9,774 sq mi), and West Virginia (24, 230 sq mi). This West Texas region is as diverse as the State of Texas. Due to the diversity of this region, each member district provides it's own unique programs to best serve its constituents.

In May of 1988, four (4) groundwater districts; Coke County UWCD, Glasscock County UWCD, Irion County WCD, and Sterling County UWCD adopted the original Cooperative Agreement. As new districts were created, they too adopted the Cooperative Agreement. In the fall of 1996, the original Cooperative Agreement was redrafted and the West Texas Regional Groundwater Alliance was created. The current member districts and the year they joined the Alliance are:

Coke County UWCD	(1988)	Crockett County GCD	(1992)	Glasscock GCD	(1988)
Hickory UWCD # 1	(1997)	Hill Country UWCD	(2005)	Irion County WCD	(1988)
Kimble GCD	(2004)	Lipan-Kickapoo WCD	(1989)	Lone Wolf GCD	(2002)
Menard County UWD	(2000)	Middle Pecos GCD	(2005)	Permian Basin UWCD	(2006)
Plateau UWC & SD	(1991)	Santa Rita UWCD	(1990)	Sterling County UWCD	(1988)
Sutton County UWCD	(1991)	Wes-Tex GCD	(2005)		

This Alliance was created because the local districts have a common objective to facilitate the conservation, preservation, and beneficial use of water and related resources. Local districts monitor the water-related activities of the State's largest industries such as farming & ranching, oil & gas and municipalities. The Alliance provides coordination essential to the activities of these member districts to monitor these activities and to accomplish their objectives.

GROUNDWATER RESOURCES *

Lipan Aquifer

The Lipan aquifer is located in the Lipan Flats of eastern Tom Green, western Concho, and southern Runnels counties (Fig. 3). Water from the aquifer is principally used for irrigation, with limited amounts used for rural domestic and livestock needs. The typical irrigation practice in the area is to pump water held in storage in the aquifer during the growing season with the expectation of recharge of the aquifer during the winter months. Water levels in the past have generally remained unchanged, but due to the drought of the 1990's and early 2000's, they dropped drastically. In some areas, the aquifer was totally dry since there was minimal or no recharge at all. With the large rainfall events in late 2004, the aquifer recovered to within 90% of its highest levels recorded in 1990 and 1991. Since rainfall has been average or above the last 3-4 years, the aquifer has remained within 75% to 80% of the highest levels even though irrigation has taken place during the dry times of the years. Thus, groundwater availability for this aquifer is a function of average annual recharge, even though storage may not recover completely during dry years.

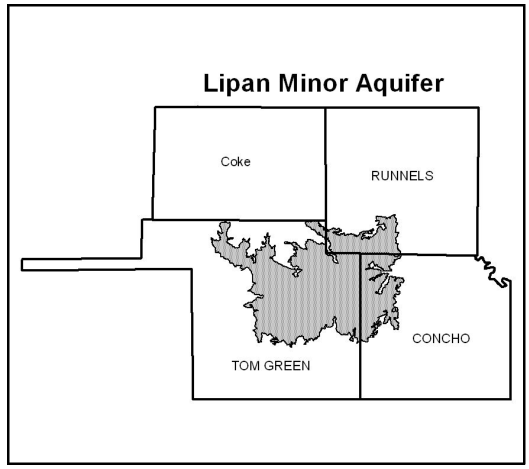

Figure 3. Location of Lipan Aquifer (Ashworth and Hopkins, 1995).

The aquifer is comprised of up to 125 feet of saturated alluvial deposits of the Leona formation of Quaternary age. Although the aquifer is located in three counties, water is found only sporadically throughout the aquifer. Also included in the Lipan aquifer are the updip portions of the underlying Choza Formation and Bullwagon Dolomite of Permian age that are hydrologically continuous with the Leona Formation. Ground water naturally discharges from the Lipan aquifer both by seepage to the Concho River and by evapotranspiration. This evapotranspiration occurs in areas where the water table is at or near the land surface. It is common for well yields to range from 50 gal/min to more then 500 gal/min.

The average annual effective recharge of the Leona formation, a formation included in the Lipan aquifer, is 35,436 acre-feet.[10] The water quality in the Leona Formation ranges from fresh to slightly saline and is very hard. Water in the underlying updip portions of the Choza and Bullwagon Formations tends to be slightly saline. The overall quality of the water within the Lipan aquifer generally does not meet drinking water standards. However, in most areas it is suitable for irrigation.[11]

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* All estimates of groundwater availability, usage, supplies, recharge, storage, and future demands are from data supplied by the Texas Water Development Board, unless otherwise noted. Data sources include Region F-2007 State Water Plan. These estimates will be used until other data are available from ongoing studies of the region's aquifers.

Edwards-Trinity (Plateau) Aquifer

The Edwards-Trinity (Plateau) aquifer (Fig. 4) is a minor source of groundwater in the southern part of Concho county and the northern and southern parts of Tom Green county and is used primarily for livestock and domestic needs, with limited amounts used for irrigation. It is also a large source of recharge for the Lipan aquifer. The Edwards-Trinity aquifer consists of saturated sediments of lower Cretaceous age Trinity Group formations and overlying limestones and dolomite of the Comanche Peak, Edwards, and Georgetown formations. The Glen Rose Limestone is the primary unit of the Trinity in the in the southern part of the plateau and is replaced by the Antlers Sand north of the Glen Rose pinch out.

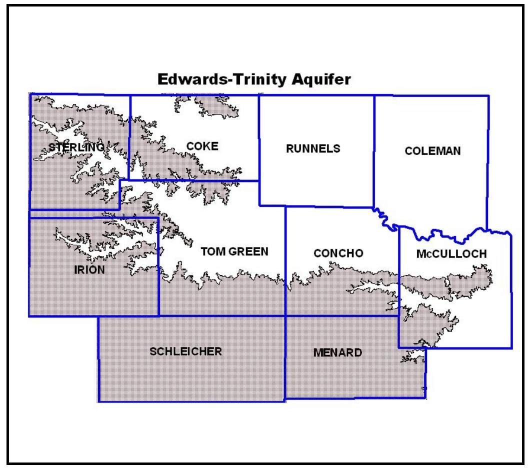

Figure 4. Location of Edwards-Trinity Aquifer.
(Ashworth & Christian, 1989)

The average annual effective recharge of the Edwards-Trinity formation located in Concho and Tom Green counties is estimated to be 26,242 acre-feet.[12] Chemical quality of Edwards-Trinity (Plateau) water ranges from fresh to slightly saline. The water is typically hard and may vary widely in concentrations of dissolved solids made up mostly of calcium and bicarbonate. The salinity of the groundwater tends to increase toward the west. Certain areas have unacceptable levels of fluoride. [13]

Hickory Aquifer

Underlying the Edwards-Trinity (Plateau) aquifer in the southeastern part of Concho county is a down-dip portion of the Hickory aquifer (Fig. 5). The Hickory formation is comprised of Cambrian-age sands and gravels eroded from the granites of the Llano uplift in central Texas. There is no outcrop area of the Hickory formation in Concho County, but the formation down-dips fairly uniformly to the west, underlying the Edwards-Trinity formation in the southeastern part of the county. [14]

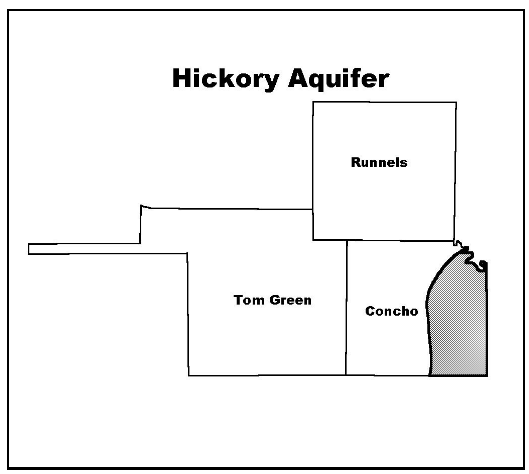

Figure 5. Location of Hickory Aquifer.
(Bluntzer, 1992).

The Hickory aquifer has an average saturated thickness of 400-500 feet in the southeast corner of Concho county. There is no recharge to the aquifer within the District and only a limited amount of recoverable storage in the District. [15] Water in the Hickory in Concho county and within the boundaries of the Lipan-Kickapoo WCD is known to be very saline. The water quality varies and the extent of radioactivity within the Hickory aquifer within the District, which is known to exist in other parts of the aquifer, is not yet known. However, all of the formation within the District is downdip from the outcrop area, so it is possible that the Hickory water supply within the District will contain these radioactive decay products in some areas.

Data Sources

Currently, the District is using data from the Texas Water Development Board as a reference source for calculating and estimating groundwater resources. However, for planning purposes, the District, wherever possible, is using local data of existing conditions to provide better accuracy in determining groundwater resources. The primary reference sources are the TWDB's Lipan Groundwater Availability Model and the Edwards Trinity Groundwater Availability Model along with the Region F, Regional Water Plan adopted in January 2006 and the 2007 State Water Plan.

Annual Amount of Additional Natural or Artificial Recharge

West Texas landowners, range scientists and water supply professionals have long suspected that noxious brush, primarily mesquite and juniper, have had and will continue to have a tremendous influence on water resources of the region. From historical data collected by the U.S. Army Corp of Engineers from 1925 to the 1960's, the area experienced a dramatic shift in hydrologic characteristics beginning about 1960. These changes occurred due to several factors:
1) In the 1950's brush infestations were complete. Comparing aerial or ground based photos to current photos shows only slight differences. The most dramatic change in vegetative types occurs when comparing the same 1960 photos to 1920 photos. The "native" condition of much of the region could be characterized as a grassland prairie.
2) An historic drought occurred during the 1950's seriously depleting surface and groundwater resources. Many historic springs stopped flowing during this period and have never recovered.
3) It is theorized that the hydrologic systems in many of the watersheds that include gaining streams and the critical relationship between the groundwater and surface water flows contained large storage volumes that were slowly being depleted with the encroachment of the brush. Following the drought of the 1950's, the systems no longer had the capacity to recover because of the increased utilization of water by the brush.[16]

The evidence is overwhelming. More than 25 percent of once perennial streams in the Concho and Colorado basins stopped flowing after the drought of the 1950's when noxious brush such as mesquite, juniper, and salt cedar began to culminate its' dominance over what was once grassland prairie. As a result, every 10 acres of moderate to heavy brush infestations now steals one acre foot of water annually (325,851 gallons).[17]

District personnel have observed that during the period in the Fall when brush and trees become dormant to late Spring when brush and trees come out of dormancy that the water levels in monitor wells increase regardless of whether or not there has been rainfall. After the brush and trees come out of dormancy, the water levels continue to drop throughout the summer until Fall.

A study completed in 1998 concluded that brush control projects on total watersheds could restore watershed yields to near historic levels.[18] Computer modeling by Blackland Research and Texas A&M and calculated by the Upper Colorado River Authority shows that the entire Colorado and Concho River basins could gain an additional 249,584 acre feet of water annually in groundwater recharge and surface flow into existing reservoirs.[19]

There is no surplus surface water in the district available for artificial recharge of the aquifers. However, research performed at Texas A & M indicates that brush control would save rain water for desirable plants and increase the amount of percolation of excess water through the soil by 1 to 2 %. In an average rainfall year, approximately 19,350 acre-feet of water saved through brush control could eventually percolate through the soil as part of the natural recharge of the aquifers. This additional water would be available for use by the residents of the District.

Under the Texas Brush Control Plan developed pursuant to Chapter 203 of the Texas Agricultural Code, there are currently three Brush Control Projects underway in the District, including the North Concho River Pilot Brush Control Project, the Twin Buttes Reservoir/Lake Nasworthy Brush Control Project, and the Lake Ballinger Brush Control Project. Some success has been observed from some of these projects as some springs are beginning to flow again.

In addition to brush control on the watersheds, desalination of slightly saline water could help increase the amount of water available for use in the District.

SURFACE WATER RESOURCES

The Lipan-Kickapoo WCD has no jurisdiction over surface water nor does the district have any obligation or the jurisdiction to supply groundwater to surface water permit holders. In addition, only one surface water management entity is located within the boundaries of the District. However, there are several lakes adjacent to the District and only Lake Ballinger/Lake Moonen is located within the District. Lakes adjacent to the District are: in Runnels county-Lake Winters / New Lake Winters, and O.H. Ivie Reservoir; in Concho county-O.H. Ivie Reservoir; and in Tom Green county-O.C. Fisher Lake, Twin Buttes Reservoir, and Lake Nasworthy.

Table 1: Water Rights and Diversions of Major Reservoirs[20]

Reservoir	County	Water Right Numbers	Permitted Storage (acre-feet)	Permitted Diversion (acre feet/yr)
Lake Winters/New Lake Winters	Runnels	CA-1095	8,347	1,755
Lake Ballinger/Lake Moonen	Runnels	CA-1072	6,850	1,000
O.H. Ivie Reservoir	Concho	A- 3866/P-3676	554,340	113,000
O.C. Fisher Lake	Tom Green	CA-1190	119,000	80,400
Twin Buttes Reservoir	Tom Green	CA-1318	186,000	29,000
Lake Nasworthy	Tom Green	CA-1319	12,500	25,000
Total			887,037	250,155

Even though there is considerable permitted storage and permitted diversions of surface water, the drought of the 1990's has reduced the amount of water stored in most of these lakes to a small fraction of what they are permitted to store, e.g. O.H. Ivie is at 61.4% (08-04-08) of storage capacity, O.C. Fisher is at 6% (08-04-08) of storage capacity, while Twin Buttes Reservoir is at 31 % (08-04-08) of capacity. It will take several years of above average rainfall with considerable runoff to fill these reservoirs to capacity.

Projected Surface Water Supplies

Table 2: Surface Water Rights by County and Category [21]

Region F - 2007 State Water Plan						
Permitted Surface Water Diversions (acre-feet per year)						
County	**Municipal**	**Industrial**	**Irrigation**	**Mining**	**Other**	**Total**
Concho	35	0	2,511	0	16	2,562
Runnels	2,919	0	6,924	70	0	9,913
Tom Green	107,934	8,002	41,019	0	0	156,955
Total	*110,888*	*8,002*	*50,454*	*70*	*16*	*169,430*

As shown in table 2, there are 2,562 acre-feet of water rights permitted by the TCEQ in Concho county, 9,913 acre-feet in Runnels county, and 156,955 acre-feet in Tom Green county for a total of 169,430 acre-feet permitted in the three counties. Of this total, 110,888 acre-feet are permitted for municipal use, 8,002 acre-feet are permitted for industrial use, 50,454 acre-feet are permitted for irrigation, 70 acre-feet are permitted for mining, and 16 acre-feet are permitted for other. Since there are no municipalities or manufacturing facilities located within the district, only the irrigation-50,454 acre-feet, mining-70 acre-feet, and other-16 acre-feet or a total of 50,540 acre-feet of surface water would be available for use in the District. Of this total, the Tom Green County Water Control and Improvement District #1, a federally owned surface water irrigation district, located within the boundaries of the LKWCD, has a permitted diversion of 25,000 acre feet per year from the Twin Buttes Reservoir located outside the LKWCD district. The majority of the remaining permitted diversions are for pumping out of the Concho and Colorado rivers. Recently, the irrigation district entered into an agreement with the city of San Angelo for all of the available waste water from the city. In return for the waste water, the irrigation district will be entitled to a maximum of 12,000 acre feet per year diversion from the Twin Buttes Reservoir instead of the permitted diversion amount of 25,000 acre feet per year.

Table 3. Projected Surface Water Supplies by County, Source, and Year [22]

2007 State Water Plan - Projected Surface Water Supplies — **Runnels County**											
RWPG	**Water User**	**County**	**River Basin**	**Source Name**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
F	County-Other	Runnels	Colorado	Ballinger/Moonen Lake/Reservoir	88	0	0 0		0 0		0
F	County-Other	Runnels	Colorado	Winters Lake/Reservoir	231	0	0	0	0	0	0
F	Irrigation	Runnels	Colorado	Colorado River Combined Run-of-River Irrigation	5500	771	771	771	771	771	771
F	Livestock	Runnels	Colorado	Livestock Local Supply	1779	1148	1148	1148	1148	1148	1148
F	Millersview-Doole WSC	Runnels	Colorado	Colorado River MWD System	0	69	62	93	85	0	0
Total Projected Surface Water Supplies (acre-feet per year) =					**7598**	**1988**	**1981**	**2012**	**2004**	**1919**	**1919**

Concho County

RWPG	Water User	County	River Basin	Source Name	2000	2010	2020	2030	2040	2050	2060
F	County-Other	Concho	Colorado	Concho River Run-of-River City of Paint Rock	67	35	35	35	35	35	35
F	Irrigation	Concho	Colorado	Concho River Combined Run-of-River Irrigation	660	228	228	228	228	228	228
F	Livestock	Concho	Colorado	Livestock Local Supply	171	123	123	123	123	123	123
F	Millersview-Doole WSC	Concho	Colorado	Colorado River MWD System	0	92	85	123	112	0	0
Total Projected Surface Water Supplies (acre-feet per year) =					**898**	**478**	**471**	**509**	**498**	**386**	**386**

Tom Green County

RWPG	Water User	County	River Basin	Source Name	2000	2010	2020	2030	2040	2050	2060
F	County-Other	Tom Green	Colorado	Twin Buttes Lake/Reservoir San Angelo System	15	0	0 0		0 0		0
F	County-Other	Tom Green	Colorado	OC Fisher Lake/Reservoir San Angelo System	35	0	0 0		0 0		0
F	County-Other	Tom Green	Colorado	Nasworthy Lake/Reservoir San Angelo System	64	0	0 0		0 0		0
F	Irrigation	Tom Green	Colorado	Direct Reuse	11530	8500	8500	8500	8500	8500	8500
F	Irrigation	Tom Green	Colorado	Concho River Combined Run-of-River Irrigation	15839	2812	2812	2812	2812	2812	2812
F	Irrigation	Tom Green	Colorado	Twin Buttes Lake/Reservoir San Angelo System	7672	0	0 0		0 0		0
F	Irrigation	Tom Green	Colorado	Nasworthy Lake/Reservoir San Angelo System	316	0	0 0		0 0		0
F	Livestock	Tom Green	Colorado	Livestock Local Supply	1990	1644	1644	1644	1644	1644	1644
F	Millersview-Doole WSC	Tom Green	Colorado	Colorado River MWD System	0	174	176	290	300	0	0
Total Projected Surface Water Supplies (acre-feet per year) =					**37461**	**13130**	**13132**	**13246**	**13256**	**12956**	**12956**

Source: Volume 3, 2007 State Water Planning Database (http://www.twdb.state.tx.us/DATA/db07/defaultReadOnly.asp) TWDB: 5/1/2008

PROJECTED GROUNDWATER SUPPLIES

In order to maintain dependable groundwater supplies, the District follows the principle that the recharge rate of the aquifers is the projected water supply. Historically the aquifers are pumped each year until water is no longer available. Since the aquifers recharge rapidly after significant rainfall on the recharge area, the estimated recharge rate will be used in this plan as the projected water supply. Since there is no recharge to the Hickory aquifer in Concho county and the water in this downdip part of the aquifer within the District is very saline, no recoverable storage of Hickory groundwater is projected.

Tables 4 and 5 contain water-budget data for each layer that constitutes the GAM for the both the Lipan and the Edwards-Trinity (Plateau) aquifers in the District. Table 6 contains the combined water-budget data for both the Lipan and the Edwards-Trinity (Plateau) aquifers in the District.

Table 4: Annual groundwater flow budget for the Lipan-Kickapoo Water Conservation District (WCD), averaged for the years 1980 through 1998 from the groundwater availability model of the Lipan Aquifer. Flows are reported in acre-feet per year. [23]

	Lipan-Kickapoo WCD		
Flow Term	**In**	**Out**	**In-Out**
Change in Storage	17,349	-3,657	13,692
Reservoirs	1,481	-669	812
Springs and Seeps[1]	0	0	0
General head boundary (inflow from Edwards-Trinity (Plateau) Aquifer along western boundary.	5,706	-847	4,859
Wells	0	-29,384	-29,384
Rivers and streams	6,050	-15,197	-9,147
Direct precipitation recharge	50,801	0	50,801
Evapotranspiration	0	-27,857	-27,857
Lateral inflow	9,411	-13,190	-3,779

1. The drain cells representing the North Concho River are not within the Lipan-Kickapoo WCD so the drain discharge is zero for the Lipan Aquifer model in the district. However, spring discharge values from the Edwards-Trinity Aquifer in the district in Tom Green County can be found in Table 5.

Note: a negative sign refers to flow out of the aquifer in the District. A positive sign refers to flow into the aquifer in the District. All numbers are rounded to the nearest 1 acre-foot.

Table 5: Groundwater flow budget for the Lipan-Kickapoo Water Conservation District (WCD), averaged for the years 1980 through 1998 from the groundwater availability model of the Edwards-Trinity (Plateau) Aquifer. Flows are reported in acre-feet per year. [24]

	Lipan-Kickapoo WCD		
Flow Term	**In**	**Out**	**In-Out**
Edwards (Layer 1)			
Change in Storage	1,333	-436	897
Reservoirs	0	0	0
Springs and Seeps	0	-12,851	-12,851
General head boundary	0	0	0
Wells	0	-169	-169
Rivers and streams	0	-1,368	-1,368
Direct precipitation recharge	11,282	0	11,282
Evapotranspiration	0	0	0
Lateral inflow	7,241	-2,821	4,420
Upper vertical flow	0	0	0
Lower vertical flow	15	-2,217	-2,202

Trinity (Layer 2)			
Change in Storage	356	-186	170
Reservoirs	0	0	0
Springs and Seeps	0	-6,325	-6,325
General head boundary	0	-54	-54
Wells	0	-202	-202
Rivers and streams	66	-3,039	-2,973
Direct precipitation recharge	4,743	0	4,743
Evapotranspiration	0	0	0
Lateral inflow	4,080	-1,652	2,428
Upper vertical flow	2,226	15	2,241
Lower vertical flow	0	0	0

1. Note: a negative sign refers to flow out of the aquifer in the District. A positive sign refers to flow into the aquifer in the District. All numbers are rounded to the nearest 1 acre-foot.

Table 6: Combined Groundwater flow budget for the Lipan-Kickapoo Water Conservation District (WCD), averaged for the years 1980 through 1998 from the groundwater availability models of the Lipan Aquifer and the Edwards-Trinity (Plateau) Aquifer. Flows are reported in acre-feet per year. [25]

	Lipan-Kickapoo WCD		
Flow Term	**In**	**Out**	**In-Out**
Combined Lipan, Edwards (Layer 1), and Trinity (Layer 2) Aquifers			
Change in Storage	19,038	-4,279	14,759
Reservoirs	1,481	-669	812
Springs and Seeps	0	-19,176	-19,176
General head boundary	5,706	-901	4,805
Wells	0	-29,755	-29,755
Rivers and streams	6,116	-19,604	-13,488
Direct precipitation recharge	66,826	0	66,826
Evapotranspiration	0	-27,857	-27,857
Lateral inflow	20,732	-17,663	3,069
Upper vertical flow	2,226	15	2,241
Lower vertical flow	15	-2,217	-2,202

1. Note: a negative sign refers to flow out of the aquifer in the District. A positive sign refers to flow into the aquifer in the District. All numbers are rounded to the nearest 1 acre-foot.

As previously stated, the aquifers are pumped each year until water is no longer available. When the aquifers are filled to capacity, the wells will supply 55,570 to 74,094 acre-feet of recoverable water. This is based on data from District pump and pivot evaluations and sales of electricity for irrigation by local electric service providers along with TWDB irrigation surveys that indicate irrigators apply from 1.5 to 2 acre-feet per acre annually. Multiplying the total estimated 37,047 acres within the District irrigated with groundwater by 1.5 acre-feet indicates that approximately 55,570 acre-feet of water is available for pumping within the District following above average recharge years. Multiplying the irrigated acres by 2 acre-feet indicates that approximately 74,094 acre-feet of water is available for pumping within the District following optimal recharge years. During an average year, irrigators generally have enough recoverable groundwater to apply 1 acre-foot per acre. This amount of pumping approximately equals the average annual recharge of the Lipan and other undifferentiated aquifers. Therefore, the estimated recoverable volume of water in storage from these aquifers is the annual recharge. There are no wells capable of pumping large volumes of water within the District. New wells being drilled in the Lipan aquifer are reducing the amount of water being pumped by existing wells. Well owners are being forced to down-size their pumps to cope with this situation. This indicates that 74,094 acre-feet is probably the maximum storage capacity of the aquifers within the District. It also reveals that the groundwater underlies a large area and that the residents of the District can effectively deplete the aquifers each year based on the amount of annual recharge, e.g. if the recharge is 25,000 acre-feet in a given year, then 25,000 acre-feet can be pumped; if the recharge is 72,000 acre-feet in a given year, then 72,000 acre-feet can be pumped. Groundwater within the District is not available for any other purpose other than supplemental irrigation and livestock and domestic use. This is a result of the scarcity of large pumping capacities, the annual depletion of the aquifers, and the poor quality of the water.

Table 7
Groundwater Availability in the Lipan-Kickapoo WCD [26]
(acre-feet per year)

Region F - 2007 State Water Plan						
County	**Aquifer**	**Basin**	**Annual Recharge During Drought**	**Annual Supply from Storage**	**County Annual Availability**	**District Annual Availability**
Concho	Edwards-Trinity	Colorado	11,869	409	12,278	8,595
	Hickory	Colorado	0	14,299	14,299	0
	Lipan	Colorado	5,984	529	6,513	6,513
Runnels	Lipan	Colorado	4,536	0	4,536	4,536
Tom Green	Dockum	Colorado	0	54	54	0
	Edwards-Trinity	Colorado	14,373	664	15,037	15,037
	Lipan	Colorado	24,916	12,570	37,486	37,486
Total Per Year			61,678	28,525	90,203	72,167

Total annual available groundwater supplies in the District as provided by the 2007 State Water Plan is estimated to be 90,203 acre-feet annually. However, data from the GAM run 08-08 indicates that only about 66,826 acre-feet per year is available from recharge each year. This annual available groundwater supply is as follows:

1) Groundwater availability from the Lipan aquifer in the District according to the GAM run 08-08 is the precipitation recharge estimated to be 50,801 acre-feet.[27]

2) The Edwards-Trinity (Plateau) aquifer provides, at best, water for livestock and limited domestic use. It is estimated that the annual recharge to the Edwards-Trinity aquifer is 26,242 acre-feet per year. According to the State Water Plan data, 27,315 acre-feet per year are available from the Edwards-Trinity (Plateau) aquifer. However, data from the GAM run 08-08 indicates that only about 16,025 acre-feet per year is available from precipitation recharge each year. Based on local data, only about 1,861 acre-feet per year is being pumped. Most of the groundwater is either being discharged from the aquifer as spring flow or is the primary source of recharge for the Lipan aquifer. Therefore, until yield estimates are improved, the District will rely on it's current local data to estimate the recoverable volume and annual recharge of the aquifer.

3) The data from the State Water Plan indicates no annual recharge to the Hickory aquifer in the District. It indicates that approximately 14,290 acre-feet per year is available for use. However, water analysis from wells drilled into the Hickory aquifer in the District indicate that the water is very saline and is therefore not usable. All wells permitted by the District that were drilled into the Hickory aquifer have been very saline or brine and have been plugged with cement to prevent any contamination to other possible fresh water aquifers.

GROUNDWATER USE

Based on available Texas Water Development Board data, the annual estimated usage in the District has varied from a low of 33,908 acre-feet to a high of 60,701 acre-feet during the 9 years ending in 2006.

Table 8
Concho, Runnels, Tom Green Counties
Historical Water Use [28]
(Surface and Groundwater Combined)

	Historical (acre ft)								
County	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Concho	4,089	5,881	2,574	2,093	3,690	2,690	3,064	3,556	7,727
Runnels	4,921	3,240	920	1,576	3,504	2,468	2,283	2,766	3,834
Tom Green	47,177	35,314	30,414	39,934	42,567	39,347	37,490	40,809	49,140
Total	56,187	44,435	33,908	43,603	49,761	44,505	42,837	47,131	60,701

During the nine years ending in 2006, the annual estimated groundwater usage in the District has varied from a low of 23,441 acre-feet to a high of 45, 421 acre-feet according to data supplied by the Texas Water Development Board.

Table 9 - Lipan-Kickapoo WCD
Concho, Runnels, Tom Green Counties
Historical Water Use [29]
(Groundwater)

	Historical (acre ft)								
County	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Concho	3,353	4,822	2,498	1,967	3,469	1,495	1,817	2,946	7,632
Runnels	1,968	1,296	480	820	1,822	1,497	1,476	1,650	2,663
Tom Green	40,100	30,017	20,463	26,756	28,520	25,892	24,356	27,809	33,086
Total	45,421	36,135	23,441	29,543	33,811	28,884	27,649	32,405	43,381

PROJECTED DEMANDS FOR WATER

Since there are no municipalities within the boundaries of the District, projected water demands are based on the Region F - 2007 State Water Plan combined surface and groundwater demands for irrigation and livestock over the next 50 years.

Table 10 - Projected Total Water Demands by Category
Irrigation and Livestock
Concho, Runnels, Tom Green Counties
(acre-feet per year)

	Historical	Projected					
Category	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Irrigation [30]	33,909	113,249	112,959	112,667	112,376	112,082	111,792
Livestock [31]	3,364	4,283	4,283	4,283	4,283	4,283	4,283
Total Per Year	37,273	117,532	117,242	116,950	116,659	116,365	116,075

Table 11 - Projected Water Demands by Category [32]
Combined Surface and Groundwater
Irrigation - By County
(acre-feet per year)

	Historical	Projected					
County	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Concho	2,574	4,297	4,280	4,262	4,245	4,229	4,213
Runnels	920	4,331	4,317	4,298	4,279	4,260	4,241
Tom Green	30,415	104,621	104,362	104,107	103,852	103,593	103,338
Total Per Year	33,909	113,249	112,959	112,667	112,376	112,082	111,792

Table 12 - Projected Water Demands by Category [33]
Combined Surface and Groundwater
Livestock - By County
(acre-feet per year)

	Historical	Projected					
County	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Concho	542	775	775	775	775	775	775
Runnels	936	1,530	1,530	1,530	1,530	1,530	1,530
Tom Green	1,886	1,978	1,978	1,978	1,978	1,978	1,978
Total Per Year	3,364	4,283	4,283	4,283	4,283	4,283	4,283

In order to manage the aquifers better, the experience of the District has been utilized in preparing another chart on projected water demands. The District's projected water demands are based on the projected water supplies and the estimated amount of irrigated land in the District. The following table 13 shows the demands on the aquifers when the aquifers are at or above normal storage capacity. Pumping in excess of recharge could result in some of the wells going dry which has occurred in the past. However, when significant rainfall events occur, the aquifers are again recharged. Since all available recharge can be pumped each year, it is safe to assume that in the future either new water conservation measures are going to have to be implemented or the demands are going to have to be reduced to equal the supply unless another source of water is located.

Table 13
Lipan-Kickapoo WCD - Projected Water Demands
Groundwater - By County
(acre-feet per year)

	Concho County		Runnels County		Tom Green County		Totals	
Year	Irrigation	Livestock	Irrigation	Livestock	Irrigation	Livestock	Irrigation	Livestock
2000	2,574	542	920	936	30,415	1,886	**33,909**	**3,364**
2010	4,698	547	5,480	941	78,258	1,876	**88,436**	**3,364**
2020	4,700	551	5,523	945	81,700	1,885	**91,923**	**3,381**
2030	4,640	548	5,544	940	82,500	1,880	**92,684**	**3,368**
2040	4,652	545	5,564	938	85,776	1,875	**95,992**	**3,358**
2050	4,622	542	5,593	935	86,260	1,870	**96,475**	**3,347**
2060	4,606	556	5,650	952	85,800	1,896	**96,056**	**3,404**

PROJECTED NEEDS FOR WATER AND MANAGEMENT STRATEGIES

Based on the projected groundwater supplies and projected groundwater demands, there will continue to be a shortage of groundwater available for irrigation in the future. Table 14 shows the projected irrigation water needs through the year 2060.

Table 14
Projected Irrigation Needs [34]
Lipan-Kickapoo WCD
(acre-feet per year)

Projected Water Needs						
Region F - 2007 State Water Plan						
County	**Projected Irrigation Needs**					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Runnels	1,358	1,344	1,325	1,306	1,287	1,268
Tom Green	47,090	46,831	46,576	46,321	46,062	45,807
Total	*48,448*	*48,175*	*47,901*	*47,627*	*47,349*	*47,075*

Since the groundwater resources are limited in the District, one of the ways to address these needs is through water conservation. Table 15 shows the projected irrigation water savings by installing more advanced irrigation technologies.

Table 15
Projected Water Management Strategies [35]
Lipan-Kickapoo WCD
(acre-feet per year)

Water Conservation Strategy					
Projected Water Savings with Advanced Irrigation Technologies					
Region F- 2007 State Water Plan					
County	**Irrigation Need**	**Projected Water Savings (acre-feet/year)**		**% Reduction of 2000 Need**	
	2010	**2020**	**2030-2060**	**2020**	**2030-2060**
Concho		748	1,496		
Runnels	1,358	0	0	0.0%	0.0%
Tom Green	47,090	5,690	11,548	12.1%	24.5%
Total	*48,448*	*6,438*	*13,044*	*12.1%*	*24.5%*

With the installation and use of more advanced irrigation technologies, the projected irrigation needs would be decreased as shown in table 16. However, even with the use of better technology there would still be a substantial need for more irrigation water. In order to prevent a water shortage in the District, the number of irrigated acres would have to be reduced.

Table 16
Revised Irrigation Needs
Lipan-Kickapoo WCD

Revised Irrigation Needs Incorporating Advanced Irrigation Technologies

Region F - 2007 State Water Plan

County	Projected Irrigation Need (acre-feet/year)						Reduction in Irrigated Acres Needed to Prevent a Shortage (Acres)					
	2000	2010	2020	2030	2040	2050	2000	2010	2020	2030	2040	2050
Concho	0	0	0	0	0	0	0	0	0	0	0	0
Runnels	1,358	1,344	1,325	1,306	1,287	1,268	1,419	1,404	1,385	1,365	1,345	1,325
Tom Green	47,090	41,141	35,028	34,773	34,514	34,259	34,770	30,377	25,863	25,675	25,484	25,295
Total	*48,448*	*42,485*	*36,353*	*36,079*	*35,801*	*35,527*	*36,189*	*31,781*	*27,248*	*27,040*	*26,829*	*26,620*

Based on supply and demand calculations and projections, it is obvious that there will be times that demands exceed supply. In this area of the State and with the type of aquifers that serve the area, this is a normal occurrence that is recognized by most local residents. However, there is a growing trend in the District of large ranches being sold to developers who in turn are creating new subdivisions. Water use on some of these lands has gone from a few widely scattered low impact livestock wells to a much greater number of higher impact domestic, and in some cases irrigation wells. The District has observed that:

1) Some domestic wells in these subdivisions have been going dry due to the greater demand on the aquifers.

2) Municipalities in the counties not covered by the District are experiencing acute municipal water shortages and are looking to the District and other surrounding areas for additional water supplies.

3) In the fall of 2004 and the spring of 2005, the aquifers in the District were recharged by heavy rainfall that occurred in the fall of 2004. This recharge brought the water levels to within 90% of the highest levels that were recorded in 1990 and 1991. Since that time, rainfall and recharge have been slightly above average so the aquifers are remaining at about 80% of the highest levels even with heavy pumping during the summer months. Residents of the District understand that groundwater supplies are limited and have modified farming and ranching techniques to match the availability of water. There are approximately 200 highly efficient pivot irrigation systems installed within the District to conserve water. Thousands of acres of highly efficient drip irrigation have also been installed and continue to be installed. Efforts are being made by the residents of the District to use the available groundwater resources with maximum efficiency, while monitoring the quality of the groundwater to protect this resource for the years to come.

It is apparent that there is a need to manage this groundwater resource. In order to better manage this resource, better information on the characteristics, recoverable supplies, and recharge of the aquifers will have to be developed.

MANAGEMENT OF GROUNDWATER SUPPLIES

Preservation and protection of groundwater quality and quantity has been the guiding principle of the District since its creation while striving to maintain the economic viability of all groundwater user groups, public and private. In consideration of the economic and cultural activities occurring within the District, the District will continue to identify and engage in such activities and practices, that if implemented, would result in preservation and protection of the groundwater. The District will continue to make a regular assessment of groundwater supply and storage conditions and make them available to the public. Additional monitor wells both water quality and water level are being added to the monitor well program along with expansion of newer programs including the rainfall monitoring program.

The District has adopted rules to regulate groundwater withdrawals by means of spacing regulations and well density (number of wells per section). These rules were amended in March 2000, November 2006, and September 2007. The District will continue to amend these rules, within the limitations imposed by Chapter 36 of the Texas Water Code, as necessary to regulate groundwater withdrawals by means of additional spacing and/or production limits. District rules also address permitting and registration of wells, waste, well drilling and completion of wells, as well as capping and plugging of unused or abandoned wells. These rules are meant to provide equitable conservation and preservation of the groundwater resources.

The District may deny a drilling permit in accordance with the provisions of the District rules. The relevant factors to be considered in granting, denying, or limiting a permit include:

1) the purpose of the District rules, including but not limited to preserving and protecting the quality and quantity of the aquifer resources, and protecting existing uses;
2) the equitable conservation and preservation of the resource; and
3) the economic hardship resulting from denial or limitation of a permit.

In pursuit of the District's mission of preserving and protecting the resource, the District will enforce the terms and conditions of permits and the rules of the District by injunction, mandatory injunction, or other appropriate remedies in a court of competent jurisdiction as provided by Chapter 36.102, Texas Water Code.

The District also recognizes the importance of public education to encourage efficient use, promote conservation, prevent waste, and preserve the integrity of groundwater. District personnel will seek opportunities to educate the public on water conservation issues and other matters relevant to the protection of groundwater resources through public meetings, newspaper articles, newsletters, speaking engagements, and other means that may become available. The District also maintains a website that is updated weekly with relevant information.

ACTIONS, PROCEDURES, PERFORMANCE AND AVOIDANCE FOR PLAN IMPLEMENTATION

The District will implement the provisions of this plan and will utilize the provisions of this plan as a guide for determining the direction and/or priority for District activities. All operations of the District will be consistent with the provisions of this plan.

The District adopted rules in 1989 and amended the rules in 2000, 2006, 2007 and will continue to amend the rules as necessary. Rules adopted or amended by the District shall be pursuant to TWC Chapter 36 and the provisions of this plan. The promulgation and enforcement of the rules will be based on the best scientific and technical evidence available.

The District shall treat all citizens with equality. For good cause, the District, in its discretion, and after notice and hearing, if required, may grant an exception to the District rules. In doing so, the Board shall consider the potential for adverse effects on adjacent owners and aquifer conditions. The exercise of said discretion by the Board shall not be construed as limiting the power of the Board.

The District maintains a website www.lipan-kickapoo.org that is updated weekly. This site contains information on: District activities, forms, rules, hearing procedures, board meetings and hearings agendas, District programs, Chapter 36-Texas Water Code, Texas Water Well Drillers and Pump Installers Rules, Rules-Quick Reference Chart for the member districts of the West Texas Regional Groundwater Alliance (WTRGA) and other pertinent information.

Coordination With Surface Water Entities

Only the Tom Green County Water Control and Improvement District #1, a federally owned surface water irrigation district, is located within the boundaries of the LKWCD. However, several reservoirs are located either in the District, partially in the District, or adjacent to it. Therefore, in the spirit of cooperation, this management plan has been forwarded for comment to all surface water entities who hold water rights in these reservoirs.

Methodology for Tracking Progress

The methodology that the District will use to trace it's progress on an annual basis, in achieving all of it's management goals will be as follows:

The District manager will prepare and present an annual report to the Board of Directors on District performance in regards to achieving management goals and objectives for the previous fiscal year, during the first meeting of each new fiscal year. The report will include the number of instances each activity was engaged in during the year.

The annual report will be maintained on file at the District office.

GOALS, MANAGEMENT OBJECTIVES AND PERFORMANCE STANDARDS

<u>**Goal**</u>
1.0 Provide for the Efficient Use of Groundwater Within the District. Gather groundwater data both to improve the understanding of the aquifers and their hydrogeologic properties and to quantify this resource for prudent planning and efficient use. (36.1071(a)(1))

<u>Management Objective</u>

1.1 Each year measure, record, and accumulate an historic record of static water levels in 20 monitor wells.

<u>Performance Standards</u>

1.1a - District will maintain a water level monitoring network and annually measure the water levels in the monitor well network.

1.1b - Annual report to Board of Directors listing the number of wells measured in the water level monitoring network.

<u>**Goal**</u>
2.0 Control and Prevent the Waste of Groundwater. Minimize potential contamination of the groundwater by monitoring the drilling and completion of wells. (36.1071(a)(2))

<u>Management Objective</u>

2.1 Each year, register all new water wells drilled in the District.

<u>Performance Standards</u>

2.1a - District will maintain files including information on the drilling and completion of all new wells drilled within the District.

2.1b - Annual report to the Board of Directors on the number of new wells registered during the year.

<u>**Goal**</u>
3.0 Conjunctive Surface Water Management Issues. (36.1071(a)(4))

<u>Management Objective</u>

3.1 Each year, monitor rainfall events on the watersheds within the District that will impact surface water runoff and groundwater recharge.

Performance Standards

3.1a - District will maintain a voluntary rainfall monitoring network to monitor rainfall events. Rainfall event data will be filed with the District and used to monitor surface water runoff and groundwater recharge within the District.

3.1b - Annual report to Board of Directors listing the total number of rain gauges in the rainfall monitoring network.

Goal
4.0 Drought Conditions. (36.1071(a)(6))

Management Objective

5.1 Each year the District will monitor the Texas Palmer Drought Severity Index.

Performance Standards

5.1a - District staff will monitor the Texas Palmer Drought Severity Index and maintain a link to the index on the District website for public access. Additional drought information will be available to the public at the District office.

5.1b - Annual report to Board of Directors listing the number of times drought information was provided to the public.

Goal
5.0(a) Conservation. (36.1071(a)(7))

Management Objective

5.1(a) Each year provide and distribute water conservation literature to District residents to promote the efficient use of water.

Performance Standards

5.1(a)1 - Water conservation information will be available to the District residents at the District office.

5.1(a)2 - Annual report to the Board of Directors listing the number of times water conservation information was distributed to area residents.

MANAGEMENT GOALS DETERMINED NOT-APPLICABLE

Goal
5.0(b) Brush Control. (36.1071(a)(7))

Not appropriate or cost effective. Brush control projects are carried out and funded through the Upper Colorado River Authority and the NRCS. The projects are being used to replenish surface water supplies through the increased flow of springs in the creeks and rivers. This management goal is not applicable to the operations of the District.

Goal
5.0(c) Recharge Enhancement. (36.1071(a)(7))

Not appropriate or cost effective. Research project "Evaluation of Groundwater Availability, Recharge, and Monitoring System Design" [36] completed for the District by LBG-Guyton on January 12, 2005 indicates that water is not available for recharge to the aquifers in the District. This management goal is not applicable to the operations of the District.

Goal
5.0(d) Rainwater Harvesting. (36.1071(a)(7))

Not appropriate or cost effective. Due to the limited amount of rainfall in the District, it is not cost effective to do large scale rainwater harvesting. This management goal is not applicable to the operations of the District.

Goal
5.0(e) Precipitation Enhancement. (36.1071(a)(7))

Not appropriate or cost effective. Due to the limited amount of rainfall in the District and the fact that some areas of the counties including the cities are not part of the District, it would not be cost effective to participate in a weather modification program. This management goal is not applicable to the operations of the District.

Goal
6.0 Natural Resource Issues. (36.1071(a)(5))
Not appropriate or cost effective. The District has no documented occurrence of endangered or threatened species dependent upon groundwater. Other issues related to resources—air, water, soil, etc. supplied by nature that are useful to life are likewise not documented. The natural resources of the oil and gas industry are regulated by the Railroad Commission on Texas, and are exempt by Chapter 36.117(e). Therefore, this management goal is not applicable to the operations of the District.

<u>Goal</u>
7.0 Control and Prevention of Subsidence. (36.1071(a)(3))

Not appropriate or cost effective. The rigid geologic framework of the region precludes significant subsidence from occurring. This management goal is not applicable to the operations of the District.

<u>Goal</u>
8.0 Desired Future Conditions (DFC's) of the Aquifers. (36.1071(a)(8))

This information is not yet available. GAM runs for the Lipan Aquifer and the Edwards-Trinity Aquifer have been received from the TWDB, but due to the complexity of the aquifers within the District and inconsistencies in the groundwater availability model (GAM) for the Edwards-Trinity (Plateau) Aquifer, as noted in the Executive Summary of both GAM Run 07-32 and 07-37, no DFC's have been determined by the District board of directors. The District is continuing to evaluate the information from the GAM runs along with the information obtained from the research project, "Evaluation of Groundwater Availability, Recharge, and Monitoring System Design", completed for the District by LBG-Guyton in 2005. In addition, the District continues to work with GMA 7, other GCD's, the public and the TWDB to establish DFC's for the aquifers prior to the September 1, 2010 deadline. Therefore, since the DFC's of the aquifers within the District have not yet been established, no estimate of the managed available groundwater is available from the Texas Water Development Board.

Definitions and Concepts

"Board" - the Board of Directors of the Lipan-Kickapoo Water Conservation District.

"DFC" - Desired Future Condition of the aquifers.

"District" - the Lipan-Kickapoo Water Conservation District.

"Effective recharge" - the amount of water that enters the aquifer and is available for development

"Groundwater" - means water percolating below the surface of the earth.

"Integrity" - means the preservation of groundwater quality.

"Natural Recourse Issues" - includes groundwater integrity preservation

"Ownership" - pursuant to TWC Chapter 36, §36.002, means the recognition of the rights of the owners of the land pertaining to groundwater.

"Recharge" - the addition of water to an aquifer.

"Surface Water Entity" - TWC Chapter 15 Entities with authority to store, take divert, or supply surface water for use within the boundaries of a district.

"TCEQ" - Texas Commission on Environmental Quality.

"TWDB" - Texas Water Development Board.

"Waste" - as defined by Chapter 36 of the Texas Water Code means any one or more of the following:

(1) withdrawal of groundwater from a groundwater reservoir at a rate and in an amount that causes or threatens to cause intrusion into the reservoir of water unsuitable for agricultural, gardening, domestic, or stock raising purposes;

(2) the flowing or producing of wells from a groundwater reservoir if the water produced is not used for a beneficial purpose;

(3) escape of groundwater from a groundwater reservoir to any other reservoir or geologic strata that does not contain groundwater;

(4) pollution or harmful alteration of groundwater in a groundwater reservoir by saltwater or by other deleterious matter admitted from another stratum or from the surface of the ground;

(5) willfully or negligently causing, suffering, or allowing groundwater to escape into any

river, creek, natural watercourse, depression, lake, reservoir, drain, sewer, street, highway, road, or road ditch, or onto any land other than that of the owner of the well unless such discharge is authorized by permit, rule, or order issued by the commission under Chapter 26;

(6) groundwater pumped for irrigation that escapes as irrigation tailwater onto land other than that of the owner of the well unless permission has been granted by the occupant of the land receiving the discharge; or

(7) for water produced from an artesian well, “waste” has the meaning assigned by Section 11.205.

“Well” - means an artificial excavation that is dug or drilled for the purpose of producing groundwater.

LIST OF REFERENCES

[1] U.S. Census Bureau, 4700 Silver Hill Road, Washington DC 20233-0001 - 2006- Population Estimate.

[2] U.S. Department of Agriculture, National Agricultural Statistics Service - 2002 Census of Agriculture.

[3] U.S. Department of Agriculture, National Agricultural Statistics Service - 2002 Census of Agriculture.

[4] U.S. Census Bureau, 4700 Silver Hill Road, Washington DC 20233-0001 - 2006- Population Estimate.

[5] U.S. Department of Agriculture, National Agricultural Statistics Service - 2002 Census of Agriculture.

[6] U.S. Census Bureau, 4700 Silver Hill Road, Washington DC 20233-0001 - 2006- Population Estimate.

[7] U.S. Department of Agriculture, National Agricultural Statistics Service - 2002 Census of Agriculture.

[8] U.S. Census Bureau, 4700 Silver Hill Road, Washington DC 20233-0001 - 2006- Population Estimate.

[9] U.S. Department of Agriculture, National Agricultural Statistics Service - 2002 Census of Agriculture.

[10] Table 3.1-1, Lipan Aquifer, Region F, State Water Plan 2007.

[11] Texas Water Development Board Report 345 - Aquifers of Texas - November 1995, p. 53.

[12] Table 3.1-1, Edwards-Trinity Aquifer, Region F, State Water Plan 2007.

[13] Texas Water Development Board Report 345 - Aquifers of Texas - November 1995, p.21.

[14] Texas Water Development Board Report 345 - Aquifers of Texas - November 1995, p. 37.

[15] Table 3.1-1, Hickory Aquifer, Region F, State Water Plan 2007.

[16] Concho River & Upper Colorado River Basins Brush Control Feasibility Study, Upper Colorado River Authority, December 2000, p. 7.

[17] Concho River & Upper Colorado River Basins Brush Control Feasibility Study, Upper Colorado River Authority, December 2000, p. 9.

[18] North Concho River Watershed Brush Control Planning, Assessment and Feasibility Study, 1998, Upper Colorado River Authority.

[19] Concho River & Upper Colorado River Basins Brush Control Feasibility Study, Upper Colorado River Authority, December 2000, p. 9.

[20] Table 3.2-1, Major Reservoirs in Region F, State Water Plan 2007.

[21] Table 1.3-3, Surface Water Rights by County and Category, Region F, State Water Plan 2007.

[22] Volume 3, 2007 State Water Planning Database, TWDB: 5/1/2008, (http://www.twdb.state.tx.us/DATA/db07/defaultReadOnly.asp).

[23] Table 1, GAM run 08-08, Texas Water Development Board, January-2008.

[24] Table 2, GAM run 08-08, Texas Water Development Board, January-2008.

[25] Combined Table 1 and Table 2, GAM run 08-08, Texas Water Development Board, January-2008.

[26] Table 3.1-1, Groundwater Availability in Region F, State Water Plan 2007.

[27] Table 1, GAM run 08-08, Texas Water Development Board, January-2008.

[28] Historical Irrigation Water Use by County, Texas Water Development Board - Mark Michon, Program Specialist, Texas Water Development Board, March 2008.

[29] Historical Irrigation Water Use by County, Texas Water Development Board - Mark Michon, Program Specialist, Texas Water Development Board, March 2008.

[30] Table 2.3-8, Irrigation Water Demand Projections for Region F Counties, 2007 State Water Plan.

[31] Table 2.3-12, Livestock Water Demand Projections for Region F Counties, 2007 State Water Plan.

[32] Table 2.3-8, Irrigation Water Demand Projections for Region F Counties, 2007 State Water Plan.

[33] Table 2.3-12, Livestock Water Demand Projections for Region F Counties, 2007 State Water Plan.

[34] Table 4.6-1, Counties with Projected Irrigation Needs, Region F, 2007 State Water Plan.

[35] Table 4.6-5, Projected Water Savings with Advanced Irrigation Technologies, Region F, 2007 State Water Plan.

[36] Evaluation of Groundwater Availability, Recharge, and Monitoring System Design, LBG-Guyton Associates, Prepared for the Lipan-Kickapoo Water Conservation District, January 12, 2005.

ATTACHMENT A

Resolution 2008-02

LIPAN-KICKAPOO WATER CONSERVATION DISTRICT

P.O. Box 67
Vancourt, Texas 76955
Ph: 325-469-3988 Fax: 325-469-3989

MANAGEMENT PLAN
2008-2018

WHEREAS, the Lipan-Kickapoo Water Conservation District (Water District) was created by Acts of the 70th Legislature (1987), p. 2010, Ch. 439, S.B. 1525, in accordance with Article 16, Section 59 of the Constitution of Texas and Chapters 51 and 52 of the Texas Water Code, as amended; and

WHEREAS, S.B. 1525 was amended by Acts of the 77th Legislature (2001), H.B. 1909, in accordance with Chapters 36 and 49 of the Texas Water Code, as amended; and

WHEREAS, the District is required by Chapter 36.1071 of the Texas Water Code to develop and adopt a Management Plan; and

WHEREAS, the District is required by Chapter 36.1072 of the Texas Water Code to review and readopt the plan with or without revisions at least once every five years and to submit the adopted Management Plan to the Executive Administrator of the Texas Water Development Board for review and approval; and

WHEREAS, the District's readopted revised Management Plan shall be approved by the Executive Administrator if the plan is administratively complete; and

WHEREAS, the District Board of Directors, after reviewing the existing Management Plan, has determined that this plan should be revised and replaced with a new 10-Year Management Plan expiring in 2018; and

WHEREAS, the District Board of Directors has determined that the 10-Year Management Plan addresses the requirements of Chapter 36.1071.

NOW, THEREFORE, be it resolved, that the Board of Directors of the Lipan-Kickapoo Water Conservation District, following notice and hearing, hereby adopts this 10-Year Management Plan; and

FURTHER, be it resolved, that this new Management Plan shall become effective immediately upon adoption.

Adopted this 6th day of August, 2008, by the Board of Directors of the Lipan-Kickapoo Water Conservation District.

Michael C Hoelscher
Presiding Officer

Attest:

Len Grade
Board Secretary

ATTACHMENT B

NOTICE OF HEARING

LIPAN-KICKAPOO WATER CONSERVATION DISTRICT

Wednesday, April 2, 2008 at 7:30 AM

A Public Hearing is scheduled to be held at the Lipan-Kickapoo Water Conservation District Office, Suite C, Vancourt Post Office Building, Vancourt, Texas. The purpose of this hearing is to take public comment on a draft 10-year Management Plan (2008-2018) for the District. Written comments are being taken until 4:00 pm, Wednesday, May 7, 2007. Comments may be mailed to the district at P.O. Box 67, Vancourt, TX 76955. Attention Management Plan Comments. Full text copies of the Draft Management Plan may be obtained from the Water District office, from the district website - www.lipan-kickapoo.org, or by calling the District office at (325) 469-3988.

PUBLIC NOTICE

REGULAR MEETING OF THE BOARD OF DIRECTORS

LIPAN-KICKAPOO WATER CONSERVATION DISTRICT

The Board of Directors will meet in a Regular Meeting on Wednesday, April 2, 2008 immediately following the Public Hearing. The meeting will be held at the Lipan-Kickapoo Water Conservation District Office, Suite C, Vancourt Post Office Building, Vancourt, Texas. Items on this Agenda may be taken out of the order indicated.

Agenda

(1) Call to Order

(2) Public Comments. *

(3) 30 Minute Presentation by Allan Standen, Daniel B. Stephens & Associates, on 3-D Modeling of the Lipan and associated aquifers for establishing the desired future conditions of the aquifers.

(4) Review and approve the minutes of the Regular meeting held on January 9, 2008.

(5) Review and approve the financial report and ratification of payments for January - March 2008.

(6) Review and approve payment of any unpaid bills.

(7) Discussion and possible action to go forward with research project on the Lipan and associated aquifers in order to develop state mandated desired future conditions (DFC's) of the aquifers.

(8) Discussion and possible action on draft 10-year Management Plan.

(9) Review and possible action on requests for exceptions to the spacing rules for domestic and livestock wells.

(10) Review and possible action on any Rules Violations reported by District staff.

(11) General Managers Report - Consider accepting as a matter of record.

(12) Next regular meeting tentatively set for August 6, 2008 (1st Wednesday) at 7:30 AM.
On the Agenda will be:
(1) Adopt new management plan.
(2) Budget Workshop for FY 2008-09

(13) Adjournment.

** Under the Open Meetings Act, Chapter 551, all meetings of the District are open to the Public, except for executive sessions. The Act does not give the public a right to speak at such meetings. However, the Board at its discretion may allow any person to address the Board on any item and for the length of time as determined by the Board.*

Date: March 26, 2008
Time: 11:12 AM

FILED #4291
The 27 Day of March,
2008 at 11:08 O'clock A. M
Barbara K Hoffman
County Clerk, Concho Co. TX
By ______

NOTICE OF HEARING

LIPAN-KICKAPOO WATER CONSERVATION DISTRICT

Wednesday, April 2, 2008 at 7:30 AM

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LIPAN-KICKAPOO WATER CONSERVATION DISTRICT

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Date: March 26, 2008
Time: 11:12 AM

NOTICE OF HEARING

LIPAN-KICKAPOO WATER CONSERVATION DISTRICT

Wednesday, April 2, 2008 at 7:30 AM

A Public Hearing is scheduled to be held at the Lipan-Kickapoo Water Conservation District Office, Suite C, Vancourt Post Office Building, Vancourt, Texas. The purpose of this hearing is to take public comment on a draft 10-year Management Plan (2008-2018) for the District. Written comments are being taken until 4:00 pm, Wednesday, May 7, 2007. Comments may be mailed to the district at P.O. Box 67, Vancourt, TX 76955. Attention Management Plan Comments. Full text copies of the Draft Management Plan may be obtained from the Water District office, from the district website - www.lipan-kickapoo.org, or by calling the District office at (325) 469-3988.

PUBLIC NOTICE

REGULAR MEETING OF THE BOARD OF DIRECTORS

LIPAN-KICKAPOO WATER CONSERVATION DISTRICT

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POSTED March 27, 2008
At 10:45 o'clock A. M.
Elesa Ocker Elesa Ocker
County Clerk, Runnels County, Texas
By ______________ Deputy

Date: March 26, 2008
Time: 11:12 AM

Notice of Meeting

Regular Meeting of the Board of Directors

Lipan-Kickapoo Water Conservation District

Wednesday, August 6, 2008 at 7:30 AM

The meeting will be held at the Lipan-Kickapoo Water Conservation District Office, Suite C, Vancourt Post Office Building, Vancourt, Texas. Items on this Agenda may be taken out of the order indicated.

Agenda

(1) Call to Order

(2) Public Comments. *

(3) Review and approve the minutes of the Public Hearing & Regular meeting held on April 2, 2008 and the Special Meeting held on May 14, 2008.

(4) Review and approve the financial report and ratification of payments for April - July 2008.

(5) Review and approve payment of any unpaid bills.

(6) Discussion and possible action on adoption of new 10-year Management Plan to expire in 2018.

(7) Discussion and possible action to sign letter of engagement with Eckert, Ingrum, Tinkler, Oliphant, Featherston, & Barr, CPA's to conduct financial audit for the fiscal year ending September 30, 2008.

(8) Discussion and possible action on disposal of old obsolete equipment.

(9) Discussion and possible action on the purchase of transducers for monitoring water levels in permanent monitor wells.

(10) Review and possible action on Budget Amendment #1 for the current fiscal year ending September 30, 2008.

(11) Review and possible action on any Rules Violations reported by District staff.

(12) General Managers Report - Consider accepting as a matter of record.

(13) Budget Workshop for Fiscal Year 2008-2009.

(14) Miscellaneous Business:
  a) Next regular meeting set for Wednesday, September 3, 2008 at 7:30 A.M.
  b) Suggested agenda items for the next meeting:
    1) Adopt Budget for FY 2008-2009.
    2) Adopt Tax Rate to fund budget

(15) Adjournment.

** Under the Open Meetings Act, Chapter 551, all meetings of the District are open to the Public, except for executive sessions. The Act does not give the public a right to speak at such meetings. However, the Board at its discretion may allow any person to address the Board on any item and for the length of time as determined by the Board.*

*** Pursuant to the provisions of Section 551.071, 551.074 and 551.076 of the open meetings act of the Government Code, the Board reserves the right to convene in Executive Session at any time deemed necessary for consideration of legal matters or consultation with legal counsel, personnel matters, or district security.*

Date: July 25, 2008
Time: 11:08 AM

#4340
FILED
The 31 Day of July
2008 at 9:36 O'clock A. M
Barbara K. Hoffman
County Clerk, Concho Co. TX
By Theresa Sonnenberg Deputy

NOTICE OF MEETING

REGULAR MEETING OF THE BOARD OF DIRECTORS

LIPAN-KICKAPOO WATER CONSERVATION DISTRICT

Wednesday, August 6, 2008 at 7:30 AM

The meeting will be held at the Lipan-Kickapoo Water Conservation District Office, Suite C, Vancourt Post Office Building, Vancourt, Texas. Items on this Agenda may be taken out of the order indicated.

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Date: July 29, 2008
Time: 10:26 AM

NOTICE OF MEETING

POSTED July 31, 2008
At 10:04 o'clock A.M.
Elesa Ocker
County Clerk, Runnels County, Texas
By Bullie Schafer Deputy

REGULAR MEETING OF THE BOARD OF DIRECTORS

LIPAN-KICKAPOO WATER CONSERVATION DISTRICT

Wednesday, August 6, 2008 at 7:30 AM

The meeting will be held at the Lipan-Kickapoo Water Conservation District Office, Suite C, Vancourt Post Office Building, Vancourt, Texas. Items on this Agenda may be taken out of the order indicated.

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    2) Adopt Tax Rate to fund budget

(15) Adjournment.

** Under the Open Meetings Act, Chapter 551, all meetings of the District are open to the Public, except for executive sessions. The Act does not give the public a right to speak at such meetings. However, the Board at its discretion may allow any person to address the Board on any item and for the length of time as determined by the Board.*

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Date: July 29, 2008
Time: 10:26 AM

ATTACHMENT C

Lipan-Kickapoo Water Conservation District

P.O. Box 67
Vancourt, Texas 76955
Ph: 325-469-3988 Fax: 325-469-3989
Email: lkwcd@airmail.net

August 6, 2008

Subject: Lipan-Kickapoo WCD Management Plan

Under §36.1071, Texas Water Code, as amended, the Lipan-Kickapoo WCD is required to coordinate with surface water entities located within the district in preparation of its management plan. Although there is only one surface water entity located within the district's boundaries, the district submitted a copy of the draft 10-year management plan not only to the Tom Green County Water Control and Improvement District #1 that is located within the District boundaries, but also to the surface water entities that have storage either in the district, partially in the district, or adjacent to the district for review and comments. The surface water entities that received copies of the draft management plan included:

1) Tom Green County Water Control Water Control and Improvement District #1
2) City of San Angelo
3) Upper Colorado River Authority
4) City of Winters
5) Colorado River Municipal Water District
6) City of Ballinger
7) Region F Regional Water Planning Group.

Comments or suggestions were requested to be submitted to the District by May 7, 2008. No comments or suggestions were received by the District.

Copies of the cover letters and certified mail receipts are enclosed.

Sincerely,

Allan J. Lange
General Manager

Lipan-Kickapoo Water Conservation District

P.O. Box 67
Vancourt, Texas 76955
Ph: 325-469-3988 Fax: 325-469-3989
Email: lkwcd@airmail.net

April 11, 2008

Mr. Yantis Green
District Manager
Tom Green County Water Control and Improvement District #1
PO Box 488
Veribest, TX 76866

Subject: Lipan-Kickapoo WCD Management Plan - DRAFT

Dear Mr. Green:

The Lipan-Kickapoo WCD has drafted a new 10 year management plan to replace the one adopted in 1998 that is set to expire later this year. Under §36.1072, Texas Water Code, as amended, the District must adopt a new plan every ten years and submit it to the Texas Water Development Board for review and approval.

Under §36.1071, Texas Water Code, as amended, the District is required to coordinate with surface water entities in preparation of its management plan. In compliance with this chapter of the water code, the District is submitting to you a copy of the new draft management plan for your review and comments.

Please review this management plan and submit any comments or suggestions to the District by May 7, 2008. If you have any questions or want additional information, as you review this plan, please contact me at 469-3988. We appreciate your attention and cooperation in reviewing this management plan.

Sincerely,

Allan J. Lange
General Manager

enclosures

Lipan-Kickapoo Water Conservation District

P.O. Box 67
Vancourt, Texas 76955
Ph: 325-469-3988 Fax: 325-469-3989
Email: lkwcd@airmail.net

April 9, 2008

Mr. W.H. Wilde
City of San Angelo
PO Box 1751
San Angelo, Texas 76902

Subject: Lipan-Kickapoo WCD Management Plan - DRAFT

Dear Mr. Wilde:

The Lipan-Kickapoo WCD has drafted a new 10 year management plan to replace the one adopted in 1998 that is set to expire later this year. Under §36.1072, Texas Water Code, as amended, the District must adopt a new plan every ten years and submit it to the Texas Water Development Board for review and approval.

Under §36.1071, Texas Water Code, as amended, the District is required to coordinate with surface water entities in preparation of its management plan. In compliance with this chapter of the water code, the District is submitting to you a copy of the new draft management plan for your review and comments.

Please review this management plan and submit any comments or suggestions to the District by May 7, 2008. If you have any questions or want additional information, as you review this plan, please contact me at 469-3988. We appreciate your attention and cooperation in reviewing this management plan.

Sincerely,

Allan J. Lange
General Manager

enclosures

Lipan-Kickapoo Water Conservation District

P.O. Box 67
Vancourt, Texas 76955
Ph: 325-469-3988 Fax: 325-469-3989
Email: lkwcd@airmail.net

April 9, 2008

Mr. Stephen Brown
Upper Colorado River Authority
512 Orient
San Angelo, Texas 76903

Subject: Lipan-Kickapoo WCD Management Plan - DRAFT

Dear Mr. Brown:

The Lipan-Kickapoo WCD has drafted a new 10 year management plan to replace the one adopted in 1998 that is set to expire later this year. Under §36.1072, Texas Water Code, as amended, the District must adopt a new plan every ten years and submit it to the Texas Water Development Board for review and approval.

Under §36.1071, Texas Water Code, as amended, the District is required to coordinate with surface water entities in preparation of its management plan. In compliance with this chapter of the water code, the District is submitting to you a copy of the new draft management plan for your review and comments.

Please review this management plan and submit any comments or suggestions to the District by May 7, 2008. If you have any questions or want additional information, as you review this plan, please contact me at 469-3988. We appreciate your attention and cooperation in reviewing this management plan.

Sincerely,

Allan J. Lange

Allan J. Lange
General Manager

enclosures

Lipan-Kickapoo Water Conservation District

P.O. Box 67
Vancourt, Texas 76955
Ph: 325-469-3988 Fax: 325-469-3989
Email: lkwcd@airmail.net

April 9, 2008

Mr. Aref Hassan
City of Winters
310 South Main
Winters, Texas 79567

Subject: Lipan-Kickapoo WCD 10 Year Management Plan - DRAFT

Dear Mr. Hassan:

The Lipan-Kickapoo WCD has drafted a new 10 year management plan to replace the one adopted in 1998 that is set to expire later this year. Under §36.1072, Texas Water Code, as amended, the District must adopt a new plan every ten years and submit it to the Texas Water Development Board for review and approval.

Under §36.1071, Texas Water Code, as amended, the District is required to coordinate with surface water entities in preparation of its management plan. In compliance with this chapter of the water code, the District is submitting to you a copy of the new draft management plan for your review and comments.

Please review this management plan and submit any comments or suggestions to the District by May 7, 2008. If you have any questions or want additional information, as you review this plan, please contact me toll free at (866) 469-3988. We appreciate your attention and cooperation in reviewing this management plan.

Sincerely,

Allan J. Lange
General Manager

enclosures

Lipan-Kickapoo Water Conservation District

P.O. Box 67
Vancourt, Texas 76955
Ph: 325-469-3988 Fax: 325-469-3989
Email: lkwcd@airmail.net

April 9, 2008

Mr. John Grant
General Manager
Colorado River Municipal Water District
P.O. Box 869
Big Spring, Texas 79721-0869

Subject: Lipan-Kickapoo WCD Management Plan - DRAFT

Dear Mr. Grant:

The Lipan-Kickapoo WCD has drafted a new 10 year management plan to replace the one adopted in 1998 that is set to expire later this year. Under §36.1072, Texas Water Code, as amended, the District must adopt a new plan every ten years and submit it to the Texas Water Development Board for review and approval.

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Sincerely,

Allan J. Lange
General Manager

enclosures

Lipan-Kickapoo Water Conservation District

P.O. Box 67
Vancourt, Texas 76955
Ph: 325-469-3988 Fax: 325-469-3989
Email: lkwcd@airmail.net

April 9, 2008

Mr. Tommy New
City of Ballinger
PO Box 497
Ballinger, Texas 76821

Subject: Lipan-Kickapoo WCD Management Plan - DRAFT

Dear Mr. New:

The Lipan-Kickapoo WCD has drafted a new 10 year management plan to replace the one adopted in 1998 that is set to expire later this year. Under §36.1072, Texas Water Code, as amended, the District must adopt a new plan every ten years and submit it to the Texas Water Development Board for review and approval.

Under §36.1071, Texas Water Code, as amended, the District is required to coordinate with surface water entities in preparation of its management plan. In compliance with this chapter of the water code, the District is submitting to you a copy of the new draft management plan for your review and comments.

Please review this management plan and submit any comments or suggestions to the District by May 7, 2008. If you have any questions or want additional information, as you review this plan, please contact me toll free at (866) 469-3988. We appreciate your attention and cooperation in reviewing this management plan.

Sincerely,

Allan J. Lange
General Manager

enclosures

Lipan-Kickapoo Water Conservation District

P.O. Box 67
Vancourt, Texas 76955
Ph: 325-469-3988 Fax: 325-469-3989
Email: lkwcd@airmail.net

April 9, 2008

Mr. John Grant
President
Region F Regional Water Planning Group
P.O. Box 869
Big Spring, Texas 79721-0869

Subject: Lipan-Kickapoo WCD Management Plan - DRAFT

Dear Mr. Grant:

The Lipan-Kickapoo WCD has drafted a new 10 year management plan to replace the one adopted in 1998 that is set to expire later this year. Under §36.1072, Texas Water Code, as amended, the District must adopt a new plan every ten years and submit it to the Texas Water Development Board for review and approval.

Under §36.1071, Texas Water Code, as amended, the District is required to coordinate with surface water entities in preparation of its management plan. In compliance with this chapter of the water code, the District is submitting to you a copy of the new draft management plan for your review and comments.

Please review this management plan and submit any comments or suggestions to the District by May 7, 2008. If you have any questions or want additional information, as you review this plan, please contact me toll free at (866) 469-3988. We appreciate your attention and cooperation in reviewing this management plan.

Sincerely,

Allan J. Lange
General Manager

enclosures

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UPPER COLORADO RIVER AUTHORITY
512 ORIENT
SAN ANGELO, TX 76903

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CITY OF WINTERS
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WINTERS, TX 79567

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Street, Apt. No.; or PO Box No. P.O. BOX 1751
City, State, ZIP+4 SAN ANGELO TX 76902

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MR. W.H. WILDE
CITY OF SAN ANGELO
P.O. BOX 1751
SAN ANGELO, TX 76902

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B. Received by (Printed Name) Charlie [illegible] C. Date of Delivery 4-11-08
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Sent To MR. JOHN GRANT, PRESIDENT REGION F REGIONAL WATER
Street, Apt. No.; or PO Box No. PLANNING GROUP P.O. BOX 869
City, State, ZIP+4 BIG SPRING TX 79721

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1. Article Addressed to:

MR. JOHN GRANT, PRESIDENT
REGION F REGIONAL
WATER PLANNING GROUP
P.O. BOX 869
BIG SPRING, TX
79721-0869

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Sent To MR. JOHN GRANT, GENERAL MGR. COLORADO RIVER MUNICIPAL WATER DIST.
Street, Apt. No.; or PO Box No. P.O. BOX 869
City, State, ZIP+4 BIG SPRING, TX 79721-0869

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1. Article Addressed to:

MR. JOHN GRANT, GENERAL
MGR. CRMWD
P.O. BOX 869
BIG SPRING, TX
79721-0869

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Street, Apt. No.; or PO Box No. P.O. BOX 497
City, State, ZIP+4 BALLINGER TX 76821

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1. Article Addressed to:

MR. TOMMY NEW
CITY OF BALLINGER
P.O. BOX 497
BALLINGER, TX
76821

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VANCOURT TX 76955 APR 11 2008 USPS

Sent To Yantis Green

Street, Apt. No.; or PO Box No. P O Box 488

City, State, ZIP+4 Veribest Tx 76866

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1. Article Addressed to:

Mr. Yantis Green, Dist Mgr.
TGC Water Control &
Improvement District #1
P.O. Box 488
Veribest, Tx 76866

COMPLETE THIS SECTION ON DELIVERY

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X Yantis Green ☑ Agent ☐ Addressee

B. Received by (Printed Name) Yantis Green

C. Date of Delivery 4/18/08

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ATTACHMENT D

GAM run 08-08

by Shirley Wade, P.G.
Texas Water Development Board
Groundwater Availability Modeling Section
(512) 936-0883
January 25, 2008

REQUESTOR:

Mr. Allan Lange, General Manager for the Lipan-Kickapoo Water Conservation District.

DESCRIPTION OF REQUEST:

To assist in preparation of his district management plan (and as a supplement to GAM Run 06-15), Mr. Lange requested a table listing the following information from the Groundwater Availability Models in his district:

- storage,
- springs and seeps,
- general head boundary,
- wells,
- rivers and streams,
- recharge (precipitation and inflow from other aquifers), and
- evapotranspiration

METHODS:

To address the request, we ran the groundwater availability model for the Lipan Aquifer for the 1980 through 1998 period, and we ran the groundwater availability model for the Edwards-Trinity (Plateau) Aquifer for the 1980 through 1998 period and averaged the results.

PARAMETERS AND ASSUMPTIONS:

We used the following assumptions in this analysis:

- We used versions 1.01 of the groundwater availability models for the Lipan Aquifer and the Edwards-Trinity (Plateau) Aquifer.

- See Beach and others (2004) for assumptions and limitations of the groundwater availability model for the Lipan Aquifer.

- See Anaya and Jones (2004) for assumptions and limitations of the groundwater availability model for the Edwards-Trinity (Plateau) Aquifer.

- The Lipan Aquifer model includes one layer representing the Quaternary Leona Formation, portions of the underlying Permian Formations, and the Edwards-Trinity (Plateau) Aquifer to the west, south, and north.

- The Edwards-Trinity (Plateau) Aquifer model includes two layers representing the Edwards and associated limestones (Layer 1) and the undifferentiated Trinity units (Layer 2) in the district.

- The mean absolute error (a measure of the difference between simulated and actual water levels during model calibration) in the groundwater availability model for the Lipan Aquifer is 18 feet for the calibration period (1980-89) and 17 feet for the verification period (1990-99: Beach and others, 2004).

- The root mean squared error (a measure of the difference between simulated and actual water levels during model calibration) in the entire groundwater availability model representing the Edwards-Trinity (Plateau) Aquifer for the period of 1990 to 2000 is 143 feet, or six percent of the range of measured water levels (Anaya and Jones, 2004).

- Recharge rates for both models are based on (1980 – 2000) precipitation (Beach and others, 2004; Anaya and Jones, 2004).

RESULTS:

A groundwater budget (Tables 1 and 2) summarizes how the model estimates water entering and leaving the aquifer. The components of the water budget are described below.

- Storage—This component is the change in the amount of water stored in the aquifer. The storage component that is included in “Inflow” is water that is removed from storage in the aquifer (that is, water levels decline). The storage component that is included in “Outflow” is water that is added back into storage in the aquifer (that is, water levels increase). This component of the budget is often seen as water both going into and out of the aquifer because this is a county-wide budget, and water levels will decline in some areas (water is being removed from storage) and will rise in others (water is being added to storage).

- Reservoirs – This is water that leaks from reservoirs into the aquifer or from the aquifer into the reservoir. This component can be shown as ”Inflow” or ”Outflow” in the budget.

- Springs and seeps— This is water that drains from an aquifer if water levels are above the elevation of the spring or seep. This component is always shown as “Outflow”, or discharge, from an aquifer. Springs and seeps are simulated in the model using the MODFLOW Drain package. The spring discharge from the model of the Lipan Aquifer in Tom Green County represents discharge to the North Concho River.

- General-Head Boundary (GHB)—The model uses general head boundaries to simulate the eastern and western aquifer boundaries. Inflow on the general-head boundary to the west represents inflow from the Edwards-Trinity (Plateau) Aquifer.

- Wells—This is water produced from rural domestic, municipal, industrial, irrigation, and livestock wells in the aquifer. For this model, this component is always shown as “Outflow” from an aquifer, because all wells included in the model produce (rather than inject) water. Wells are simulated in the model using the MODFLOW Well package.

- Rivers and Streams—This is water that flows between streams and rivers and an aquifer. The direction and amount of flow depends on the water level in the stream or river and the aquifer. In areas where water levels in the stream or river are above the water level in the aquifer, water flows into the aquifer and is shown as “Inflow” in the budget. In areas where water levels in the aquifer are above the water level in the stream or river, water flows out of the aquifer and into the stream and is shown as “Outflow” in the budget. Rivers and streams are simulated using the MODFLOW Stream package.

- Recharge—This component simulates areally distributed recharge due to precipitation falling on the outcrop areas of aquifers. Recharge is always shown as “Inflow” into an aquifer. This component does not include runoff from precipitation events that may later recharge an aquifer as stream losses, which is included in the model using the stream (or river) package. Recharge is simulated in the model using the MODFLOW Recharge package.

- Evapotranspiration—This is water that flows out of an aquifer due to direct evaporation and plant transpiration. This component of the budget will always be shown as “Outflow”. Evapotranspiration is simulated in the model using the MODFLOW Evapotranspiration (EVT) package.

- Lateral flow between counties—This component describes lateral flow within the aquifer between adjacent counties.

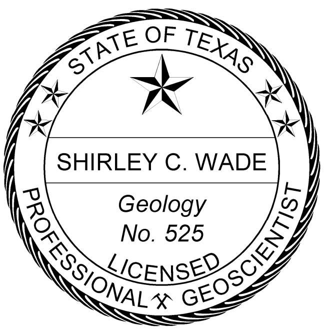
It is important to note that sub-regional water budgets for individual counties are not exact. This is due to the one-mile spacing of the model grid and because we assumed each model cell is assigned to a single county. The water budgets for an individual cell containing a county boundary are assigned to either one county or the other and therefore very minor variations in the county-wide budgets may be observed. Also, the Lipan-Kickapoo budget terms in Table 1 are not equal to the sum of Tom Green, Concho, and Runnels Counties because some areas of those counties are not included in the Water Conservation District.

REFERENCES:

Anaya, R., and Jones, I., 2004, Groundwater availability model for the Edwards-Trinity (Plateau) and Cenozoic Pecos Alluvium aquifer systems, Texas: Texas Water Development Board, GAM Report, 208 p.

Beach, James A., Burton, Stuart, and Kolarik, Barry, 2004, Groundwater availability model for the Lipan Aquifer in Texas: final report prepared for the Texas Water Development Board by LBG-Guyton Associates

Smith, R. 2006, GAM Run 06-15 Final Report, Texas Water Development Board GAM Run Report, August 9, 2006, 3 pp.



The seal appearing on this document was authorized by Shirley C. Wade, P.G. on February 12, 2008.

Table 1: Groundwater flow budget for each county in the model and for the Lipan-Kickapoo Water Conservation District (WCD), averaged for the years 1980 through 1998 from the groundwater availability model of the Lipan Aquifer. Flows are reported in acre-feet per year.

	Coke		Concho		Irion		Runnels		Schleicher		Tom Green		Lipan-Kickapoo WCD	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Change in storage	143	-127	2,438	-1,138	118	-104	350	-258	39	-34	14,206	-3,631	17,349	-3,657
Reservoirs	0	0	0	0	0	0	0	0	0	0	9,068	-1,511	1,481	-669
Springs and seeps[1]	0	0	0	0	0	0	0	0	0	0	0	-5,447	0	0
General head boundary (Inflow from Edwards-Trinity (Plateau) Aquifer along western boundary)	490	-219	630	-841	3,723	0	48	-2	0	0	6,602	0	5,706	-847
Wells	0	-1	0	-1,914	0	-12	0	-60	0	0	0	-27,891	0	-29,384
Rivers and streams	0	0	49	-7,485	2,160	-1	0	0	0	0	7,807	-9,229	6,050	-15,197
Direct precipitation recharge	1,735	0	15,718	0	2,761	0	2,621	0	395	0	42,425	0	50,801	0
Evapotrans-piration	0	-23	0	-12,554	0	-6,778	0	-5	0	-6	0	-35,545	0	-27,857
Lateral inflow	0	-1,998	5,487	-392	1,258	-3,125	1,472	-4,165	19	-412	8,248	-5,104	9,411	-13,190

1.The drain cells representing the North Concho River are not within the Lipan-KickapooWater Conservation District so the drain discharge is zero for the Lipan Aquifer model in the district. However, spring discharge values from the Edwards-Trinity Aquifer in the district in Tom Green County can be found in Table 2.

Note: a negative sign refers to flow out of the aquifer in the county or District. A positive sign refers to flow into the aquifer in the county or District. All numbers are rounded to the nearest 1 acre-foot.

Table 2: Groundwater flow budget for the Lipan-Kickapoo Water Conservation District, averaged for the years 1980 through 1998 from the groundwater availability model of the Edwards-Trinity (Plateau) Aquifer. Flows are reported in acre-feet per year.

	Edwards (Layer 1)	
	In	**Out**
Change in storage	1,333	-436
Reservoirs	0	0
Springs and seeps	0	-12,851
General head boundary	0	0
Wells	0	-169
Rivers and streams	0	-1,368
Direct precipitation recharge	11,282	0
Evapotranspiration	0	0
Lateral inflow	7,241	-2,821
Upper vertical flow	0	0
Lower vertical flow	15	-2,217
	Trinity (Layer2)	
Change in storage	356	-186
Reservoirs	0	0
Springs and seeps	0	-6,325
General head boundary	0	-54
Wells	0	-202
Rivers and streams	66	-3,039
Direct precipitation recharge	4,743	0
Evapotranspiration	0	0
Lateral inflow	4,080	-1,652
Upper vertical flow	2,226	15
Lower vertical flow	0	0

Note: a negative sign refers to flow out of the aquifer in the Lipan-KickapooWater Conservation District. A positive sign refers to flow into the aquifer in the District. All numbers are rounded to the nearest 1 acre-foot.

ATTACHMENT E

GAM Run 07-32

by Andrew C. A. Donnelly, P.G.
Texas Water Development Board
Groundwater Availability Modeling Section
(512) 463-3132
December 11, 2007

EXECUTIVE SUMMARY:

We ran the groundwater availability model for the Edwards-Trinity (Plateau) Aquifer for a 71-year simulation, which consisted of 21 years of historic conditions followed by a 50-year predictive time period. Average recharge conditions were used for the first 44 years of the predictive portion of the simulation, followed by a six-year drought-of-record. The same baseline pumpage approved by the members of Groundwater Management Area 7 for use in GAM Run 07-03 (Donnelly, 2007) was used in this simulation.

Results of this model run indicated that water levels after 50 years of baseline pumpage stayed within 25 feet of water levels at the end of 2000 with one exception. An area of extreme drawdown (up to 500 feet) centered in Glasscock and Reagan counties in the Trinity Aquifer was predicted by the model at the end of fifty years. Research into the model performance during the calibration time period indicates that the model is not simulating the response of the aquifer to pumpage in this area appropriately. Because properties for this layer are consistent across the entire model area, it is recommended that the use of this model to evaluate desired future conditions in this layer be done with care.

REQUESTOR:

Ms. Caroline Runge from the Menard County Underground Water Conservation District (on behalf of Groundwater Management Area 7).

DESCRIPTION OF REQUEST:

Ms. Runge asked for a baseline model run using the groundwater availability model for the Edwards-Trinity (Plateau) Aquifer. This baseline model run would be a 71-year simulation, with the first 21 years being the historic portion of the simulation followed by a 50-year predictive time period. Average recharge conditions were used for the first 44 years of the predictive portion of the simulation, followed by the drought-of-record at the end of the predictive time period. Each year of the predictive portion of the simulation would use a specified baseline pumpage approved by members of Groundwater Management Area 7.

METHODS:

Initial streamflows were averaged for the 1961 to 1990 time period. These averages were then used for each year of the 50-year predictive portion of the model simulation along with the baseline pumpage. Recharge was also averaged for the 1961 to 1990 time period. Average recharge was used for the first 44 years of the predictive portion of the model run. The final six years of the predictive portion of the run used drought-of-record recharge, representing recharge for the years 1951 to 1956. Resulting water levels and drawdowns were then evaluated and are described in the Results section below.

PARAMETERS AND ASSUMPTIONS:

The groundwater availability model for the Edwards-Trinity (Plateau) Aquifer was used for this model run. The parameters and assumptions for this model are described below:

- We are using version 1.0 of the groundwater availability model of the Edwards-Trinity (Plateau) Aquifer, which includes the Pecos Valley Aquifer (formerly known as the Cenozoic Pecos Alluvium Aquifer). See Anaya and Jones (2004) for assumptions and limitations of the model.

- The root mean squared error (a measure of the difference between simulated and actual water levels during model calibration) in the entire Edwards-Trinity (Plateau) and Pecos Valley (formerly the Cenozoic Pecos Alluvium) groundwater availability model for the period of 1990 to 2000 is 143 feet, or six percent of the range of measured water levels (Anaya and Jones, 2004).

- The model includes two layers, representing the Edwards and associated limestones (Layer 1) and undifferentiated Trinity units (Layer 2). The Pecos Valley Aquifer is included in Layer 1 of the model.

- The model run was 71 years in length. The first 21 years were the historic calibration-verification portion of the simulation, followed by a 50-year predictive period.

- Pumpage for each year of the predictive portion of the model run was based the baseline pumpage requested by members of Groundwater Management Area 7, and is the same pumpage used in the previous baseline GAM Run (GAM Run 07-03). A description of how the baseline pumpage data set was assembled is included in the GAM07-03 report (Donnelly, 2007).

- The groundwater availability model simulates discharge to springs and seeps mostly along the northern and eastern margins of the aquifer. Spring and seep parameters used in the model are from the calibrated model.

- Recharge was distributed in the groundwater availability model based on a percent of annual precipitation and aquifer outcrop (surface geology).

- The groundwater availability model simulates the interaction between the aquifer(s) and major streams and rivers flowing in the region. Flow both from the stream to the aquifer and from the aquifer to the stream is allowed, and the direction of flow is determined by the water levels in the aquifer and the surface water elevation of the stream during each stress period in the simulation. The stream parameters, including streambed conductance and initial flow values, used in the model are from the calibrated model.

- The groundwater availability model uses general head boundary cells to simulate cross-formational groundwater flow between the Edwards-Trinity (Plateau) and Pecos Valley aquifers and adjacent aquifers, including the Ogallala, Dockum, Edwards (Balcones Fault Zone), and Llano Uplift area aquifers. Parameters assigned to the general head boundary cells such as aquifer conductance and water levels were from the calibrated model.

RESULTS:

Included in the results are estimates of the water budgets after running the model for 50 years. The components of the water budget are described below.

- Wells—water produced from wells in each aquifer. This component is always shown as "Outflow" from the water budget, because all wells included in the model produce (rather than inject) water. Wells are modeled using the MODFLOW Well package.

- Springs and seeps—water that drains from an aquifer to seeps and springs along the margins of the aquifer. This component is always shown as "Outflow", or discharge, from the water budget. Springs and seeps are modeled using the MODFLOW Drain package.

- Recharge—simulates areally distributed recharge due to precipitation falling on the outcrop areas of aquifers. Recharge is always shown as "Inflow" into the water budget. Recharge is modeled using the MODFLOW Recharge package.

- Vertical Leakage (Upward or Downward)—describes the vertical flow, or leakage, between two aquifers. This flow is controlled by the water levels in each aquifer and aquifer properties of each aquifer that define the amount of leakage that can occur. "Inflow" to an aquifer from an overlying or underlying aquifer will always equal the "Outflow" from the other aquifer.

- Storage—water stored in the aquifer. The storage component that is included in "Inflow" is water that is removed from storage in the aquifer (that is, water level declines). The storage component that is included in "Outflow" is water that is added back into storage in the aquifer (that is, water level increases). This component of the budget is often seen as water both going into and out of the aquifer because this is a regional budget, and water levels will decline in some areas (water is being removed from storage) and will rise in others (water is being added to storage).

- Lateral flow—describes lateral flow within an aquifer between a county and adjacent counties.

- Rivers and Streams—water that flows between perennial streams and rivers and an aquifer. The direction and amount of flow depends on the water level in the stream or river and the aquifer. In areas where water levels in the stream or river are above the water level in the aquifer, water flows into the aquifer and out of the stream and is shown as "Inflow" in the budget. In areas where water levels in the aquifer are above the water level in the stream or river, water flows out of the aquifer and into the stream and is shown as "Outflow" in the budget. Rivers and streams are modeled using the MODFLOW Stream package.

- Inter-aquifer Flow—The model uses general-head boundaries to simulate the movement of water between the Edwards or Trinity aquifer units and adjacent aquifers, including the Ogallala, Dockum, Edwards (Balcones Fault Zone), and Llano Uplift area aquifers.

The results of the model run are described for the individual aquifers units, the Edwards and associated limestones (Layer 1) and the undifferentiated Trinity unit (Layer 2). The Pecos Valley Aquifer is included in Layer 1.

Water levels from the end of the transient calibration portion of the model run (the end of 2000) for Layers 1 and 2 are shown in Figures 1 and 2, respectively. These figures show the starting water levels for the 50-year predictive portion of the model run.

Water levels at the end of the 50-year predictive portion of the simulation for Layers 1 and 2 are shown in Figures 3 and 4, respectively. Water levels at the end of the 50-year runs are similar to initial water levels (Figures 1 and 2), except that water levels in Layer 2 for Glasscock and Reagan counties are obviously lower at the end of the 50-year predictive portion of the run (Figure 4). Because differences between initial water levels and water levels after 50 years of pumpage are sometimes difficult to discern in these figures, maps of water level changes were made. A water level change map shows the difference between the water levels at the end of the historic portion of the model run (2000) and the water levels at the end of the 50-year predictive portion of the model run.

Water level changes over the 50-year predictive portion of the model simulation for Layers 1 and 2 are shown in Figures 5 and 6, respectively. Figure 5 indicates that water levels in Layer 1 (Edwards and associated limestones and the Pecos Valley Aquifer) show mainly decreases in water levels over the 50-year predictive portion of the run ranging up to 70 feet of decline over 50 years. Very few areas in Layer 1 show water level recovery.

Figure 6 indicates that water levels in Layer 2 (Trinity) decrease throughout most of the region, mostly less than 25 feet. However a very large cone of depression centered in

Glasscock and Reagan counties that is present at the end of the historic portion of the model run (Figure 2) continues to deepen, with the model predicting up to an additional 600 feet of decline in this area over the 50-year predictive time period. Because this appeared to be a very large drawdown for a baseline run that used a constant pumpage based on historic estimated pumpage totals, the model response in this area was evaluated. It was determined that the model did not simulate the response of water levels in this area appropriately during model calibration, and in fact water level declines during the historic calibration-verification time period were much lower than the model simulated water level declines. While using the model results without consideration of this could be viewed as taking a conservative approach, the water level declines predicted by the model are so great that we recommend taking another approach to evaluate the desired future conditions in this area, especially if a “managed depletion” approach to aquifer management is being considered.

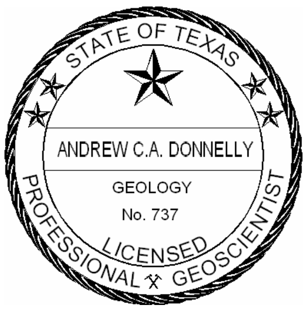
Another change in water levels that can be observed in Figure 6 is an area of increasing water levels centered in Blanco, Hays, and Kendall counties. The reason for this increase is not known at this time and will require further evaluation, but it occurs primarily outside of the Groundwater Management Area 7 boundaries. This area is also included in the groundwater availability model for the Trinity Hill Country Aquifer, which may be a better tool for evaluating aquifer conditions in this area than the groundwater availability model for the Edwards-Trinity (Plateau) Aquifer.

Because some of the desired future conditions for the groundwater management area may be based on discharge to springs or baseflow to rivers and streams, we also evaluated the water budgets for each of these components for each county in the model area. These budgets are provided in Appendix A. The components of the water budget are divided up into “In” and “Out”, representing water that is coming into and leaving from the budget. As might be expected, water from wells is only in the “Out” column, representing water that is removed from the aquifer from wells. Likewise, recharge is only found in the “In” column. Streams and rivers, however, have values in both the “In” and “Out” columns. This is because some stream reaches lose water to the aquifer, and some gain water from the aquifer depending on the water levels in the aquifer. Also included in these budgets are values for vertical leakage to overlying and underlying formations as well as lateral inflow from adjacent counties. Future model runs can be compared to these budgets to determine the impact of additional pumpage compared to this baseline run.

REFERENCES:

Anaya, R., and Jones, I., 2004, Groundwater availability model for the Edwards-Trinity (Plateau) and Cenozoic Pecos Alluvium aquifer systems, Texas: Texas Water Development Board, GAM Report, 208 p.

Donnelly, A.C.A., 2007, GAM Run 07-03, Texas Water Development Board GAM Run Report, 49 p.



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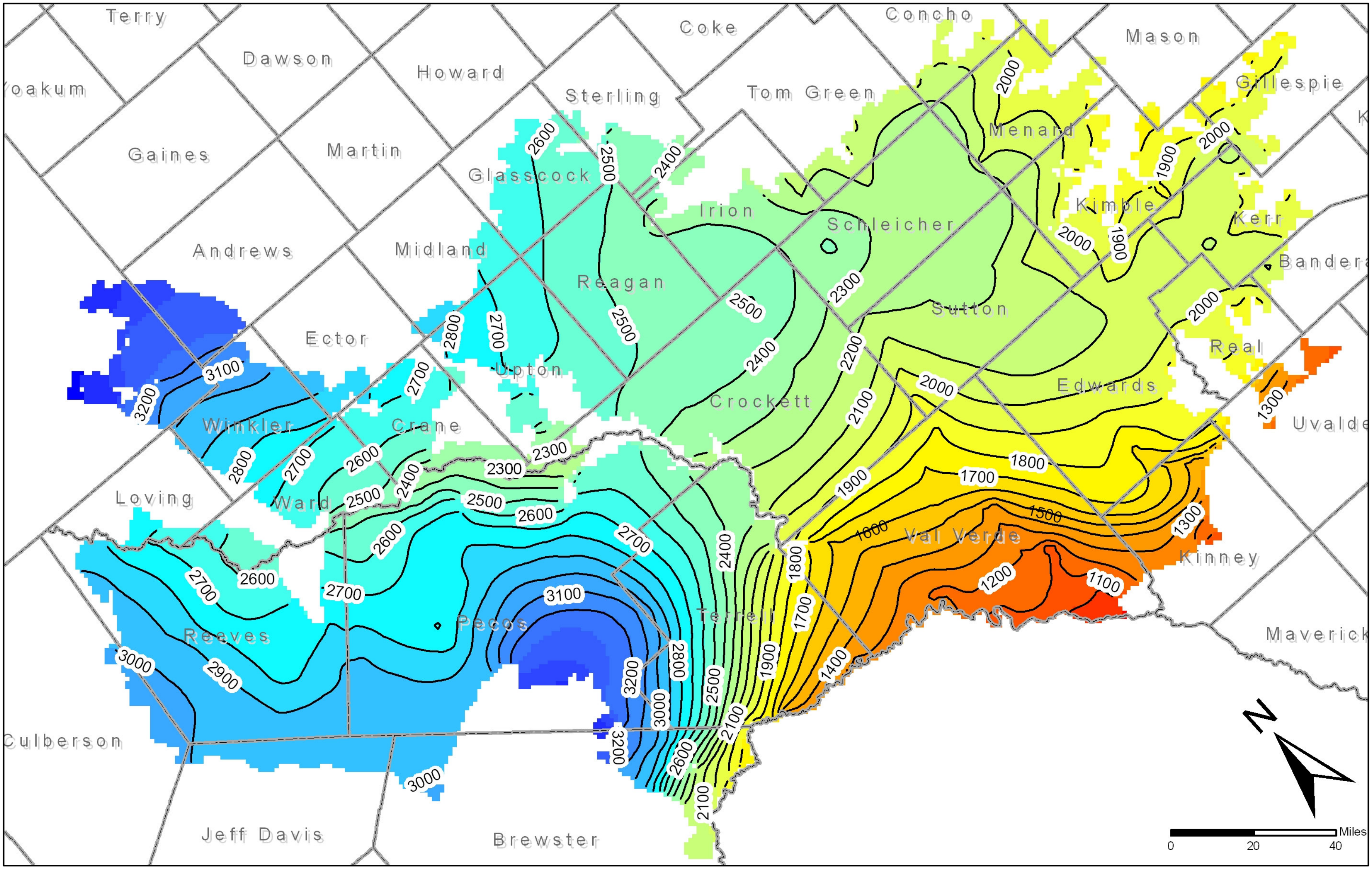


Figure 1. Initial water level elevations for the predictive model run in Layer 1 (Edwards and associated limestones and the Pecos Valley Aquifer) of the groundwater availability model for Edwards- Trinity (Plateau) Aquifer. Water level elevations are in feet above mean sea level. Contour interval is 100 feet.

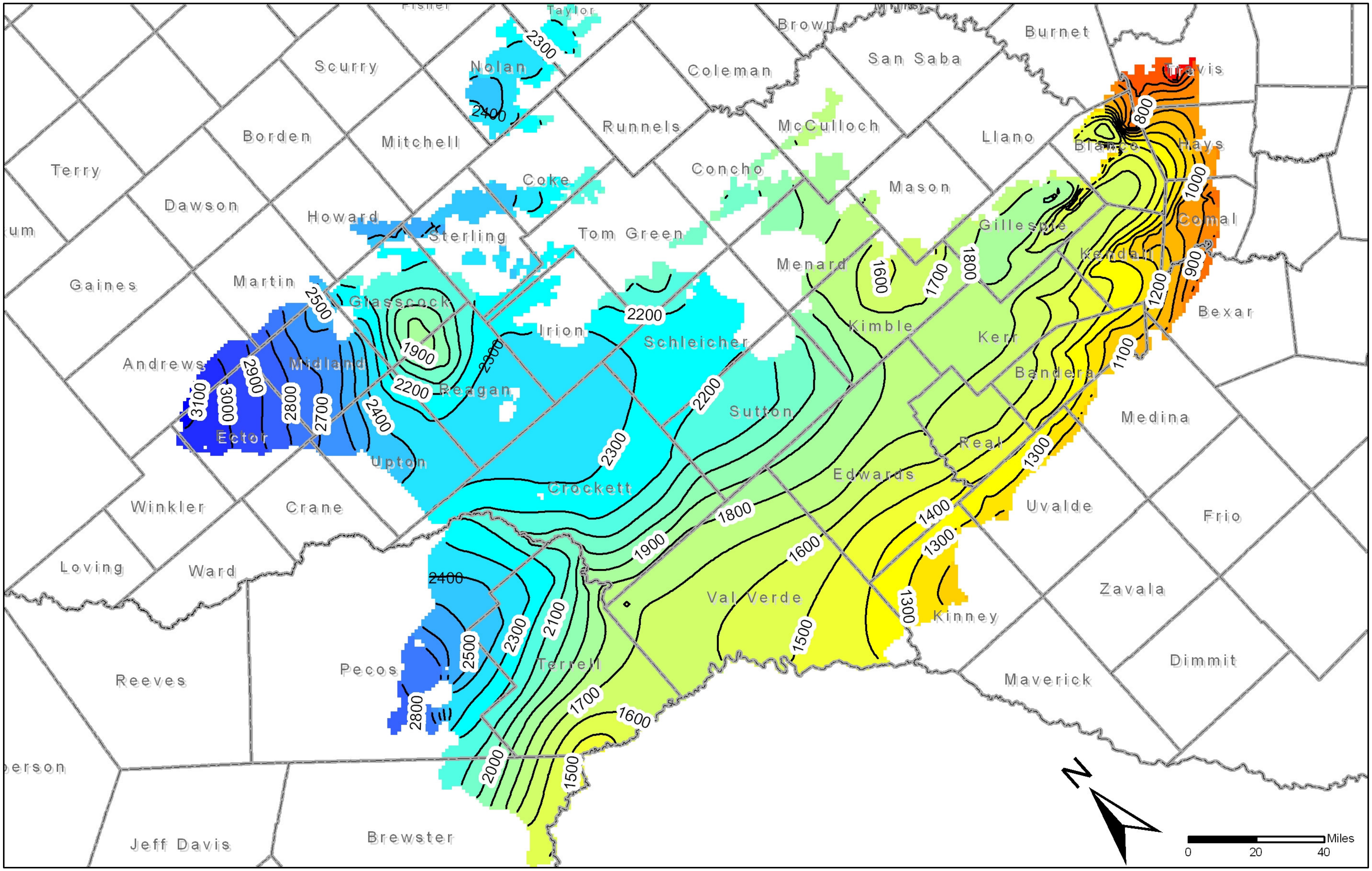


Figure 2. Initial water level elevations for the predictive model run in Layer 1 (Trinity Aquifer) of the groundwater availability model for Edwards- Trinity (Plateau) Aquifer. Water level elevations are in feet above mean sea level. Contour interval is 100 feet.

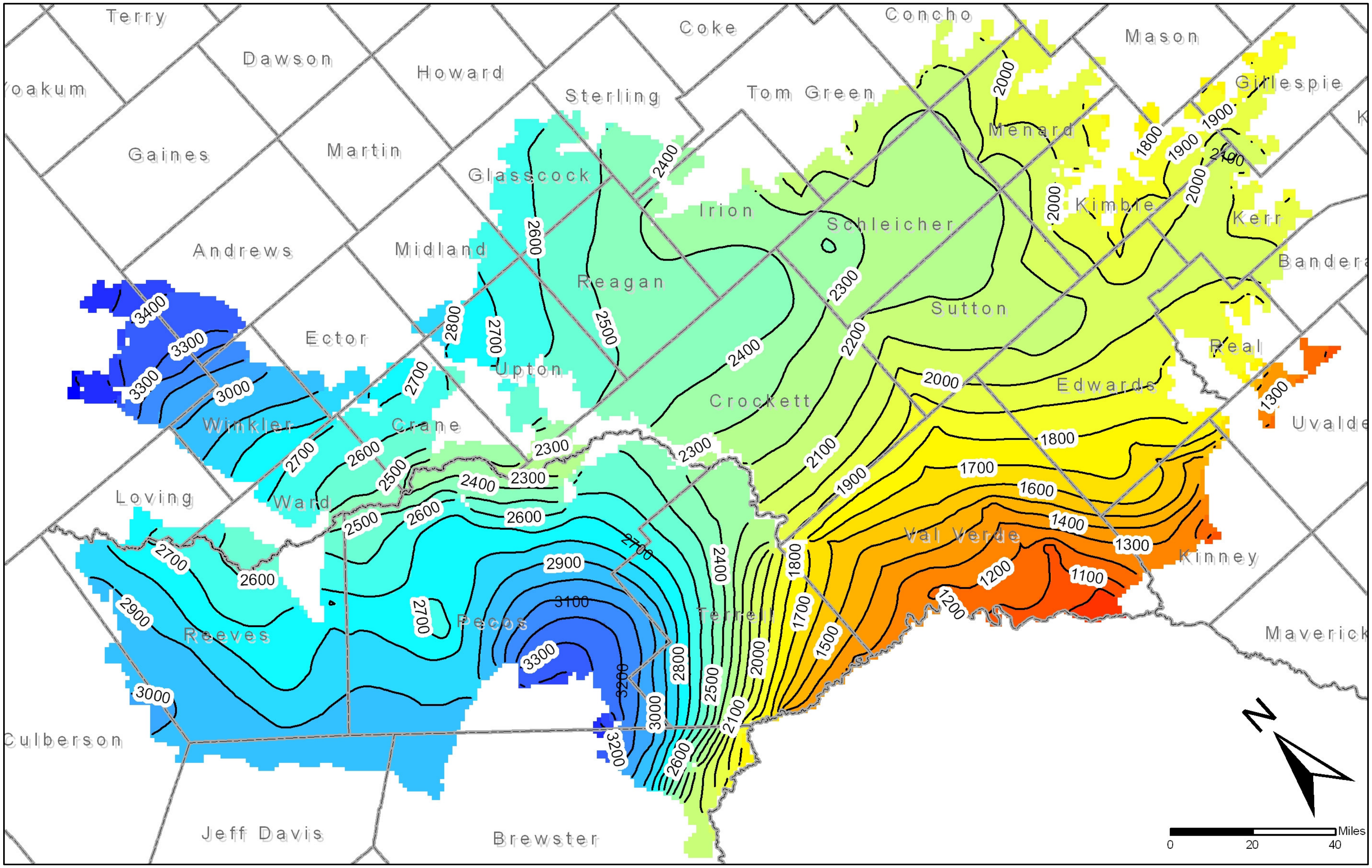


Figure 3. Water level elevations after 50 years using baseline pumpage in Layer 1 (Edwards and associated limestones and the Pecos Valley Aquifer). Water level elevations are in feet above mean sea level. Contour interval is 100 feet.

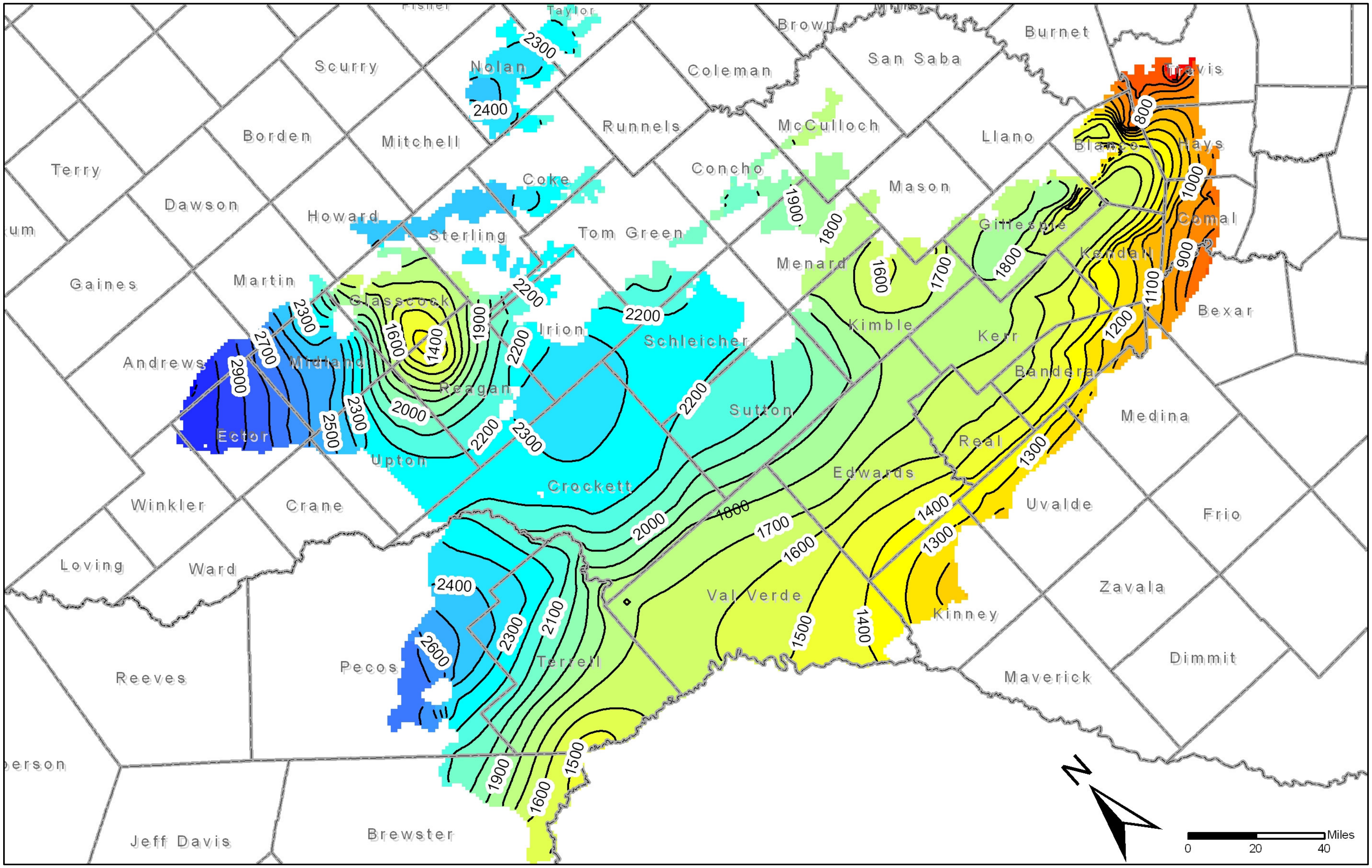


Figure 4. Water level elevations after 50 years using baseline pumpage in Layer 2 (Trinity Aquifer). Water level elevations are in feet above mean sea level. Contour interval is 100 feet.

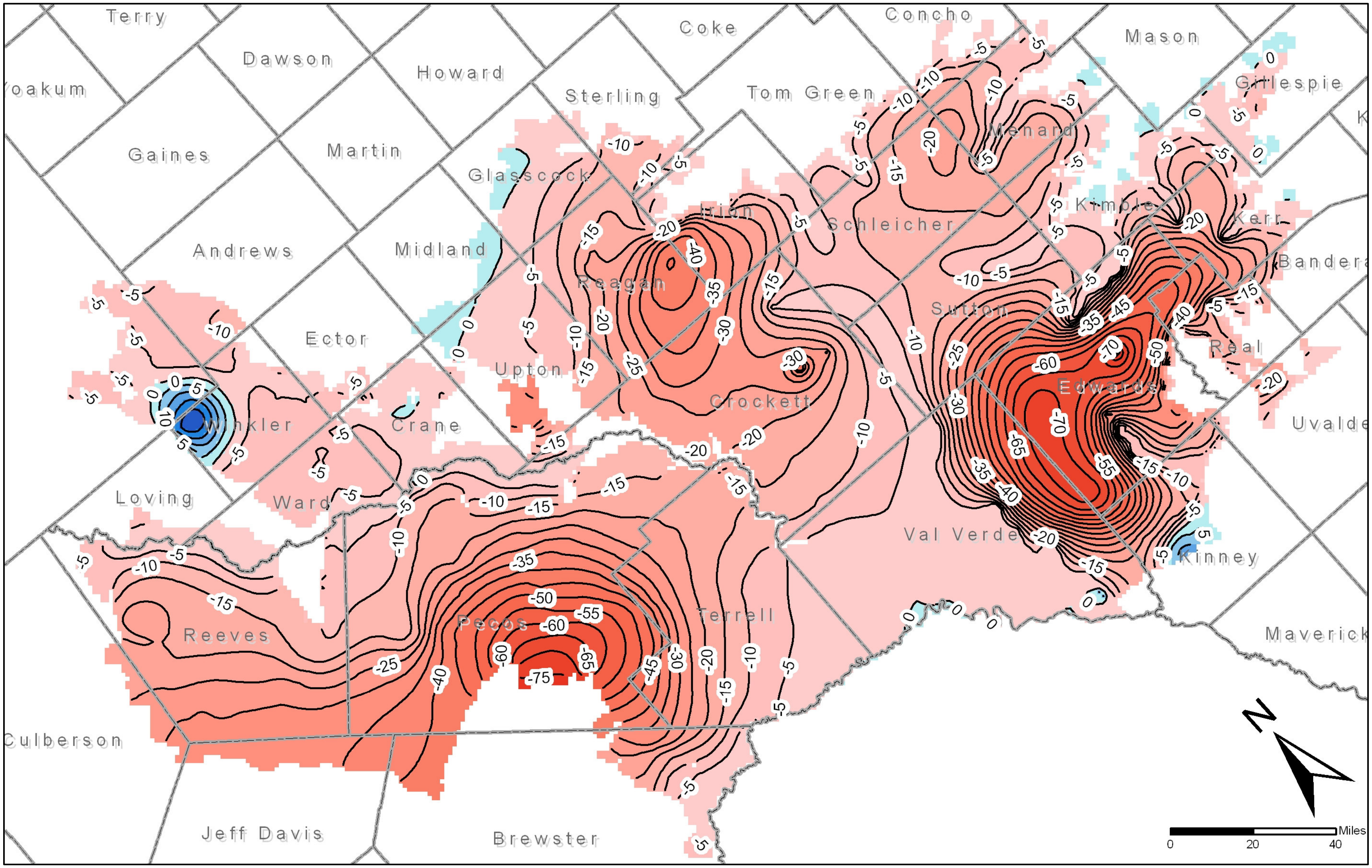


Figure 5. Changes in water levels after 50 years using baseline pumpage in Layer 1. Drawdowns are in feet. Contour interval is 5 feet. Decreases in water levels (drawdowns) are shown in red. Increases in water levels are shown in blue.

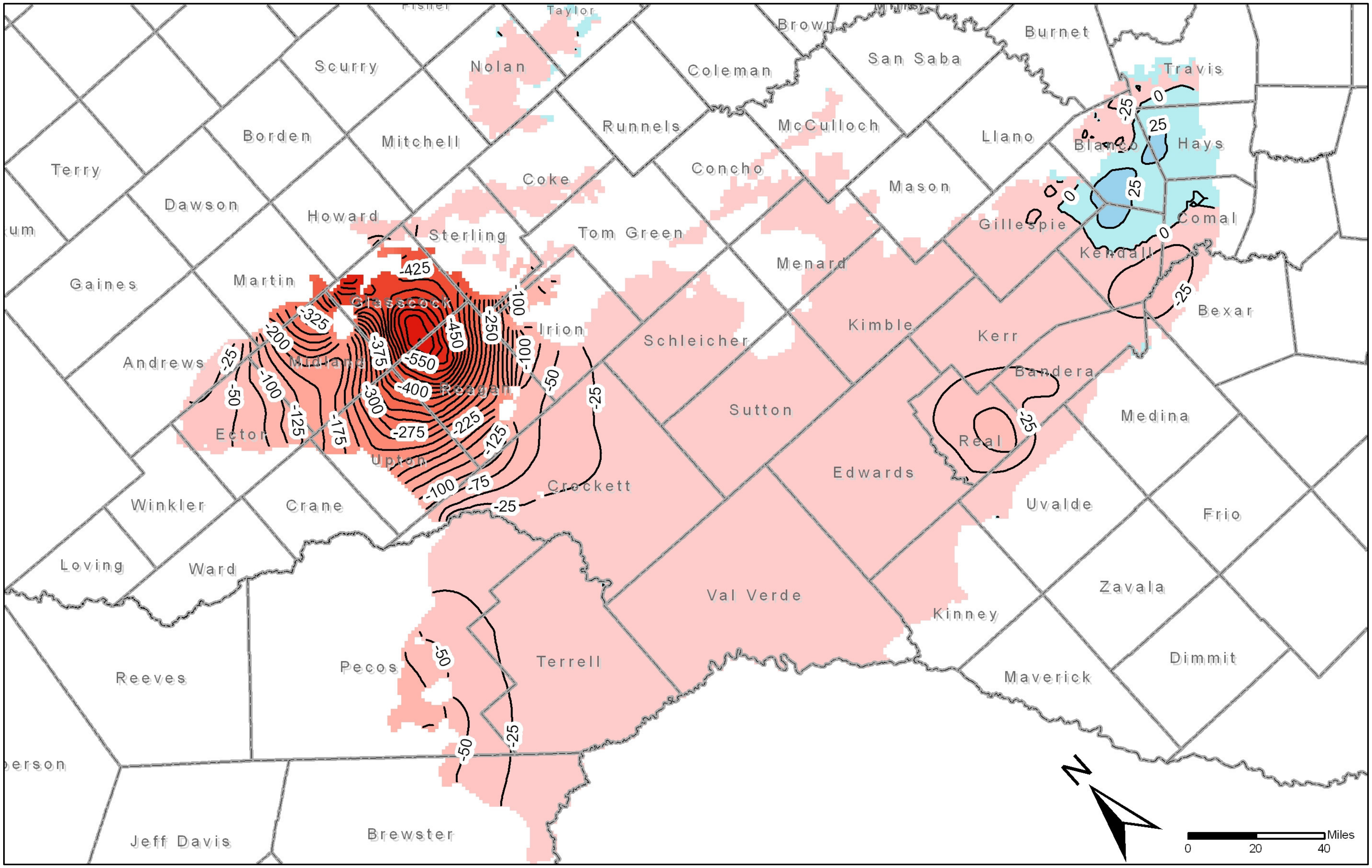


Figure 6. Changes in water levels after 50 years using baseline pumpage in Layer 2 (Trinity Aquifer). Drawdowns are in feet. Contour interval is 25 feet. Decreases in water levels (drawdowns) are shown in red. Increases in water levels are shown in blue.

Table A-1. Annual water budgets for each county at the end of the 50-year predictive portion of the model run using the requested pumpage and drought-of-record recharge in the groundwater availability model for the Edwards-Trinity (Plateau) Aquifer (in acre-feet per year).

	Andrews		Bandera		Bexar		Blanco		Brewster		Burnet	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Edwards and Pecos Valley Aquifer (Layer 1)												
Reservoirs (Constant Head Cells)	0	0	0	0	--	--	--	--	0	0	--	--
Storage	1,201	0	0	94	--	--	--	--	4,296	0	--	--
Springs and Seeps (Drain Package)	0	0	0	1,627	--	--	--	--	0	21,844	--	--
Inter-aquifer Flow (GHB Package)	0	1,266	0	0	--	--	--	--	0	0	--	--
Wells	0	60	0	28	--	--	--	--	0	85	--	--
Streams and Rivers (Stream Package)	0	0	3,549	772	--	--	--	--	0	0	--	--
Recharge	1,377	0	1,259	0	--	--	--	--	14,193	0	--	--
Lateral Inflow	851	2,113	691	2,895	--	--	--	--	6,983	3,751	--	--
Vertical Leakage Downward	--	--	5	83	--	--	--	--	1,236	1,076	--	--
Trinity (Layer 2)												
Reservoirs (Constant Head Cells)	0	0	526	1,871	0	0	0	0	0	0	0	529
Storage	254	2	3,987	444	0	311	6,554	1,552	1,071	72	0	93
Springs and Seeps (Drain Package)	0	0	0	0	0	0	0	12,615	0	0	0	668
Inter-aquifer Flow (GHB Package)	3,260	864	0	2,243	0	21,710	0	7	0	0	0	0
Wells	0	8	0	2,303	0	2,399	0	744	0	588	0	114
Streams and Rivers (Stream Package)	0	0	4,372	22,053	0	0	0	9,601	1,608	12,395	0	0
Recharge	2,982	0	35,898	0	11,321	0	33,319	0	4,315	0	1,391	0
Vertical Leakage Upward	--	--	83	5	--	--	--	--	1,076	1,236	--	--
Lateral Inflow	294	5,919	15,445	31,374	18,126	5,011	5,094	20,452	6,204	0	1,208	1,190

Table A-1. (continued)

	Coke		Comal		Concho		Crane		Crockett		Culberson	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Edwards and Pecos Valley Aquifer (Layer 1)												
Reservoirs (Constant Head Cells)	--	--	--	--	0	0	0	0	0	0	0	0
Storage	--	--	--	--	559	67	2,807	10	12,261	17	1,429	0
Springs and Seeps (Drain Package)	--	--	--	--	0	4,077	0	0	0	0	0	0
Inter-aquifer Flow (GHB Package)	--	--	--	--	0	0	89	1,809	0	42	66	439
Wells	--	--	--	--	0	108	0	552	0	4,794	0	37
Streams and Rivers (Stream Package)	--	--	--	--	0	0	59	7,681	9,874	5,185	0	0
Recharge	--	--	--	--	3,514	0	3,920	0	30,263	0	1,647	0
Lateral Inflow	--	--	--	--	2,469	1,584	5,147	1,994	9,363	32,320	637	3,316
Vertical Leakage Downward	--	--	--	--	7	711	--	--	292	19,832	--	--
Trinity (Layer 2)												
Reservoirs (Constant Head Cells)	0	0	7,339	5,007	0	0	0	0	0	0	--	--
Storage	949	0	0	437	182	105	73	0	1,421	0	--	--
Springs and Seeps (Drain Package)	0	4,557	0	0	0	2,474	0	0	0	0	--	--
Inter-aquifer Flow (GHB Package)	0	53	2,800	8,556	0	20	3	3	0	3,463	--	--
Wells	0	21	0	3,059	0	169	0	5	0	698	--	--
Streams and Rivers (Stream Package)	0	0	873	22,203	0	0	0	0	196	11,583	--	--
Recharge	2,963	0	18,227	0	2,395	0	101	0	1,471	0	--	--
Vertical Leakage Upward	--	--	--	--	711	7	--	--	19,832	292	--	--
Lateral Inflow	1,138	432	18,981	8,867	781	1,302	900	1,070	7,975	14,902	--	--

Table A-1. (continued)

	Ector		Edwards		Gillespie		Glasscock		Hays		Howard	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Edwards and Pecos Valley Aquifer (Layer 1)												
Reservoirs (Constant Head Cells)	0	0	0	0	0	0	0	0	--	--	--	--
Storage	673	1	0	2,987	0	908	412	0	--	--	--	--
Springs and Seeps (Drain Package)	0	0	0	2,783	0	7,937	0	833	--	--	--	--
Inter-aquifer Flow (GHB Package)	0	432	0	0	0	0	0	0	--	--	--	--
Wells	0	48	0	7,049	0	616	0	54	--	--	--	--
Streams and Rivers (Stream Package)	0	0	14,288	19,543	1,091	1,096	0	0	--	--	--	--
Recharge	539	0	55,471	0	8,698	0	5,696	0	--	--	--	--
Lateral Inflow	336	1,057	8,578	41,283	3,611	1,883	540	1,978	--	--	--	--
Vertical Leakage Downward	0	14	19	3,794	519	1,492	362	4,063	--	--	--	--
Trinity (Layer 2)												
Reservoirs (Constant Head Cells)	0	0	0	0	0	0	0	0	0	0	0	0
Storage	3,547	0	1,092	36	864	2,173	11,966	0	6,794	194	282	0
Springs and Seeps (Drain Package)	0	0	0	0	0	6,161	0	0	0	0	0	0
Inter-aquifer Flow (GHB Package)	11	2,578	0	0	0	7	16,611	66	0	15,003	785	24
Wells	0	5,489	0	745	0	3,354	0	59,226	0	2,818	0	585
Streams and Rivers (Stream Package)	0	0	3,092	331	3,295	18,389	0	0	0	3,033	0	0
Recharge	8,978	0	2,412	0	31,164	0	3,036	0	21,262	0	922	0
Vertical Leakage Upward	14	0	3,794	19	1,492	519	4,063	362	--	--	--	--
Lateral Inflow	3,473	8,004	11,964	21,234	1,401	7,174	34,312	10,576	7,074	14,118	226	1,609

Table A-1. (continued)

	Irion		Jeff Davis		Kendall		Kerr		Kimble		Kinney	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Edwards and Pecos Valley Aquifer (Layer 1)												
Reservoirs (Constant Head Cells)	0	0	0	0	--	--	0	0	0	0	0	0
Storage	311	87	1,466	0	--	--	0	1,544	9	1,836	1,998	948
Springs and Seeps (Drain Package)	0	4,992	0	0	--	--	0	7,095	0	18,340	0	7,143
Inter-aquifer Flow (GHB Package)	0	0	11	12	--	--	0	0	0	0	0	12,064
Wells	0	232	0	141	--	--	0	559	0	251	0	4,148
Streams and Rivers (Stream Package)	690	4,312	0	0	--	--	8,526	4,702	1,247	3,574	1,268	13,150
Recharge	9,091	0	4,382	0	--	--	15,116	0	19,947	0	34,642	0
Lateral Inflow	6,724	2,066	1,918	7,644	--	--	3,505	11,965	16,388	6,471	15,693	13,613
Vertical Leakage Downward	266	5,388	--	--	--	--	9	1,211	66	7,134	8	885
Trinity (Layer 2)												
Reservoirs (Constant Head Cells)	0	0	--	--	0	0	0	0	0	0	0	0
Storage	962	0	--	--	4,637	697	3,576	661	803	359	116	16
Springs and Seeps (Drain Package)	0	1,186	--	--	0	0	0	0	0	4,284	0	0
Inter-aquifer Flow (GHB Package)	637	548	--	--	0	0	0	0	0	0	28	12,724
Wells	0	200	--	--	0	3,515	0	3,622	0	592	0	2,684
Streams and Rivers (Stream Package)	0	0	--	--	1,031	28,737	3,515	14,066	7,013	23,850	0	0
Recharge	1,243	0	--	--	33,048	0	21,387	0	5,813	0	939	0
Vertical Leakage Upward	5,388	266	--	--	--	--	1,211	9	7,134	66	885	8
Lateral Inflow	3,230	9,299	--	--	9,907	15,613	6,395	17,671	11,860	3,368	15,199	1,734

Table A-1. (continued)

	Loving		Martin		Mason		McCulloch		Medina		Menard	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Edwards and Pecos Valley Aquifer (Layer 1)												
Reservoirs (Constant Head Cells)	0	0	--	--	0	0	0	0	--	--	0	0
Storage	525	79	--	--	0	51	0	50	--	--	1,620	354
Springs and Seeps (Drain Package)	0	0	--	--	0	673	0	563	--	--	0	3,576
Inter-aquifer Flow (GHB Package)	2	163	--	--	0	0	0	0	--	--	0	0
Wells	0	32	--	--	0	0	0	2	--	--	0	927
Streams and Rivers (Stream Package)	962	1,814	--	--	0	0	0	0	--	--	0	10,290
Recharge	452	0	--	--	697	0	528	0	--	--	13,251	0
Lateral Inflow	1,862	1,719	--	--	324	214	270	75	--	--	7,538	4,458
Vertical Leakage Downward	--	--	--	--	17	99	23	130	--	--	7	2,821
Trinity (Layer 2)												
Reservoirs (Constant Head Cells)	--	--	0	0	0	0	0	0	590	595	0	0
Storage	--	--	1,087	0	7	115	9	744	862	34	892	31
Springs and Seeps (Drain Package)	--	--	0	0	0	2,074	0	4,672	0	0	0	1,154
Inter-aquifer Flow (GHB Package)	--	--	1,762	83	0	0	0	320	0	25,096	0	0
Wells	--	--	0	94	0	3	0	29	0	69	0	918
Streams and Rivers (Stream Package)	--	--	0	0	0	0	0	0	0	0	711	1,292
Recharge	--	--	2,051	0	1,218	0	4,529	0	5,850	0	2,202	0
Vertical Leakage Upward	--	--	--	--	99	17	130	23	--	--	2,821	7
Lateral Inflow	--	--	4,849	9,584	1,733	846	1,381	254	23,695	5,208	1,457	4,689

Table A-1. (continued)

	Midland		Nolan		Pecos		Reagan		Real		Reeves	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Edwards and Pecos Valley Aquifer (Layer 1)												
Reservoirs (Constant Head Cells)	0	0	--	--	0	0	0	0	0	0	0	0
Storage	10	15	--	--	51,713	82	231	159	0	770	85,900	14
Springs and Seeps (Drain Package)	0	0	--	--	0	0	0	474	0	6,233	0	0
Inter-aquifer Flow (GHB Package)	0	0	--	--	34	5,089	0	0	0	0	208	4,168
Wells	0	3	--	--	0	83,272	0	1,001	0	2,844	0	107,747
Streams and Rivers (Stream Package)	0	0	--	--	169	18,608	0	0	259	3,834	977	35,261
Recharge	1,776	0	--	--	106,399	0	12,492	0	9,799	0	56,111	0
Lateral Inflow	185	980	--	--	14,754	46,909	4,150	2,783	6,458	2,328	14,882	11,728
Vertical Leakage Downward	177	1,132	--	--	1,817	21,458	316	12,711	49	532	--	--
Trinity (Layer 2)												
Reservoirs (Constant Head Cells)	0	0	0	0	0	0	0	0	0	0	--	--
Storage	25,128	0	636	112	4,628	48	10,705	0	858	44	--	--
Springs and Seeps (Drain Package)	0	0	0	8,395	0	0	0	0	0	0	--	--
Inter-aquifer Flow (GHB Package)	2,740	765	0	0	0	0	14,327	235	0	0	--	--
Wells	0	21,137	0	151	0	2,236	0	60,815	0	8,680	--	--
Streams and Rivers (Stream Package)	0	0	0	0	0	16,817	0	0	8,413	446	--	--
Recharge	10,617	0	8,891	0	5,318	0	11	0	7,023	0	--	--
Vertical Leakage Upward	1,132	177	--	--	21,458	1,817	12,711	316	532	49	--	--
Lateral Inflow	19,293	37,104	162	1,037	10,499	21,079	37,333	13,930	9,793	17,365	--	--

Table A-1. (continued)

	Schleicher		Sterling		Sutton		Taylor		Terrell		Tom Green	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Edwards and Pecos Valley Aquifer (Layer 1)												
Reservoirs (Constant Head Cells)	0	0	0	0	0	0	--	--	0	0	0	0
Storage	4,411	8	106	0	3,701	293	--	--	13,176	0	756	4
Springs and Seeps (Drain Package)	0	0	0	1,626	0	0	--	--	0	4,247	0	7,267
Inter-aquifer Flow (GHB Package)	0	0	0	0	0	0	--	--	0	0	0	0
Wells	0	3,723	0	82	0	3,425	--	--	0	308	0	159
Streams and Rivers (Stream Package)	8,928	6,397	0	0	4,411	21,917	--	--	182	33,164	0	1,041
Recharge	16,970	0	2,231	0	20,413	0	--	--	28,859	0	5,254	0
Lateral Inflow	4,450	19,452	1,017	1,112	16,838	14,088	--	--	43,624	33,495	6,710	2,533
Vertical Leakage Downward	11	5,247	266	772	719	6,396	--	--	318	15,107	8	1,721
Trinity (Layer 2)												
Reservoirs (Constant Head Cells)	0	0	0	0	0	0	0	0	0	0	0	0
Storage	84	0	1,185	0	516	0	0	369	1,346	0	207	27
Springs and Seeps (Drain Package)	0	0	0	1,266	0	0	0	3,951	0	0	0	3,579
Inter-aquifer Flow (GHB Package)	0	0	993	1,153	0	0	0	0	0	0	196	32
Wells	0	9	0	293	0	20	0	117	0	724	0	582
Streams and Rivers (Stream Package)	0	0	0	0	371	0	0	0	149	19,156	211	3,169
Recharge	0	0	2,974	0	0	0	4,089	0	429	0	2,126	0
Vertical Leakage Upward	5,247	11	772	266	6,396	719	--	--	15,107	318	1,721	8
Lateral Inflow	2,114	7,429	2,545	5,524	5,502	12,055	443	89	19,843	16,714	7,214	4,292

Table A-1. (continued)

	Travis		Upton		Uvalde		Val Verde		Ward		Winkler	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Edwards and Pecos Valley Aquifer (Layer 1)												
Reservoirs (Constant Head Cells)	--	--	0	0	0	0	17,280	47,301	0	0	0	0
Storage	--	--	1,036	563	0	139	3,965	491	4,568	17	4,011	628
Springs and Seeps (Drain Package)	--	--	0	0	0	2,125	0	758	0	0	0	0
Inter-aquifer Flow (GHB Package)	--	--	5	862	0	5,783	0	0	2	4,802	0	3,683
Wells	--	--	0	337	0	241	0	14,405	0	5,821	0	558
Streams and Rivers (Stream Package)	--	--	0	0	0	0	28,551	112,493	433	12,511	0	0
Recharge	--	--	10,264	0	5,809	0	57,067	0	4,754	0	3,458	0
Lateral Inflow	--	--	1,049	4,876	2,864	1,197	74,006	8,571	17,733	4,383	5,056	7,691
Vertical Leakage Downward	--	--	286	5,981	849	32	3,443	613	--	--	--	--
Trinity (Layer 2)												
Reservoirs (Constant Head Cells)	3,729	30,406	0	0	0	0	0	0	--	--	0	0
Storage	1,915	202	8,415	0	559	115	578	0	--	--	44	0
Springs and Seeps (Drain Package)	0	0	0	0	0	0	0	0	--	--	0	0
Inter-aquifer Flow (GHB Package)	13,237	348	7,564	47	997	21,566	0	0	--	--	0	23
Wells	0	1,721	0	20,266	0	501	0	157	--	--	0	1
Streams and Rivers (Stream Package)	7	6,258	0	0	2,990	15,900	13	1,871	--	--	0	0
Recharge	10,468	0	1,883	0	15,525	0	98	0	--	--	81	0
Vertical Leakage Upward	--	--	5,981	286	32	849	613	3,443	--	--	--	--
Lateral Inflow	9,610	30	17,630	21,025	24,572	5,730	11,753	7,599	--	--	49	150

ATTACHMENT F

GAM Run 07-37

by Kan Tu, Ph.D., P.G.
Texas Water Development Board
Groundwater Availability Modeling Section
(512) 463-2132
April 9, 2008

EXECUTIVE SUMMARY:

We ran the groundwater availability model for the Edwards-Trinity (Plateau) Aquifer for a 71-year simulation, which consisted of 20 years (1980-1999) of historic conditions followed by a 51-year (2000-2050) predictive time period. Average recharge conditions were used for the entire 51 years of the predictive portion of the simulation. The pumpage used in this simulation was based on the groundwater availability estimates from the 2007 State Water Plan and baseline pumpage discussed in GAM Run 07-03 (Donnelly, 2007).

Results of this model run indicate that water-level declines after 51 years range from 50 feet to 100 feet for most counties in the model area. This mainly resulted from the increase in pumpage from the baseline pumpage that was approved by the Groundwater Management Area 7 and used in the previous GAM Run 07-03 (Donnelly, 2007). Extreme drawdowns (up to 600 feet) in Pecos, Glasscock, and Reagan counties in the Trinity part of the Edwards-Trinity (Plateau) Aquifer were predicted by the model at the end of 51 years, but research into the model performance during the calibration time period indicates that the model is not appropriately simulating the response of the Trinity Aquifer to pumpage in these areas (Donnelly, 2007). It is recommended that this model not be used to evaluate groundwater conditions in Pecos, Glasscock, and Reagan counties.

REQUESTOR:

Ms. Caroline Runge from the Menard County Underground Water Conservation District (on behalf of Groundwater Management Area 7).

DESCRIPTION OF REQUEST:

Ms. Runge asked for a new model run using the groundwater availability model for the Edwards-Trinity (Plateau) Aquifer. This model run would be a 71-year simulation, with the first 20 years being the historic portion of the simulation followed by a 51-year predictive period. Average recharge conditions were used for the predictive portion of the simulation. Each year of the predictive portion of the simulation would use a specified pumpage based on groundwater availability estimates from the 2007 State Water Plan and pumpage approved by members of Groundwater Management Area 7.

METHODS:

Recharge and initial streamflow were averaged for the 1961 to 1990 time period. These averages were then used in the 51-year predictive portion of the model simulation along with adjustments to the baseline pumpage to reflect availability estimates from the 2007 State Water Plan. Resulting water levels and drawdowns using 1999 water levels as a baseline were then evaluated and are described in the Results section below.

PARAMETERS AND ASSUMPTIONS:

The groundwater availability model for the Edwards-Trinity (Plateau) Aquifer was used for this model run. The parameters and assumptions for this model are described below:

- We used version 1.01 of the groundwater availability model of the Edwards-Trinity (Plateau) Aquifer, which includes the Pecos Valley Aquifer (formerly known as the Cenozoic Pecos Alluvium Aquifer). See Anaya and Jones (2004) for assumptions and limitations of the model.

- The root mean squared error (a measure of the difference between simulated and actual water levels during model calibration) in the entire Edwards-Trinity (Plateau) and Pecos Valley (formerly the Cenozoic Pecos Alluvium) groundwater availability model for the period of 1990 to 2000 is 143 feet, or six percent of the range of measured water levels (Anaya and Jones, 2004).

- The model includes two layers, representing the Edwards and associated limestones (Layer 1) and undifferentiated Trinity units (Layer 2). The Pecos Valley Aquifer is included in Layer 1 of the model.

- The model run was 71 years in length. The first 20 years were the historic calibration-verification portion of the simulation, followed by a 51-year predictive period.

- The groundwater availability model simulates discharge to springs and seeps mostly along the northern and eastern margins of the aquifer. Spring and seep parameters used in the model are from the calibrated model.

- Recharge was distributed in the groundwater availability model based on a percent of annual precipitation and aquifer outcrop (surface geology).

- The groundwater availability model simulates the interaction between the aquifer(s) and major streams and rivers flowing in the region. Flow both from the stream to the aquifer and from the aquifer to the stream is allowed, and the direction of flow is determined by the water levels in the aquifer and the surface water elevation of the stream during each stress period in the simulation. The stream parameters, including streambed conductance and initial flow values, used in the model are from the calibrated model.

- The groundwater availability model uses general head boundary cells to simulate cross-formational groundwater flow between the Edwards-Trinity (Plateau) and adjacent aquifers, including the Ogallala, Dockum, Edwards (Balcones Fault Zone), and Llano Uplift area aquifers. Parameters assigned to the general head boundary cells such as aquifer conductance and water levels were from the calibrated model.

- We used Groundwater Vistas Version 5 as the interface to process model output.

Specified Pumpage

The pumpage for this model run considered the individual county groundwater availability estimates from the 2007 State Water Plan. The baseline pumpage approved by the Groundwater Management Area 7 and used in GAM Run 07-03 (Donnelly, 2007) was used as the basis for generating the new pumpage data set. The following modifications were made to the GAM Run 07-03 (Donnelly, 2007) baseline pumpage to create the specified pumpage used in this simulation.

- The baseline pumpage totals were increased in most counties in the model area. The total amount of pumpage used in each county in this simulation is shown in Tables 1 and 2. For each county, the higher pumpage of either the 2007 State Water Plan or the GAM Run 07-03 (Donnelly, 2007) baseline pumpage was determined for this specified pumpage. In addition, Groundwater Management Area 7 requested that 59,234 acre-feet per year of pumpage be used for Kinney County.

- For all counties listed in Table 1 the specified pumpage maintains the existing model spatial pumping distribution used in the baseline simulation discussed in GAM Run 07-03 (Donnelly, 2007). When the groundwater availability per aquifer and county from the 2007 State Water Plan value exceeded the baseline pumpage from GAM Run 07-03, then this additional amount of pumpage was evenly distributed among all cells that had pumpage in baseline GAM Run 07-03 (Donnelly, 2007) on a county-by-county and aquifer basis. This information is presented under the column 'Added Pumpage to Each Cell' in Table 1

- Pumpage was distributed in a slightly different manner in Crockett, Irion, Kimble, Kinney, Schleicher, Sutton, and Val Verde counties (Table 2). The additional Edwards-Trinity (Plateau) Aquifer pumpage was allocated proportionally to both model layer 1 and 2 based on the existing baseline pumpage distributions. For model layer 1 (the Edwards layer in the area of interest), the additional pumpage was evenly distributed among all cells that had existing pumpage in the GAM Run 07-03 (Donnelly, 2007) baseline run. However, for model layer 2 (the Trinity layer), the additional pumpage was assigned evenly across all active cells per county.

Table 1. The specified pumpage used in this model simulation in comparison with both GAM Run 07-03 (Donnelly, 2007) baseline pumpage and the groundwater availability numbers from the 2007 State Water Plan. All pumpage numbers are reported in acre-feet per year

County	Aquifer	GAM Run 07-03 baseline pumpage	2007 State Water Plan availability	Specified pumpage used in this run	Addition to baseline pumpage	Total number of well cells	Added pumpage to each cell
Andrews	Pecos Valley Aquifer	60	1,189	1,189	1,129	267	4
	Edwards-Trinity (Plateau) Aquifer	8	4,640	4,640	4,632	163	28
	Total	68	5,829	5,829	5,761	430	
Bandera	Edwards-Trinity (Plateau) Aquifer	327	17,310	17,310	16,983	242	70
	Trinity Aquifer	2,004	18,558	18,558	16,554	574	29
	Total	2,331	35,868	35,868	33,537	816	
Bexar	Trinity Aquifer	2,399	1,175	2,399	0	245	0
Blanco	Edwards-Trinity (Plateau) Aquifer	17	157	157	140	17	8
	Trinity Aquifer	727	1,600	1,600	873	535	2
	Total	744	1,757	1,757	1,013	552	
Brewster	Edwards-Trinity (Plateau) Aquifer	673	300	673	0	976	0
Burnet	Trinity Aquifer	114	2,550	2,550	2,436	23	106
Coke	Edwards-Trinity (Plateau) Aquifer	21	3,242	3,242	3,221	244	13
Comal	Trinity Aquifer	3,059	1,800	3,059	0	343	0
Concho	Edwards-Trinity (Plateau) Aquifer	277	12,278	12,278	12,001	348	34
Crane	Pecos Valley Aquifer	549	2,537	2,537	1,988	561	4
	Edwards-Trinity (Plateau) Aquifer	8	115	115	107	21	5
	Total	557	2,652	2,652	2,095	582	
Culberson	Edwards-Trinity (Plateau) Aquifer	37	55	55	18	142	0
Ector	Pecos Valley Aquifer	48	3,143	3,143	3,095	101	31
	Edwards-Trinity (Plateau) Aquifer	5,489	11,324	11,324	5,835	666	9
	Total	5,538	14,467	14,467	8,929	767	
Edwards	Edwards-Trinity (Plateau) Aquifer	7,794	8,699	8,699	905	2,239	0
Gillespie	Edwards-Trinity (Plateau) Aquifer	1,494	1,500	1,500	6	611	0
	Trinity Aquifer	2,476	3,400	3,400	924	366	3
	Total	3,970	4,900	4,900	930	977	

County	Aquifer	GAM Run 07-03 baseline pumpage	2007 State Water Plan availability	Specified pumpage used in this run	Addition to baseline pumpage	Total number of well cells	Added pumpage to each cell
Glasscock	Edwards-Trinity (Plateau) Aquifer	59,280	20,938	59,280	0	942	0
Hays	Trinity Aquifer	2,818	3,713	3,713	895	370	2
Howard	Edwards-Trinity (Plateau) Aquifer	585	1,700	1,700	1,115	72	15
Jeff Davis	Edwards-Trinity (Plateau) Aquifer	141	200	200	59	325	0
Kendall	Edwards-Trinity (Plateau) Aquifer	124	905	905	781	89	9
	Trinity Aquifer	3,391	3,935	3,935	544	576	1
	Total	3,515	4,840	4,840	1,325	665	
Kerr	Edwards-Trinity (Plateau) Aquifer	1,762	16,410	16,410	14,648	1,102	13
	Trinity Aquifer	2,419	17,324	17,324	14,905	278	54
	Total	4,181	33,734	33,734	29,553	1,380	
Loving	Edwards-Trinity (Plateau) Aquifer	32	4,363	4,363	4,331	98	44
Martin	Edwards-Trinity (Plateau) Aquifer	94	3,398	3,398	3,304	62	53
Mason	Edwards-Trinity (Plateau) Aquifer	3	3,828	3,828	3,825	91	42
McCulloch	Edwards-Trinity (Plateau) Aquifer	31	8,249	8,249	8,218	201	41
Medina	Trinity Aquifer	69	860	860	791	113	7
Menard	Edwards-Trinity (Plateau) Aquifer	1,844	19,000	19,000	17,156	962	18
Midland	Edwards-Trinity (Plateau) Aquifer	21,140	19,395	21,140	0	876	0
Nolan	Edwards-Trinity (Plateau) Aquifer	151	1,000	1,000	849	463	2
Pecos	Pecos Valley Aquifer	44,038	58,578	58,578	14,540	1,049	14
	Edwards-Trinity (Plateau) Aquifer	41,471	114,849	114,849	73,378	3,641	20
	Total	85,509	173,427	173,427	87,918	4,690	
Reagan	Edwards-Trinity (Plateau) Aquifer	61,816	31,235	61,816	0	1,769	0
Real	Edwards-Trinity (Plateau) Aquifer	11,375	5,737	11,375	0	734	0
	Trinity Aquifer	150	380	380	230	14	16
	Total	11,525	6,117	11,755	230	748	
Reeves	Pecos Valley	54,401	60,520	60,520	6,119	1,220	5
	Edwards-Trinity (Plateau) Aquifer	53,346	53,845	53,845	499	1,139	0
	Total	107,747	114,365	114,365	6,618	2,359	

County	Aquifer	GAM Run 07-03 baseline pumpage	2007 State Water Plan availability	Specified pumpage used in this run	Addition to baseline pumpage	Total number of well cells	Added pumpage to each cell
Sterling	Edwards-Trinity (Plateau) Aquifer	375	5,168	5,168	4,793	521	9
Taylor	Edwards-Trinity (Plateau) Aquifer	117	500	500	383	166	2
Terrell	Edwards-Trinity (Plateau) Aquifer	1,032	2,100	2,100	1,068	3,419	0
Tom Green	Edwards-Trinity (Plateau) Aquifer	741	15,037	15,037	14,296	601	24
Travis	Trinity Aquifer	1,721	3,900	3,900	2,179	186	12
Upton	Edwards-Trinity (Plateau) Aquifer	20,604	18,929	20,604	0	1,467	0
Uvalde	Edwards-Trinity (Plateau) Aquifer	566	3,185	3,185	2,619	323	8
	Trinity Aquifer	176	580	580	404	84	5
	Total	742	3,765	3,765	3,023	407	
Ward	Pecos Valley Aquifer	5,821	17,288	17,288	11,467	658	17
Winkler	Pecos Valley Aquifer	558	51,994	51,994	51,436	747	69
	Edwards-Trinity (Plateau) Aquifer	1	517	517	516	8	64
	Total	559	52,511	52,511	51,952	755	

Table 2. The specified pumpage used in this model simulation in comparison with GAM Run 07-03 (Donnelly, 2007) baseline pumpage and the groundwater availability numbers from the 2007 State Water Plan. All pumpage numbers are reported in acre-feet per year.

County	GAM Run 07-03 baseline pumpage	2007 State Water Plan availability	Addition to baseline pumpage	Model layer	Total number of active cells	Total number of well cells	Added pumpage
Crockett	5,493	25,460	19,967	Layer 1	2,662	2,560	17,429
				Layer 2	2,744	1,436	2,539
				Total	5,406	3,996	19,968
Irion	432	9,445	9,013	Layer 1	674	625	4,836
				Layer 2	664	387	4,177
				Total	1,338	1,012	9,013
Kimble	843	23,965	23,122	Layer 1	943	858	6,888
				Layer 2	1,197	952	16,235
				Total	2,140	1,810	23,122
Kinney	6,832	59,234	52,402	Layer 1	556	529	31,817
				Layer 2	564	211	20,585
				Total	1,120	740	52,402
Schleicher	3,732	16,164	12,432	Layer 1	1,310	1,310	12,400
				Layer 2	996	4	31
				Total	2,306	1,314	12,431
Sutton	3,445	20,775	17,330	Layer 1	1,454	1,448	17,227
				Layer 2	1,351	69	103
				Total	2,805	1,517	17,330
Val Verde	14,562	49,607	35,045	Layer 1	3,112	3,052	34,668
				Layer 2	3,213	555	377
				Total	6,325	3,607	35,045

RESULTS:

Included in Appendix A are estimates of the water budgets after running the model for 51 years. The components of the water budget are described below.

- Wells—water produced from wells in each aquifer. This component is always shown as “Outflow” from the water budget, because all wells included in the model produce (rather than inject) water. Wells are modeled using the MODFLOW Well package.

- Springs and seeps—water that drains from an aquifer to seeps and springs along the margins of the aquifer. This component is always shown as “Outflow”, or discharge, from the water budget. Springs and seeps are modeled using the MODFLOW Drain package.

- Recharge—simulates areally distributed recharge due to precipitation falling on the outcrop areas of aquifers. Recharge is always shown as “Inflow” into the water budget. Recharge is modeled using the MODFLOW Recharge package.

- Vertical Leakage (Upward or Downward)—describes the vertical flow, or leakage, between two aquifers. This flow is controlled by the water levels in each aquifer and aquifer properties of each aquifer that define the amount of leakage that can occur. “Inflow” to an aquifer from an overlying or underlying aquifer will always equal the “Outflow” from the other aquifer.

- Storage—water stored in the aquifer. The storage component that is included in “Inflow” is water that is removed from storage in the aquifer (that is, water level declines). The storage component that is included in “Outflow” is water that is added back into storage in the aquifer (that is, water level increases). This component of the budget is often seen as water both going into and out of the aquifer because this is a regional budget, and water levels will decline in some areas (water is being removed from storage) and will rise in others (water is being added to storage).

- Lateral flow—describes lateral flow within an aquifer between a county and adjacent counties.

- Rivers and Streams—water that flows between perennial streams and rivers and an aquifer. The direction and amount of flow depends on the water level in the stream or river and the aquifer. In areas where water levels in the stream or river are above the water level in the aquifer, water flows into the aquifer and out of the stream and is shown as “Inflow” in the budget. In areas where water levels in the aquifer are above the water level in the stream or river, water flows out of the aquifer and into the stream and is shown as “Outflow” in the budget. Rivers and streams are modeled using the MODFLOW Stream package.

- Inter-aquifer Flow—The model uses general-head boundaries to simulate the movement of water between the Edwards or Trinity aquifer units and adjacent aquifers, including the Ogallala, Dockum, Edwards (Balcones Fault Zone), and Llano Uplift area aquifers.

The results of the model run are described for the individual aquifers units, the Edwards and associated limestones (Layer 1) and the undifferentiated Trinity unit (Layer 2). The Pecos Valley Aquifer is included in Layer 1.

Water levels from the end of the transient calibration portion of the model run (the end of 1999) for layers 1 and 2 are shown in Figures 1 and 2, respectively. These figures show the starting water levels for the 51-year (2000 to 2050) predictive portion of the model run. Water levels at the end of the 51-year predictive portion of the simulation for layers 1 and 2 are shown in Figures 3 and 4, respectively. Because differences between initial water levels and water levels after 51 years of pumpage are sometimes difficult to discern in these figures, maps of water level changes were made. A water-level change map shows the difference between the water levels at the end of the historic portion of the model run (1999) and the water levels at the end of the 51-year predictive portion of the model run (2050). Water-level changes over the 51-year predictive portion of the model simulation for Layers 1 and 2 are shown in Figures 5 and 6, respectively. Average and maximum water-level changes for each aquifer in each county of the model are provided in Table 3.

Table 3. Average and maximum water level changes by county and aquifer. Negative values indicate an average lowering of water levels between 1999 and 2050 while a positive value indicates an increase in water levels since 1999. A dashed line indicates the aquifer does not exist or was not modeled for a particular county.

	Edwards and Pecos Valley aquifers (Layer 1)			**Trinity Aquifer (Layer 2)**		
County Name	Area (square miles)	Average change (feet)	Maximum change (feet)	Area (square miles)	Average change (feet)	Maximum change (feet)
Andrews	267	-27	-66	163	-78	-172
Bandera	52	-34	-48	798	-68	-177
Bexar	--	--	--	245	37	11
Blanco	--	--	--	552	41	-33
Brewster	774	-25	-126	712	-77	-219
Burnet	--	--	--	26	-49	-152
Coke	--	--	--	244	-19	-41
Comal	--	--	--	362	31	0
Concho	194	-64	-120	189	-323	-487
Crane	573	-9	-39	9	-176	-177
Crockett	2,662	-62	-105	2,744	-65	-134
Culberson	142	-24	-29	--	--	--
Ector	105	-24	-45	667	-157	-207
Edwards	2,015	-26	-75	2,120	-72	-156
Gillespie	313	5	0	889	-7	-75
Glasscock	572	18	2	761	-465	-613

	Edwards and Pecos Valley aquifers (Layer 1)			Trinity Aquifer (Layer 2)		
Hays	--	--	--	370	29	0
Howard	--	--	--	72	-64	-107
Irion	674	-34	-72	664	-105	-307
Jeff Davis	325	-54	-96	--	--	--
Kendall	--	--	--	665	18	-34
Kerr	625	-11	-39	1,106	-90	-166
Kimble	943	-8	-59	1,197	-61	-163
Kinney	556	-78	-140	564	-125	-182
Loving	98	-12	-27	--	--	--
Martin	--	--	--	110	-347	-506
Mason	28	-13	-32	78	-87	-184
Medina	--	--	--	119	-17	-66
Menard	756	-39	-120	472	-107	-170
Midland	158	9	5	862	-242	-505
McCulloch	24	-20	-30	198	-198	-357
Nolan	--	--	--	464	2	-2
Pecos	4,269	-70	-166	1,634	-301	-620
Reagan	1,173	-7	-72	1,141	-316	-603
Real	421	-10	-36	700	-88	-158
Reeves	2,359	-20	-67	--	--	--
Schleicher	1,310	-64	-117	996	-58	-81
Sterling	215	2	-6	360	-111	-441
Sutton	1,454	-48	-85	1,351	-62	-156
Taylor	--	--	--	166	1	0
Terrell	2,343	-24	-64	2,380	-86	-307
Tom Green	346	-45	-116	372	-83	-337
Travis	--	--	--	254	1	-21
Upton	922	8	-33	940	-229	-429
Uvalde	157	-7	-22	394	-23	-68
Val Verde	3,206	-21	-112	3,213	-71	-174
Ward	658	-21	-62	--	--	--
Winkler	749	-52	-83	8	-207	-211

Figure 5 indicates that water levels in Layer 1 (Edwards and associated limestones and the Pecos Valley Aquifer) show mainly decreases in water levels ranging from 0 to 50 feet over the 51-year predictive portion of the run. Several localized areas of higher water level declines of greater than 100 feet can be seen in Figure 5, centering in Pecos, Kinney, Schleicher, and Concho counties.

Figure 6 indicates that water levels in Layer 2 (Trinity Aquifer) decrease throughout most of the region, generally less than 100 feet. Very large cones of depression are centered in Glasscock, Reagan, and Pecos counties, that are present at the end of the historic portion of the model run (Figure 2), continue to deepen with the model predicting up to 600 feet of decline in this area over the 51-year predictive time period. Several other smaller localized areas of higher water level declines can be seen in Figure 6, including in Kinney, Bandera, Menard, and Concho counties.

During previous model runs, the model response for the Trinity Aquifer was evaluated. It was determined that the model did not correctly simulate the response of water levels in Glasscock and Reagan counties appropriately during model calibration, and in fact water level declines during the historic calibration-verification time period were much lower than the model simulated water level declines (Donnelly, 2007). While using the model results without consideration of this could be viewed as taking a conservative approach, the water level declines predicted by the model are so great that we recommend taking another approach to evaluate the desired future conditions in this area, especially if a "managed depletion" approach to aquifer management is being considered.

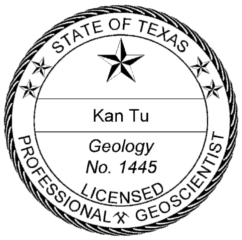
Another change in water levels that can be observed in Figure 6 is an area of increasing water levels centered Blanco, Hays, Kendall, and Comal counties. The reason for this increase is not known at this time and will require further evaluation, but it occurs primarily outside of the Groundwater Management Area 7 boundaries. Blanco, Hays, Kendall, and Comal counties are also included in the groundwater availability model for the Trinity Hill Country Aquifer, which may be a better tool for evaluating aquifer conditions in this area than the groundwater availability model for the Edwards-Trinity (Plateau) Aquifer.

Because some of the desired future conditions for the groundwater management area may be based on discharge to springs or baseflow to rivers and streams, we also evaluated the water budgets for each of these components for each county in the model area. These budgets are provided in Appendix A. The components of the water budget are divided up into "In" and "Out", representing water that is coming into and leaving from the budget. As might be expected, water from wells is only in the "Out" column, representing water that is removed from the aquifer from wells. Likewise, recharge is only found in the "In" column. Streams and rivers, however, have values in both the "In" and "Out" columns. This is because some stream reaches lose water to the aquifer, and some gain water from the aquifer depending on the water levels in the aquifer. Also included in these budgets are values for vertical leakage to overlying and underlying formations as well as lateral inflow from adjacent counties. Future model runs can be compared to these budgets to determine the impact of additional pumpage compared to this baseline run.

REFERENCES:

Anaya, R., and Jones, I., 2004, Groundwater availability model for the Edwards-Trinity (Plateau) and Cenozoic Pecos Alluvium aquifer systems, Texas: Texas Water Development Board, GAM Report, 208 p.

Donnelly, A.C.A., 2007, GAM Run 07-03, Texas Water Development Board GAM Run Report, 49 p.



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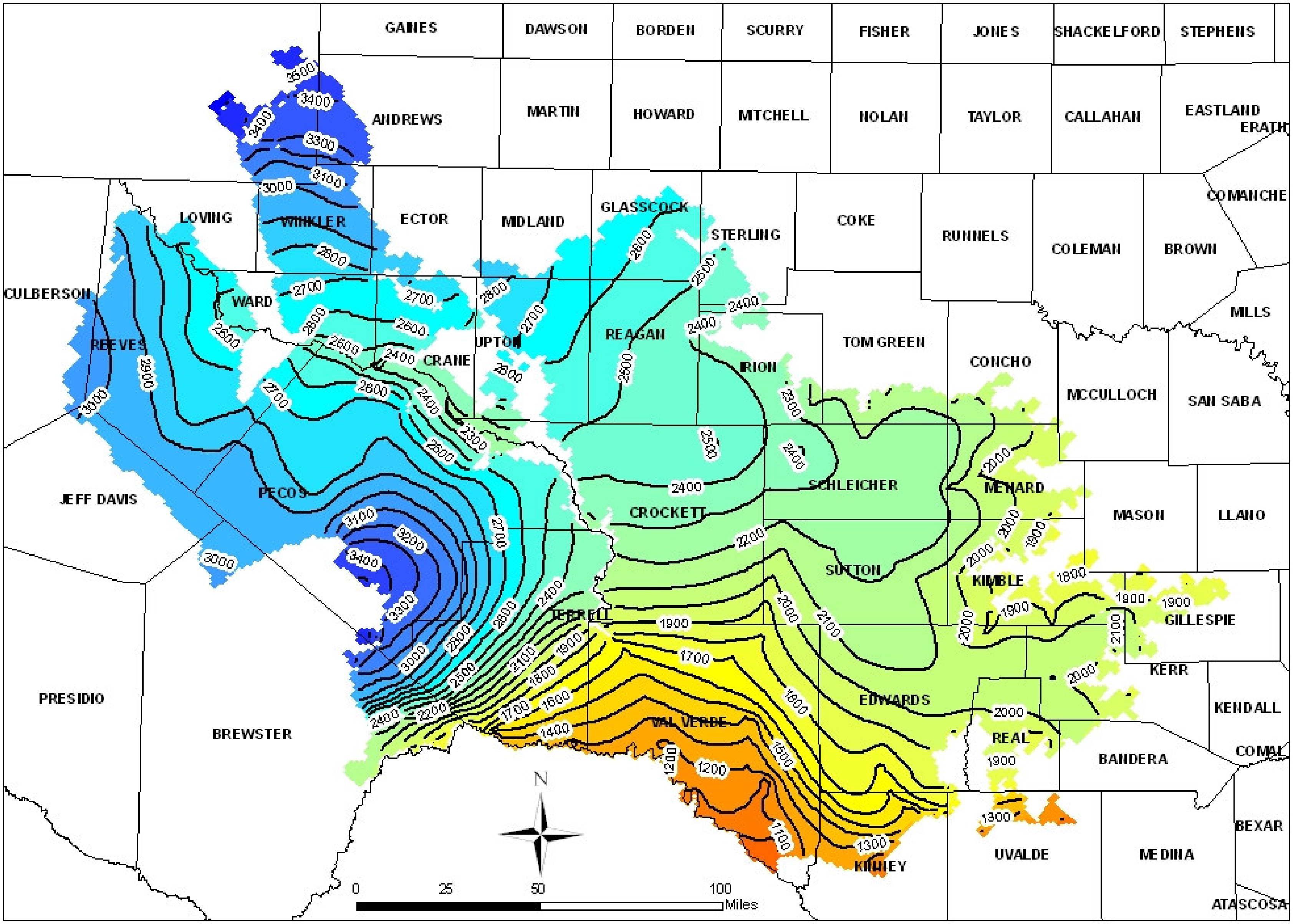

Figure 1. Initial water level elevations for the predictive model run in Layer 1 (Edwards and associated limestones and the Pecos Valley Aquifer) of the groundwater availability model for Edwards-Trinity (Plateau) Aquifer. Water level elevations are in feet above mean sea level. Contour interval is 100 feet.

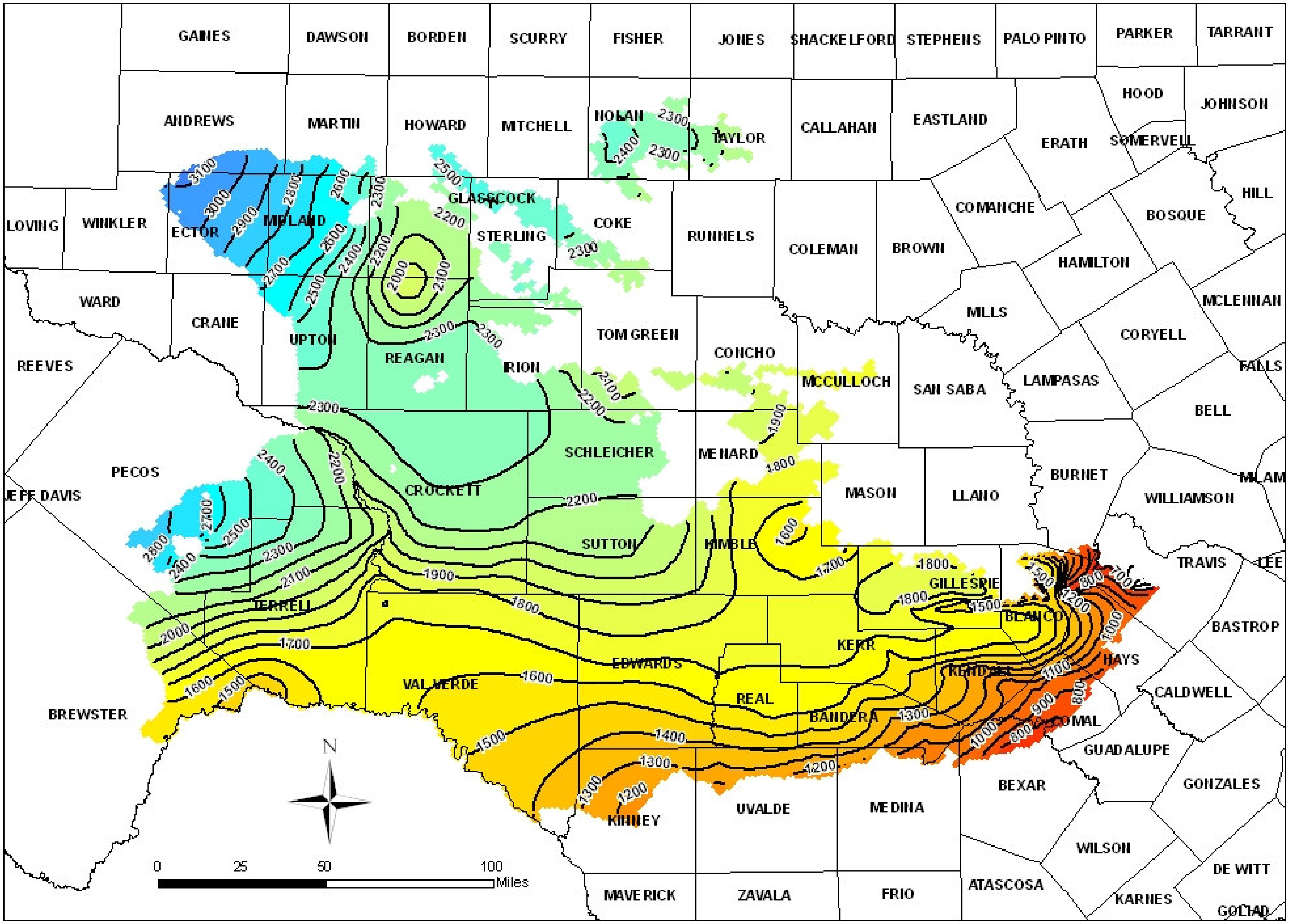

Figure 2. Initial water level elevations for the predictive model run in Layer 2 (Trinity Aquifer) of the groundwater availability model for Edwards- Trinity (Plateau) Aquifer. Water level elevations are in feet above mean sea level. Contour interval is 100 feet.

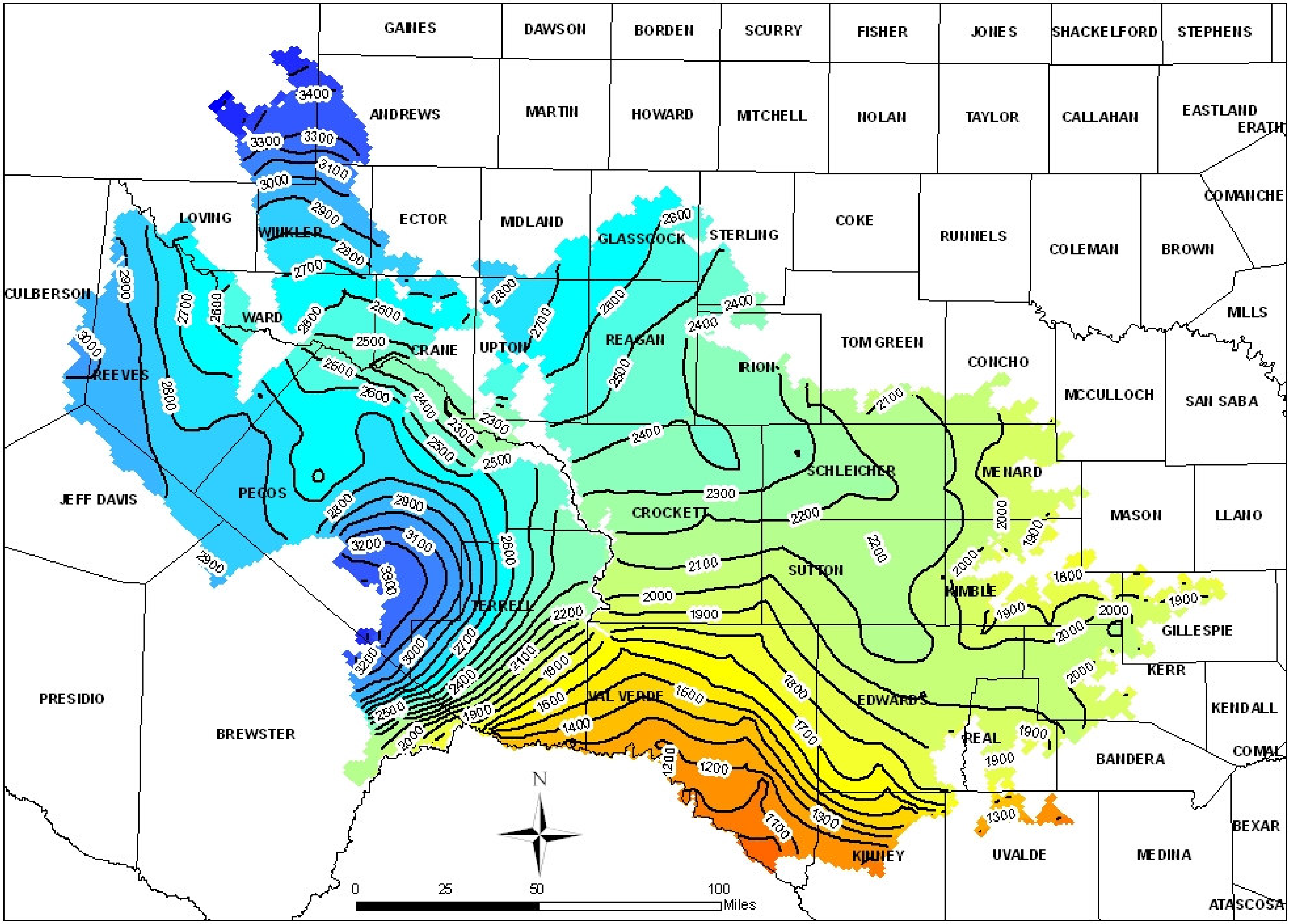

Figure 3. Water level elevations after 51 years using baseline pumpage in Layer 1 (Edwards and associated limestones and the Pecos Valley Aquifer). Water level elevations are in feet above mean sea level. Contour interval is 100 feet.

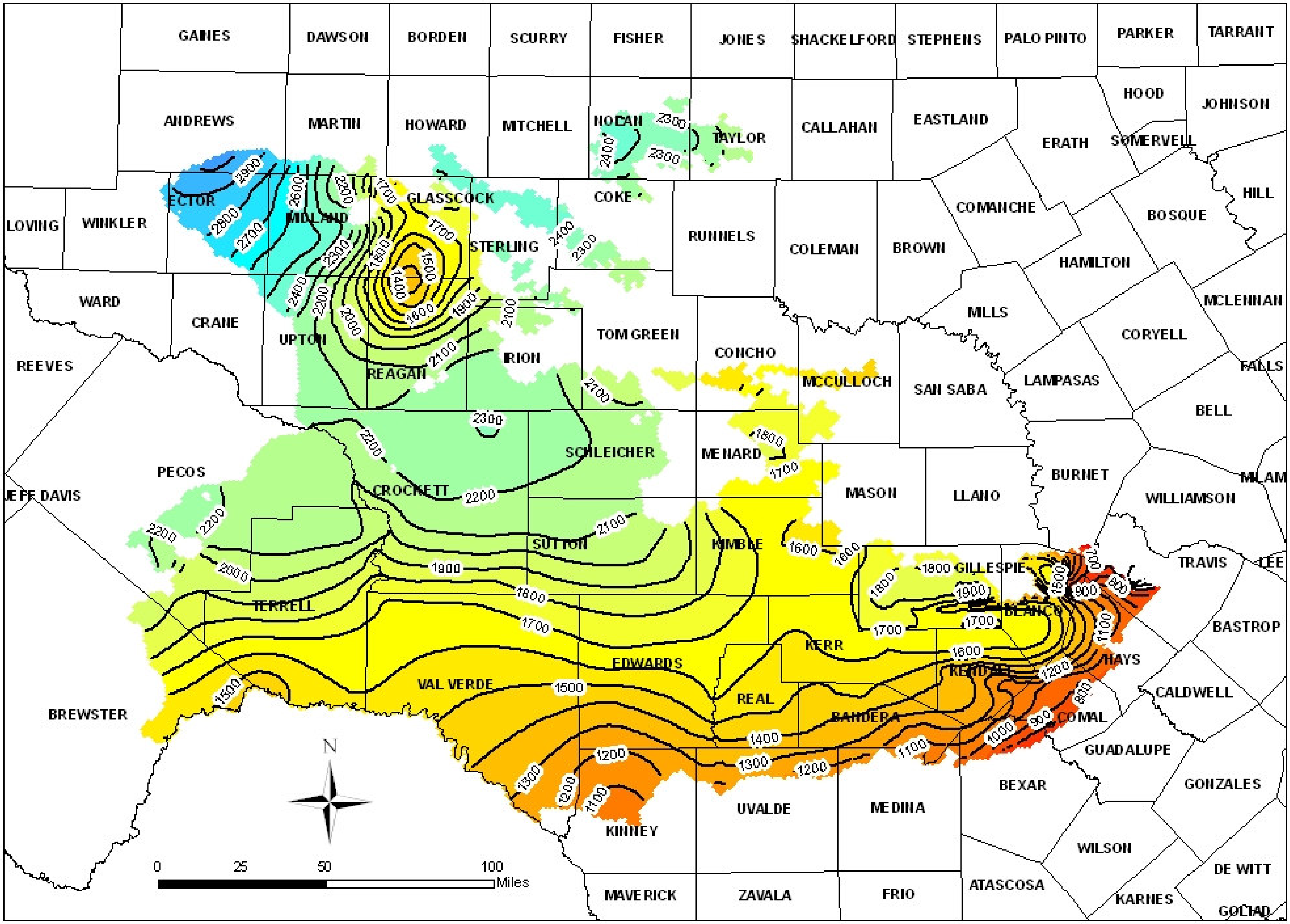

Figure 4. Water level elevations after 51 years using baseline pumpage in Layer 2 (Trinity Aquifer). Water level elevations are in feet above mean sea level. Contour interval is 100 feet.

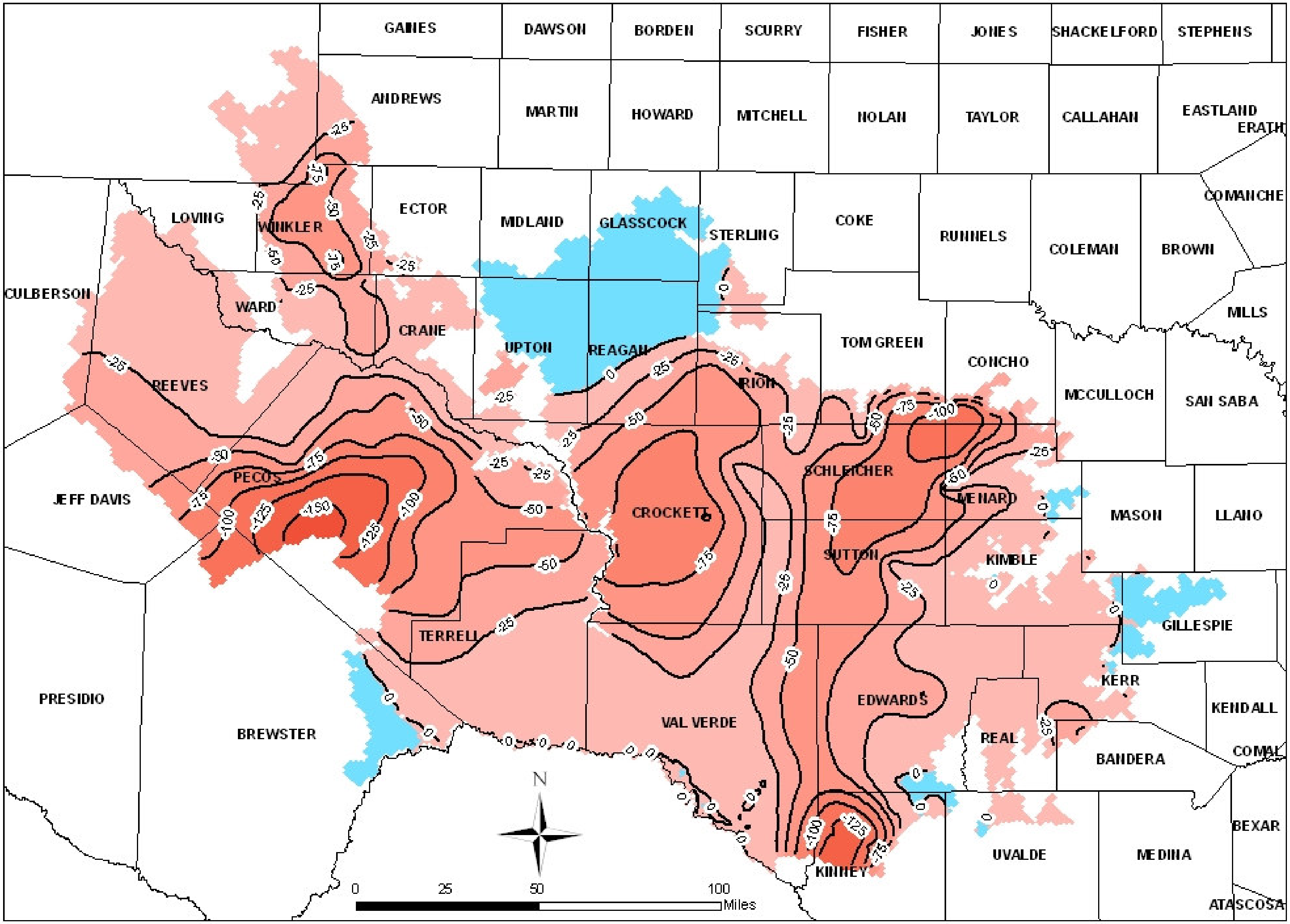

Figure 5. Changes in water levels (in feet) after 51 years using the specified pumpage in Layer 1 (Edwards and associated limestones and the Pecos Valley Aquifer). Decreases in water levels (drawdowns) are shown in red and increases in water levels are shown in blue. Contour interval is 25 feet.

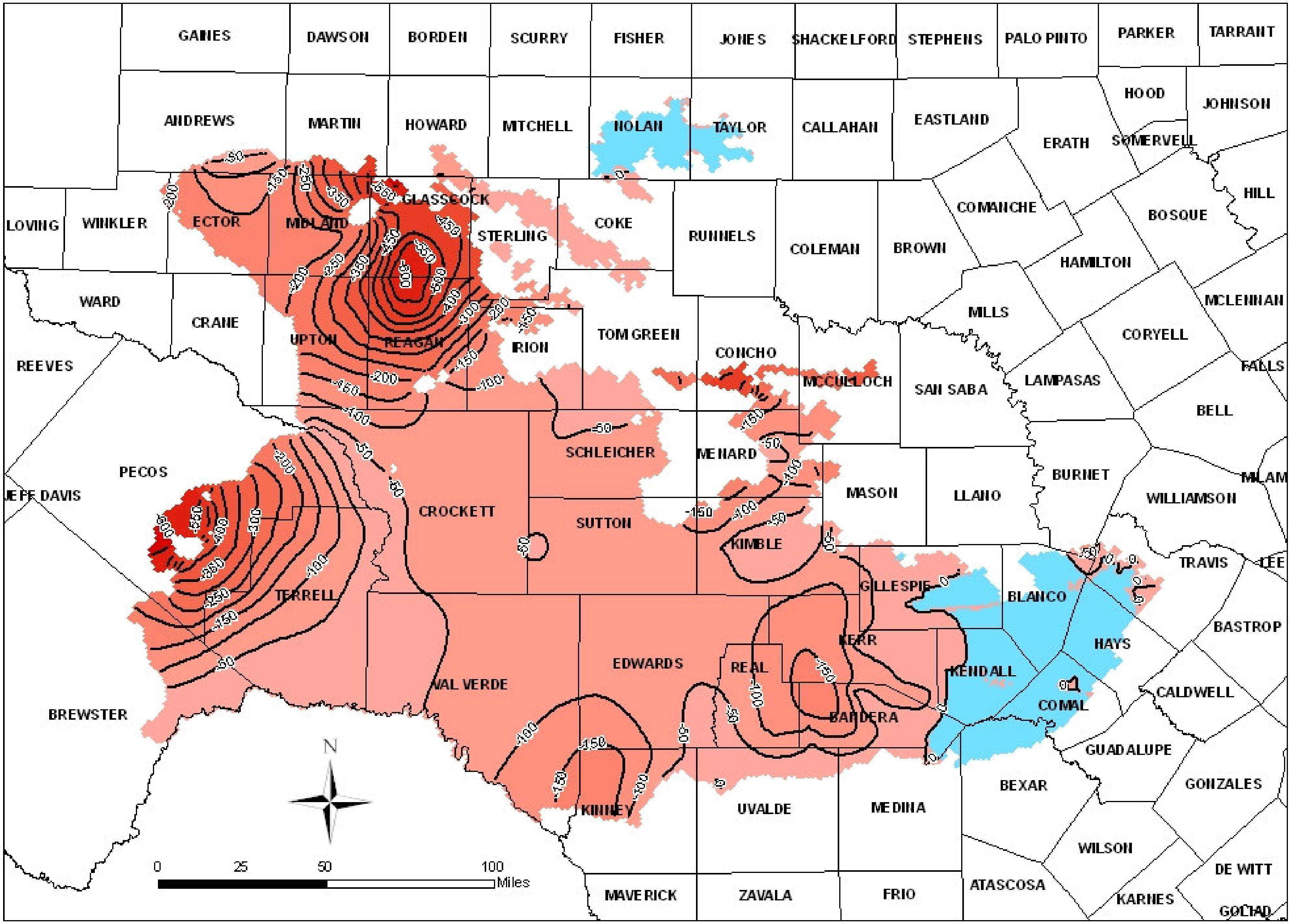

Figure 6. Changes in water levels after 51 years using the specified pumpage in Layer 2 (Trinity Aquifer). Decreases in water levels (drawdowns) are shown in red and increases in water levels are shown in blue. Contour interval is 50 feet.

Table A-1. Annual water budgets for each county at the end of the 51-year predictive portion of the model run using the requested pumpage and normal rainfall condition in the groundwater availability model for the Edwards-Trinity (Plateau) Aquifer (in acre-feet per year). Total pumpage for each county listed in Tables 1 and 2 matches the total value listed for wells in the water budget. The model includes two layers, representing the Edwards and associated limestones (Layer 1) and undifferentiated Trinity units (Layer 2). The Pecos Valley Aquifer is included in Layer 1 of the model

	Andrews		Bandera		Bexar		Blanco		Brewster		Burnet	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Model Layer 1												
Reservoirs (Constant Head Cells)	0	0	0	0	--	--	--	--	0	0	--	--
Storage	1,616	0	0	0	--	--	--	--	945	0	--	--
Springs and Seeps (Drain Package)	0	0	0	816	--	--	--	--	0	22,808	--	--
Inter-aquifer Flow (GHB Package)	0	1,189	0	0	--	--	--	--	0	0	--	--
Wells	0	1,188	0	3,537	--	--	--	--	0	85	--	--
Streams and Rivers (Stream Package)	0	0	3,785	282	--	--	--	--	0	0	--	--
Recharge	2,079	0	1,579	0	--	--	--	--	19,850	0	--	--
Lateral Inflow	1,172	2,490	1,127	1,803	--	--	--	--	7,033	4,932	--	--
Vertical Leakage Downward	--	--	9	63	--	--	--	--	1,161	1,163	--	--
Model Layer 2												
Reservoirs (Constant Head Cells)	0	0	381	2,280	0	0	0	0	0	0	0	226
Storage	214	0	1,022	0	0	0	0	420	1,331	0	0	0
Springs and Seeps (Drain Package)	0	0	0	0	0	0	0	15,533	0	0	0	260
Inter-aquifer Flow (GHB Package)	7,680	521	0	1,972	0	30,505	0	8	0	0	0	0
Wells	0	4,641	0	32,332	0	2,399	0	1,758	0	588	0	2,550
Streams and Rivers (Stream Package)	0	0	6,466	12,992	0	0	0	10,961	1,730	10,454	0	0
Recharge	3,912	0	48,555	0	21,238	0	45,590	0	5,854	0	1,877	0
Vertical Leakage Upward	--	--	63	9	--	--	--	--	1,163	1,161	--	--
Lateral Inflow	228	6,873	16,316	23,217	18,973	7,307	4,742	21,653	2,796	671	1,877	718
Total Pumpage		5,829		35,869		2,399		1,758		673		2,550

Table A-1. (continued)

	Coke		Comal		Concho		Crane		Crockett		Culberson	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Model Layer 1												
Reservoirs (Constant Head Cells)	--	--	--	--	0	0	0	0	0	0	0	0
Storage	--	--	--	--	124	0	3,670	0	4,305	0	1,188	0
Springs and Seeps (Drain Package)	--	--	--	--	0	566	0	0	0	0	0	0
Inter-aquifer Flow (GHB Package)	--	--	--	--	0	0	89	1,749	0	43	65	439
Wells	--	--	--	--	0	6,729	0	2,603	0	22,222	0	55
Streams and Rivers (Stream Package)	--	--	--	--	0	0	100	6,762	11,891	3,693	0	0
Recharge	--	--	--	--	5,205	0	5,465	0	43,957	0	2,183	0
Lateral Inflow	--	--	--	--	2,125	635	3,998	2,208	12,215	28,515	548	3,490
Vertical Leakage Downward	--	--	--	--	519	41	--	--	162	18,056	--	--
Model Layer 2												
Reservoirs (Constant Head Cells)	0	0	6,276	7,129	0	0	0	0	0	0	--	--
Storage	2	0	0	1	1,901	0	48	0	809	0	--	--
Springs and Seeps (Drain Package)	0	3,343	0	0	0	0	0	0	0	0	--	--
Inter-aquifer Flow (GHB Package)	0	50	2,437	12,111	48	0	8	1	10	2,830	--	--
Wells	0	3,243	0	3,059	0	5,548	0	51	0	3,229	--	--
Streams and Rivers (Stream Package)	0	0	471	27,570	0	0	0	0	336	8,018	--	--
Recharge	5,916	0	30,369	0	3,274	0	138	0	2,301	0	--	--
Vertical Leakage Upward	--	--	--	--	41	519	--	--	18,056	162	--	--
Lateral Inflow	1,164	446	20,169	9,854	976	174	658	800	6,782	14,055	--	--
Total Pumpage		3,243		3,059		12,278		2,654		25,451		55

Table A-1. (continued)

	Ector		Edwards		Gillespie		Glasscock		Hays		Howard	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Model Layer 1												
Reservoirs (Constant Head Cells)	0	0	0	0	0	0	0	0	--	--	--	--
Storage	3,848	0	32	0	0	0	0	0	--	--	--	--
Springs and Seeps (Drain Package)	0	0	0	4,149	0	9,298	0	1,615	--	--	--	--
Inter-aquifer Flow (GHB Package)	0	405	0	0	0	0	0	0	--	--	--	--
Wells	0	3,143	0	7,835	0	619	0	54	--	--	--	--
Streams and Rivers (Stream Package)	0	0	13,089	25,346	1,043	1,323	0	0	--	--	--	--
Recharge	788	0	74,639	0	10,113	0	11,144	0	--	--	--	--
Lateral Inflow	103	1,161	6,278	51,894	3,493	2,040	509	2,118	--	--	--	--
Vertical Leakage Downward	0	32	5	4,821	362	1,732	137	8,002	--	--	--	--
Model Layer 2												
Reservoirs (Constant Head Cells)	0	0	0	0	0	0	0	0	0	0	0	0
Storage	2,304	0	1,456	0	105	21	7,655	0	0	454	25	0
Springs and Seeps (Drain Package)	0	0	0	0	0	7,430	0	0	0	0	0	0
Inter-aquifer Flow (GHB Package)	117	1,057	0	0	0	7	16,893	59	0	17,804	1,335	22
Wells	0	11,324	0	860	0	4,280	0	59,226	0	3,715	0	1,700
Streams and Rivers (Stream Package)	0	0	3,417	166	3,485	20,920	0	0	0	3,239	0	0
Recharge	11,774	0	3,185	0	36,773	0	5,156	0	32,522	0	1,517	0
Vertical Leakage Upward	32	0	4,821	5	1,732	362	8,002	137	--	--	--	--
Lateral Inflow	4,596	6,441	12,673	24,522	716	9,790	32,705	10,989	7,255	14,566	311	1,466
Total Pumpage		14,467		8,695		4,899		59,280		3,715		1,700

Table A-1. (continued)

	Irion		Jeff Davis		Kendall		Kerr		Kimble		Kinney	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Model Layer 1												
Reservoirs (Constant Head Cells)	0	0	0	0	--	--	0	0	0	0	0	0
Storage	119	0	1,633	0	--	--	0	0	9	0	1,881	0
Springs and Seeps (Drain Package)	0	4,654	0	0	--	--	0	7,371	0	18,322	0	5,069
Inter-aquifer Flow (GHB Package)	0	0	11	12	--	--	0	0	0	0	1,859	8,195
Wells	0	5,068	0	201	--	--	0	5,208	0	7,135	0	35,963
Streams and Rivers (Stream Package)	1,042	3,352	0	0	--	--	8,297	5,221	1,192	3,726	1,908	11,445
Recharge	14,334	0	5,294	0	--	--	19,184	0	25,672	0	42,401	0
Lateral Inflow	6,244	1,881	1,364	8,088	--	--	3,566	12,008	15,516	6,344	24,616	10,872
Vertical Leakage Downward	106	6,891	--	--	--	--	10	1,248	148	7,009	2	1,127
Model Layer 2												
Reservoirs (Constant Head Cells)	0	0	--	--	0	0	0	0	0	0	0	0
Storage	448	0	--	--	6	346	952	1	659	0	193	0
Springs and Seeps (Drain Package)	0	171	--	--	0	0	0	0	0	2,175	0	0
Inter-aquifer Flow (GHB Package)	969	277	--	--	0	0	0	0	0	0	3,345	2,169
Wells	0	4,375	--	--	0	4,842	0	28,524	0	16,830	0	23,268
Streams and Rivers (Stream Package)	0	0	--	--	246	38,587	6,394	5,260	10,568	11,224	0	0
Recharge	2,287	0	--	--	51,352	0	27,329	0	7,256	0	1,163	0
Vertical Leakage Upward	6,891	106	--	--	--	--	1,248	10	7,009	148	1,127	2
Lateral Inflow	3,120	8,786	--	--	9,152	16,981	10,907	13,035	9,629	4,745	20,291	681
Total Pumpage		9,444		201		4,842		33,732		23,965		59,231

Table A-1. (continued)

	Loving		Martin		Mason		McCulloch		Medina		Menard	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Model Layer 1												
Reservoirs (Constant Head Cells)	0	0	--	--	0	0	0	0	--	--	0	0
Storage	2,421	0	--	--	0	0	0	0	--	--	229	0
Springs and Seeps (Drain Package)	0	0	--	--	0	344	0	9	--	--	0	3,193
Inter-aquifer Flow (GHB Package)	2	161	--	--	0	0	0	0	--	--	0	0
Wells	0	4,363	--	--	0	967	0	942	--	--	0	12,518
Streams and Rivers (Stream Package)	1,799	1,096	--	--	0	0	0	0	--	--	253	5,718
Recharge	604	0	--	--	829	0	677	0	--	--	20,304	0
Lateral Inflow	2,254	1,458	--	--	533	61	230	39	--	--	5,883	3,685
Vertical Leakage Downward	--	--	--	--	80	69	117	34	--	--	256	1,811
Model Layer 2												
Reservoirs (Constant Head Cells)	--	--	0	0	0	0	0	0	541	599	0	0
Storage	--	--	633	0	43	0	1,078	0	265	0	639	0
Springs and Seeps (Drain Package)	--	--	0	0	0	277	0	0	0	0	0	0
Inter-aquifer Flow (GHB Package)	--	--	2,480	41	0	0	171	13	0	24,180	0	0
Wells	--	--	0	3,398	0	2,861	0	7,306	0	860	0	6,482
Streams and Rivers (Stream Package)	--	--	0	0	0	0	0	0	0	0	3,795	99
Recharge	--	--	2,833	0	1,477	0	5,073	0	8,448	0	3,142	0
Vertical Leakage Upward	--	--	--	--	69	80	34	117	--	--	1,811	256
Lateral Inflow	--	--	6,205	8,713	2,126	497	1,089	9	21,445	5,061	750	3,304
Total Pumpage		4,363		3,398		3,828		8,248		860		19,000

Table A-1. (continued)

	Midland		Nolan		Pecos		Reagan		Real		Reeves	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Model Layer 1												
Reservoirs (Constant Head Cells)	0	0	--	--	0	0	0	0	0	0	0	0
Storage	0	0	--	--	49,618	0	61	0	0	0	85,455	0
Springs and Seeps (Drain Package)	0	0	--	--	0	0	0	651	0	7,762	0	0
Inter-aquifer Flow (GHB Package)	0	0	--	--	57	4,871	0	0	0	0	209	4,156
Wells	0	3	--	--	0	138,264	0	1,001	0	2,844	0	114,361
Streams and Rivers (Stream Package)	0	0	--	--	302	14,674	0	0	259	4,604	1,063	33,048
Recharge	2,691	0	--	--	148,323	0	21,100	0	12,474	0	67,867	0
Lateral Inflow	226	789	--	--	20,063	43,519	3,380	5,111	5,857	2,802	11,712	14,741
Vertical Leakage Downward	10	2,135	--	--	1,881	18,918	277	18,056	41	619	--	--
Model Layer 2												
Reservoirs (Constant Head Cells)	0	0	0	0	0	0	0	0	0	0	--	--
Storage	21,775	0	0	0	11,543	0	4,764	0	749	0	--	--
Springs and Seeps (Drain Package)	0	0	0	9,932	0	0	0	0	0	0	--	--
Inter-aquifer Flow (GHB Package)	3,214	423	0	0	0	0	15,009	98	0	0	--	--
Wells	0	21,137	0	1,001	0	35,171	0	60,815	0	8,680	--	--
Streams and Rivers (Stream Package)	0	0	0	0	1,859	5,428	0	0	9,511	112	--	--
Recharge	15,283	0	11,947	0	7,165	0	21	0	8,759	0	--	--
Vertical Leakage Upward	2,135	10	--	--	18,918	1,881	18,056	277	619	41	--	--
Lateral Inflow	16,939	37,775	167	1,180	8,356	5,363	36,585	13,244	5,845	16,649	--	--
Total Pumpage		21,140		1,001		173,435		61,816		11,525		114,361

Table A-1. (continued)

	Schleicher		Sterling		Sutton		Taylor		Terrell		Tom Green	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Model Layer 1												
Reservoirs (Constant Head Cells)	0	0	0	0	0	0	--	--	0	0	0	0
Storage	1,335	0	0	0	782	0	--	--	2,156	0	168	0
Springs and Seeps (Drain Package)	0	0	0	2,061	0	0	--	--	0	4,296	0	3,530
Inter-aquifer Flow (GHB Package)	0	0	0	0	0	0	--	--	0	0	0	0
Wells	0	16,124	0	1,563	0	20,652	--	--	0	698	0	7,390
Streams and Rivers (Stream Package)	12,162	2,484	0	0	6,918	13,582	--	--	170	33,633	198	423
Recharge	24,018	0	4,546	0	29,044	0	--	--	43,448	0	8,029	0
Lateral Inflow	4,135	17,666	1,329	1,289	16,390	12,217	--	--	42,829	34,323	6,462	1,960
Vertical Leakage Downward	1	5,378	172	1,134	272	6,955	--	--	267	15,920	47	1,601
Model Layer 2												
Reservoirs (Constant Head Cells)	0	0	0	0	0	0	0	0	0	0	0	0
Storage	23	0	100	0	274	0	0	0	6,214	0	423	0
Springs and Seeps (Drain Package)	0	0	0	740	0	0	0	4,490	0	0	0	1,013
Inter-aquifer Flow (GHB Package)	0	0	1,064	1,102	0	0	0	0	0	0	273	18
Wells	0	43	0	3,604	0	122	0	500	0	1,395	0	7,647
Streams and Rivers (Stream Package)	0	0	0	0	327	0	0	0	185	15,959	573	1,741
Recharge	0	0	5,992	0	0	0	4,595	0	682	0	3,601	0
Vertical Leakage Upward	5,378	1	1,134	172	6,955	272	--	--	15,920	267	1,601	47
Lateral Inflow	1,879	7,236	2,189	4,861	5,483	12,644	495	100	6,903	12,283	7,114	3,120
Total Pumpage		16,167		5,167		20,774		500		2,093		15,037

Table A-1. (continued)

	Travis		Upton		Uvalde		Val Verde		Ward		Winkler	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Model Layer 1												
Reservoirs (Constant Head Cells)	--	--	0	0	0	0	18,105	47,386	0	0	0	0
Storage	--	--	495	0	0	0	367	0	13,519	0	46,206	0
Springs and Seeps (Drain Package)	--	--	0	0	0	2,592	0	574	0	0	0	0
Inter-aquifer Flow (GHB Package)	--	--	4	902	5	5,857	0	0	2	4,645	0	3,083
Wells	--	--	0	337	0	1,433	0	49,078	0	17,290	0	51,996
Streams and Rivers (Stream Package)	--	--	0	0	0	0	29,574	104,264	739	10,649	0	0
Recharge	--	--	15,277	0	7,422	0	90,068	0	6,575	0	5,300	0
Lateral Inflow	--	--	1,007	5,665	3,116	1,464	72,312	10,465	15,412	3,662	7,936	4,363
Vertical Leakage Downward	--	--	105	9,983	840	37	2,468	1,128	--	--	--	--
Reservoirs (Constant Head Cells)	3,563	31,081	0	0	0	0	0	0	--	--	0	0
Storage	0	81	4,611	0	272	0	1,435	0	--	--	26	0
Springs and Seeps (Drain Package)	0	0	0	0	0	0	0	0	--	--	0	0
Inter-aquifer Flow (GHB Package)	13,129	346	7,831	16	964	19,660	0	0	--	--	0	5
Wells	0	3,900	0	20,266	0	2,332	0	534	--	--	0	517
Streams and Rivers (Stream Package)	19	6,704	0	0	2,566	14,394	93	1,370	--	--	0	0
Recharge	16,098	0	2,632	0	19,757	0	152	0	--	--	119	0
Vertical Leakage Upward	--	--	9,983	105	37	840	1,128	2,468	--	--	--	--
Lateral Inflow	9,364	60	16,320	20,989	18,930	5,301	12,010	10,445	--	--	377	0
Total Pumpage		3,900		20,604		3,765		49,612		17,290		52,513