Texas Water Development Board

Open-File Report 98-02

Changes in Groundwater Conditions in El Paso County, Texas 1988 - 1998

By Richard D. Preston,
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A Memorandum Report by Richard D. Preston, Geologist, Douglas Coker, Hydrologist, and Raymond C. Mathews, Jr., Environmental Specialist

This memorandum report provides an updated evaluation of the groundwater resources of El Paso County, Texas. A previous study of El Paso County was conducted to address problems of overdraft and quality deterioration with respect to the Hueco Bolson, Mesilla Bolson, and the Rio Grande aquifers. This report was published as Texas Water Development Board Report 324, *Evaluation of Groundwater Resources in El Paso County, Texas* (Ashworth, 1990) in March 1990 as part of the Critical Area Program.

The Critical Area Program was established by the 69th Texas Legislature (House Bill 2) to identify areas of the State with significant groundwater problems between 1985 and 1990. Based on this information, the Executive Director of the Texas Water Commission (now the Texas Natural Resource Conservation Commission--TNRCC) approved a groundwater protection and recovery program for El Paso County. The provisions of this program were described in a February 1990 report, *Groundwater Protection and Management Strategies for the El Paso County Area* (Estepp, 1990), in which the Executive Director for TWC recommended designation of the County as a "Critical Area" (presently referred to as a "Priority Groundwater Management Area"--PGMA).

Groundwater quantity and quality problems are caused by increasing demands for water in and around the cities of El Paso and Ciudad Juarez, Mexico. This part of the Trans-Pecos ecosystem is characterized by very low precipitation, resulting in low rates of recharge to regional aquifers. These characteristics in aquifer recharge and demand have resulted in significant declines in groundwater levels (McBee, 1997), as illustrated by the hydrograph for El Paso County, Texas (Figure 1). In some observation wells, water levels have fallen as much as 150 feet (Ashworth,

1990). Observation well number 49-13-702, which produces from the Hueco Bolson aquifer, has experienced a water-level decline of 148 feet in the past 36 years, from an elevation of 3,674 feet above mean sea level (msl) in 1951 to 3,530 feet msl in 1994. The lowered water table has caused a commensurate alteration in the vertical and lateral migration trends of groundwater throughout the Hueco Bolson and Rio Grande aquifers.

Hydraulic gradients are steep on the Hueco Mountains, and are probably even steeper on the Organ and Franklin Mountains (Hibbs and Boghici, 1997). Groundwater tends to flow along the axis of the basin toward the Rio Grande, except where large cones of depression (the result of extended production) beneath the City of El Paso and Ciudad Juarez have reversed the natural hydraulic gradient. These cones of depression have created an artificial groundwater divide just north of the Rio Grande (Figure 2). Nearly all of the groundwater in the Hueco Bolson aquifer flowed toward the Rio Grande during predevelopment times (White, 1987). Under predevelopment or natural conditions, groundwater moved upward through the Rio Grande alluvium and discharged by channel seepage and by consumptive use by phreatophytes (Hibbs

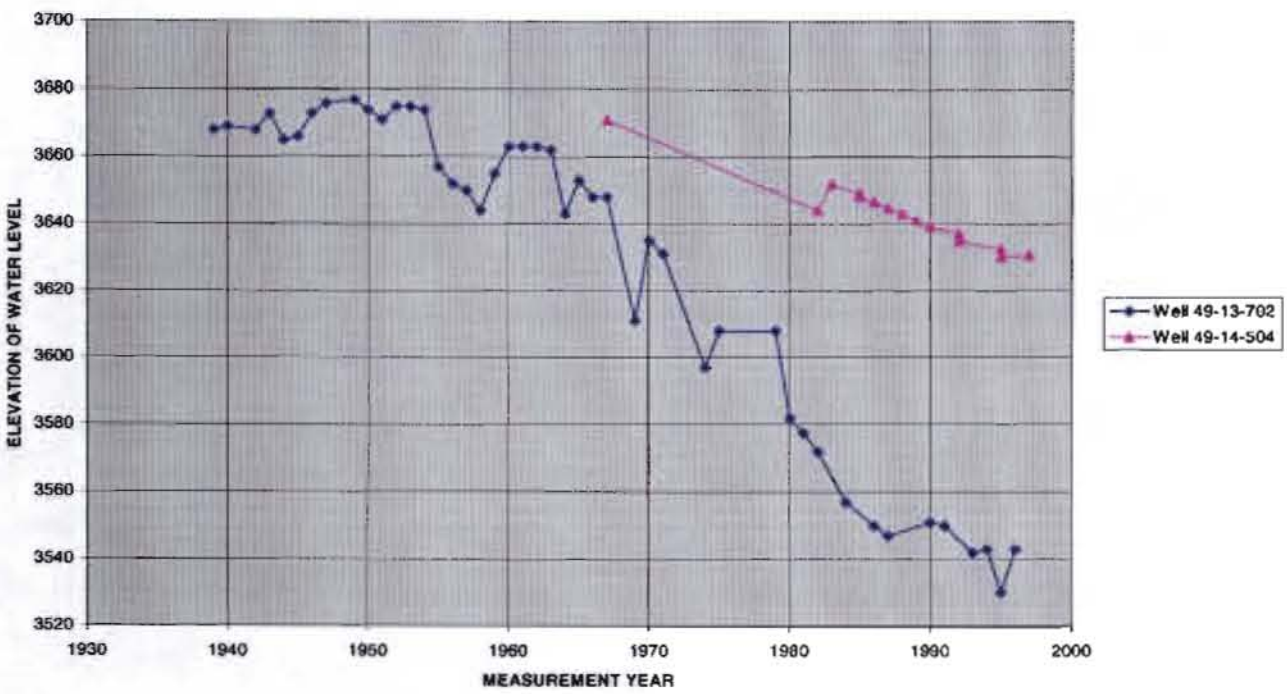

Figure 1. Hydrograph of selected observation wells, El Paso County, Texas.

et al., 1997). Heavy pumpage in the Hueco Bolson aquifer reversed the hydraulic head gradient between the Rio Grande alluvium and the Hueco Bolson aquifer in some areas. In areas where pumpage from the Hueco Bolson aquifer is not great, the hydraulic head gradient between the Hueco Bolson aquifer and Rio Grande alluvium remains positive and artesian conditions exist (Hibbs et al., 1997).

The twin-cities of El Paso, Texas and Ciudad Juarez, Mexico are heavily dependent upon well water from the Hueco Bolson aquifer to satisfy municipal and industrial water demands. Since heavy development of the aquifer began in the mid-1950s, chloride, sulfate, and other dissolved solids have increased over time in water from many municipal wells, frequently exceeding the recommended drinking water standards (Hibbs and Boghici, 1997).

Recent water-level data (Hibbs et al., 1997) indicate continued extensive regional water table declines, especially where pumpage from large well fields occurs to provide water supplies to the cities of El Paso, Texas and Ciudad Juarez, Mexico. Declining water levels in major areas of groundwater pumpage have increased the potential for the migration of poorer quality water (ie., water with high total dissolved solids (TDS) concentrations) into zones of good quality water, and may have contributed to El Paso County's water quality problems. These problems are illustrated in Figure 3, which shows an increasing trend in the concentration of TDS since the 1980s for selected observation wells. Two of the observation wells in the Hueco Bolson aquifer have experienced TDS concentration increases of 54 percent (well no. 49-13-702) and 30 percent (well no. 49-22-133), respectively. TDS levels in this aquifer which exceed the drinking water standard of 1,000 mg/l reduce the availability of usable-water supply, and those supplies will likely be further reduced in the future if these trends continue.

The City of El Paso's well fields, owned and operated by the El Paso Water Utilities Public Service Board, are located within a much larger area of groundwater use, which includes Ciudad Juarez, Mexico. Selected wells utilized by Fort Bliss and El Paso have shown a decline in water table elevation of up to 40 feet in the six-year period from 1987-93 (Figure 4). These wells

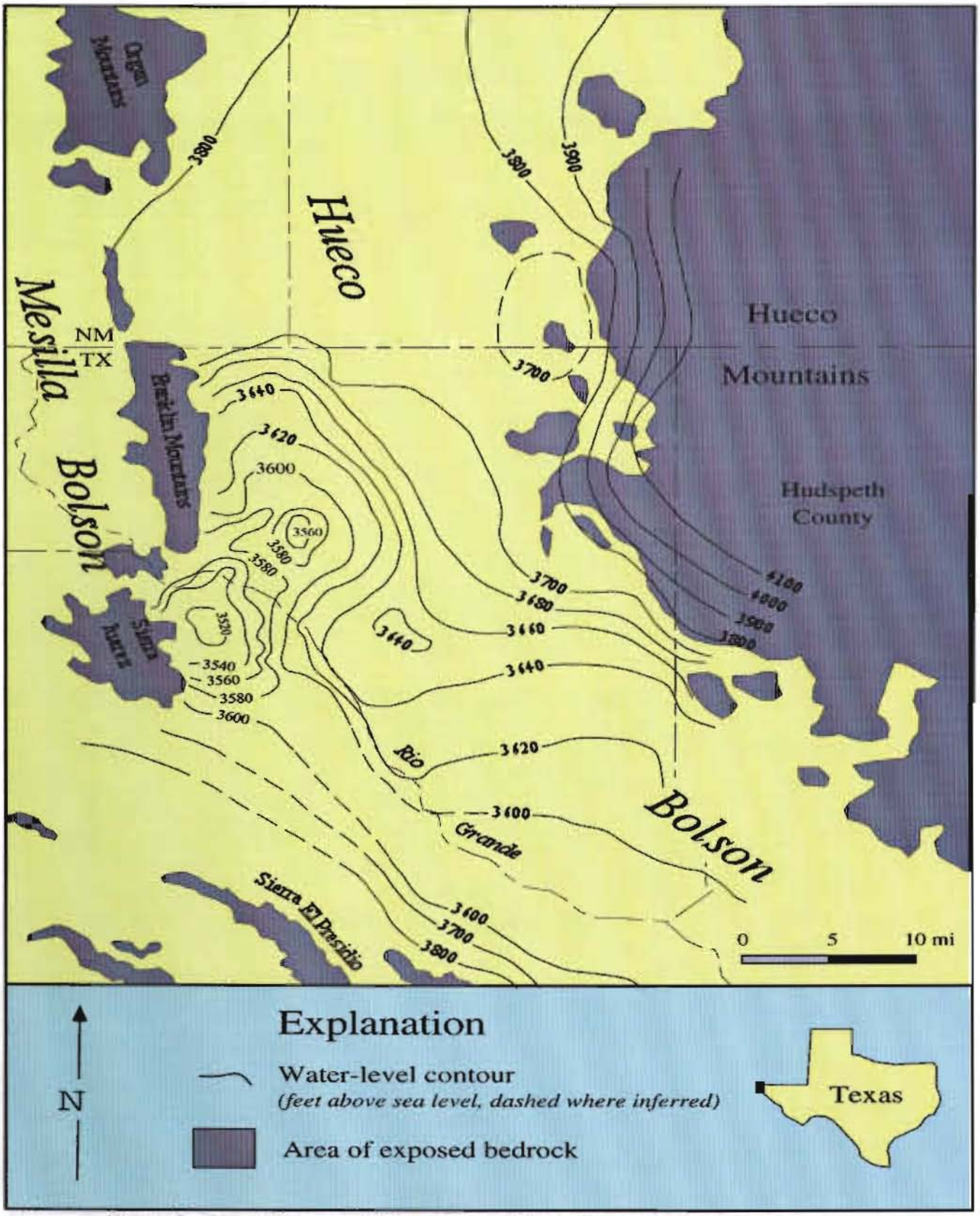

Figure 2. Potentiometric surface map for El Paso County and surrounding areas, based on Hibbs and Boghici (1997).

produce water from the Hueco Bolson aquifer. Additionally, declining water levels in excess of 60 feet have occurred during the same six-year period in Ciudad Juarez (Hibbs et al., 1997).

Water problems identified in El Paso County (Ashworth, 1990) include inadequate availability of surface and groundwater supplies, as well as water quality deterioration, due to large withdrawals and declining water levels. Poorer quality water occurs where irrigation practices bring leached minerals to the groundwater system. Downward leakage of poor quality water from the alluvium has caused serious problems in areas where the underlying Hueco Bolson aquifer is being heavily

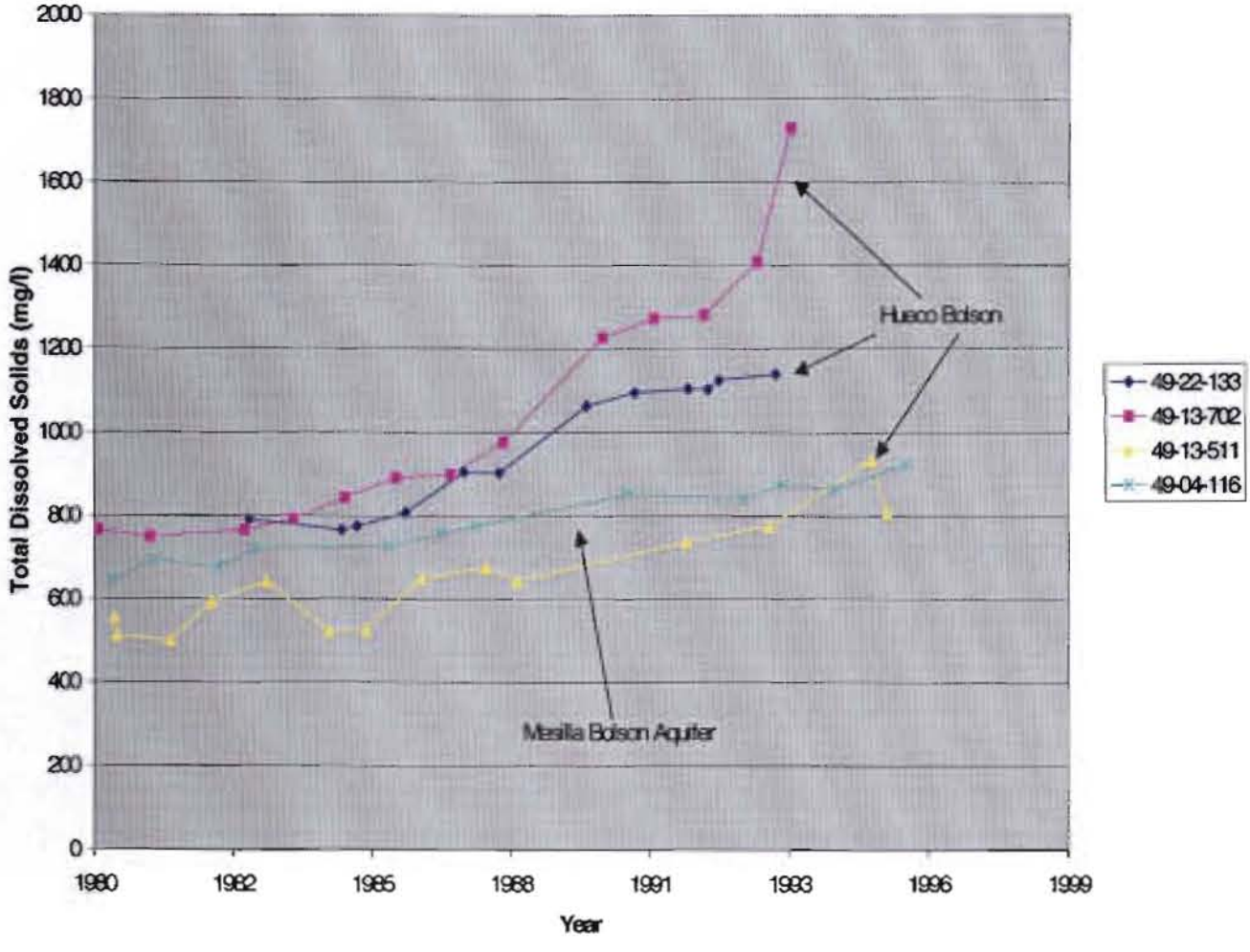

Figure 3. Changes in total dissolved solids concentration in water from selected wells in El Paso County, Texas.

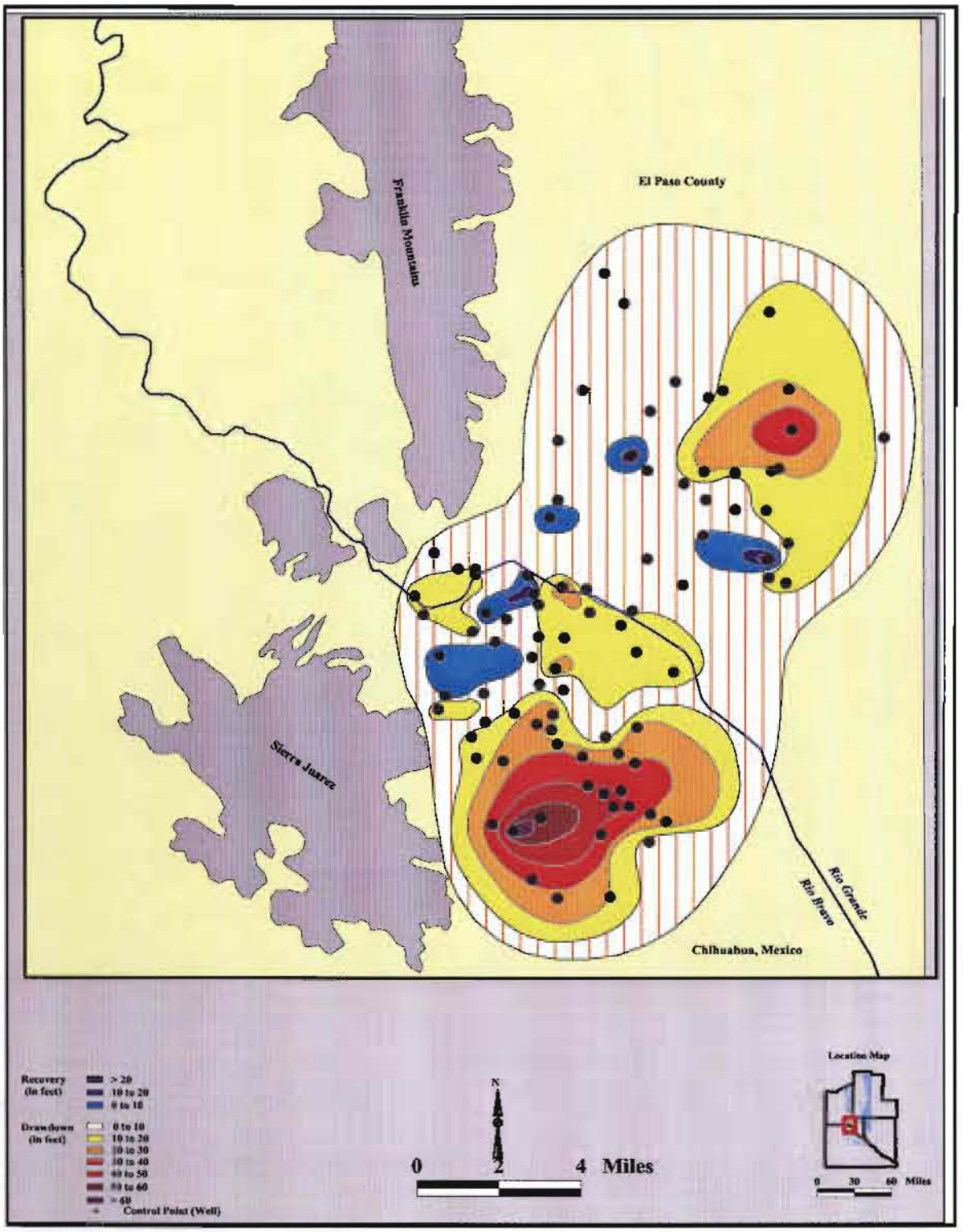

Figure 4. Map of the transboundary aquifers of the El Paso/Ciudad Juarez/Las Cruces Region illustrating the areas of decline in the water table, ranging from 10-40 feet for areas of El Paso County that are characterized by extensive groundwater use, based on data for the period between 1987 and 1993 (Hibbs et al., 1997).

pumped (Ashworth, 1990; Cardenas and Hicks, 1993). Groundwater generally moves toward centers of pumpage, which in turn initiates the vertical and lateral encroachment of poor quality brackish inflow from the surrounding formations (Muller and Price, 1979). In portions of El Paso County along the Rio Grande, colonia residents utilize on-site wastewater treatment systems which often fail to adequately treat household wastewater. One study in San Elizario community (Cardenas and Hicks, 1993; Applegate, 1988) showed that nitrate, detergent, and chemical oxygen demand levels exceed federal and state standards in most cases. Furthermore, all samples from this study were bacteriologically contaminated with high levels of fecal coliform. The TWDB's Economically Distressed Areas Program is addressing these localized water quality issues and rural water supply needs of the colonias.

Impoundments of the Rio Grande provide all of the area surface-water supplies. Groundwater supplies have historically provided most of the municipal (78%), manufacturing (78%), and mining (95%) demands of the county, while surface water supplies have provided most of the irrigation water demands (96%), based on the TWDB Historical Water Use Database, 1974-1995. Table 1 illustrates the various reported uses of water by source for the surface and groundwater inventories conducted in 1985 and 1995 for the State Water Plan. Public water supply was the greatest user of groundwater, while irrigation was the greatest user of surface water during both years. There was a 10 percent decrease in groundwater use between 1985 and 1995. However, there was a 40 percent increase in surface water use during this period; with irrigation use increasing 25 percent, public water supply use increasing 179 percent, and rural use decreasing 23 percent. During the winter months, all public water supplies come from groundwater sources because surface water from the Rio Grande is unavailable or the water quality is too poor to be used for this purpose (Rebuck and Jorat, 1997).

Annual average recharge is estimated at 18,000 acre-feet for the Mesilla Bolson aquifer (Leggat, 1962) and 6,000 acre-feet for the Hueco Bolson aquifer (Meyer, 1976). Pumpage from the Hueco Bolson aquifer has exceeded recharge since the early 1900s (Ashworth, 1990). Pumpage from the Mesilla aquifer has not caused a net decline in piezometric head (Rebuck and Jorat, 1997).

Use	1985			1995		
Acre-Feet	Groundwater	Surface Water	Total Water	Groundwater	Surface Water	Total Water
Public Supply	80,845	17,572	98,417	78,457	49,087	127,544
Rural	7,367	875	8242	4,984	670	5,654
Manufacturing	10,657	1,054	11,711	8,146	1,904	10,050
Power	5,941	0	5,941	3,237	0	3,237
Irrigation	1,490	162,272	163,762	0	202,849	202,849
Mining	176	0	176	124	66	190
Livestock	602	31	633	1,552	82	1,634
Total	**107,078**	**181,804**	**288,882**	**96,500**	**254,658**	**351,158**

Table 1. 1985 and 1995 water use in El Paso County by water use category and source (Ashworth, 1990; TWDB, 1997).

Theoretically, very large amounts of fresh groundwater (i.e., water containing less than 1,000 mg/l TDS) are available from the aquifers in El Paso County (see page 20, TWDB Report 324, Ashworth, 1990). However, the presence of poor quality (high TDS) water throughout much of the county, and the likelihood of migration of this water into nearby highly pumped zones, reduces the amount of available useable-quality water.

Table 2 exemplifies the differences in groundwater versus surface water use for the major public water supply users in El Paso County. Groundwater accounted for 82 and 61 percent of major public water use for the years of 1985 and 1995, respectively. This decline in groundwater use represents a difference of 3,342 acre-feet per year. Surface water diversion for major public water supply use increased from 18 to 39 percent (or 32,469 acre-feet per year) between 1985 and 1995. Both years show that the city of El Paso was the greatest user of both sources for public water supplies in El Paso County. The recent update shows that in 1995, the city of El Paso used 87 percent of the groundwater pumped, and 97 percent of the surface water diverted in El Paso County for public supply. Fort Bliss was the second largest user of groundwater in El Paso County, but only accounted for 8 percent of the use. The cities of Anthony, Fabens, Fort Bliss, and Horizon City depended exclusively on groundwater use for their water supply. Cumulatively, the cities of Anthony, Canutillo, Clint, Fabens, Horizon City, and Socorro accounted for less than 6 percent of the groundwater use. The cities of Canutillo, Clint, and Socorro, the only cities with the exception of El Paso that depended on surface water supplies, required less than 3 percent of the total volume of surface water used in 1995.

City	1985		1995	
Acre-Feet	Groundwater	Surface Water	Groundwater	Surface Water
Anthony	463	0	637	0
Canutillo	274	21	183	97
Clint	230	55	181	129
El Paso	72,149	16,924	67,233	48,686
Fabens	677	0	852	0
Fort Bliss	7,052	572	6,004	0
Horizon City	NR	NR	834	0
Socorro	NR	NR	1579	1129
Total	80,845 (82%)	17,572 (18%)	77,503 (61%)	50,041 (39%)

NR = Not Reported. Estimates are not available for these cities in 1985, because they were either unincorporated or had a population of less than 1,000.

Table 2. Major public supply users. From TWDB Annual Survey of Ground and Surface Water Uses.

A 4 percent decrease in total groundwater use between 1985 and 1995, equal to a 3,342 acre-foot per year reduction in pumping, is shown in Table 2. Most of the decrease is associated with the city of El Paso, which pumped 4,916 acre-feet per year (7 percent) less. The cities of Anthony and Fabens, however, increased their use of groundwater slightly during this period. Surface water use increased by 32,469 acre-feet per year (185 percent), with most of the increase by the City of El Paso (31,762 acre-feet per year or 188 percent). The cities of Canutillo, Clint, and Anthony also increased their use of surface water, while Fort Bliss decreased its surface water usage.

Table 3 shows a gradual trend in increasing use of surface water by the City of El Paso between 1985 and 1989, and a greater rate of increased use from 1991 to 1995. Surface water use appears to have stabilized by 1994-95. Groundwater use showed a similar trend of increasing use through 1989, but then a trend reversal occurred between 1989 and 1995.

The 1990 report (Ashworth, 1990) included a table similar to Table 4. However, the referenced table included results of inappropriately assessing water used from mixed sources. This oversight has been corrected in Table 4. The information in Table 4 generally shows a decrease in the use

Year	Groundwater	Surface Water
1985	72,149	17,554
1986	77,319	19,330
1987	87,720	16,709
1988	84,911	19,917
1989	89,141	20,909
1990	80,454	25,407
1991	76,871	22,961
1992	69,408	32,662
1993	69,045	42,318
1994	66,159	47,909
1995	67,233	48,686

Table 3. Annual water uses, based on TWDB Historical Water Use Database for the City of El Paso, by source, from 1985 to 1995 (all units in acre-feet).

Year	Groundwater (acre-feet)	Surface Water (acre-feet)	Acres Irrigated	Irrigation Wells
1958	14,097	178,905	55,551	547
1964	120,303	20,378	55,000	550
1969	6,698	199,316	57,919	593
1974	5,807	173,503	56,375	601
1979	3,393	161,682	53,810	590
1984	2,421	157,288	47,526	590
1989	3,529	167,865	45,845	475
1994	986	174,141	45,795	475

Table 4. Five-year inventories of irrigation use (acre-feet by source), the acres irrigated, and the number of irrigation wells in El Paso County, Texas (TWDB, 1996).

of groundwater for irrigation within El Paso County, in addition to a slight decrease in the number of acres irrigated. The anomaly in this trend for the amount of groundwater used in 1964 is a result of a severe drought. This highlights the county's dependency on groundwater when

the surface water flow of the Rio Grande is reduced by drought conditions in the upstream portion of the watershed in New Mexico. A drought period occurred during much of 1964 (ranging from 1963-65) in the Rio Grande Basin (Figures 5 and 6), causing a deficit in surface water availability, as indicated by the 1964 irrigation use reported in Table 4. Water flows were inadequate to meet the needs of the Rio Grande valley irrigators, forcing them to make up the difference with groundwater. Conjunctive water use has and will continue to be required to meet the demands of all the needs in El Paso County. Population projections, based on the TWDB's high series population projections for the State Water Plan (TWDB, 1997), indicate that the population for El Paso County, including its cities, Fort Bliss military base, and the rural population, will increase through 2010 (Table 5).

The term "Rural" in Table 5 refers to communities with a population of less than 500, as well as unincorporated areas of the county. In general, the population estimates in 1997 projections (TWDB, 1997) are higher than those estimated in 1988 (TWDB, 1990). For example, El Paso County's population was projected to grow to 818,757 by 2010 based on 1988 projections, but is expected to grow to a population of 921,780 based on 1997 projections.

Table 6 indicates a higher total water demand in 2010 than was previously estimated in the 1990 State Water Plan (TWDB, 1990). The increased projected water use is a result of higher rural, mining, livestock, and irrigation demands. However, the public water supply demand is estimated to decrease through 2010, as compared with projections included in Ashworth (1990).

SUMMARY

While most TWDB data indicate a general reduction in the amount of groundwater use within El Paso County, the total pumpage is still considerably greater than the estimated annual yield of the county's aquifers, based on average recharge. Therefore, the water-level declines experienced within the heavily pumped areas of El Paso County will likely continue. The projected population growth will continue to require larger amounts of water, while the sources of water

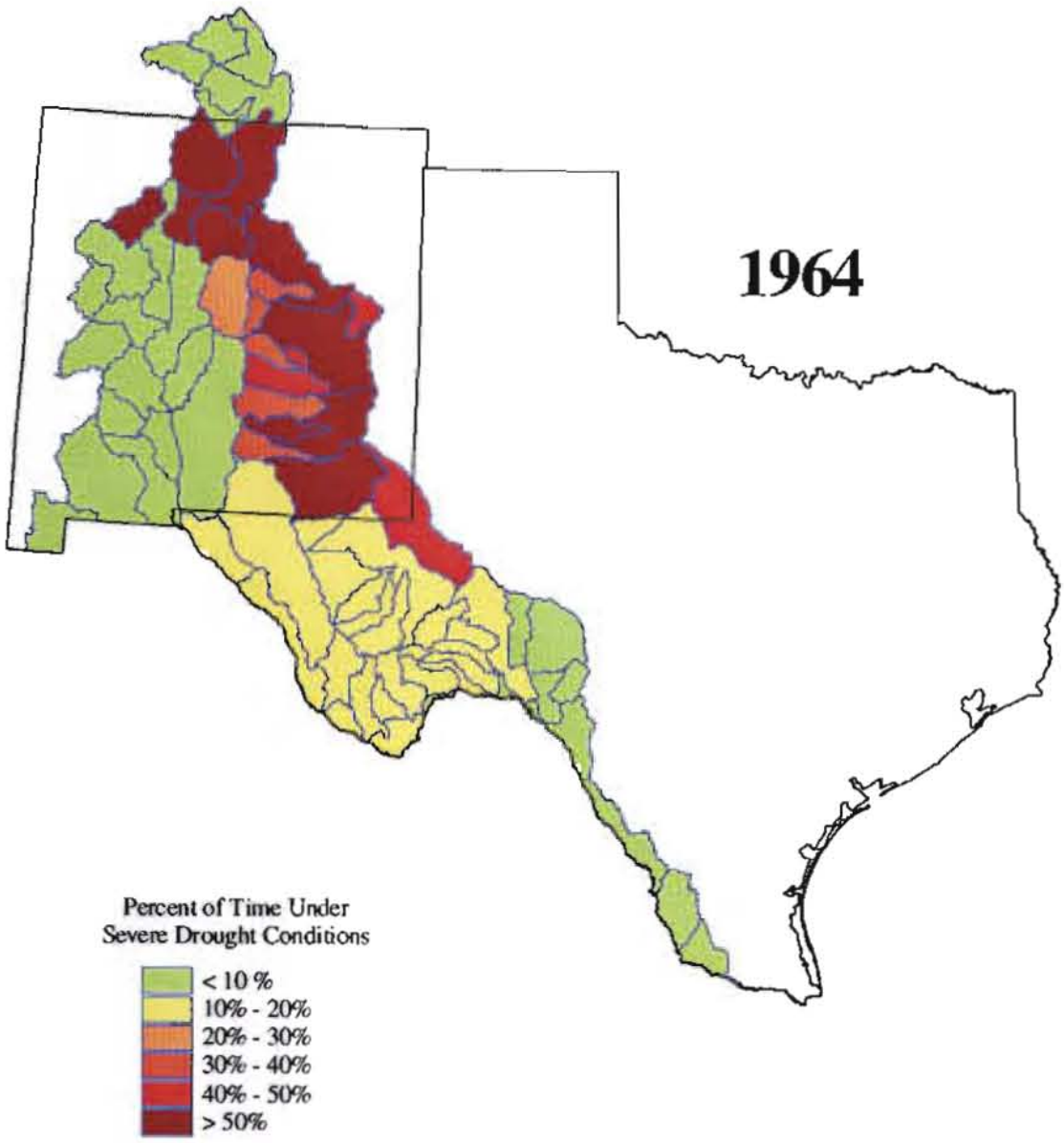

Figure 5. Severe drought conditions in Rio Grande Basin watersheds for 1964 (National Drought Mitigation Center, 1998).

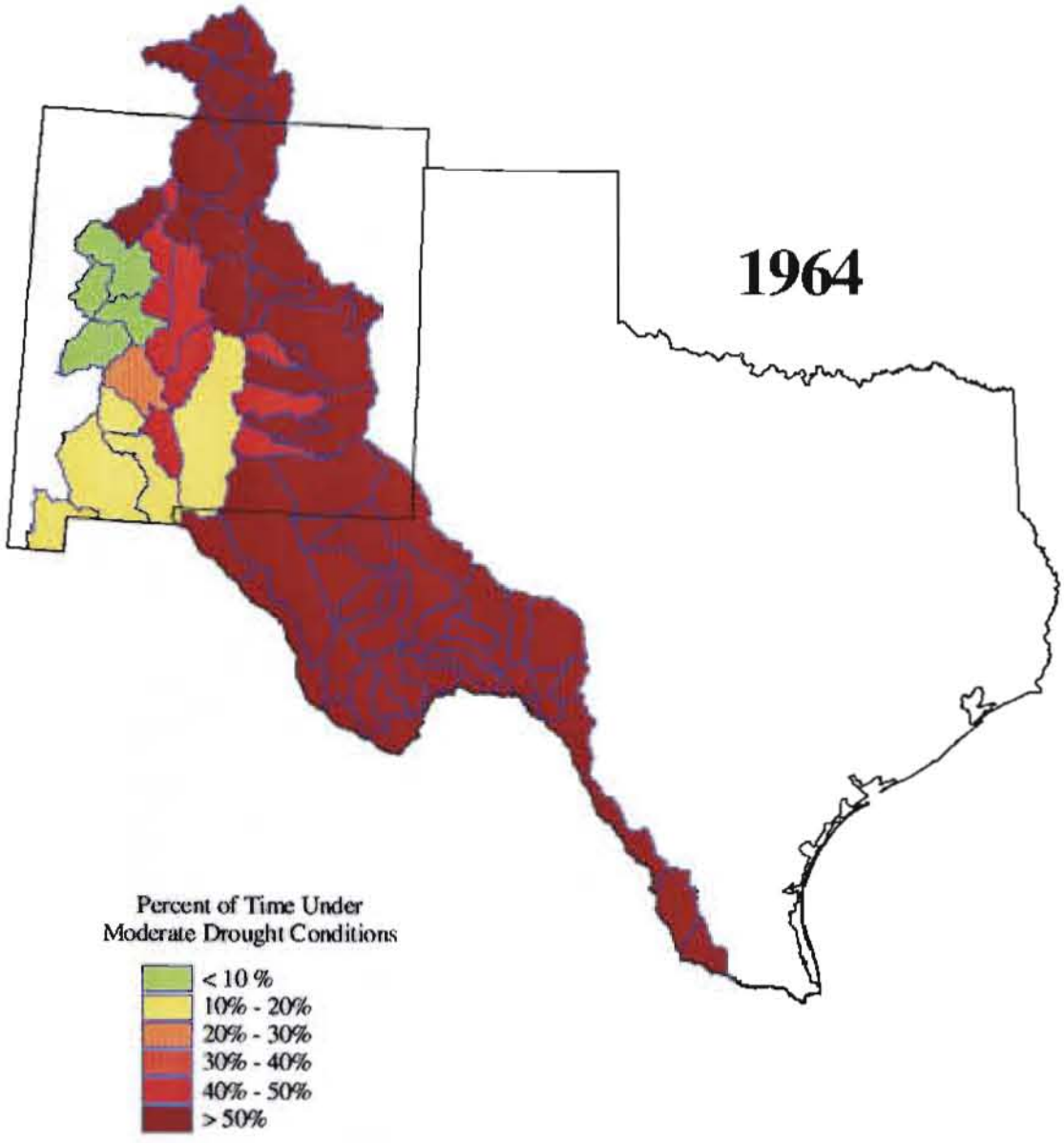

Figure 6. Moderate drought conditions in Rio Grande Basin watersheds for 1964 (National Drought Mitigation Center, 1998).

from aquifers, reservoirs, and run-of-the-river supplies may potentially be of poorer quality. If present conditions persist, El Paso County will continue to experience problems with declining water quality over the next 25 years and beyond. To mitigate this problem, the 1997 State Water Plan (TWDB, 1997) has recommended desalinization, mixing of waters with varying quality to meet with attainment standards, management of conjunctive water supplies, and protective measures to ensure the future quality and quantity of the county's aquifers.

	Population Projections			
City	**1990**	**2000**	**2010**	**2020**
Anthony	3,328	4,403	5,378	6,422
Canutillo	4,442	5,748	6,749	7,804
Clint	1,035	1,299	1,555	1,824
El Paso	515,342	632,199	749,541	873,710
Fabens	5,599	6,158	7,113	8,110
Fort Bliss	13,915	13,915	13,915	13,915
Horizon City	2,308	3,172	3,856	4,585
Socorro	22,995	29,365	39,711	51,027
Rural	22,646	74,274	93,962	115,048
County Total	**591,610**	**770,533**	**921,780**	**1,082,445**

Table 5. Population projections from 1997 State Water Plan (TWDB, 1997), calculated for El Paso County. Based on the Texas Water Development Board's high series population and water demand projections.

Use	1995[1]	2000	2010	2020
Public Supply[2]	127,544	139,479	151,985	166,169
Rural[3]	5,654	18,043	20,828	23,671
Manufacturing	10,050	14,786	16,192	17,145
Power	3,237	6,000	6,000	6,000
Irrigation	202,849	179,842	164,338	161,470
Mining	190	246	110	56
Livestock	1,634	1,729	1,729	1,729
Total	351,158	360,125	361,182	376,240

Note: Projected demand includes both surface and groundwater and is based on TWDB projected demands, from *Water for Texas Today and Tomorrow, A Consensus-Based Update to the State Water Plan, Volume II, Technical Planning Appendix*, 1997.

[1] Actual 1995 uses as reported.

[2] Public supply includes demands for the Cities of Anthony, Canutillo, Clint, El Paso, Fabens, Fort Bliss, Horizon City, and Socorro.

[3] Rural includes unincorporated cities (<500 population).

Table 6. Projected total water demand by use in El Paso County (in acre-feet).

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