

**Middle Pecos Groundwater Conservation District  
Pecos County, Texas**

**Groundwater Management Plan**

**Middle Pecos Groundwater Conservation District  
Groundwater Management Plan**

## **District Mission**

The Middle Pecos Groundwater Conservation District (the District) is committed to manage and protect the groundwater resources of The District. The District was created to help maintain a sustainable, adequate, reliable, cost effective and high quality source of groundwater to promote the vitality, economy and environment of the District. The District will work with and for the citizens of the District and cooperate with other local, regional and State agencies involved in the study and management of groundwater resources.

## **Purpose of Management Plan**

In 1997 the 75<sup>th</sup> Texas Legislature established a statewide comprehensive regional water planning initiative with the enactment of Senate Bill 1 (SB1). Among the provisions of SB1 were amendments to Chapter 36 of the Texas Water Code requiring groundwater conservation districts to develop a groundwater management plan that shall be submitted to the Texas Water Development Board (TWDB) for certification. The groundwater management plan was specified to contain estimates on the availability of groundwater in the district, details of how the district would manage groundwater, and management goals for the district. In 2001 the 77<sup>th</sup> Texas Legislature further clarified the water planning and management provisions of SB1 with the enactment of Senate Bill 2 (SB2).

The requirements of the Chapter 36 Texas Water Code provisions for groundwater management plan development are specified in 31 Texas Administrative Code Chapter 356 of the TWDB Rules. This plan fulfills all requirements for groundwater management plans in SB1, SB2, Chapter 36 Texas Water Code, and TWDB rules.

## **Time Period of Management Plan**

This plan shall be in effect for a period of ten years from the date of certification by TWDB, unless a new or amended management plan is adopted by the District Board of Directors and certified by TWDB.

## **Middle Pecos Groundwater Conservation District**

The District was created in 1999. The creation of the District is recorded in Chapter 1331 of the Acts of the 76<sup>th</sup> Texas Legislature (SB 1911). This act enabled the District to function in a limited capacity until the creation of the District was fully validated in the 77<sup>th</sup> Legislature. The validation of the District is recorded in Chapter 1299 of the Acts of the 77<sup>th</sup> Texas Legislature (HB 1258). The District was confirmed by local election held in Pecos County on November 5, 2002.

The District boundaries are coterminous with the boundaries of Pecos County, Texas. The District is bounded by Reeves, Ward, Crane, Crockett, Terrell, Brewster, and Jeff Davis counties. As of the plan date, groundwater conservation districts (GCDs) that bound the District are in Jeff Davis, Brewster, and Crockett Counties. The GCDs neighboring the District are: Brewster County GCD, Jeff Davis County Underground Water Conservation District (UWCD), and Emerald UWCD (Crockett County). Fig.1

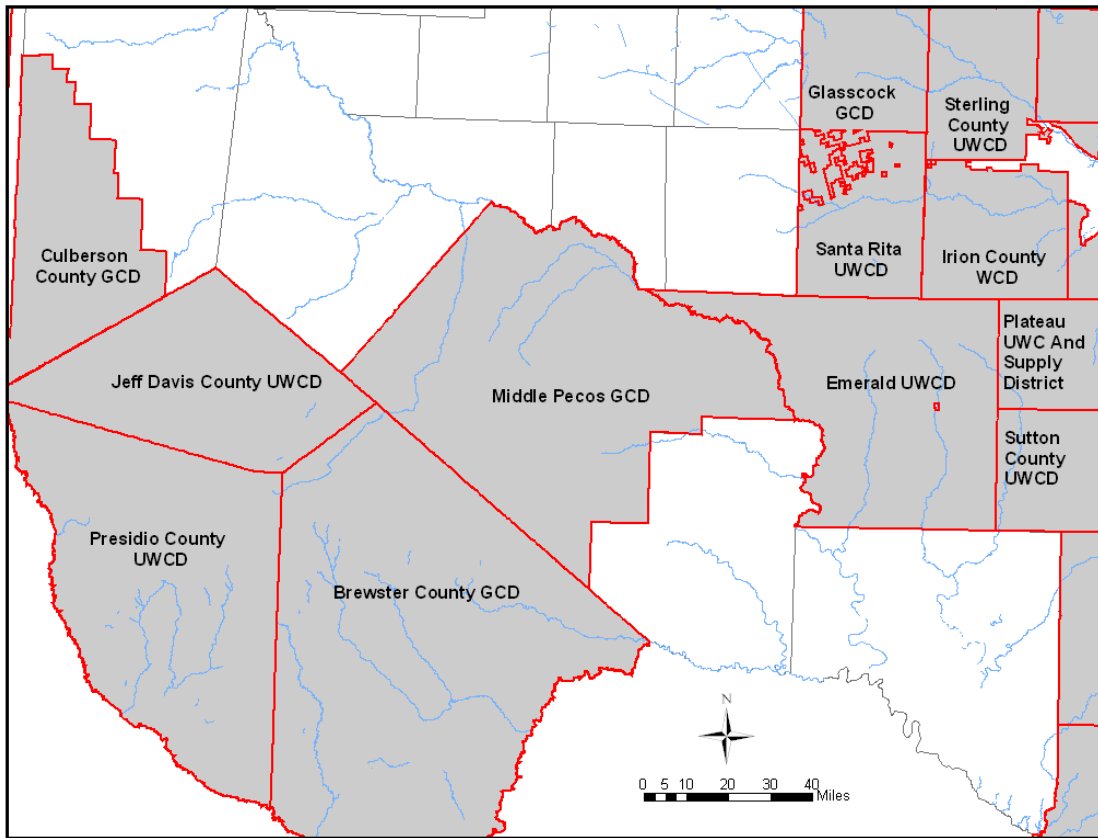


Figure1, Neighboring Districts to Middle Pecos Groundwater Conservation District

Most of the District is in Groundwater Management Area (GMA) 7, with the northern part of the District in GMA 3. Chapter 36 of the Texas Water Code authorizes the District to co-ordinate its management of groundwater with other GCDs in both GMA 7 and GMA 3. The District is currently the only GCD in GMA 3. The other GCDs that are located in GMA 7 are: Emerald UWCD (Crockett), Santa Rita UWCD (Reagan), Irion County Water Conservation District (WCD), Glasscock GCD, Sterling County UWCD, Lone Wolf GCD (Mitchell), Wes-Tex GCD (Nolan), Coke County UWCD, Lipan-Kickapoo WCD (Tom Green, Concho, and Runnels), Hickory UWCD No. 1 (McCulloch, San Saba, and Mason), Menard County UWCD, Hill Country UWCD (Gillespie), Kimble County GCD, Plateau Underground Water Conservation and Supply District (Schleicher), Sutton County UWCD, Real-Edwards C and R District, and Kinney County GCD. Fig. 2

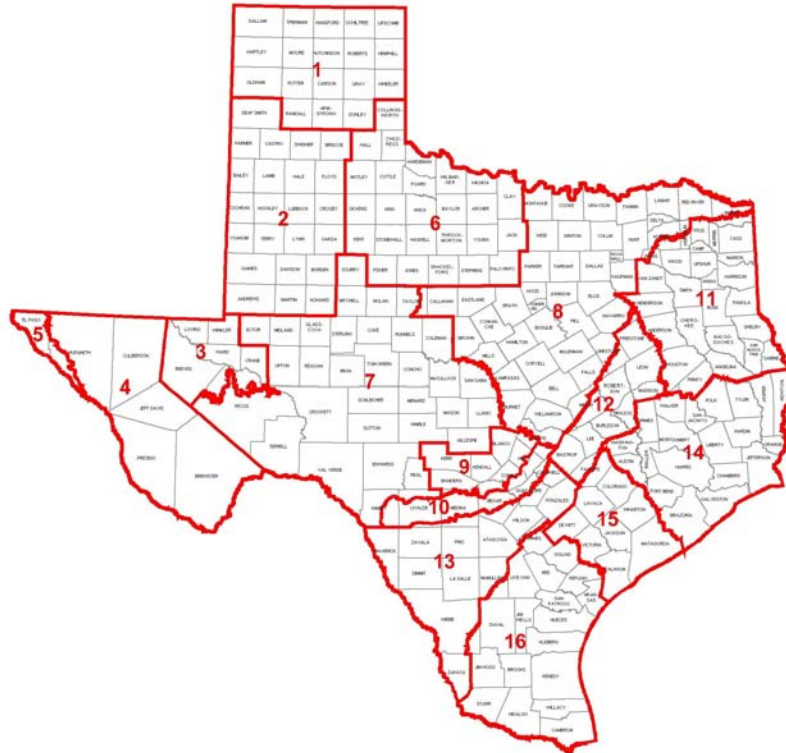


Figure 2, Groundwater Management Areas in Texas

The District Board of Directors is composed of eleven members elected to staggered four-year terms. Two directors are elected from each of the four county precincts, one director is elected at-large, one director is elected from the City of Iraan and one director is elected from the City of Fort Stockton. The Board of Directors holds regular meetings, at least quarterly. Meetings of the Board of Directors are public meetings noticed and held in accordance with public meeting requirements.

### **Authority of the District**

The District derives its authority to manage groundwater use within the District by virtue of the powers granted and authorized in the District enabling act HB 1258 of the 77<sup>th</sup> Texas Legislature (Appendix A). The District, acting under authority of the enabling legislation, assumes all the rights and responsibilities of a groundwater conservation district specified in Chapter 36 of the Texas Water Code. The District is currently developing the rules specifying the bounds of due process governing District actions. Upon completion of the rule development process, the draft rules will be considered for adoption in a public meeting after notice and hearing (Appendix C).

## Groundwater Resources of the District

There are 5 sources of groundwater recognized by TWDB in the District. Two of these sources; the Edwards-Trinity (Plateau) aquifer and the Cenozoic Pecos Alluvium are classified as major aquifers by TWDB. (Fig. 3) The other three sources of groundwater; the Rustler Formation, the Dockum aquifer and the Capitan Reef Complex are classified as minor aquifers by TWDB. (Fig. 4)

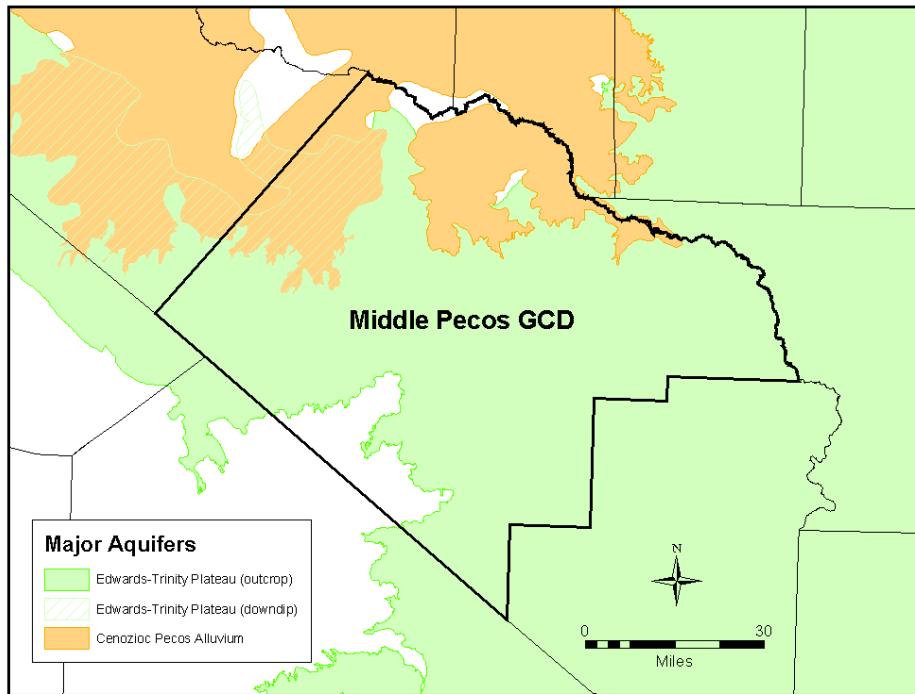


Figure 3, Major Aquifers in Middle Pecos GCD

A major aquifer is defined by TWDB as a source of groundwater that is capable of producing large quantities of groundwater or that produces groundwater over a large area. A minor aquifer is defined as an aquifer that produces small quantities of groundwater or produces groundwater in a limited area. The distinction of a source of groundwater as a major or minor aquifer may have no bearing on the importance of a source of groundwater to a particular locality.

The groundwater sources in the District may produce both fresh and moderately saline (brackish) water. The geologic origins of the groundwater sources of the District cover a broad range of geologic time. Listed in ascending order by geologic age, these sources and their ages are: Rustler Formation and Capitan Reef Complex (Permian), Dockum aquifer (Triassic), Edwards-Trinity (Plateau) aquifer (Cretaceous), and Cenozoic Pecos Alluvium (Cenozoic). The geologic age of the various sources of groundwater in the District and the geologic history of Pecos County have a bearing on the structure of the groundwater sources of the District and their relationships.

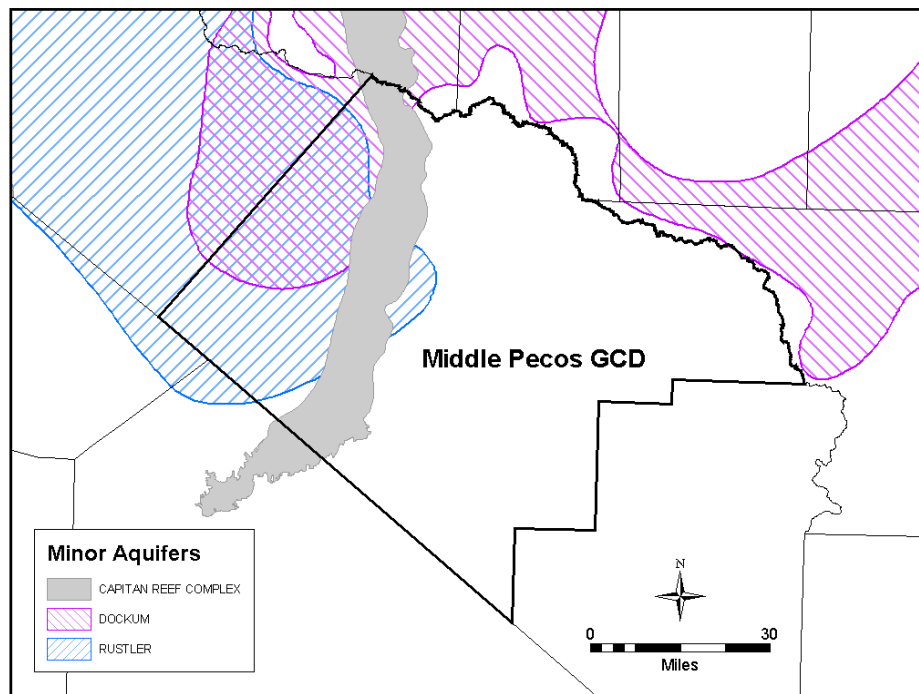


Figure 4, Minor Aquifers in Middle Pecos GCD

### **Aquifer Relationships in the Western Portion of the District**

Parts of the District lie within the Delaware and Val Verde Basins. These basins were centers of sediment deposition at various times in geologic history. Near the end of Permian time, the seas of the Delaware Basin became shallow and restricted. This resulted in high evaporation rates of the sea water and allowed the deposition of very large amounts of evaporite minerals such as Halite (Sodium Chloride - NaCl), Anhydrite (Calcium Sulfate – CaSO<sub>4</sub>) and Gypsum (Calcium Sulfate – CaSO<sub>4</sub>+H<sub>2</sub>O). (Rees and Buckner, 1980)

In Cretaceous time, seas again advanced and deposited significant amounts of additional sediment that covered the Permian evaporite mineral deposits. When the Cretaceous seas eventually withdrew, fresh groundwater percolated through the Permian evaporite deposits. The groundwater percolation dissolved much of the evaporite minerals beneath the overlying Cretaceous rocks taking away much of their support. The unsupported Cretaceous rocks subsided with extensive faulting and folding. (Fig. 5) The areas where the Cretaceous rocks subsided were filled with erosional material from the nearby volcanic activity associated with the formation of the Davis Mountains. (Rees and Buckner, 1980)

The western portion of the District lies within the Delaware Basin. In the area bounded generally by the Capitan Reef Complex, the Edwards-Trinity (Plateau) aquifer is covered and dissected by the Cenozoic Pecos Alluvium aquifer. In this area water is commingled between the two aquifers. The water quality in this area is affected mainly by sulfates from water percolating upward from the Rustler aquifer. Water that is recharged by

infiltration on the Rustler outcrops in highlands to the west of the District leeches anhydrite and gypsum as it moves down-gradient into the District. The faulted and collapsed condition of the Edwards-Trinity allows the sulfate laden water to infiltrate relatively easily. In the portion of the District which lies outside of the Delaware Basin, the Edwards-Trinity (Plateau) aquifer is undisturbed. (Rees and Buckner, 1980) (Fig 5)

### **Aquifer Descriptions**

**Capitan Reef Aquifer** – The Capitan Reef aquifer is a Permian age reef complex on the eastern and western margins of the Delaware Basin. Within the District the aquifer occurs as a generally north-south trending strip approximately 10 to 20 miles wide. This strip is part of a trend which runs from northern Brewster County to the New Mexico state line through Pecos, Ward and Winkler Counties. The aquifer is composed of various cavernous limestone formations that make up the reef complex. The Capitan aquifer outcrops in the Glass Mountains but is deeply buried below the Edwards-Trinity (Plateau) aquifer in other parts of the District. The aquifer may be 1,500 to 2,000 feet thick and up to 3,600 feet deep. Water quality in the Capitan aquifer may be fresh near the mountain outcrop areas but may be moderately saline in other areas. Because of the cavernous nature of the aquifer, well yields may be high with a generally high availability of groundwater. The Capitan Reef aquifer has been little studied in Texas. (Ashworth, 1990) (Guyton, 2003)

**Rustler aquifer** – The Rustler aquifer is made up of the Permian age Rustler Formation. The Rustler Formation is approximately 200 to 500 feet thick. It is mostly dolomite and anhydrite but has sand and conglomerate at its base and also contains some shale and limestone. From outcrops in Culberson County the Rustler aquifer dips into the subsurface to the east. It is deformed by folding and may not produce groundwater in all areas. The Rustler is recharged by runoff infiltration in the outcrop areas but age-dating of the water may indicate that more water is recharged by cross-formation flow than from infiltration. The water quality of the Rustler aquifer is moderately saline. Well yields may vary from low to high. The Rustler aquifer is relatively deeply buried in the District and contributes water to the Edwards-Trinity (Plateau) and Cenozoic Pecos Alluvium aquifers. The principal use of the Rustler aquifer is for irrigation and oil field uses. The Rustler aquifer is not well understood and has been little studied. (Guyton, 2003)

**Dockum Aquifer** – The Dockum aquifer is composed of the Triassic age formations of the Dockum Group; the Santa Rosa and Tecovas Formations within the District. The aquifer has upper and lower shale sections with a fine grained sand in the middle often referred to as the “Santa Rosa” sand. The Dockum aquifer occurs only under artesian conditions in a limited area of the north western part of the District. It receives recharge from infiltration of runoff in the outcrop areas but may only receive cross-formation recharge within the area of the District. In areas where the Dockum aquifer is hydraulically connected to the Cenozoic Pecos Alluvium aquifer, the two units have been referred to as the Allurosa aquifer. Water quality in the Dockum aquifer within the District is slightly (3,000 mg/l) to moderately (5,000 mg/l) saline with a generally low productivity of wells. (Rees and Buckner, 1980) (Ashworth, 1990) (Guyton, 2003)

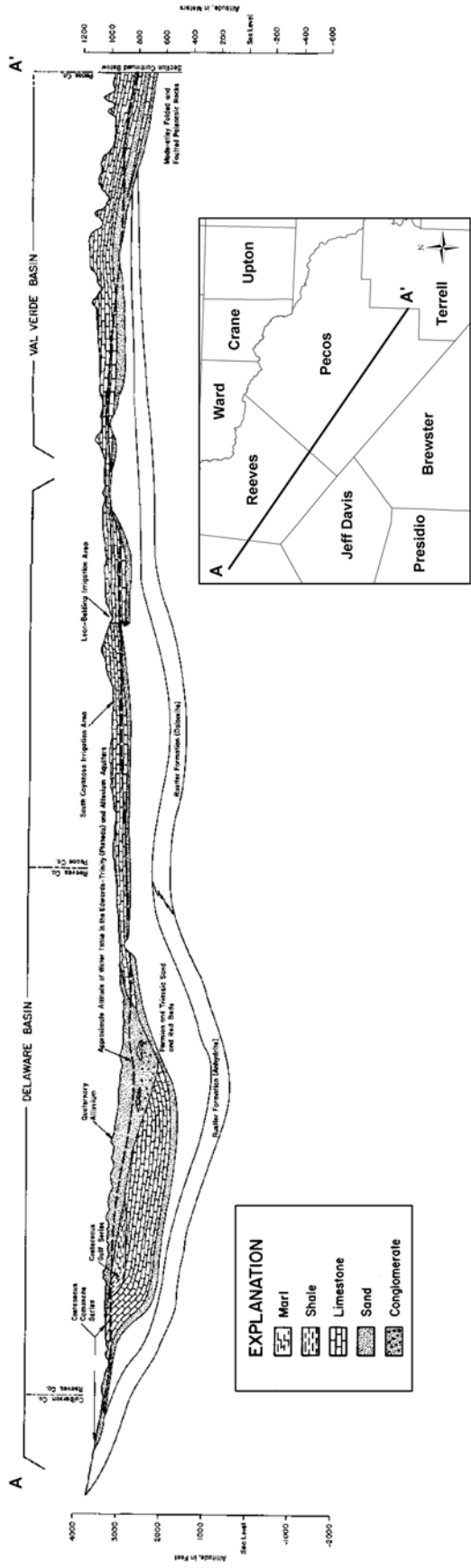


Figure 5, Geologic Cross Section of Reeves and Pecos Counties (Rees and Buckner, 1980)

**Edwards-Trinity (Plateau) Aquifer** – The Edwards-Trinity (Plateau) aquifer is of Cretaceous age and consists of the Edwards Group limestones and the sands and limestone of the Trinity Group. Within the District the Edwards Group is currently considered to consist of the Segovia and Fort Terrett Formations, but other terminology conventions may be applied to the Edwards Group. (BEG, 1975, 1981, 1982) The Trinity Group consists of the Maxon Sand, the Glen Rose Limestone and may include a basal conglomerate. (Rees and Buckner, 1980) The aquifer may be up to 1,200 feet in thickness and produces small to moderately large quantities of fresh to slightly saline (3,000 mg/l) water. The Edwards-Trinity (Plateau) aquifer is hydraulically connected to the Rustler and Cenozoic Pecos Alluvium aquifers in the western part of the District. (Ashworth, 1990)

**Cenozoic Pecos Alluvium Aquifer** – Consists of up to 1,500 feet of unconsolidated to partially consolidated sand, silt, clay and caliche. The alluvial fill material of the aquifer had two main deposition centers; the Pecos trough and the Monument Draw trough. The aquifer is a principal source of irrigation supply in the northern and western portions of the District. The water quality is fresh to moderately (5,000 mg/l) saline and well yields may be high. The Cenozoic Pecos Alluvium aquifer is hydraulically connected to the Rustler and Edwards-Trinity (Plateau) aquifers in the western part of the District. (Ashworth, 1990)

System	Geologic Unit	Hydrologic Unit
Quaternary	Alluvial Fill Material	Cenozoic Pecos Alluvium aquifer
Cretaceous	Edwards Group	Edwards-Trinity (Plateau) aquifer
	Trinity Group	
Triassic	Santa Rosa and Tecovas Formations (may be undifferentiated)	Dockum aquifer
Permian	Rustler Formation	Rustler aquifer
	Capitan Reef Complex	Capitan Reef aquifer

Figure 6, Water-bearing Geologic and Hydrologic Units of Pecos County, Modified from Rees and Buckner, 1980; Ashworth, 1990

## Geomorphology of the District

The topography of the District ranges from nearly level to gently undulating in the northern half and hilly to mountainous in the southern half. The eastern and central portions of the District are on the edge of the Edwards Plateau and are marked by mesas of varying sizes with intervening arroyos. Hills become more rounded and valleys more pronounced with generally undulating terrain further west. The northern part of the District slopes generally toward the Pecos River. Elevation ranges from about 2,200 feet above mean sea level (amsl) near the Pecos River to about 5,200 feet amsl in the mountains. All drainages flow to the Pecos River. The Pecos River flows continuously, but other streams in the county flow only after infrequent torrential rains. Springs were at one time an important water source for the area, but many no longer flow. (Rives 1980 and TSHA 2002)

## Estimate of the Total Useable Amount of Groundwater in the District

The estimate of the total amount of useable groundwater in the District is an expression of the amount of groundwater in the District that is available for use. The District has chosen to express the estimate of the total amount of useable groundwater in the District as an annual rate at which groundwater may be sustainably used. The amount of useable groundwater available from the aquifers in the District is estimated to be 149,605 acre-feet per year. This estimate is taken from the data on groundwater availability in Exhibit B, Data Table 4 of the Region F Water Plan. The District intends to use the Region F estimates until the District has completed the well registration and permitting process and will be able to base future estimates on the actual amounts of reported use in each aquifer.

Aquifer	2000	2010	2020	2030	2040	2050
Cenozoic Pecos Alluvium aquifer	20,408	20,408	20,408	20,408	20,408	20,408
Dockum aquifer	1,089	1,089	1,089	1,089	1,089	1,089
Edwards-Trinity aquifer	126,615	126,615	126,615	126,615	126,615	126,615
Other aquifers	1,493	1,493	1,493	1,493	1,493	1,493
<b>Total in acre-feet per year</b>	<b>149,605</b>	<b>149,605</b>	<b>149,605</b>	<b>149,605</b>	<b>149,605</b>	<b>149,605</b>

Table 1, Region F estimates of groundwater availability in Pecos County

## Estimate of the Annual Amount of Groundwater Use in the District

To estimate the annual amount of groundwater being used in the District, the District has relied on the TWDB Annual Water use Survey Data. In past years responses to the TWDB survey was voluntary. As a result, the TWDB water use survey data is subject to variations in the completeness or accuracy of the data. The estimate of the amount of groundwater being used in the District on an annual basis is 79,485 acre-feet per year. The estimate is from the TWDB Annual Water Use Survey for the Year 2000 which is the most recent data available. TWDB data on estimated groundwater use is available from 1980 to 2000, excepting 1981 to 1983 when no data was collected. Details of the estimate of the total amount of groundwater use are presented in Appendix D.

## Estimate of the Annual Amount of Natural or Artificial Recharge to the Groundwater Resources within the District

The estimated annual amount of recharge to the groundwater resources of the District is 115,484 acre-feet per year. This estimate is based in part on data from Table 3-1 on page 3-5 of the Region F Regional Water Plan text and gives recharge estimates for the Cenozoic Pecos Alluvium, Edwards-Trinity (Plateau) and Dockum aquifers in the District. The estimates of annual recharge for the Capitan Reef and Rustler aquifers are based on estimates developed by the District.

In the TWDB rules concerning groundwater management plans, recharge is defined as "The addition of water from precipitation or runoff by seepage or infiltration to an aquifer from the land surface, streams, or lakes directly into a formation or indirectly by way of leakage from another formation." This definition precludes the inclusion of down-gradient movement of water in an aquifer in the estimate of recharge. Neither the Rustler aquifer nor the Dockum aquifer has an outcrop within the District and can not receive recharge by infiltration. As of the date of this plan the District has not located an estimate or an estimated rate of inter-formation leakage that recharges these aquifers. The District affirms the Region F estimate of recharge to the Dockum aquifer and estimates recharge to the Rustler aquifer as 0 ac-ft per year in accordance with the definition of recharge in Chapter 356 of the TWDB rules.

Capitan Reef	824
Cenozoic Pecos Alluvium	11,880
Dockum	0
Edwards-Trinity (Plateau)	102,780
Rustler	0
Total Estimated Annual Recharge (ac-ft per year) =	115,484

Table 2, Region F annual recharge estimates for Pecos County

As of the date of this plan, no published estimates on the annual amount of recharge or estimates of the rate of infiltration for recharge of the Capitan Reef aquifer have been identified. Published estimates on the rate of recharge infiltration for portions of the Edwards-Trinity (Plateau) aquifer near the outcrop of the Capitan Reef aquifer may be applicable. Published estimates recharge rates for the Edwards-Trinity Plateau aquifer are available for Pecos County, Anaya 2002, and Crockett County, Inglehart 1967. The range of these estimates is 4 percent of annual precipitation for Pecos County to 1.6 percent for Crockett County. Because the actual rate of infiltration recharge for the Capitan Reef aquifer is unknown the District has chosen to use a mid-range assumptive rate of 2.8 percent of annual precipitation.

The Capitan Reef aquifer has an estimated area of outcrop within the District of 22,279 acres. The assumed rate of infiltration of 2.8 percent of annual precipitation was applied to the average annual precipitation for this area of the District (16 inches per year). (USDA-NRCS, 1999) The District estimates the annual recharge to the Capitan Reef aquifer to be 824 ac-ft per year. The details of the District calculation of the estimated recharge to the Capitan Reef aquifer are included in Appendix E.

The estimates of individual aquifer annual recharge used in this plan were existing published estimates or based on a reasonable methodology and available data that could be considered applicable. As more information on groundwater conditions in the District becomes available, the District may use this information to refine the specific methodology by which the District will seek to sustainably manage the groundwater in the District.

### **How the Natural or Artificial Recharge in the District May be Increased**

The natural or artificial recharge in the District might be increased by the construction of small retention structures on ephemeral streams to impound storm-water run-off.

### **Estimate of the Projected Total Water Demand within the District**

Estimates of projected water demand are based on anticipated patterns of population growth and migration that are applied to standardized estimated water use rates for the recognized categories of water use. Estimates of projected annual total water demand represent a need for water that may ultimately be met by a supply of surface water or groundwater. The estimation of projected total water demand is the first step in determining the adequacy of a regional system of water supply. The estimate of projected total water demand within the District in the year 2010 is 87,195 acre-feet. The source of this estimate is from Exhibit B, Data Table 2 in the Region F Regional Water Plan.

<b>WUG</b>	<b>Category</b>	<b>2000</b>	<b>2010</b>	<b>2020</b>	<b>2030</b>	<b>2040</b>	<b>2050</b>
County-Other	Municipal	730	746	733	722	705	671
Fort Stockton	Municipal	2,892	3,047	3,086	3,101	3,092	3,108
Iraan	Municipal	525	580	600	616	627	642
Irrigation	Irrigation	82,458	81,190	79,921	78,652	77,383	76,114
Livestock	Livestock	1,351	1,351	1,351	1,351	1,351	1,351
Manufacturing	Manufacturing	7	8	10	11	13	15
Mining	Mining	322	267	263	266	270	277
Power	Power	6	6	6	6	6	6
<b>Projected Demand in acre-feet/year =</b>		<b>88,291</b>	<b>87,195</b>	<b>85,970</b>	<b>84,725</b>	<b>83,447</b>	<b>82,184</b>

Table 3, Region F Estimates of Projected Water Demands in Pecos County

At the time that the estimates of projected total water demand for Pecos County were developed by the Region F Planning Group, the District was not yet in operation and able to participate in the estimate development process.

## Estimate of Projected Surface Water and Groundwater Supplies

Estimates of projected water supplies represent the estimated capacity of water supply systems to deliver water to meet user needs on an annual basis. Estimates of projected water supplies are compared with estimates of projected demand to determine if the existing infrastructure is capable of meeting the expected needs of a water user group. The annual water delivery capacity of different water systems in different areas may not be estimated by the same methods. The estimate of projected groundwater supplies in the District for the year 2010 is 89,933 acre-feet. This estimate is from Exhibit B, Data Table 5 in the Region F Water Plan.

Estimates of projected groundwater supplies typically represent the pumping capacity of the wells or well fields that supply a water user group. The estimation methodology for projected groundwater supplies may or may not reduce projections based on expected water-level drawdown or other conditions. The projected groundwater supplies of a water user group may significantly exceed the amount of water actually used by the user because the well fields supplying the user groups have additional or redundant capacity. This is particularly true of municipal water user groups where redundant capacity is built in to the system to insure a constant supply of water.

WUG	Source Name	2000	2010	2020	2030	2040	2050
Co.-Other	Cenozoic Pecos Alluvium aquifer	302	302	302	302	302	302
Co.-Other	Edwards-Trinity aquifer	600	600	600	600	600	600
Fort Stockton	Edwards-Trinity aquifer	5,600	5,600	5,600	5,600	5,600	5,600
Iraan	Edwards-Trinity aquifer	525	580	600	616	627	642
Irrigation	Direct reuse	864	864	864	864	864	864
Irrigation	Red Bluff Lake	1,558	1,558	1,558	1,558	1,558	1,558
Irrigation	Cenozoic Pecos Alluvium aquifer	19,846	19,846	19,846	19,846	19,846	19,846
Irrigation	Edwards-Trinity aquifer	58,713	57,445	56,176	54,907	53,638	52,369
Irrigation	Other aquifers	1,483	1,483	1,483	1,483	1,483	1,483
Livestock	Livestock local supply	57	57	57	57	57	57
Livestock	Cenozoic Pecos Alluvium aquifer	220	220	220	220	220	220
Livestock	Edwards-Trinity aquifer	1,070	1,070	1,070	1,070	1,070	1,070
Livestock	Other aquifers	5	5	5	5	5	5
Manufacture	Edwards-Trinity aquifer	8	8	8	8	8	8
Mining	Cenozoic Pecos Alluvium aquifer	40	40	40	40	40	40
Mining	Edwards-Trinity aquifer	249	249	249	249	249	249
Power	Edwards-Trinity aquifer	6	6	6	6	6	6
<b>Total Projected Supplies in acre-feet/year =</b>		<b>91,146</b>	<b>89,933</b>	<b>88,684</b>	<b>87,431</b>	<b>86,173</b>	<b>84,919</b>

Table 4, Region F Estimates of Projected Water Supplies in Pecos County

At the time that the estimates of projected water supplies for Pecos County were developed by the Region F Planning Group, the District was not yet in operation and able to participate in the estimate development process.

## Water Management Strategies to Meet Needs of Water User Groups

The projected water supplies and demand estimates for Pecos County taken from the Region F Water Plan indicate that projected demands do not exceed projected supplies through 2050. Only one water management strategy was recommended in the Region F Regional Water Plan that involved additional groundwater development in the District. This strategy involves the expansion of the existing Pecos County well field for an electric generating plant in Crockett County.

Water User Group	WUG County	Water Management Strategy	Source	2000	2010	2020	2030	2040	2050
Manufacturing	Pecos	No Management Strategy Identified	None	0	0	0	0	0	0
Steam Electric Power	Crockett	Additional Wells in Existing Pecos County Well Field	Edwards-Trinity (Plateau) aquifer	0	1900	1900	1900	1900	1900
Mining	Pecos	No Management Strategy Identified	None	0	0	0	0	0	0

Table 5, Water Management Strategies Recommended for Pecos County in the Region F Regional Water Plan

## How the Groundwater Management Plan Addresses Water Supply Needs in a Manner Not in Conflict with the Region F Water Plan

In order to address water supply needs in a manner not in conflict with the TWDB approved regional water plan from the Region F Water Planning Group, the District has adopted a groundwater availability value of 149,605 ac-ft per year taken from Table 4 of the approved Region F Water Plan.

## Details on How the District Will Manage Groundwater in the District

The District will manage the supply of groundwater within the District in order to conserve the resource while seeking to maintain the economic viability of all resource user groups, public and private. The District seeks to manage the groundwater resources of the District as practicably as possible in a sustainable manner. The Texas Legislature established that groundwater conservation districts are the preferred method of groundwater management in Section 36.0015 of the Texas Water Code. In consideration of the economic and cultural activities occurring within the District, the District will identify and engage in such activities and practices, that if implemented may result in the conservation of groundwater in the District. The District will manage groundwater resources through rules developed and implemented in accordance with Chapter 36 of the Texas Water Code and the provisions of the District Enabling Act recorded in Chapter 1299 of the Acts of the 77<sup>th</sup> Texas Legislature (HB 1258). The District will require that any well constructed as an exempt well under activities regulated by the Texas Railroad Commission (TRC) and later converted to another use not regulated by the TRC will be required to seek a permit for the use of groundwater in the District.

An observation well network may be established and maintained in order to monitor changing storage conditions of groundwater supplies within the District. When a monitoring well network has been established the District will make a regular assessment of water supply and groundwater storage conditions and will report those conditions to the District Board of Directors and to the public. The District may undertake, as necessary, investigations of the groundwater resources within the District and will make the results of investigations available to the public upon adoption by the District Board of Directors. The District will co-operate with investigations of the groundwater resources of the District undertaken by other local political subdivisions or agencies of the State of Texas.

In order to better manage groundwater resources the District may establish management zones for all sources of groundwater within the District. In each management zone the District may:

- a) Establish groundwater availability and authorize the production of groundwater
- b) Determine and implement the proportional reductions of the use of groundwater for all classes of groundwater use that are established by the District
- c) Allow for the transfer of the permitted right to use groundwater if a process is established in the District rules

Section 36.116 of the Texas Water Code provides that the District may use the management zones to adopt different rules for each:

- a) Aquifer
- b) Aquifer subdivision
- c) Geologic formation
- d) Geographic area in which any part of a through c above may occur within the District

For the purpose of managing the use of groundwater within the District, the District will define sustainable use as the use of an amount of groundwater in the District as a whole or any management zone established by the District that does not exceed:

- a) The amount of annual recharge of the aquifer or aquifer subdivision in which the use occurs as recognized by the District or
- b) Any other criteria established by the District as being a threshold of use beyond which further use of the aquifer or aquifer subdivision may result in a specified undesirable or injurious condition

The District will use the currently available estimates of groundwater recharge, movement and availability within the District in exercising the statutory responsibility of managing the groundwater in the District. As more information on groundwater conditions in the District becomes available, the District may use that information to refine the specific methodology by which the District will seek to sustainably manage the groundwater in the District.

The annual amount of water used from an aquifer or aquifer subdivision in the District or in a management zone established by the District will be averaged over a period of years specified in the District rules to determine if the sustainable use has been exceeded. If the sustainable use of an aquifer or aquifer subdivision in the District or a management zone is found to have been exceeded the District may implement proportional reductions in the permitted use of groundwater in the District or management zone to reduce the levels of use to the sustainable amount. The District will implement proportional reductions in the permitted use of groundwater only to the extent that is required to maintain sustainable use in an aquifer, aquifer subdivision or a management zone when averaged over time.

The District rules will specify the methodology by which the District will track the usage of groundwater from an aquifer or aquifer subdivision in the District or a management zone to determine whether the sustainable use has been exceeded. The District rules will specify the methodology by which the District will implement any proportional reductions in the permitted use of groundwater in the District. All District actions with regard to proportional reductions of the permitted use of groundwater will be taken in noticed public meetings and in accord with the District rules.

The District will implement rules establishing a claims process in which the District may require an existing or historic user of groundwater to obtain a historic use permit. The claims process is intended to protect existing use as provided for in Section 36.113(e) of the Texas Water Code. To the extent practicable while remaining consistent with this plan, the District's existing and historic use claims process and period will preserve historic use as provided in Section 36.116(b) of the Texas Water Code.

The District will protect the existing and historical use of groundwater in the District prior to the effective date of the rules establishing the claims process. To obtain a historic use permit, an existing or historic user must prove the maximum annual amount of groundwater that the user put towards a beneficial use during an existing and historic use period established in the District rules. The protection extended to historic use permit holder would be achieved by imposing more restrictive permit conditions on new permit applications. In extending this protection to historic use permit holders the District will establish limitations that:

- a) Apply to all subsequent new applications for the permitted use of groundwater and applications for the increased use of groundwater by holders of historic user permits regardless of the type or location of use
- b) Bear a reasonable relationship to the District's management plan
- c) Are reasonably necessary to protect existing use

The District may adopt rules to regulate groundwater withdrawals by means of spacing and/or production limits. The District may deny a well construction permit or limit groundwater withdrawals in accordance with the guidelines stated in the rules of the District. In making a determination to deny a permit or reduce the amount of groundwater withdrawals authorized in an existing permit, the District will weigh the public benefit in managing the aquifer to be derived from the denial of a groundwater withdrawal permit or the reduction of the amount of authorized groundwater withdrawals against the individual hardship imposed by the permit denial or authorization reduction.

The relevant factors to be considered in making a determination to deny a permit or limit groundwater withdrawals may include:

- a) The rules of the District
- b) The distribution of groundwater resources in the District or any management zones established by the District
- c) The economic hardship resulting from grant or denial of a permit or the terms prescribed by the permit

In pursuit of the District's mission of protecting the resource, the District may require reduction of groundwater withdrawals. To achieve this purpose, the District may, at the Board's discretion amend or revoke any permits after notice and hearing. The determination to seek the amendment, reduction or revocation of a permit by the District will be based on aquifer conditions observed by the District. The District will, when necessary, enforce the terms and conditions of permits and the rules of the District by enjoining the permit holder in a court of competent jurisdiction as provided for in Texas Water Code Chapter 36.102.

The District will establish rules for the proportional reduction of the permitted use of groundwater in the District that will recognize the following priorities of use:

- 1) Exempt users with particular consideration to livestock and domestic use
- 2) Holders of historic use of groundwater permits
- 3) Holders of non-historic groundwater use permits

The District may employ technical resources at its disposal, as needed, to evaluate the resources available within the District and to determine the effectiveness of regulatory or conservation measures. In consideration of particular individual, localized or District-wide conditions the District may allow the production in a management zone to exceed the sustainable amount for a period of time considered necessary by the District. The exercise of this discretion by the District shall not be construed as limiting the authority of the District in any other matter. A public or private user may appeal to the Board for discretion in enforcement of the provisions of a reduction in the permitted use of groundwater on grounds of adverse economic hardship or unique local conditions. The exercise of said discretion by the Board shall not be construed as limiting the power of the Board.

## **Actions, Procedures, Performance and Avoidance Necessary to Effectuate the Plan**

The District will implement the provisions of this management plan and will utilize the objectives of the plan as a guide for District actions, operations and decision-making. The District will ensure that planning efforts, activities and operations are consistent with the provisions of this plan.

The District will adopt rules in accordance with Chapter 36 of the Texas Water Code and all rules will be followed and enforced. The development of rules will be based on the scientific information and technical evidence available to the District.

The District will encourage cooperation and coordination in the implementation of this plan. All operations and activities will be performed in a manner that encourages the cooperation of the citizens of the District and with the appropriate water management entities at the state, regional and local level.

## **Methodology for Tracking the District's Progress in Achieving Management Goals**

The General Manager of the District will prepare and submit an annual report (Annual Report) to the District Board of Directors. The Annual Report will include an update on the District's performance in achieving the management goals contained in this plan. The general manager will present the Annual Report to the Board of Directors within one hundred twenty (120) days following the completion of the District's Fiscal Year, beginning in the fiscal year starting on November 1, 2004. A copy of the annual audit of District financial records will be included in the Annual Report. The District will maintain a copy of the Annual Report on file for public inspection at the District offices, upon adoption by the Board of Directors.

## **Management Goals**

### **1) Providing for the Most Efficient Use of Groundwater in the District**

**1.1 Objective** – Each year, the District will require all new exempt or permitted wells that are constructed within the boundaries of the District to be registered with the District in accordance with the District rules.

**1.1 Performance Standard** – Each Year the number of exempt and permitted wells registered by the District for the year will be incorporated into the Annual Report submitted to the Board of Directors of the District.

## **2) Controlling and Preventing the Waste of Groundwater in the District**

**2.1 Objective** – Each year, the District will make an evaluation of the District Rules to determine whether any amendments are recommended to decrease the amount of waste of groundwater within the District.

**2.1 Performance Standard** – The District will include a discussion of the annual evaluation of the District Rules and the determination of whether any amendments to the rules are recommended to prevent the waste of groundwater in the Annual Report of the District provided to the Board of Directors.

**2.2 Objective** – Each year, the District will provide information to the public on eliminating and reducing wasteful practices in the use of groundwater by a page on groundwater waste reduction on the District’s website or by providing an article on eliminating and reducing wasteful practices to a newspaper of general circulation in the District for potential publication.

**2.2 Performance Standard** – Each year, a copy of the information provided on the groundwater waste reduction page of District’s website or a copy of the article provided to a newspaper of general circulation in the District will be included in the District’s Annual Report to be given to the District Board of Directors.

## **3) Controlling and Preventing Subsidence**

This Management Goal is not Applicable to the District.

## **4) Natural Resource Issues That Affect the Use and Availability of Groundwater or are affected by the Use of Groundwater.**

**4.1 Objective** – The District will inquire to the Texas Railroad Commission asking for the location of existing salt water or waste disposal injection wells permitted by the Texas Railroad Commission within the District by the end of fiscal year 2004.

**4.1 Performance Standard** – A copy of the letter to the Texas Railroad Commission asking for the location of existing salt water or waste disposal wells permitted to operate within the District will be included in the Annual Report submitted to the Board of Directors of the District for fiscal year 2004.

**4.2 Objective** – Each year the District will inquire to the Texas Railroad Commission asking whether any new salt water or waste disposal injection wells have been permitted by the Texas Railroad Commission to operate within the District.

**4.2 Performance Standard** – Each year a copy of the letter to the Texas Railroad Commission asking for the location of any new salt water or waste disposal wells permitted to operate within the District will be included in the Annual Report submitted to the Board of Directors of the District.

**4.3 Objective** – Each year the District will request the Texas Railroad Commission to provide a copy of the results of integrity tests performed on salt water or waste disposal injection wells permitted by the Texas Railroad Commission to operate within the District..

**4.3 Performance Standard** – Each year a copy of the letter to the Texas Railroad Commission requesting the results of the integrity testing performed on salt water or waste disposal injection wells permitted by the Texas Railroad Commission to operate within the District will be included in the Annual Report submitted to the Board of Directors of the District.

## **5) Conjunctive Surface Water Management Issues**

**5.1 Objective** – Each year, the District will participate in the regional planning process by being represented at the Region F Regional Water Planning Group meetings.

**5.1 Performance Standard** – The attendance of a District representative to at least 50 percent of the Region F Regional Water Planning Group meetings will be noted in the Annual Report presented to the District Board of Directors.

## **6) Addressing Conservation**

**6.1 Objective** – The District will submit an article annually, regarding water conservation for publication to at least one newspaper of general circulation in Pecos County.

**6.1 Performance Standard** – A copy of the article submitted by the District for publication to a newspaper of general circulation in Pecos County regarding water conservation will be included in the Annual Report to the Board of Directors.

## **7) Addressing Drought Conditions**

**7.1 Objective** – Each month, the District will download the updated Palmer Drought Severity Index (PDSI) map and check for the periodic updates to the Drought Preparedness Council Situation Report (Situation Report) posted on the Texas Water Information Network website [www.txwin.net](http://www.txwin.net) .

**7.1 Performance Standard** – Quarterly, the District will make an assessment of the status of drought in the District and prepare a quarterly briefing to the Board of Directors. The downloaded PDSI maps and Situation Reports will be included with copies of the quarterly briefing in the District Annual Report to the Board of Directors.

## References

- Ashworth, John. B. 1989; *Evaluation of Ground-Water Resources in Parts of Loving, Pecos, Reeves, Ward and Winkler Counties, Texas*; Texas Water Development Board, Report 317.
- Anaya, Roberto, 2002; *Approach to Estimating Areal Recharge for the Edwards-Trinity Aquifer*; Texas Water Development Board Presentation to the Edwards-Trinity (Plateau) aquifer Groundwater Availability Model Stakeholder Advisory Forum meeting November 7, 2002; Available on-line  
[http://www.twdb.state.tx.us/gam/eddt\\_p/SAF5\\_ET-p.pdf](http://www.twdb.state.tx.us/gam/eddt_p/SAF5_ET-p.pdf)
- Bureau of Economic Geology 1975; *Geologic Atlas of Texas, Pecos Sheet*; The University of Texas at Austin, Bureau of Economic Geology.
- Bureau of Economic Geology 1981; *Geologic Atlas of Texas, Sonora Sheet*; The University of Texas at Austin, Bureau of Economic Geology.
- Bureau of Economic Geology 1982; *Geologic Atlas of Texas, Fort Stockton Sheet*; The University of Texas at Austin, Bureau of Economic Geology.
- Iglehart, H. H. 1967; *Occurrence and Quality of Groundwater in Crockett County, Texas*; Texas Water Development Board, Report 47.
- United States Department of Agriculture-Natural Resource Conservation Service USDA-NRCS National Cartography and Geospatial Center 1999; *Map of Average Annual Precipitation in Texas 1961-1990*; Available on-line:  
<ftp://ftp.ftw.nrcs.usda.gov/pub/ams/prism/maps/tx.pdf>
- Rees, R. W., and A. W. Buckner 1980; *Occurrence and Quality of Ground Water in the Edwards-Trinity (Plateau) Aquifer in the Trans-Pecos Region of Texas*; Texas Water Development Board Report 255
- Rives, J. L. 1980; *Soil Survey of Pecos County, Texas*; U.S. Department of Agriculture Soil Conservation Service
- Texas State Historical Association (TSHA), 2002; *The Handbook of Texas Online*. Available on-line:  
<http://www.tsha.utexas.edu/handbook/online/articles/view/PP/hcp5.html>.

# Appendix A

## District Enabling Act HB 1258 of 77<sup>th</sup> Texas Legislature Validating Creation of the Middle Pecos Groundwater Conservation District

1-1 AN ACT

1-2 relating to the ratification of the creation of and to the

1-3 administration, powers, duties, operation, and financing of the

1-4 Middle Pecos Groundwater Conservation District.

1-5 BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF TEXAS:

1-6 SECTION 1. RATIFICATION OF CREATION. The creation by

1-7 Chapter 1331, Acts of the 76th Legislature, Regular Session,

1999

1-8 (Senate Bill No. 1911), of the Middle Pecos Groundwater

1-9 Conservation District in Pecos County is ratified as required by

1-10 Section 15(a) of that Act, subject to approval at a confirmation

1-11 election under Section 7 of this Act.

1-12 SECTION 2. DEFINITION. In this Act, "district" means the

1-13 Middle Pecos Groundwater Conservation District.

1-14 SECTION 3. BOUNDARIES. The boundaries of the district are

1-15 coextensive with the boundaries of Pecos County, Texas.

1-16 SECTION 4. GENERAL POWERS. (a) The district has all of

1-17 the

1-18 rights, powers, privileges, authority, functions, and duties

1-19 provided by the general law of this state, including Chapter 36,

1-20 Water Code, applicable to groundwater conservation districts

1-21 created under Section 59, Article XVI, Texas Constitution. This

1-22 Act prevails over any provision of general law that is in

conflict

1-23 or inconsistent with this Act, including any provision of

Chapter

1-24 1331, Acts of the 76th Legislature, Regular Session, 1999

(Senate

1-25 Bill No. 1911).

2-1 (b) Notwithstanding Subsection (a) of this section, the

2-2 following provisions prevail over a conflicting or inconsistent

2-3 provision of this Act:

2-4 (1) Sections 36.1071-36.108, Water Code;

2-5 (2) Sections 36.159-36.161, Water Code; and

2-6 (3) Subchapter I, Chapter 36, Water Code.

2-7 (c) Section 36.121, Water Code, does not apply to the

2-8 district.

2-9 (d) The rights, powers, privileges, authority, functions,

2-10 and duties of the district are not subject to the continuing

right

2-11 of supervision of the state through the Texas Natural Resource

2-12 Conservation Commission.

2-13 (e) In addition to other fees assessed by the district,

the

2-14 district may assess an additional fee on groundwater transferred

2-15 out of the district not to exceed 10 percent of the amount of  
the  
2-16 fee assessed for the production of water for use within the  
2-17 district.  
2-18 (f) The district may not impose any additional rules or  
2-19 regulations on the production of groundwater for use outside of  
the  
2-20 district than imposed upon production for in-district use.  
2-21 SECTION 5. BOARD OF DIRECTORS. (a) The district is  
governed  
2-22 by a board of 11 directors.  
2-23 (b) Temporary directors serve until initial directors are  
2-24 elected under Section 7 of this Act.  
2-25 (c) Initial directors serve until permanent directors are  
2-26 elected under Section 8 of this Act.  
2-27 (d) Permanent directors serve staggered four-year terms.  
3-1 (e) Each director must qualify to serve as director in  
the  
3-2 manner provided by Section 36.055, Water Code.  
3-3 (f) A director serves until the director's successor has  
3-4 qualified.  
3-5 (g) If there is a vacancy on the board, the remaining  
3-6 directors shall appoint a director to serve the remainder of the  
3-7 term. If at any time there are fewer than three qualified  
3-8 directors, the Pecos County Commissioners Court shall appoint  
the  
3-9 necessary number of persons to fill all the vacancies on the  
board.  
3-10 (h) A director may not receive a salary or other  
3-11 compensation for service as a director but may be reimbursed for  
3-12 actual expenses of attending meetings at the rate in effect for  
3-13 employees of Pecos County.  
3-14 SECTION 6. METHOD OF ELECTING DIRECTORS. (a) The  
directors  
3-15 of the district shall be elected according to the method  
provided  
3-16 by this section.  
3-17 (b) One director shall be elected by the qualified voters  
of  
3-18 the entire district, two directors shall be elected from each  
3-19 county commissioners precinct by the qualified voters of that  
3-20 precinct, one director shall be elected from the city of Iraan  
by  
3-21 the qualified voters of that city, and one director shall be  
3-22 elected from the city of Fort Stockton by the qualified voters  
of

3-23 that city.  
3-24 (c) To be qualified to be a candidate for or to serve as  
a  
3-25 director at large, a person must be a registered voter in the  
3-26 district. To be a candidate for or to serve as director from a  
3-27 county commissioners precinct or a city, a person must be a  
4-1 registered voter of that precinct or city, as applicable.  
4-2 (d) A person shall indicate on the application for a  
place  
4-3 on the ballot:  
4-4 (1) the precinct or city that the person seeks to  
4-5 represent; or  
4-6 (2) that the person seeks to represent the district  
at  
4-7 large.  
4-8 (e) At the first election after the county commissioners  
4-9 precincts are redrawn under Section 18, Article V, Texas  
4-10 Constitution, eight new directors shall be elected to represent  
the  
4-11 precincts. The directors elected shall draw lots to determine  
4-12 which four directors serve two-year terms and which four  
directors  
4-13 serve four-year terms.  
4-14 SECTION 7. CONFIRMATION AND INITIAL DIRECTORS' ELECTION.  
(a)  
4-15 The temporary board of directors shall call and hold an election  
to  
4-16 confirm establishment of the district and to elect initial  
4-17 directors.  
4-18 (b) At the confirmation and initial directors' election,  
the  
4-19 temporary board of directors shall have placed on the ballot the  
4-20 name of any candidate filing for an initial director's position  
and  
4-21 blank spaces to write in the names of other persons. A  
temporary  
4-22 director who is qualified to be a candidate under Sections 5 and  
6  
4-23 may file for an initial director's position.  
4-24 (c) Section 41.001(a), Election Code, does not apply to a  
4-25 confirmation and initial directors' election held as provided by  
4-26 this section.  
4-27 (d) Except as provided by this section, a confirmation  
and  
5-1 initial directors' election must be conducted as provided by  
5-2 Sections 36.017(b)-(h), Water Code, and the Election Code.

5-3 (e) The elected initial directors shall draw lots to  
5-4 determine their terms. One director from each county  
commissioners  
5-5 precinct and the director from the district at large serve terms  
5-6 that expire on the date of the first election held under Section  
8  
5-7 of this Act. The remaining directors serve terms that expire on  
the  
5-8 date of the second election held under Section 8 of this Act.  
5-9 (f) If the majority of the votes cast at an election held  
5-10 under this section is against the confirmation of the district,  
the  
5-11 temporary directors may call another election under this section  
5-12 not later than August 31, 2003.  
5-13 SECTION 8. ELECTION OF DIRECTORS. On the first Saturday  
in  
5-14 May of the first even-numbered year after the year in which the  
5-15 district is authorized to be created at a confirmation election  
and  
5-16 on the first Saturday in May of each subsequent second year, an  
5-17 election shall be held in the district to elect the appropriate  
5-18 number of directors.  
5-19 SECTION 9. FINDINGS RELATED TO PROCEDURAL REQUIREMENTS.  
(a)  
5-20 The proper and legal notice of the intention to introduce this  
Act,  
5-21 setting forth the general substance of this Act, has been  
published  
5-22 as provided by law, and the notice and a copy of this Act have  
been  
5-23 furnished to all persons, agencies, officials, or entities to  
which  
5-24 they are required to be furnished by the constitution and other  
5-25 laws of this state, including the governor, who has submitted  
the  
5-26 notice and Act to the Texas Natural Resource Conservation  
5-27 Commission.  
6-1 (b) The Texas Natural Resource Conservation Commission  
has  
6-2 filed its recommendations relating to this Act with the  
governor,  
6-3 lieutenant governor, and speaker of the house of representatives  
6-4 within the required time.  
6-5 (c) All requirements of the constitution and laws of this  
6-6 state and the rules and procedures of the legislature with  
respect



## Appendix B

# Evidence of the Administrative Processes Required For the Certification of the Groundwater Management Plan as Administratively Complete

# Appendix C

## Draft Rules Being Considered for Adoption by the Middle Pecos Groundwater Conservation District

## Appendix D

# TWDB Groundwater Use Estimates For Pecos County

## Estimated Annual Groundwater use in Pecos County in Acre-Feet Texas Water Development Board Water Uses Survey Data

Aquifer	Year	Municipal	Mfg	Power	Mining	Irrigation	Livestock	Annual Total
Cenozoic Pecos Alluvium	1980	87	0	0	0	50,000	282	50,369
Edwards-Trinity (Plateau)		4,177	6	2,087	3,070	53,134	1,100	63,574
Other Un-Differentiated		1	0	0	7	0	5	13
Rustler		0	0	0	0	10	5	15
		<b>4,265</b>	<b>6</b>	<b>2,087</b>	<b>3,077</b>	<b>103,144</b>	<b>1,392</b>	<b>113,971</b>

Aquifer	Year	Municipal	Mfg	Power	Mining	Irrigation	Livestock	Annual Total
Cenozoic Pecos Alluvium	1984	336	3	0	5,090	20,000	225	25,654
Edwards-Trinity (Plateau)		4,440	10	2,391	5,176	70,000	760	82,777
Other Un-Differentiated		5	0	0	106	0	5	116
Rustler		0	0	0	63	22	5	90
		<b>4,781</b>	<b>13</b>	<b>2,391</b>	<b>10,435</b>	<b>90,022</b>	<b>995</b>	<b>108,637</b>

Aquifer	Year	Municipal	Mfg	Power	Mining	Irrigation	Livestock	Annual Total
Cenozoic Pecos Alluvium	1985	326	3	0	58	17,718	240	18,345
Edwards-Trinity (Plateau)		4,334	9	2,169	341	62,013	809	69,675
Other Un-Differentiated		5	0	0	9	0	5	19
Rustler		0	0	0	0	20	5	25
		<b>4,665</b>	<b>12</b>	<b>2,169</b>	<b>408</b>	<b>79,751</b>	<b>1,059</b>	<b>88,064</b>

Aquifer	Year	Municipal	Mfg	Power	Mining	Irrigation	Livestock	Annual Total
Cenozoic Pecos Alluvium	1986	308	1	0	64	14,700	87	15,160
Edwards-Trinity (Plateau)		4,199	9	2,184	207	51,450	291	58,340
Other Un-Differentiated		4	0	0	5	0	2	11
Rustler		0	0	0	0	17	2	19
		<b>4,511</b>	<b>10</b>	<b>2,184</b>	<b>276</b>	<b>66,167</b>	<b>382</b>	<b>73,530</b>

Aquifer	Year	Municipal	Mfg	Power	Mining	Irrigation	Livestock	Annual Total
Cenozoic Pecos Alluvium	1987	304	0	0	53	13,450	173	13,980
Edwards-Trinity (Plateau)		3,467	9	1,989	191	47,076	584	53,316
Other Un-Differentiated		4	0	0	4	0	4	12
Rustler		0	0	0	0	15	4	19
		<b>3,775</b>	<b>9</b>	<b>1,989</b>	<b>248</b>	<b>60,541</b>	<b>765</b>	<b>67,327</b>

Aquifer	Year	Municipal	Mfg	Power	Mining	Irrigation	Livestock	Annual Total
Cenozoic Pecos Alluvium	1988	319	0	0	36	13,065	146	13,566
Edwards-Trinity (Plateau)		4,166	8	1,969	204	45,727	495	52,569
Other Un-Differentiated		4	0	0	6	0	3	13
Rustler		0	0	0	0	15	3	18
		<b>4,489</b>	<b>8</b>	<b>1,969</b>	<b>246</b>	<b>58,807</b>	<b>647</b>	<b>66,166</b>

Aquifer	Year	Municipal	Mfg	Power	Mining	Irrigation	Livestock	Annual Total
Cenozoic Pecos Alluvium	1989	257	0	0	48	14,648	164	15,117
Edwards-Trinity (Plateau)		3,971	8	1,312	188	51,268	642	57,389
Other Un-Differentiated		4	0	0	7	0	4	15
Rustler		0	0	0	0	17	4	21
		<b>4,232</b>	<b>8</b>	<b>1,312</b>	<b>243</b>	<b>65,933</b>	<b>814</b>	<b>72,542</b>

Aquifer	Year	Municipal	Mfg	Power	Mining	Irrigation	Livestock	Annual Total
Cenozoic Pecos Alluvium	1990	260	0	0	37	14,028	170	14,495
Edwards-Trinity (Plateau)		3,543	6	1,509	197	49,098	667	55,020
Other Un-Differentiated		1	0	0	10	0	4	15
Rustler		0	0	0	0	16	4	20
		<b>3,804</b>	<b>6</b>	<b>1,509</b>	<b>244</b>	<b>63,142</b>	<b>845</b>	<b>69,550</b>

Aquifer	Year	Municipal	Mfg	Power	Mining	Irrigation	Livestock	Annual Total
Cenozoic Pecos Alluvium	1991	293	0	0	29	13,490	176	13,988
Edwards-Trinity (Plateau)		2,957	5	1,577	129	47,215	691	52,574
Other Un-Differentiated		1	0	0	8	0	4	13
Rustler		0	0	0	0	15	4	19
		<b>3,251</b>	<b>5</b>	<b>1,577</b>	<b>166</b>	<b>60,720</b>	<b>875</b>	<b>66,594</b>

Aquifer	Year	Municipal	Mfg	Power	Mining	Irrigation	Livestock	Annual Total
Cenozoic Pecos Alluvium	1992	244	0	0	31	13,284	215	13,774
Edwards-Trinity (Plateau)		2,807	5	1,610	149	46,496	845	51,912
Other Un-Differentiated		1	0	0	9	0	5	15
Rustler		0	0	0	0	15	5	20
		<b>3,052</b>	<b>5</b>	<b>1,610</b>	<b>189</b>	<b>59,795</b>	<b>1,070</b>	<b>65,721</b>

Aquifer	Year	Municipal	Mfg	Power	Mining	Irrigation	Livestock	Annual Total
Cenozoic Pecos Alluvium	1993	317	0	0	42	16,355	193	16,907
Edwards-Trinity (Plateau)		3,537	4	1,588	154	57,245	757	63,285
Other Un-Differentiated		1	0	0	1	0	4	6
Rustler		0	0	0	0	18	4	22
		<b>3,855</b>	<b>4</b>	<b>1,588</b>	<b>197</b>	<b>73,618</b>	<b>958</b>	<b>80,220</b>

Aquifer	Year	Municipal	Mfg	Power	Mining	Irrigation	Livestock	Annual Total
Cenozoic Pecos Alluvium	1994	377	0	0	26	25,436	216	26,055
Edwards-Trinity (Plateau)		3,719	4	1,319	171	44,227	849	50,289
Other Un-Differentiated		1	0	0	0	0	4	5
Rustler		0	0	0	0	1,283	4	1,287
		<b>4,097</b>	<b>4</b>	<b>1,319</b>	<b>197</b>	<b>70,946</b>	<b>1,073</b>	<b>77,636</b>

Aquifer	Year	Municipal	Mfg	Power	Mining	Irrigation	Livestock	Annual Total
Cenozoic Pecos Alluvium	1995	431	0	0	37	29,403	201	30,072
Edwards-Trinity (Plateau)		3,697	4	1,493	215	51,125	791	57,325
Other Un-Differentiated		1	0	0	0	0	4	5
Rustler		0	0	0	0	1,483	4	1,487
		<b>4,129</b>	<b>4</b>	<b>1,493</b>	<b>252</b>	<b>82,011</b>	<b>1,000</b>	<b>88,889</b>

Aquifer	Year	Municipal	Mfg	Power	Mining	Irrigation	Livestock	Annual Total
Cenozoic Pecos Alluvium	1996	439	0	0	15	26,912	219	27,585
Edwards-Trinity (Plateau)		4,149	4	1,267	249	46,794	861	53,324
Other Un-Differentiated		1	0	0	0	0	4	5
Rustler		0	0	0	0	1,357	4	1,361
		<b>4,589</b>	<b>4</b>	<b>1,267</b>	<b>264</b>	<b>75,063</b>	<b>1,088</b>	<b>82,275</b>

Aquifer	Year	Municipal	Mfg	Power	Mining	Irrigation	Livestock	Annual Total
Cenozoic Pecos Alluvium	1997	395	0	0	17	27,677	214	28,303
Edwards-Trinity (Plateau)		3,953	4	979	236	48,125	840	54,137
Other Un-Differentiated		1	0	0	0	0	4	5
Rustler		0	0	0	0	1,396	4	1,400
		<b>4,349</b>	<b>4</b>	<b>979</b>	<b>253</b>	<b>77,198</b>	<b>1,062</b>	<b>83,845</b>

Aquifer	Year	Municipal	Mfg	Power	Mining	Irrigation	Livestock	Annual Total
Cenozoic Pecos Alluvium	1998	390	0	0	17	28349	177	28,933
Edwards-Trinity (Plateau)		4544	4	990	59	49293	693	55,583
Other Un-Differentiated		1	0	0	0	0	3	4
Rustler		0	0	0	0	1430	3	1,433
		<b>4,935</b>	<b>4</b>	<b>990</b>	<b>76</b>	<b>79,072</b>	<b>876</b>	<b>85,953</b>

Aquifer	Year	Municipal	Mfg	Power	Mining	Irrigation	Livestock	Annual Total
Cenozoic Pecos Alluvium	1999	395	0	0	5	27,853	208	28,461
Edwards-Trinity (Plateau)		4,263	1	993	71	48,431	817	54,576
Other Un-Differentiated		1	0	0	0	0	4	5
Rustler		0	0	0	0	1,404	4	1,408
		<b>4,659</b>	<b>1</b>	<b>993</b>	<b>76</b>	<b>77,689</b>	<b>1,033</b>	<b>84,451</b>

Aquifer	Year	Municipal	Mfg	Power	Mining	Irrigation	Livestock	Annual Total
Cenozoic Pecos Alluvium	2000	430	0	0	11	25,961	188	26,590
Edwards-Trinity (Plateau)		4,610	0	937	152	45,142	739	51,580
Other Un-Differentiated		1	0	0	0	0	3	4
Rustler		0	0	0	0	1,309	2	1,311
		<b>5,041</b>	<b>0</b>	<b>937</b>	<b>163</b>	<b>72,412</b>	<b>932</b>	<b>79,485</b>

## Appendix E

### Details on the Development of the Estimate Of Annual Recharge to the Capitan Reef Aquifer in Pecos County

## Discussion

As mentioned in the plan text, as of the date of the plan no published estimates on the amount or rates of annual recharge to the Capitan Reef aquifer have been identified. In order to meet the TWDB requirement that groundwater management plans include an estimate of the annual recharge rates used by other researchers for the Edwards-Trinity (Plateau) aquifer near the outcrop area of the Capitan reef aquifer in Pecos County may be applicable. The preliminary rate of recharge used in the development of the TWDB Edwards-Trinity (Plateau) aquifer groundwater availability model (GAM) is 4 percent of annual precipitation. (Anaya 2002) The Edwards-Trinity (Plateau) aquifer GAM includes the area of Pecos County adjacent to the Capitan Reef aquifer outcrop area. A rate of 1.6 percent of annual precipitation was estimated for the Edwards-Trinity (Plateau) aquifer for Crockett County. (Inglehart 1967) In order to develop a preliminary estimate of the annual recharge to the Capitan Reef aquifer in Pecos County the District used a median value of 2.8 percent of annual precipitation as an assumptive recharge rate to meet TWDB groundwater management plan requirements.

The area of the outcrop of the Capitan Limestone was estimated using a GIS to calculate the area from a scanned image of the Fort Stockton Sheet of the Geologic Atlas of Texas. (BEG, 1994) The 1961-1990 annual average precipitation for the portion of Pecos County where the Capitan Limestone outcrops is given as 16-18 inches in the USDA-NRCS map of Texas Annual Precipitation. (USDA-NRCS 1999) The District used the lower value of 16 inches per year to develop the estimate of annual recharge. The estimate of annual recharge to the Capitan Reef aquifer was calculated in the following manner:

$2.8 \text{ percent of } 16 \text{ inches annual precipitation} = 0.448 \text{ inches per year}$

$0.448 \text{ inches per year} / 12 \text{ inches (1 foot)} = 0.037333 \text{ feet per year}$

$0.037333 \text{ feet per year rounded to } 0.037 \text{ feet per year}$

$\text{Estimated Area of the Capitan limestone in Pecos County} = 22,279 \text{ acres}$

$0.037 \text{ feet per year} \times 22,279 \text{ acres} = 824.323 \text{ ac-ft per year}$

**Rounded to 824 ac-ft per year**