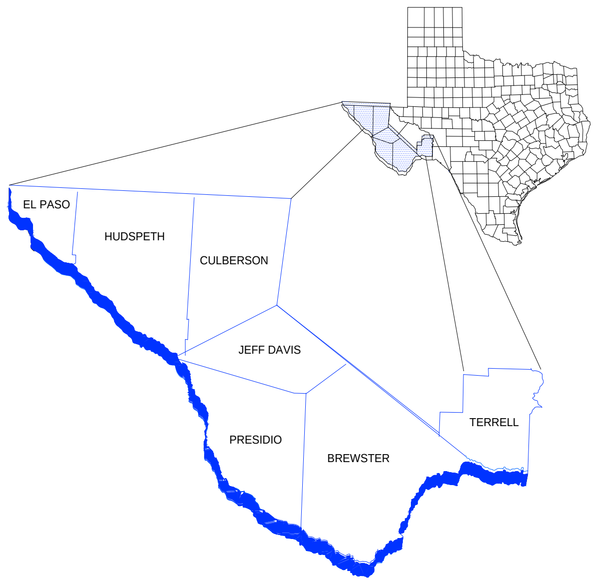
# FAR WEST TEXAS

# REGIONAL WATER PLAN

***January 2001***



# PREFACE

Water is vital to our very existence, for without it, society ceases to function and civil society ceases to exist. The realization of the importance of water is of particular concern in times of diminished supply. Because of problems caused by drought and a rapidly growing population, the State Legislature has sought for many years to insure that there will always be a safe and sufficient supply of water to meet future needs in Texas. At the direction of the Legislature, the Texas Water Development Board (TWDB) has developed a number of statewide water plans. None of these plans, however, have been properly utilized due primarily to the lack of local participation.

Because of severe drought conditions in 1995 and 1996 several communities around the state experienced dangerously low water supplies, and the agricultural industry suffered extreme economic losses. Legislators became keenly aware that the state was unprepared for severe drought conditions. Texas was one of only three western states without a drought plan. With a population projected to double in the next 50 years and the possibility of insufficient water supplies to meet the growing demand, State Legislators took a bold move during the 75$^{th}$ Regular Legislative Session by enacting Senate Bill 1.

Senate Bill 1 (SB 1), the comprehensive water resource planning, management, and development bill, has been described as the most comprehensive revision of Texas water law in the last 30 years. As stated in SB 1, the goal of the State Water Plan is to *provide for the orderly development, management, and conservation of water resources and preparation for and response to drought conditions, in order that sufficient water will be available at a reasonable cost to insure public health, safety, and welfare; further economic development; and protect the agricultural and natural resources of the entire state.*

The TWDB, in coordination with the Texas Natural Resource Conservation Commission (TNRCC) and the Texas Parks and Wildlife Department (TPWD), was charged with providing oversight in the establishment of regional plans developed through local involvement.

The state was divided into 16 regions and voluntary regional planning group members were selected to represent the following water-use categories:

- Agricultural
- Counties
- Electric Generating Utilities
- Environmental
- Industries
- Municipalities
- River Authorities
- Public
- Small Business
- Water Districts
- Water Utilities
- Other categories determined to be appropriate by the regional planning group

Each of the 16 designated regions was to engage in a "bottoms up" approach to developing a 50-year, drought-contingency, water-supply management plan, based on consensus. The plan provides an evaluation of current and future water demands for all water-use categories, and evaluates water supplies available during drought-of-record conditions to meet those demands. Where future water demands exceed available supplies, alternative strategies are considered to meet the potential water shortages. Upon completion of the regional plans, the TWDB will aggregate the 16 individual plans into a single state plan. Each unique regional plan is required to be developed from a common task outline and must:

- recognize existing state laws and regulations;
- recognize existing water rights and contracts;
- consider existing plans;
- consider water-supply needs for all water-use categories; and
- come to agreement with adjacent regions on water use across regional boundaries.

The Far West Texas Region is made up of Brewster, Culberson, El Paso, Hudspeth, Jeff Davis, Presidio and Terrell Counties. These counties claim some of the most impressive geography and scenic beauty in Texas. This region is home to the Guadalupe Mountains National Park, Big Bend National Park and the contiguous Big Bend Ranch State Park. El Paso, the largest city in the region, is also the nation's largest city on the U.S.-Mexico border. Ciudad Juarez, with a population of 1.5 million, is located across the Rio Grande from El Paso, and shares the same water sources with El Paso.

All seven counties that comprise the planning region lie solely within the Rio Grande River Basin. The Rio Grande not only forms the border between the two countries but is also a vital water-supply source for communities, industries, and agricultural activities adjacent to the river. Water supply in the Rio Grande is controlled primarily by the operations of the Rio Grande Project, which was developed to supply agricultural water in southern New Mexico and West Texas. Other than along the Rio Grande corridor, the region is dependent on ground-water resources derived from several aquifer systems.

Work on the Far West Texas Regional Water Plan was approached along two parallel tracks; (1) an urban track representing the metropolitan portion of El Paso County, and (2) a rural track representing the other six rural counties and the eastern portion of El Paso County. The Regional Planning Group members were appointed evenly to each track team such that each track team was composed of members residing in both areas. Each track team was responsible for the development of the plan with oversight of tasks and concerns specific to its area. Work developed along the two track approach was integrated at appropriate intervals to ensure a unified, coherent regional plan.

Because of its large population and water demand, as well as the breadth of its previous water planning efforts, the urban track team focused on tasks pertinent to the El Paso County metropolitan area. Key to this track team's planning effort was El Paso's role as the designated regional water supply planner for El Paso County. The rural track focused on issues relevant to the predominantly rural nature of the remaining counties that characteristically contain small communities located far apart. The distance between cities in the six rural counties, and the disparity between rural and urban interests, are factors that hamper the ability of the region to solve water-supply problems with regional solutions.

The planning decisions and recommendations made in the regional plan will have far-reaching and long-lasting social, economic, and political repercussions on each community involved in this planning effort and on individuals throughout the region. Therefore, involvement of the public was accepted initially as a key factor in the success and acceptance of the plan. Open discussion and citizen input was encouraged throughout the planning process and helped planners develop a plan that reflects community values and concerns. Some members of the public participated almost as non-voting members. To insure public involvement, notice of all regional planning group and track meetings was posted in advance and all meetings were held in publicly accessible locations. Special public meetings were held to convey information on project progress and to gather input on the development of the plan. Prior to submittal of the initially prepared plan to the TWDB, a copy of the regional water plan was provided for inspection in the county clerk's office and in at least one library in each county. Following public inspection of the initially prepared plan, a public meeting was conducted to present results of the planning process and gather public input and comments. To provide a common public access point, an internet web site (**http://24.28.171.253/rio/fwtwpgsplash.htm**) was designed and implemented that contains timely information that includes names of planning group members, bylaws, meeting schedules, agendas, minutes, and important documents.

It is important to understand that this water-planning document is principally a drought-contingency plan. As such, the 50-year plan basically recognizes those entities and water-use categories where, under drought-of-record conditions, future demands may exceed the current ability to provide water supplies. These conditions may be the result of insufficient supplies, or could be the lack of necessary infrastructure to treat and deliver water. Water supply and demand volumes reported in the tables are based strictly on these drought-of-record and current infrastructure conditions and, thus, should not be interpreted as expected volumes under average climatic conditions.

The Far West Texas Regional Water Plan consists of the following:

- Regional overview describing relevant water issues
- Current and projected population and water demand
- Evaluation of currently available water supplies
- Determination of water needs based on a demand-supply comparison
- Water management strategies to meet water shortages
- Water management recommendations

The regional water plan presented in this document contains no regulatory mandates, but rather is a set of recommendations based on understanding and compromise. The plan assumes 50-year population and water-demand trends that likely will change over time. Therefore, the completion and adoption of this plan is only the first generation of a regional water management planning process that must be revised on a continuing basis; SB 1 specifies that regional plans are to be revised and readopted at 5-year intervals. This plan anticipates more frequent, even continual, review.

Living in an arid climate has conditioned the citizens of this region to regard water planning in a more serious manner than does much of the remainder of the state. Limited water-supply options create challenges that will be met by a dedication to the development of innovative solutions.

# EXECUTIVE SUMMARY

## SENATE BILL 1 REGIONAL WATER PLANNING

The severe drought of 1996 throughout Texas increased State legislators' awareness of the importance of water planning. As a result of that drought (which in some localized areas became the new drought-of-record) several communities experienced dangerously low water supplies, and the agricultural industry suffered major economic losses. Legislators became keenly aware that the state was unprepared for severe drought conditions. With the population of Texas projected to double in the next 50 years and the possibility of insufficient water supplies to meet the growing demand, State legislators took a bold move during the 75$^{th}$ Regular Legislative Session by enacting Senate Bill 1 (SB1). This landmark water bill emphasized water issues and responsible water planning by enacting several new provisions to the existing Texas Water Code.

The Texas Water Development Board (TWDB), in coordination with the Texas Natural Resource Conservation Commission (TNRCC) and the Texas Parks and Wildlife Department (TPWD), was charged with providing oversight in the development of regional water plans developed through local involvement, and the compilation of these plans into a cohesive statewide water plan. In establishing the boundaries of the 16 regions, the TWDB attempted to: (1) break as few links between demand centers and their existing sources of water supply as possible, (2) divide as few counties as possible, (3) divide as few water-supply districts as possible, and (4) divide as few regional ground-water aquifers as possible.

Each of the 16 designated regions is to engage in a "bottom up" local approach to developing a 50-year, drought-contingency, water-supply management plan based on consensus. The plan provides an evaluation of current and future water demands for all water-use categories, and evaluates water supplies available during drought-of-record conditions to meet those demands. Where future water demands exceed available supplies, alternative strategies are considered to meet potential water shortages. Each unique regional plan is required to be developed from a common task outline and must:

- recognize existing state laws and regulations
- recognize existing water rights and contracts
- consider existing plans

- consider water-supply needs for all water-use categories
- come to agreement with adjacent regions on water use and water management across regional boundaries.

The TWDB appointed an initial coordinating body or regional water planning group (RWPG) for each region based upon names submitted by the public for consideration. The RWPG then expanded its membership based on the their knowledge of additional persons who could appropriately represent a water user group. Senate Bill 1 provisions mandate that one or more representatives of the following water user groups be seated on each RWPG: agriculture, counties, electric generating utilities, environment, industries, municipalities, river authorities, public, small business, water districts, and water utilities. The Far West Texas RWPG members themselves are unpaid and voluntarily devote considerable amounts of their time to the planning process.

RWPGs do not have legal standing as a governmental agency or entity – i.e., they do not have regulatory authority of any kind. However, the regional water plans developed by the RWPGs and their consultants exert considerable influence on water planning and future water-related infrastructure through two requirements in SB 1:

- Water management strategies not contained in the regional water plan will not receive state funding through TWDB
- Water management strategies requiring surface water permits or amendments from TNRCC will not receive such permits unless the strategies are consistent with the approved regional water plan

In addition to the above, locally developed plans based on more detailed local information and public input appear in the regional water plan to a degree unprecedented in previous statewide water plans prepared by TWDB, TNRCC and TPWD.

The Far West Texas RWPG (FWTRWPG) adopted bylaws and submitted a scope of work and associated budget to the TWDB. With SB1 funds administered through TWDB, the FWTRWPG hired consultants to prepare the regional plan. Work required to complete the plan followed well-defined guidelines intended to meet the mandated language of SB1 and to establish a degree of format uniformity between all 16 regional plans. The FWTRWPG operates its administrative function through the Rio Grande Council of Governments (RGCOG). All meetings of the FWTRWPG are governed by the requirements of the Open Meetings Act.

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One reason identified by the FWTWPG mandating constant review and revision of the plan is the lack of data regarding the water resources of the Far West Texas Water Planning Area. Another is the uncertainty of many variables in the water planning process, including administrative and legislative changes to applicable water laws and regulations. The FWTRWPG decided it was therefore imperative to fix a point in time which would define the law and regulations applicable to the Far West Texas regional water plan. For this planning cycle, the FWTRWPG determined that the interpretation and implementation of all strategies in the regional water plan would be subject to the laws and regulations in effect at the time of the adoption of the regional water plan, which occurred on December 18, 2000. If, however, the applicable laws and regulations are modified during the next planning cycle in a manner which significantly affects the underlying assumptions upon which an existing strategy is based, then the affected strategy will be revisited by the FWTRWPG and, if advisable, modified and re-adopted.

Living in an arid climate has conditioned the citizens of this region to regard water planning in a more serious manner than does much of the remainder of the state. Limited water-supply options create challenges that will be met by a dedication to the development of innovative solutions.

**FAR WEST TEXAS REGIONAL WATER PLANNING GROUP**

The Far West Texas Region is made up of Brewster, Culberson, El Paso, Hudspeth, Jeff Davis, Presidio and Terrell Counties. These counties claim some of the most impressive geography and scenic beauty in Texas. This region is home to the Guadalupe Mountains National Park, Big Bend National Park, the contiguous Big Bend Ranch State Park and the Davis Mountains State Park. El Paso, the largest city in the region, is also the nation's largest city on the U.S.-Mexico border. Ciudad Juarez, with a population of 1.5 million, is located across the Rio Grande from El Paso, and shares the same water sources with El Paso.

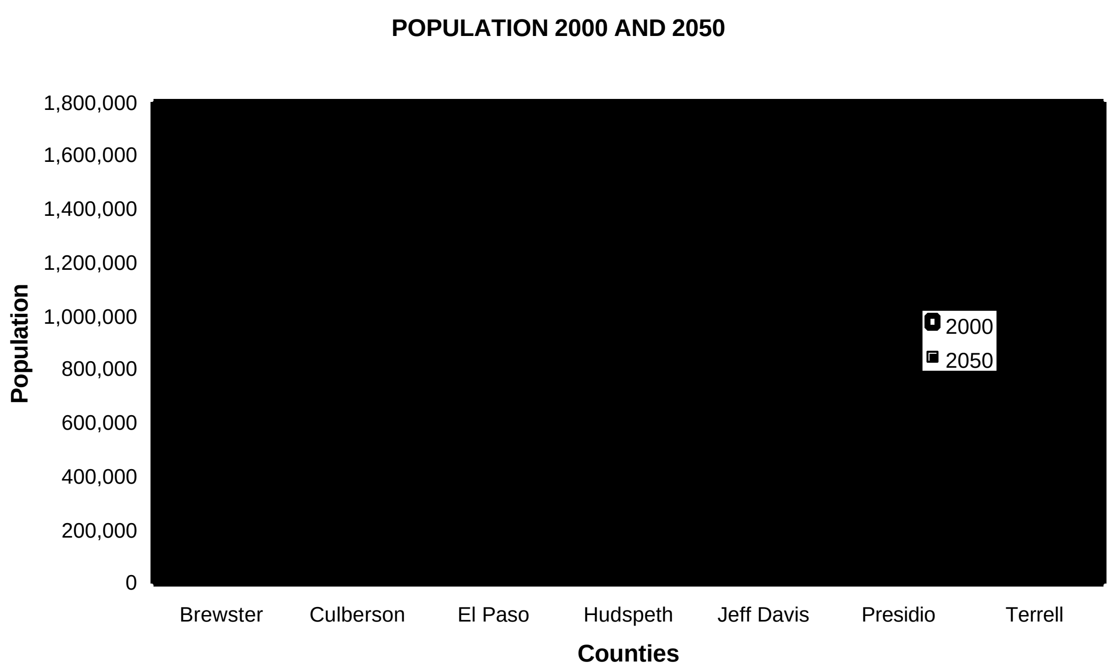
In contrast to El Paso County, the other six counties in the planning region are sparsely populated; therefore, the primary challenge facing the Far West Texas Regional Planning Group was the balancing of urban and rural interests in the water plan. Throughout the process, the planning group members worked to achieve consensus on water management strategies that would address the water deficits in the urban area without adversely impacting the rural way of life. To achieve this purpose and assure equal representation, the Regional Planning Group members were divided into rural and urban tracts (see Chapter 7, Section 7.3).

All seven counties that comprise the planning region lie solely within the Rio Grande River Basin. The Rio Grande not only forms the border between the two countries but is also a vital water-supply source for communities, industries, farms and ranches along the river. Water supply in the segment of the Rio Grande above Ft. Quitman is controlled primarily by the operations of the Rio Grande Project, which was developed to supply agricultural water in southern New Mexico and West Texas. Below Ft. Quitman, the office of the Rio Grande Watermaster controls water supplied to the Texas side of the Rio Grande. Other than along the Rio Grande corridor, the region is dependent on ground-water resources derived from several aquifer systems.

**POPULATION PROJECTIONS**

The estimated population of the seven-county Far West Texas region for the year 2000 is 800,857. Of this amount, 96 percent reside in El Paso County. The population of the seven counties is expected to almost double by the year 2050 to a population of 1,587,097. The largest increases, with respect to population and percent gain, are expected to occur in El Paso County, where the population is projected to increase to 1,536,423 by 2050 - or by 99 percent over the 2000 census estimate. Most of this population growth will occur in the City of El Paso where the number of residents is expected to rise to 1,234,889 by 2050. This represents a 95-percent increase over the 2000 city census estimate.

The population of the six rural counties is expected to increase by 67 percent from the 2000 census estimate of 30,324 to 50,674 by 2050. The largest increases, with respect to population and percent gain, are expected to occur in Brewster and Presidio Counties. The population of Brewster County is expected to grow from 10,330 in 2000 to 18,059 in 2050, an increase of 75 percent. The population of Presidio County is projected to increase by 119 percent from the 2000 estimate of 9,229 to 20,211 in 2050.

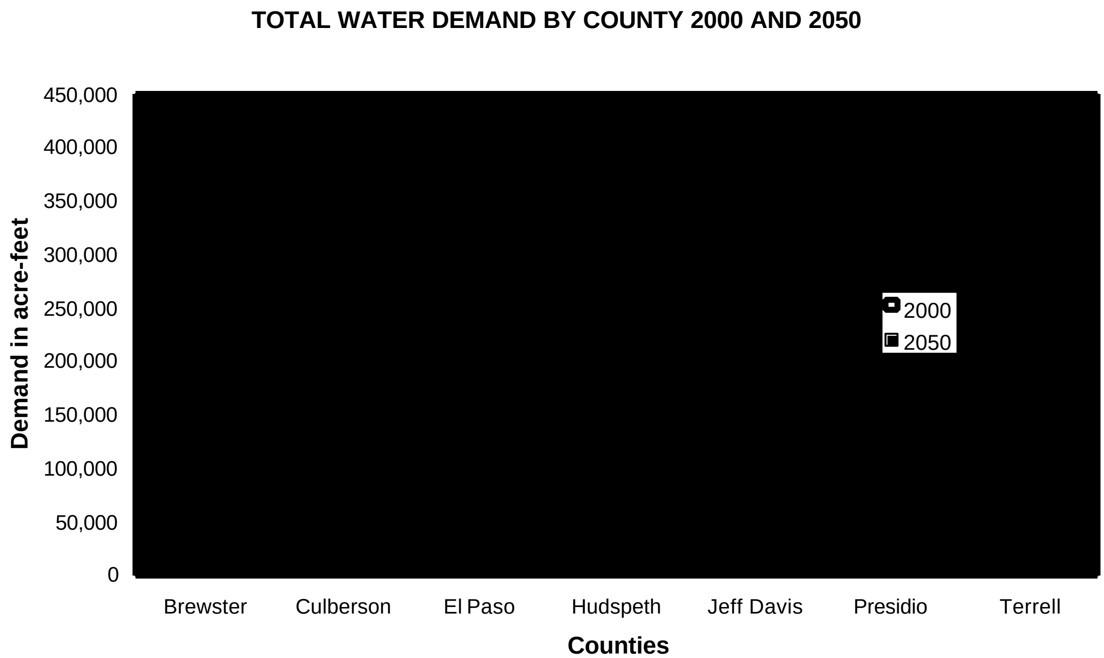


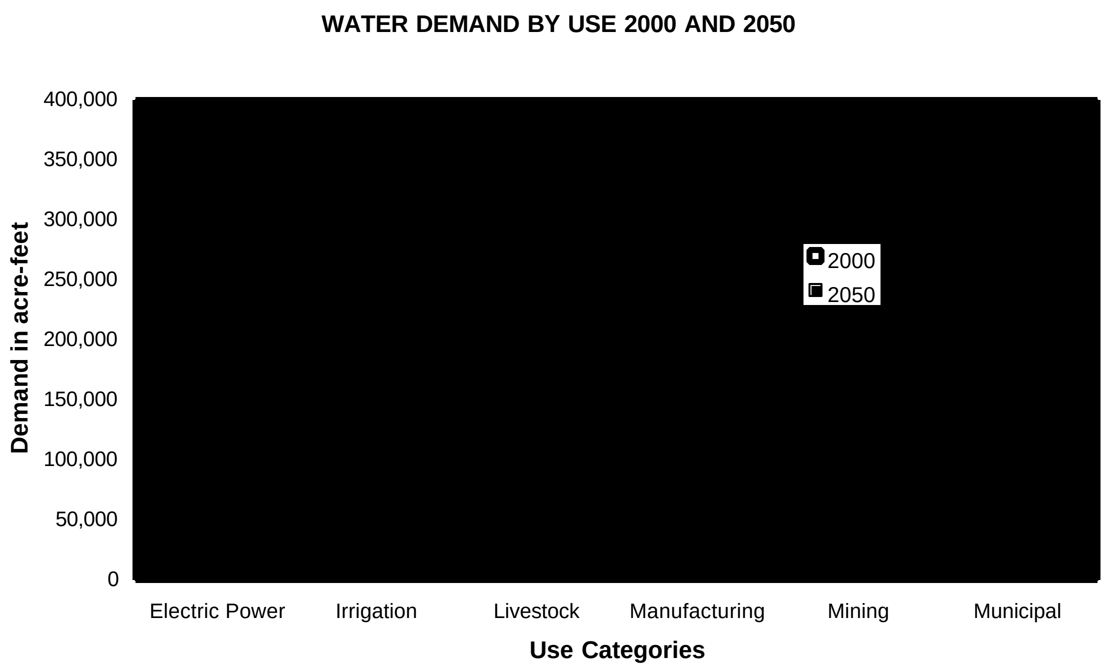
## WATER DEMAND PROJECTIONS

The estimated total water use in the region for the year 2000 is 509,426 acre-feet, and is expected to increase by 15 percent to 585,742 acre-feet by the year 2050. Sixty-six percent of the current use (336,221 acre/ft) is attributable to usage in El Paso County. Municipal water use in the year 2000 represents approximately 27 percent of the total water use in the region; approximately 95 percent of this municipal water demand is concentrated in El Paso County. Region wide, municipal water demand is expected to increase by 83 percent to 252,270 acre-feet by the year 2050. Although per capita water use is expected to decline slightly over time, municipal water demand solely for the City of El Paso is expected to increase from 101,928 acre-feet in 2000 to 199,097 acre-feet in 2050. Municipal water demands are also expected to increase in Brewster and Presidio Counties over the next 50 years by 43 percent (1,171 acre-feet) and 62 percent (1,250 acre-feet) respectively. Municipal water needs in the remaining counties are expected to increase slightly.

Sources of nonmunicipal water demand are identified as (1) irrigation, (2) manufacturing and industrial, (3) electric power cooling, (4) livestock, and (5) mining. Within the five categories, irrigation, which accounts for the largest source of water demand (67 percent), is projected to decrease from a high of 342,848 acre-feet in 2000 to 298,848 acre-feet by 2050. This represents a 13-percent reduction in demand over the 50-year planning period.

Most irrigation demand is associated with farms in El Paso and Hudspeth Counties. Irrigation demand in El Paso County is projected to decrease from the year-2000 estimate of 179,842 acre-feet to 152,014 acre-feet by 2050. Irrigation demand over the same period in Hudspeth County is expected to drop from 124,521 acre-feet to 112,136 acre-feet. Irrigation demand in other counties is not expected to change as significantly as demand in El Paso and Hudspeth Counties. Although demand from other nonmunicipal sources is expected to increase, the overall trend for the region will be a decrease in nonmunicipal water consumption because of the substantial reduction in irrigation demand.


TOTAL WATER DEMAND BY COUNTY 2000 AND 2050
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
Demand in acre-feet
2000
2050
Brewster
Culberson
El Paso
Hudspeth
Jeff Davis
Presidio
Terrell
Counties


WATER DEMAND BY USE 2000 AND 2050
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
Demand in acre-feet
2000
2050
Electric Power
Irrigation
Livestock
Manufacturing
Mining
Municipal
Use Categories

## WATER SUPPLY RESOURCES

Water resources available to meet supply needs in the seven-county Far West Texas Region during Drought-of-Record conditions include both surface-water and ground-water sources. The Rio Grande, Pecos River, and Phantom Creek are identified as surface-water sources, while nine specific ground-water sources, or aquifers, are described. Estimates of quantities available during Drought-of-Record conditions only are based on the following assumptions:

- The Rio Grande water supply is divided at Ft. Quitman into an Upper Rio Grande section and a Lower Rio Grande section.
- The supply available in the Upper Rio Grande section is based on the lowest diversions according to U.S. Bureau of Reclamation (USBR) records.
- The supply available in the Lower Rio Grande section is based on the lowest gauged flow below the confluence of the Rio Conchos and the Rio Grande.
- Little return flow to the Rio Grande is expected during periods when there are no diversions from the river.
- Reuse of river water is calculated for the City of El Paso only during the period when supplies are available.
- Pecos River water is based on the absence of flow at the Langtry gauging station during a Drought-of-Record.
- No water is considered to be available in stock tanks and small lakes during Drought-of-Record conditions.
- The flow of water in Phantom Creek (Jeff Davis County) is affected by Drought-of-Record conditions.
- The availability of ground water is based on the percentage of recoverable water in storage in each aquifer and little or no recharge.

## SURFACE WATER RESOURCES

Waters of the **Rio Grande** originate in the San Luis Valley, the principal drainage basin of the San Juan Mountains in southwestern Colorado, and in the mountain ranges of northern New Mexico. The river flows southward through New Mexico, and then forms the international boundary between the

Mexican States of Chihuahua, Coahuila, Nuevo Leon, Tamaulipas, and the State of Texas. The water supply available from the Upper Rio Grande is primarily affected by climatic conditions in southern Colorado and northern New Mexico. Although dams have been built on the River in New Mexico to provide a degree of control, floods and droughts still take their toll in the region.

The Elephant Butte Dam and Reservoir in New Mexico is approximately 125 miles north of El Paso and can store over two million acre-feet of water. Water in the reservoir is stored to meet irrigation demands in the Rincon, Mesilla, El Paso, and Juarez valleys and is also released in a pattern for power generation. Above El Paso, flow in the river is largely controlled by releases from Caballo Reservoir located below Elephant Butte; while downstream from El Paso to Fort Quitman, flow consists of a blend of raw river water, treated municipal wastewater from El Paso, untreated municipal wastewater from Juarez and irrigation return flow. Below the El Paso-Hudspeth County Line, flow consists mostly of return flow and occasional floodwater and runoff from adjacent areas. Channel losses are significant enough that the Rio Grande is often dry from below Fort Quitman to the confluence with the Mexican river, the Rio Conchos, upstream of Presidio. The River becomes a permanent stream again at the point where the Mexican river, the Rio Conchos, enters upstream of Presidio. From Presidio downstream through the Big Bend region, the Rio Grande generally contains sufficient water flow to support recreational use at almost any time of the year. There are no significant tributaries, other than the Rio Conchos, in the 350 miles between Elephant Butte Reservoir and Presidio. It should be noted that, based on historical data, it may take up to 30 years for Rio Grande Project water storage levels to recover from a severe drought or drought-of-record.

The Rio Grande Compact governs the obligations of the states of Colorado and New Mexico for eventual delivery of water to the Rio Grande Project at Elephant Butte Reservoir. Deliveries of Rio Grande Project waters are based upon irrigation requirements authorized for the Project and are agreed upon by the Elephant Butte Irrigation District (EBID), the El Paso County Water Improvement District No. 1 (EPCWID #1), and the United States Bureau of Reclamation (USBR). The annual allotment of Rio Grande Project water downstream of the Caballo Reservoir is determined by the USBR based on the amount of usable water in storage.

The Rio Grande Project is primarily an irrigation storage and flood control federal reclamation project administered by the USBR. The International Boundary and Water Commission (IBWC) also administers flow in the Rio Grande. Elephant Butte and Caballo Reservoirs in New Mexico and the diversion dams at the headings of the main canals make up the Project's primary facilities. The Project delivers water to the EBID and the EPCWID #1. The EBID encompasses all the project lands in New Mexico south of the Caballo Reservoir, while the EPCWID #1 encompasses the project lands in El Paso County, Texas. The Districts deliver water to farmlands in New Mexico and Texas. Since 1941, EPCWID#1 has delivered water to the City of El Paso for municipal and industrial (M&I) use through contracts among the District, the City and the USBR. The City of El Paso also owns farmland with its associated water rights, which it uses for municipal purposes. The Project also delivers water to Mexico in accordance with the Treaty of 1906. In 1979 and 1980, the two Districts took over the operation and maintenance responsibilities of most of the respective irrigation works within the boundaries of each entity.

Under drought conditions, flows in the Rio Grande are significantly reduced and are allotted by the USBR in accordance with a prearranged schedule. The lowest total release from Caballo Dam was 206,081 acre-ft in 1964. The lowest diversion by EPCWID#1 is estimated to be 72,746 acre-ft in 1964. Low releases and diversions significantly affect downstream water users who are highly dependent on a steady source of river water. In addition, such low diversions would result in a decrease in the water quality to the extent that the water ~~it~~ would be unsuitable for M&I or agricultural use. Under these conditions, ground water becomes the major source of supply.

The Rio Grande water supply is divided at Ft. Quitman into an Upper Rio Grande section and a Lower Rio Grande section. In the Upper Rio Grande section, river flow in the general range of the drought-of-record results in minimal flows and poorer quality. Flow of this volume is not sufficient to meet the needs of water users in the El Paso and Hudspeth Counties area. Under these conditions, supply availability is considered to be "zero". The amount of water available to the Lower Rio Grande section below Ft. Quitman is determined by the lowest gauged amount below the confluence of the Rio Conchos and the Rio Grande. Gauging records show that the lowest yearly flow has been 35,438 acre-ft.

The **Pecos River**, a tributary of the Rio Grande, flows southward through New Mexico and Texas, and discharges into the channel of the Rio Grande near Langtry, Texas, in Val Verde County. The Pecos River forms the easternmost border of Far West Texas along the northeast corner of Terrell County. Flows of the Pecos River are controlled by releases from the Red Bluff Reservoir. Storage in the reservoir is affected by the delivery of water from New Mexico. The USGS' river gauge at Girvin (Pecos County) shows that the average daily discharge at Girvin varies between 4 to 15 cubic ft per second (cfs). Gauging records from the lower segment of the Pecos River indicate virtually no flow during major drought conditions.

**Phantom Creek** originates from the water discharging at Phantom Spring in Jeff Davis County. The creek flows northeastward into Reeves County, where it gains additional flow from San Solomon, Giffin, Saragosa, East Sandia and West Sandia Springs. Phantom Creek is an important source of water for irrigation in southern Reeves County. Gauging records indicate that average annual discharge from Phantom Spring has decreased from approximately 13,000 to 15,000 acre-ft in the early 1930's to approximately 1,500 acre-ft in the 1990's.

## GROUND WATER RESOURCES

Ground water is a major source of water for most of the Far West Texas Region. Aquifers are replenished by recharge that includes precipitation, infiltration of water from perennial or ephemeral streams, inflow of ground water from areas adjacent to an aquifer, and irrigation return flow. Precipitation recharge to the aquifers in Far West Texas is limited by the substantially high rate of evaporation. The principal aquifers within the region are summarily described below.

The **Hueco Bolson aquifer**, located in El Paso and Hudspeth Counties, extends from east of the Franklin Mountains in New Mexico toward the east-southeast into Hudspeth County, where it is bounded in El Paso County by the Hueco Mountains and in Hudspeth County by the Diablo Plateau and the Quitman Mountains. The aquifer then continues south a short distance into Mexico. The Hueco Bolson aquifer is the sole source of municipal supply for Ciudad Juarez, Chihuahua, and provides approximately half of the municipal supply for the City of El Paso. Large-scale ground-water withdrawals, especially from municipal well fields in areas of El Paso and Ciudad Juarez, have caused major declines in the water table. These declines have significantly changed the direction of flow, the rate of flow, and the chemical quality of ground water in the aquifer. Declining water levels have also caused a minor amount of land subsidence.

The **Rio Grande Alluvium aquifer** consists of Quaternary floodplain sediments laid down by the Rio Grande as the river incised the surface of the Hueco Bolson. The floodplain forms a narrow valley within the topographically lowest part of the Hueco Bolson and extends nearly 90 miles from El Paso to Fort Quitman, where the valley is constricted between the Sierra de la Cienguilla of Chihuahua and the Quitman Mountains of Hudspeth County. The aquifer is hydrogeologically integrated with the sediments of the Hueco Bolson. It is a source of irrigation water for farms in El Paso and Hudspeth Counties.

The **Mesilla Bolson aquifer** lies in the Upper Rio Grande Valley west of the Franklin Mountains and extends to the north into New Mexico. The aquifer is primarily used for agricultural purposes and public supply in New Mexico. In Texas, the agricultural use of this aquifer is much less than in New Mexico. The City of El Paso's Canutillo well field is located in the Mesilla Bolson.

The **Edwards-Trinity (Plateau) aquifer** underlies the Edwards Plateau east of the Pecos River and the Stockton Plateau west of the Pecos River. It provides water to all or parts of 38 Texas counties. The aquifer extends from the Hill Country of Central Texas to the Trans-Pecos region of West Texas, where it is a source of water in Culberson, Jeff Davis, Brewster and Terrell Counties. There is relatively little pumpage from the aquifer over most of its extent. Consequently, water levels have remained constant or have fluctuated in response to seasonal precipitation. The City of Sanderson in Terrell County is the only municipality in the region that pumps water from this aquifer.

The **Bone Spring-Victorio Peak aquifer** is located along the eastern edge of the Diablo Plateau west of the Guadalupe Mountains in northeast Hudspeth County. It extends northward into the Crow Flats area of New Mexico. The Bone Spring and Victorio Peak Formations are composed of nearly 2,000 ft of limestone beds. Water occurs in joints, fractures and solution cavities. Permeability of the limestones is highly variable, and well yields differ widely from about 150 gallons per minute (gal/min) to more than 2,000 gal/min.

The aquifer is used primarily as a source of irrigation water. Dell City is the only municipality that relies on the aquifer as a source of public supply. Although the water table has declined since pre-irrigation development, water levels have remained relatively constant since the late 1970s.

The **Capitan Reef aquifer** consists of arcuate strips of limestone (10 to 14 miles wide) that formed along the shelf edge of the Central Basin Platform during the late Permian Period. The formation is exposed in the Guadalupe, Apache and Glass Mountains. The reef continues northward into New Mexico, where the aquifer is a source of abundant fresh water for the City of Carlsbad. Within the planning region, the aquifer underlies sections of Culberson County and a small area of northern Brewster County.

Most of the ground water pumped from the aquifer in Texas is withdrawn from wells in Ward and Winkler Counties and used for oil reservoir water-flooding operations. A small amount of water is used for irrigation of salt-tolerant crops in Pecos and Culberson Counties.

The **Igneous aquifer** occurs in three areas within Brewster, Presidio and Jeff Davis Counties. Ground water is stored in the fissures and fractures of tuffs and related intrusive and extrusive rocks. The rocks reach an average thickness of 900 ft to 1,000 ft. The Cities of Alpine, Fort Davis and Marfa rely on the aquifer as a source of municipal supply.

Well yields are moderate to large in the Marfa area and are small to moderate in the Alpine and Fort Davis areas. Water quality is generally considered to be good for municipal and domestic uses. Elevated levels of silica and fluoride have been found in some wells.

The **Marathon aquifer** is located entirely within north-central Brewster County. Ground water is used primarily as a municipal water supply by the City of Marathon, and for domestic and livestock purposes. Ground water occurs in numerous crevices, joints and cavities at depths ranging from 350 ft to about 900 ft, and well yields range from 10 gal/min to more than 300 gal/min. Many of the shallow wells in the region actually produce water from alluvial deposits that overlie rocks of the Marathon aquifer. Ground water is typically of good quality but hard. Total dissolved solids (TDS) range from 500 milligrams per liter (mg/l) to 1,000 mg/l.

The **Rustler Formation** is exposed in eastern Culberson County. The formation plunges eastward into the subsurface of the Delaware Basin. The aquifer is principally located beneath Loving, Pecos, Reeves, and Ward Counties, where it yields water for irrigation, livestock and water-flooding operations in oil-producing areas. Water occurs in highly permeable solution zones in dolomite, limestone and gypsum beds of the Rustler Formation. Large concentrations of dissolved solids render the water unsuitable for human consumption.

Several deep **West Texas Bolsons**, or basins, filled with sediments of both igneous and sedimentary origin of Quaternary age underlie Far West Texas. The basins contain significant quantities of ground water in the boson deposits and potentially in underlying fractured volcanic rocks. These bolsons are referred to as Red Light Draw, Eagle Flat, Green River Valley, Presidio-Redford, and the

Salt Basin. The Salt Basin is subdivided into the Wild Horse, Michigan, Lobo, and Ryan Flats. The upper part of the Salt Basin extending north of Wild Horse Flat contains ground water with total dissolved solids well in excess of 3,000 mg/l. The bolson aquifers provide variable amounts of water for irrigation and municipal water supplies in parts of Culberson, Hudspeth, Jeff Davis, and Presidio Counties. The communities of Presidio, Sierra Blanca, Valentine and Van Horn rely on the bolson aquifers for municipal water supplies.

## IDENTIFIED WATER SHORTAGES

As stated previously, the objective of this plan is to identify municipalities and water-use categories that may, in times of severe drought, be unable to meet expected water-supply needs based on today's ability to capture, treat, and distribute the supply. Recommended alternatives, or strategies, to meet anticipated drought-induced shortages are presented for consideration. It should be acknowledged that the Far West Texas RWPG has no authority to mandate that any recommended strategies be implemented, and that it is the individual entity's initiative to act on needed changes. The table below lists the cities and water-use categories by county that were determined to have potential future shortages during drought-of-record conditions based on no new infrastructure development.

**WATER SUPPLY SHORTAGES DURING**
**DROUGHT-OF-RECORD CONDITIONS (Acre-Feet)**

| Water User Name | S2000 | S2010 | S2020 | S2030 | S2040 | S2050 |
|---|---|---|---|---|---|---|
| **BREWSTER COUNTY** | | | | | | |
| COUNTY-OTHER | -507 | -639 | -668 | -747 | -793 | -741 |
| **EL PASO COUNTY** | | | | | | |
| ANTHONY | | | -885 | -1,028 | -1,136 | -1,255 |
| CANUTILLO | | | | -441 | -465 | -514 |
| CLINT | | | | -492 | -547 | -608 |
| EL PASO | | | | -162,505 | -179,873 | -199,097 |
| FABENS | | | | -1,137 | -1,227 | -1,349 |
| FORT BLISS | -760 | -292 | | -5,689 | -5,674 | -5,642 |
| HOMESTEAD | | | | -865 | -893 | -942 |
| SAN ELIZARIO | | | | -1,475 | -1,571 | -1,653 |
| SOCORRO | | | | -1,535 | -1,664 | -1,800 |
| VINTON | | | -100 | -106 | -111 | -115 |

| | | | | | | |
|---|---|---|---|---|---|---|
| WESTWAY | | | | -338 | -340 | -351 |
| COUNTY-OTHER | | | | -23,343 | -25,931 | -27,549 |
| MANUFACTURING | | | | -17,904 | -19,142 | -20,332 |
| STEAM ELECTRIC POWER | | | | -6,000 | -6,000 | -6,000 |
| MINING | | | | -28 | -10 | |
| IRRIGATION | -127,386 | -101,457 | -85,417 | -156,920 | -151,289 | -148,761 |
| LIVESTOCK | -78 | -78 | -78 | -78 | -78 | -78 |
| **HUDSPETH COUNTY** | | | | | | |
| COUNTY-OTHER ** | 41 | 34 | 33 | 32 | 34 | 35 |
| IRRIGATION (River Farms Only) | -46,988 | -45,878 | -44,791 | -43,726 | -42,683 | -41,662 |
| **JEFF DAVIS COUNTY** | | | | | | |
| COUNTY-OTHER | -73 | -74 | -72 | -69 | -64 | -65 |
| LIVESTOCK | -24 | -24 | -24 | -24 | -24 | -24 |
| **PRESIDIO COUNTY** | | | | | | |
| COUNTY-OTHER | -132 | -170 | -216 | -275 | -284 | -286 |
| **TERRELL COUNTY** | | | | | | |
| COUNTY-OTHER | -21 | -23 | -18 | -14 | -12 | -11 |
| | | | | | | |

** Although Hudspeth "County Other" does not indicate a supply deficit, current supply problems of not meeting State Drinking Water Standards will result in immediate shortages unless strategies are implemented.

## MUNICIPAL WATER SUPPLY SHORTAGES

Potential municipal shortages are expected for a number of communities in El Paso County that rely on supplies from the Rio Grande. Under drought-of-record conditions, flows in the Rio Grande are significantly restricted and, therefore, no supply is expected. The City of El Paso and those communities and industries supplied by the City of El Paso depend on ground-water supplies when river water is unavailable. Due to the limited supply of remaining usable-quality ground water, the City of El Paso and its service area would likely face supply shortages by the year 2030 under Drought-of-Record conditions. The City is considering the following strategies to meet potential shortages.

## CITY OF EL PASO WATER SUPPLY STRATEGIES

Water demand within the City is almost entirely supplied by El Paso Water Utilities (EPWU). EPWU also has a regional role as the Senate Bill 450 (1995, 74th Legislative Session) designated regional planner for meeting municipal and industrial (M&I) water demands and as a wholesale supplier to many surrounding water districts.

In addition to this regional role in support of El Paso County, EPWU is also engaged in planning initiatives with southern New Mexico through the New Mexico – Texas Water Commission and with the Junta Municipal de Agua Y Sanamiento (JMAS) in Ciudad Juarez through a Memorandum of Agreement to coordinate surface water resource planning. The New Mexico-Texas planning is part of a regional effort to switch to sustainable surface water as further discussed in the El Paso strategies. The joint planning with Juarez will consider concepts such as treating some of the 60,000 acre-feet per year of Rio Grande surface water delivered to Mexico under treaty obligations. The water could be treated at El Paso water treatment plants for delivery to points of high municipal demand in Juarez.

EPWU intends to reserve, to the extent reasonably feasible, the fresh portions of the Hueco and Mesilla Bolsons for use as drought contingency. Surface water usage will over time provide most of the Utility's supply. Supplemental sources of supply are expected to be developed to make up shortfalls in surface supply. Shortfalls may occur as a result of difficulty in converting the right to use water from the Rio Grande Project. The ability to convert additional Rio Grande water from agricultural use to municipal use is currently being negotiated. Other strategic sources of supply include importing groundwater from outside El Paso County and desalinating brackish water in El Paso County. Whether importing and desalinating will be viable strategies depends on the results of ongoing planning and feasibility studies.

Strategies to maintain achievements in water conservation (demand side conservation) and to continue toward the goal of per capita usage of 160 gallons per day per person will continue. Active programs to reduce usage through replacement and changes in plumbing fixtures and codes will be advanced. Further reduction will be achieved by promoting the use of water saving appliances and replacing evaporative coolers with refrigerated air conditioners. Demand reduction will also be achieved by developing water-efficient landscaping codes and promotions. Growth Management will be used to the degree possible to control demand. It is important to remember that, among other things, much of El Paso's growth is fueled by surplus births over deaths. Programs will be developed to limit demand by industry and other users and to promote low water use by residential development. Limiting population growth is difficult. The cost of these programs varies considerably. Historically, the residential rates for city water in El Paso have been low. El Paso has begun to increase its water rates and will continue to do so to encourage further conservation and to finance its water supply capital projects. Whether controls would be a viable strategy for water-demand reduction will be addressed in the next planning cycle.

Reclamation strategies are being implemented. Replacing large-scale use of potable water with reclaimed wastewater for industrial, commercial, and landscape watering will continue to provide approximately 10 percent of the water needed throughout the region. Reclaimed water not put to M&I use is commingled with irrigation flows and reused for agricultural purposes. The high and variable cost of infrastructure and the impracticality of implementation in some situations limits the potential for expanding reclaimed water use. M&I uses near the source (wastewater treatment/reclamation plant) are more economical than those which require long reclaimed water line extensions.

Water conserved by improving the agricultural supply system (supply side conservation) may be converted to municipal usage if mutually agreed to by the El Paso County Water Improvement District #1, Bureau of Reclamation and El Paso Water Utilities. The lining of canals is the primary action for this strategy. Based on the complexity of institutional conversion of conserved water from agricultural to municipal use, and the high cost of the projects, in-depth cost planning has not been fully explored. The cost of this activity is therefore undetermined although specific projects have been identified. The American Canal Extension and Lining Project is complete but the Bureau of Reclamation, United States Geological Survey, the EPCWID#1 and EPWU are still analyzing the amount of savings that have been achieved; until this is determined, the cost of the water cannot be calculated. This project and potential canal lining projects face significant institutional, legal and hydrologic issues, both to establish the amount of water saved and to allow it's conversion to M&I uses.

Similarly, surface water treatment involves the conversion of Project rights to use water from agriculture to municipal use through mechanisms such as the purchase of water-right lands and the conversion of rights to use water associated with such lands to municipal use, the leasing of small (two acres or less) urbanized land tracts under existing contracts, and the future execution of forbearance contracts (partial and complete) with farmers. These conversions are based on contractual agreements among El Paso County Water Improvement District #1, Bureau of Reclamation and El Paso Water Utilities.

Sizable brackish water deposits exist adjacent to the fresh water zone of the Hueco and Mesilla Bolsons. These water sources are usable if the total dissolved solids content in the water can be treated to below 1,000 milligrams per liter (mg/l). Desalination of these waters is possible. Three very distinct issues keep this option from being a preferred source: 1) the quality of the water is not constant; 2) the desalination is energy intensive and expensive; and 3) the brine reject (concentrated solution) is highly regulated, increasing the expense and technical feasibility to a point that makes any project very risky. Therefore, desalination by treatment may only be able to provide a small portion of the projected demand.

Blending (classified as a desalination technique) can be utilized with either imported waters or waters desalinated by treatment. Blending involves mixing brackish water with low TDS waters to expand the supply. Any low TDS source can be mixed with local or regional waters. This is the basis for the blended amounts in the desalination and importation categories in the tables of this report. The cost of both strategies has been adjusted to account for the final product water amount after blending. If either strategy did not include blending the cost would be two hundred percent higher than stated.

Importation of ground water from outside El Paso County is another possible strategy. Options for ground-water transfers from water ranches owned by EPWU at Valentine and Van Horn, Texas are being considered. Cost estimates include a preliminary assessment for construction of a pipeline and blending when the water reaches El Paso. Further detailed analysis is under way using a public/private partnership including EPWU. This analysis will consider importing desalinated ground water from Dell City and other potential sources as well as the EPWU water ranches.

A detailed statement that includes basic information and a cost estimate, following TWDB guidance, is provided for each strategy. Within the current context of variability in the outcome of rights to use water negotiations and the assumptions specified by Texas Water Development Board, each strategy is as complete as practically feasible at this time.

The relative quantities of water from various source categories depend on results of feasibility studies, negotiations and implementation and are, therefore, hypothetical. If these strategies are implemented, as stated in this approximation and given these cost constraints, El Paso Water Utilities will be able to reserve the Hueco and Mesilla Bolsons for drought contingency.

## COUNTY OTHER WATER USE STRATEGIES

"County Other" water supply shortages appear in all the counties of the region except for Culberson. The "County Other" category includes water use for rural domestic homes and small communities with populations less than 500. Although the supply/demand analysis indicates a water-supply shortage for this category, the supply will be met in most cases by the drilling of additional private wells. In more densely populated rural areas, consideration may be needed for supplied services where appropriate. Strategies most prominently considered for this category include:

- Drilling additional wells
- Increased production from existing wells
- Maintenance of distribution system
- Catchment and storage of rainfall
- Use surface water supplies
- Desalinate brackish water
- Purchase water from landowner
- Water production management as imposed in counties by groundwater conservation districts

## MANUFACTURING WATER USE STRATEGIES

The only shortage expected in the Manufacturing category occurs in El Paso County where most of the water used by this category is purchased from EPWU. The potential to meet future shortages will likely be dependent on the ability of manufacturing companies to purchase needed water from EPWU. In turn, EPWU's ability to provide the needed supplies is discussed above under "City of El Paso Water Supply Strategies".

## ELECTRIC POWER GENERATION WATER USE STRATEGIES

The only steam electric generation occurs in El Paso County. The operation of the existing power generating plant relies on water purchased from El Paso Water Utilities. As discussed above, EPWU's ability to provide the needed supplies is discussed above under "City of El Paso Water Supply

Strategies". The power generating industry also recognizes that a certain amount of water savings may be possible by modernizing the operating system.

**IRRIGATION WATER USE STRATEGIES**

Water used for agricultural irrigation in the region is significantly greater than all other water-use categories. The quantity and quality of water needed for irrigation is dependent on the type of crop grown and on soil characteristics. Although a minimal amount of agriculture can persist on limited water supplies, most crops require significantly larger water applications to remain profitable. Irrigated farms along the Rio Grande corridor are almost entirely dependent on water supplies derived from the river. When Rio Grande water is limited or not available, most farming temporarily ceases until water supplies once again become available. Irrigated farms in other areas within the region are dependent on ground-water supplies. The availability of these supplies depends on localized pumping, water-bearing formation characteristics and the cost of energy.

Under Drought-of Record conditions, the limited availability of water in the Upper Rio Grande section will result in significant irrigation water shortages in El Paso County and along the river corridor in Hudspeth County. Irrigated farming operations dependent on ground water in the Dell Valley area of Hudspeth County are not expected to be as severely impacted by drought. Downriver from Presidio, Rio Grande water should be available, if releases from Mexican rivers are maintained. Strategies being considered to meet the irrigation surface water shortages in El Paso and Hudspeth Counties include:

- Drilling additional wells in the Rio Grande Alluvium aquifer
- Increasing production from existing wells
- Water use savings through conservation and technology
- Reservoir storage expansion

**LIVESTOCK WATER USE STRATEGIES**

Livestock shortages only appear in El Paso and Jeff Davis Counties. Drought-induced shortages for livestock watering occur as surface water supplies diminishes and more demand is placed on ground-water supplies. Ranchers may chose to invest in additional wells or expanded use of existing wells during these dry periods. A more critical problem for ranchers during drought periods concerns the ability to maintain adequate forage even when adequate ground-water supplies are available. Ranching operations may resort to herd reductions during these pressing times.

## MINING WATER USE STRATEGIES

Water used in mining operations in the region is mostly related to the excavation of sand and gravel. Perceived water shortages in the mining industry in El Paso County is minimal and will likely be met with purchased water from EPWU.

## WATER PLANNING CONCLUSIONS

The planning decisions and recommendations made in the regional plan will have far-reaching and long-lasting social, economic, and political repercussions on each community involved in this planning effort and on individuals throughout the region. Therefore, involvement of the public was accepted initially as a key factor in the success and acceptance of the plan. Open discussion and citizen input was encouraged throughout the planning process and helped planners develop a plan that reflects community values and concerns. Some members of the public participated almost as non-voting members. To insure public involvement, notice of all regional planning group and track meetings was posted in advance and all meetings were held in publicly accessible locations. Special public meetings were held to convey information on project progress and to gather input on the development of the plan. Prior to submittal of the initially prepared plan to the TWDB, a copy of the regional water plan was provided for inspection in the county clerk's office and in at least one library in each county. Following public inspection of the initially prepared plan, a public meeting was conducted to present results of the planning process and gather public input and comments. To provide a common public access point, an internet web site (**http://24.28.171.253/rio/fwtwpgsplash.htm**) was designed and implemented that contains timely information that includes names of planning group members, bylaws, meeting schedules, agendas, minutes, and important documents.

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# CHAPTER 1

# DESCRIPTION OF THE REGION

## 1.1 INTRODUCTION

Far West Texas encompasses the most arid region of the State of Texas. Residents of this expansive desert environment recognize that water is a scarce and valuable resource that must be developed and managed with great care to ensure the long-term viability of the seven counties that make up Far West Texas. The region's economic health and quality of life concerns, such as the environment and recreation, are dependent on a sustainable water supply that is equitably managed. Chapter 1 presents a broad overview of the region and of many of the key issues that must be addressed as part of any attempt to develop a comprehensive water management plan that is acceptable to all who reside there. This chapter provides background information on (1) population, (2) the regional economy, (3) total water use and the amount of water used by different sectors of the economy, (4) climate and precipitation, (5) geology and hydrogeology, (6) sources of surface water, (7) sensitive environmental concerns, (8) water management plans and drought contingency plans developed by cities and irrigation districts, and (9) trans-boundary water issues between Far West Texas and the Mexican State of Chihuahua.

### 1.1.1 Definitions

The following definitions are included in Chapter 1 to provide the reader with a reference source for selected technical terms found in this report. In this report, the term "ground water" is used as a noun to refer to all subsurface water. The hyphenated form "ground-water" is used as an adjective.

**Acre-Foot -** The volume of water required to cover one acre to a depth of one foot; 325,851 gallons.

**Alluvial** - Pertaining to or composed of sediment deposited by running water, such as a stream.

**Aquifer** - One or more formations that contain sufficient saturated permeable material to conduct ground water and to yield economically significant quantities of water to wells and springs. Refer to definitions of "formation," "hydrostratigraphy" and "stratigraphy."

**Arcuate -** A term used to describe physiographic features that are bent or curved.

**Arid** - A term used to describe a climate characterized by dryness, variously defined as rainfall insufficient for plant life or for crops without irrigation; less than 10 inches of annual rainfall; or a higher evaporation rate than a precipitation rate. Compare with "semiarid."

**Bolson/Basin** - A term used, especially in the southwestern U.S., to describe flat, saucer-shaped, alluvium-floored basins that are surrounded by mountains and in which drainage is internal. Bolson aquifer or basin aquifer implies the water-saturated portion of the sediments filling the bolson or basin.

**Convective** - A term that describes the process of "convection" - the vertical movement of air caused by atmospheric heating and cooling processes.

**Demand** - The total volume of water required to meet the needs of a water-use category.

**Drought** - A period of abnormally dry weather of sufficient length to cause serious hydrologic imbalance as indicated by crop damage, water-supply shortage, etc.

**Drought-of-record** - A drought period with the greatest hydrologic/agricultural/ public water-supply impact recorded in a region.

**Ephemeral** - Describes a stream or reach of a stream that flows briefly only in direct response to precipitation in the immediate locality and whose channel is at all times above the water table.

**Evaporation** - The process by which water passes from the liquid state to the vapor state.

**Evapotranspiration** - The loss of water from a land area through transpiration by plants and evaporation from the soil.

**Forbearance Contract** - A contract in which a landowner agrees to forego delivery of Rio Grande Project Water.

**Formation** - The basic stratigraphic unit in the classification of rocks, consisting of a body of rock generally characterized by some degree of compositional homogeneity, by a prevailingly but not necessarily tabular shape over its areal extent, and by mappability at Earth's surface or traceability in the subsurface; a convenient unit, of considerable thickness and extent, used in mapping, describing, or interpreting the geology of a region, and the only formal unit that is used for completely dividing the geologic column in a region.

**Holophytic** - An adjective describing vegetation that derives its nourishment entirely from its own organs.

**Hydraulic interconnection** - The degree to which ground water is able to move between different water-bearing rocks or between basins.

**Hydrogeology (hydrology)** - The branch of the science of geology that deals with subsurface waters and related geologic aspects of surface waters.

**Hydrostratigraphy** - The identification of formations that have considerable lateral extent and that also form a geologic framework for a reasonably distinct hydrogeologic system.

**Irrigation Demand** - The quantity of water needed on a field to economically grow crops.

**Perennial stream** - A stream or reach of a stream that flows continuously throughout the year and whose upper surface generally stands lower than the water table in the region adjoining the stream.

**Reuse** - The process of recapturing water following its initial use and making it available for additional uses. The process generally requires a level of treatment appropriate for its next intended use.

**Riparian** - Pertaining to being situated on the bank of a body of water, especially of a watercourse such as a river; situated on or abutting a stream bank.

**Semiarid** - A climate in which there is slightly more precipitation (10 to 20 inches) than in an arid climate (less than 10 inches), and in which grasses are the characteristic vegetation.

**Storage** - The volume of water contained within the pore space of an aquifer. Recoverable storage is the percentage of water in storage that can be economically produced.

**Stratigraphy** - The branch of geology that deals with the definition and description of major and minor formations available for study in outcrop or from the subsurface, and with the interpretation of their significance in geologic history; the geologic study of the form, arrangement, geographic distribution, chronological succession, classification, correlation, and relationships of rock strata.

**Topography -** (1) the general configuration of a land surface or any part of Earth's surface, including its relief and the position of its natural and man-made features. (2) The natural or physical surface features of a region; the features revealed by the contour lines of a map.

**Transpiration** - The process by which water absorbed by plants, usually through the roots, is evaporated into the atmosphere.

**Tributary -** A stream feeding, joining, or flowing into a large stream or a lake.

**Water budget** - (1) An accounting of the inflow to, outflow from, and storage in a hydrologic unit such as a drainage basin, aquifer, soil zone, lake, or reservoir; (2) the relationship between evaporation, precipitation, runoff, and the change in water storage.

**Water-supply availability** - The volume of water capable of being withdrawn or diverted from specific sources of supply.

**Xerophytic** - An adjective describing vegetation adapted to dry conditions.

### 1.1.2 Far West Texas

The counties of the Far West Texas Region are among the largest in the state, occupying 24,069 square miles ($mi^2$), or 9 percent of the 266,807 $mi^2$ of the total area (Figure 1-1). Ranked by total area, the counties that make up the region are Brewster

(6,193 $mi^2$), Hudspeth (4,572 $mi^2$), Presidio (3,856 $mi^2$), Culberson (3,813 $mi^2$), Terrell (2,358$mi^2$), Jeff Davis (2,264 $mi^2$), and El Paso (1,013 $mi^2$).

### 1.1.3 Population and the Regional Economy

With the exception of El Paso County, the counties of Far West Texas are among the least populated of the state. The population density of the six rural counties is approximately 1.3 persons per square mile. Ninety-six percent (770,500) of the region's 800,900 residents reside in El Paso County (Figure 1-2), where the population density is 760 persons per square mile. Seventy-five percent (600,200) are of Mexican-American ancestry, 21 percent (168,000) are European-American, 3 percent (24,000) are African-American, and 1 percent (8,300) belong to other ethnic groups.

The regional economy is predominantly comprised of agriculture, agribusiness, manufacturing, tourism, wholesale and retail trade, and government. Farming and ranching have been mainstays of the economy for more than 100 years in the six rural counties. In recent years, tourism and outdoor recreation have become more significant components of the economies of the rural counties. El Paso County, which is not included with the group of rural counties in this study, has developed an economy that is driven largely by manufacturing, international trade, military training, wholesale and retail trade, and educational services.

Per capita income in the seven counties, based on 1993 figures reported by the Bureau of Economic Analysis, is below the state's average of $19,145. Ranked in descending order by per capita income, the counties are: (1) Terrell, $17,825; (2) Jeff Davis, $15,505; (3) Brewster, $15,020; (4) El Paso, $12,790; (5) Culberson, $10,619; (6) Presidio, $9,958; and (7) Hudspeth, $9,526.

### 1.1.4 Municipalities

#### 1.1.4.1 Major Population Centers

El Paso, one of the fastest growing cities in Texas, is the largest city in the region, with an estimated population in the year 2000 of 632,199. This is equivalent to 82 percent of the total population of El Paso County and to 79 percent of the region's population. The other 12 communities in El Paso County are expected to have 82,318 residents by the year 2000, and the population of outlying areas of El Paso County is projected to be 56,015. The projected year 2000 populations of cities in the six rural counties are as follows: Alpine, Brewster County (6,479); Van Horn, Culberson County (3,296); Dell City, Hudspeth County (728); Sierra Blanca, Hudspeth County (610); Fort Davis, Jeff Davis County (1,153); Marfa, Presidio County (2,612); Presidio, Presidio County (5,157); Sanderson, Terrell County (1,158). The total population of the cities of the six rural counties is expected to be 21,191 by the year 2000, or 70 percent of the total population of the rural counties. The population of the outlying areas is estimated to be 5,307. The projected growth of population in Far West Texas is discussed in detail in Chapter 2.

#### 1.1.4.2 Water Supply and Quality Issues

The City of El Paso and the urban areas of El Paso County receive approximately half of their water from the Rio Grande. The rest comes from wellfields in the Mesilla Bolson and Hueco Bolson aquifers. The City supplies water to other incorporated areas and to businesses. Other entities in El Paso County not served by the City of El Paso rely exclusively on ground-water resources. All of the cities and unincorporated areas of the six rural counties depend entirely on the ground-water resources of the other major and minor aquifers of the region.

Water resources developed for municipal consumption are expected to meet "primary" and "secondary" safe drinking-water standards mandated by the U.S. Environmental Protection Agency and the Texas Natural Resource Conservation Commission. "Primary standards" are concerned with dissolved constituents (e.g., heavy metals and organic contaminants) that are known to have adverse effects on human health. "Secondary standards" are concerned with factors that affect the aesthetic quality (e.g., taste and odor) of drinking water. These include dissolved constituents such as chloride, sulfate and iron, along with a variety of suspended components that may require filtration.

Within the region, water quality varies widely. In many areas of the rural counties, ground water is of sufficient quality that only chlorination is required as a means of treatment. In other areas, various methods of treatment are required to bring the water into compliance with primary and secondary standards. For example, Dell City operates a desalination plant to reduce the concentration of total dissolved solids (TDS) in ground water produced from the Bone Spring-Victorio Peak aquifer. The City of El Paso blends fresh water with marginally elevated TDS water. The City of El Paso also operates a tertiary treatment plant to condition wastewater for reuse.

### 1.1.5. Manufacturing and Other Industries

#### 1.1.5.1 Major Manufacturers and Industries

Manufacturing and industrial companies represent a significant component of the economy of Far West Texas. Most of these businesses, however, are located in El Paso County. The degree to which these businesses are concentrated in El Paso County is shown by the fact that all but 7 acre-feet of the 14,793 acre-feet projected to be used in the region by the manufacturing and industrial sector in the year 2000 is expected to be used in El Paso County. (An acre-foot is equal to 325,851 gallons of water.) Manufactured products include clothing, electronics, auto equipment, plastics, refined hydrocarbons, mineral products, and agricultural products. (Dallas Morning News, Texas Almanac, 1998-1999).

#### 1.1.5.2 Water Supply and Quality Issues

A large part of the manufacturing and industrial sector purchases water from the City of El Paso, or is self-supplied by water wells. In some cases, companies use treated wastewater provided by the City of El Paso. Chemical quality standards for water used for industrial purposes vary greatly with the type of industry utilizing the water. The primary concern with many industries is that the water not have constituents that are corrosive or scale-forming. Also of concern are those minerals that affect color, odor, and taste; therefore, water with a high concentration of dissolved solids is avoided in many manufacturing processes.

### 1.1.6 Agricultural Industry

#### 1.1.6.1 Significance of the Agricultural Industry

In general, the cultural and physical landscape of Far West Texas has more in common with the desert southwest than with other areas of Texas. The dominant commercial land use throughout the rural areas of the region is extensive cattle grazing. Aridity and historic land-tenure practices have combined to produce large ranches and low animal densities (Schmidt, 1995).

There is virtually no rain-fed agriculture, and even irrigated agriculture is confined to a small fraction of the basins. Floodplain-irrigated agriculture is found along the Rio Grande extending above and below El Paso and in a much smaller strip near Presidio. Irrigated agriculture based upon ground-water pumping is essentially limited to the Salt Basin around Dell City and its southward extension through Van Horn. High quality cotton, pecans, alfalfa, and vegetables such as tomatoes, onions, and chiles are the major crops of the region (Schmidt, 1995).

Of the nearly 11.3 million acres of farm and ranch land in the region, only about 80,000 acres (Figure 1-3) are irrigated. This is only 0.7 percent of areas identified as agricultural land. According to statistics in the 1997 Census of Agriculture (U.S.D.A., http://www.nass.usda.gov/census/census97/tx.tx.html), most of the irrigated land in Far West Texas is in El Paso and Hudspeth Counties (41,500 acres and 31,000 acres, respectively). The amount of irrigated land within a county varies from one year to another, depending on factors such as expected commodity prices, operating costs and availability of water. The Texas Water Development Board (TWDB) reports variations of as much as 20,000 acres in the amount of irrigated land in Hudspeth County, based on irrigation surveys conducted at 5-year intervals between 1958 and 1994 (TWDB, 1996). The Hudspeth County Conservation and Reclamation District irrigates approximately 18,000 acres, while irrigated acreage in the Dell City area has varied from 20,000 to 40,000 acres.

The amount of land actually irrigated in the El Paso County Water Improvement District in any given year varies from 40,000 to 50,000 acres. The total water rights acreage for the District is 69,010. The City of El Paso currently owns or leases land with rights to use water for approximately 13,000 acres.

Smaller, but significant, irrigated areas are located in Presidio and Culberson Counties (4,600 and 2,900 acres, respectively). Despite the relatively small area of irrigated land, the value of crop production is as much as $36.7 million in El Paso County, $16.5 million in Hudspeth County, and $4.9 million in Presidio County (Figure 1-4).

Cow and calf operations dominate the livestock industry in every county except Terrell County, where sheep and goats predominate. In addition to livestock, many of the ranches supplement revenue through hunting programs. The value of livestock production (Figure 1-4) ranges from $3.7 million in Culberson County to $39.9 million in El Paso County. Dairy operations in El Paso County represent the largest proportion of the market valuation for livestock, as El Paso County traditionally ranks in the top five dairy-production counties in Texas. Agricultural water-demand forecasts addressed in Chapter 2 consider irrigation and livestock needs separately.

#### 1.1.6.2 Water Availability and Quality Issues

Crop production is not sustainable without a source of irrigation water. A reduction in the quantity of water available for irrigation will cause a reduction in the number of acres that can be irrigated profitably. Similarly, cutbacks in the supply of water for livestock will cause a reduction in herd size. As water supplies are depleted, modifications will be required to use the available range resource, and water hauling within a given ranch may be required to better distribute water to livestock.

Although drought is a relative constant for the region, extended periods of below-normal rainfall can have significant and long-lasting harmful effects on the range resource. Reduction of livestock numbers because of drought usually lags behind the impact of drought on the range-grass ecosystem. Extended periods of drought can lead to the depletion of grass species and to an increase in shrub species. This leads to a decrease in soil cover and increases the potential for erosion by water and wind.

A decrease in water quality has a greater impact on crop production than on livestock output. As the salinity of irrigation water increases, the amount of irrigation water applied must also increase. This satisfies the leaching requirement, and keeps the root zone salinity at levels that allow for economic crop production. If salinity levels increase, the mixture of crops may change to include crops with greater tolerance to soil salinity.

#### 1.1.6.3 AGRICULTURAL USE OF GROUND WATER

Ground-water use for irrigated farming principally occurs along the Rio Grande, in the Dell City region, and along the various flats that compose the Salt Basin. Principal aquifers from which irrigation water is withdrawn include the Rio Grande Alluvium, Bone Spring-Victorio Peak, and the Wild Horse-Michigan, Lobo, and Ryan Flats of the West Texas Bolson aquifers. Characteristics of these aquifers are described in Chapter 3.

Future availability of water for agricultural use from these aquifers varies. During times of insufficient river flow farmers may use ground water from the Rio Grande Alluvium to sustain crops. However, because of its high mineral content, this water can only be used on a short-term basis. In the Dell City area ground water from the Bone Spring-Victorio Peak aquifer has deteriorated in quality particularly in the central part of the valley as a result of repeated return flow. The aquifer should remain viable in the future if total withdrawals do not exceed approximately 100,000 acre-feet per year. Water levels have declined in the past in the Salt Basin aquifers but have generally recovered due to a decrease in pumpage in recent years. Future availability of water from these Salt Basin aquifers for agricultural use may be influenced in some areas by potential withdrawals for other uses.

## 1.2 PHYSIOGRAPHY, LAND USE, CLIMATE AND NATIVE VEGETATION

### 1.2.1 Physiography

The Far West Texas Region is located in a topographically distinct area of North America known as the Basin and Range Physiographic Province (Fenneman, 1931;

Thornbury, 1965). The Region is bounded on the north by New Mexico, on the south by the Rio Grande, and along the east by the Pecos River. Traversed from north to south by an eastern range of the Rocky Mountains, the Region contains all of Texas= true mountains (Figure 1-5). Far West Texas is characterized by higher elevations and greater local relief than is characteristic of other areas of the state. Although most of Texas is generally flat and less than 2,500 feet above mean sea level (msl), the floors of most of the basins in West Texas are at elevations greater than 3,000 feet. Widely spaced mountain ranges rise from 1,000 to more than 3,000 feet above the lowlands. The basins are filled with sediments eroded from the surrounding mountains. At the deepest points of the basins, deposits of basin-fill (bolson deposits) range in thickness from less than 1,000 feet to more than 9,000 feet. With the exception of the Rio Grande and its tributaries, the Rio Conchos (Chihuahua, Mexico) and the Pecos River, all surface water in the region drains toward the lowest elevation within each basin. "Salt flats" occur in northeastern Hudspeth and northwestern Culberson Counties where water, collected in these shallow lakes, rapidly evaporates leaving behind accumulations of mineral deposits.

Highest of the mountain ranges is the Guadalupe Range, which enters the state from New Mexico. The range comes to an abrupt end about 20 miles south of the Texas/New Mexico boundary line, where Guadalupe Peak (8,751 feet above msl) overlooks the Salt Basin to the south. Lying west of the Guadalupes and extending to the Hueco Mountains a short distance east of El Paso is the Diablo Plateau. The Plateau has no drainage outlet to the sea. Runoff from the scant rains that fall on the surface of the Plateau drains into a series of salt lakes that lie just west of the Guadalupe Mountains. These lakes are dry during periods of low rainfall, exposing bottoms of solid salt. For years, this area was a source of commercial salt.

The Eagle Mountains (7,484 feet), the Quitman Mountains (5,200 feet), the Carrizo Mountains (5,200 feet) and the Sierra Blanca Peaks (6,800 feet) are located south of the Diablo Plateau in Hudspeth County. These mountains overlook several intermontane basins from which there is no external drainage (e.g., Eagle Flat, Ryan Flat, Michigan Flat, Wildhorse Flat). Two of the basins are dissected by and drain to the Rio Grande (Red Light Draw and Green River Valley).

The Davis Mountains are principally in Jeff Davis County. Mount Livermore (8,206 feet) is one of the highest peaks in Texas. There are a number of mountains with elevations greater than 7,000 feet. These mountains intercept moisture-bearing winds and receive more precipitation than other locations in West Texas. The Davis Mountains are greener with the growth of grass and forest trees than other mountains of the region.

The Big Bend country, which lies south of the Davis Mountains, is bounded on three sides by a great eastward swing of the Rio Grande. It is a sparsely populated mountainous country with scant rainfall. Its principal mountains, the Chisos, rise to an elevation of 7,825 feet. Along the Rio Grande are the Santa Elena, Mariscal and Boquillas Canyons, with rim elevations of 3,500 feet to 3,775 feet. Because of its remarkable topography and plant and animal life, the southern part of this region along the Rio Grande is home to Big Bend National Park and Big Bend Ranch State Park.

The "Upper and Lower Valleys" of the Rio Grande in El Paso County are narrow strips of irrigated land separated in El Paso County by the Franklin Mountains, which rise 3,000 feet above the valley floor to an elevation of 7,192 feet. The historic towns and missions of Ysleta, Socorro and San Elizario are located along the Lower Valley.

### 1.2.2 Climate and Precipitation

A large part of Far West Texas is associated with the northern portion of the Chihuahuan Desert, a large arid zone that extends southward into Mexico. It is only the highest altitudes and the eastern edge of the region paralleling the Pecos River that receive sufficient precipitation to be considered semiarid, rather than true desert (Schmidt, 1986).

The mean annual temperature of the region is approximately 65° F. The average annual low temperature is between 45° F and 54° F, and the average high is 77° F to 80° F. During summer months, afternoon temperatures often exceed 100° F. Far West Texas is the most arid region of the state of Texas (Bomar, 1995; Schmidt, 1995). The region usually reports the lowest annual precipitation (the regional average is 12.9 inches) and the highest lake-surface evaporation (the regional average is 70 inches) in Texas (Figures 1-6 and 1-7). The combination of low rainfall and high evaporation creates drought conditions during all or part of most years (Bomar, 1995).

From highest to lowest values, average annual rainfall in the counties of Far West Texas is reported as follows: Mount Locke, Jeff Davis County (20.8 in); Alpine, Brewster County (16.9 in); Marfa, Presidio County (15.9 in); Sanderson, Terrell County (14.3 in.); Van Horn, Culberson County (13.1 in); Presidio, Presidio County (10.8 in); Hudspeth County (10 in), City of El Paso, El Paso County (8.8 in) (Dallas Morning News, 1998-1999 Texas Almanac; Bomar, 1995). Most rainfall occurs between the months of June and October, as indicated by a graph of average monthly rainfall for selected stations (Figure 1-8). Rainfall during the spring and summer months is dominated by widely scattered thunderstorms (Larkin and Bomar, 1983; Nativ and Riggio, 1989 and 1990). Because of the convective nature of thunderstorms, the amount of spring and summer precipitation in the region increases with elevation (Gile, et al., 1981).

### 1.2.3 Drought

"Drought" is generally defined as a condition in which the amount of water transpired and evaporated exceeds the amount available in the soil (Thornthwaite, 1947). As such, drought is associated with a sustained period of significantly lower soil moisture and water supply relative to "normal" levels established within a region (Rasmussen et al, 1993). Climatologists have described three classes of drought (Critchfield, 1966): (1) permanent drought associated with arid climates; (2) seasonal drought, which occurs in climates with distinct annual periods of dry weather; and (3) drought due to precipitation variability. Compared with other regions of the state, Far West Texas experiences drought (or drought-like) conditions most, or all, of the year – and often for many consecutive years.

The above definitions, however, may be too broad to be of much significance for the region, and for this reason, the following operational definitions are used (Rasmussen et al., 1993; Bomar, 1995):

- Meteorologic drought
- Agricultural drought
- Hydrologic drought

**Meteorologic drought** is defined as an interval of time, usually over a period of months or years, during which precipitation cumulatively falls short of the expected supply.

**Agricultural drought** is defined as that condition when rainfall and soil moisture are insufficient to support the healthy growth of crops and to prevent extreme crop stress. It may also be defined as a deficiency in the amount of precipitation required to support livestock and other farming or ranching operations.

**Hydrologic drought** is a long-term condition of abnormally dry weather that ultimately leads to the depletion of surface-water and ground-water supplies, the drying up of lakes and reservoirs, and the reduction or cessation of springflow or streamflow. (The tables developed in this report reflect hydrologic drought.)

Although agricultural drought and hydrologic drought are consequences of meteorological drought, the occurrence of meteorological drought does not guarantee that either one or both of the others will develop. With regard to El Paso County, drought is not related to rainfall, but to the amount of snowmelt in southern Colorado, and also to hydrologic and climatic conditions that affect the amount of storage in the Elephant Butte Reservoir of southern New Mexico. It is important, therefore, to develop a set of criteria that will enable the residents of Far West Texas to identify either the precursors or the onset of drought.

These criteria may include (adapted from Rasmussen et al., 1993):

- Lower precipitation in key watersheds
- Extended periods of high temperature
- Higher levels of evapotranspiration
- Reduced runoff and snow melt
- Stressed plants and grasses
- Reduced stream flow and spring flow
- Lower reservoir and ground-water levels
- Increased regional water demand

Trigger criteria to assist the communities of Far West Texas in determining when to implement drought contingency plans are presented in Chapter 5.

### 1.2.4 Influence of Climate on Native Vegetation

The major climatic influence on natural vegetation is the scarcity of moisture. Altitudinal differences, along with associated local temperature and precipitation variations, are the major secondary controls. Desert shrub communities, particularly of creosote bush and mesquite, are more associated with the region's western arid zones from the lowest altitudes to about 4,500 ft. The two plant indicators of the Chihuahuan Desert are lechuguilla (*Agave lechuguilla*), and sotol (D*asylirion wheeleri*). They are generally found on the rough limestone slopes of the foothills of highlands. There are indications that xerophytic vegetation has been expanding upslope through the region for more than a century as a result of grassland disturbance (Schmidt, 1995).

The more semiarid eastern area supports short grassland. This is the most widespread vegetation type in Far West Texas. At higher elevations, the desert grassland grades into open woodland consisting of juniper and various species of oak. Woodlands and areas of pine and fir are generally restricted to the higher elevations of the Davis and Guadalupe Mountains above 6,900 ft. Scattered through the region are smaller areas of riparian, holophytic, and other vegetation adapted to specific site conditions (Schmidt, 1995).

### 1.2.5 Land Use

Land use in the seven-county region is divided into seven categories (Figure 1-9):

- Urban (or developed)
- Cultivated Agricultural
- Range
- Forest
- Water
- Wetlands
- Barren

The largest concentration of urban land is, of course, in El Paso County, where 96 percent of the region's residents live. Urban lands make up less than one percent of the region's total land area. Cultivated agricultural lands are identified as areas that support the cultivation of crops. These lands require extensive irrigation. Areas designated as cultivated agricultural lands comprise less than one percent of the total land area of the region. These lands require access to high volumes of ground water or surface water. Both urban and agricultural lands comprise the two most significant areas of water consumption.

Rangeland is defined as all areas that are either associated with or are suitable for livestock production. Although this is the largest category of land use in the region, rangeland accounts for one of the smallest sources of water demand. Forest land is limited to areas where topography and climate support the growth of native trees. These are limited to highlands, such as the Davis Mountains, the Guadalupe Mountains, and the Chisos Mountains. Forest lands rely exclusively on rainfall as a source of moisture.

Areas designated as either water or wetlands are associated with the Rio Grande and its tributaries, or the tributaries of the Pecos River. Most of the designated wetlands in the region are associated with the Rio Grande. The Rio Grande is also a major source of irrigation water for agricultural lands in El Paso, Hudspeth and Presidio Counties. All other streams in the region are ephemeral. Finally, barren lands are defined as undeveloped areas with little potential for use as agricultural land, rangeland, or forestland.

## 1.3 WATER-SUPPLY SOURCES

### 1.3.1 Ground Water

The Texas Water Development Board (TWDB) has identified three major aquifers and six minor aquifers in Far West Texas (Figure 1-10). The difference between the major and minor classification as used by the TWDB relates to the total quantity of water produced from an aquifer and not the total volume available.

The major aquifers are the:

- Hueco Bolson,
- Mesilla Bolson, and
- Edwards-Trinity (Plateau).

The minor aquifers are the:

- Bone Spring-Victorio Peak,
- Capitan Reef,
- Igneous,
- Marathon,
- Rustler, and
- West Texas Bolsons.

The following generalized descriptions of the major and minor aquifers are based largely on the work of Ashworth and Hopkins (1995). A more thorough discussion of these aquifers, especially as it relates to water-supply availability, can be found in Chapter 3.

#### 1.3.1.1 Hueco Bolson Aquifer

The Hueco Bolson aquifer (Figure 1-10), located in El Paso and Hudspeth Counties, extends from east of the Franklin Mountains in New Mexico toward the east-southeast into Hudspeth County, where it is bounded in El Paso County by the Hueco

Mountains and in Hudspeth County by the Diablo Plateau and the Quitman Mountains. The aquifer then continues south a short distance into Mexico. The Hueco Bolson aquifer is the sole source of municipal supply for Ciudad Juarez, Chihuahua, and provides approximately half of the municipal supply for the City of El Paso. Large-scale ground-water withdrawals, especially from municipal well fields in areas of El Paso and Ciudad Juarez, have caused major declines in the water table. These declines have significantly changed the direction of flow, the rate of flow, and the chemical quality of ground water in the Hueco Bolson aquifer. Declining water levels have also resulted in a minor amount of land subsidence.

### 1.3.1.2 Rio Grande Alluvium Aquifer

The Rio Grande Alluvium aquifer (Figure 1-10) consists of Quaternary floodplain sediments laid down by the Rio Grande as the river incised the surface of the Hueco Bolson. The floodplain forms a narrow valley within the topographically lowest part of the Hueco Bolson and extends nearly 90 miles from El Paso to Fort Quitman, where the valley is constricted between the Sierra de la Cienguilla of Chihuahua and the Quitman Mountains of Hudspeth County. The aquifer is hydrogeologically integrated with the sediments of the Hueco Bolson. It is a source of irrigation water for farms in El Paso and Hudspeth Counties.

### 1.3.1.3 Mesilla Bolson Aquifer

The Mesilla Bolson aquifer (Figure 1-10) lies in the Upper Rio Grande Valley west of the Franklin Mountains and extends to the north into New Mexico. The aquifer is primarily used for agricultural purposes and public supply in New Mexico. In Texas, the agricultural use of this aquifer is much less than in New Mexico. The City of El Paso=s Canutillo well field is located in the Mesilla Bolson.

### 1.3.1.4 Edwards-Trinity (Plateau) Aquifer

The Edwards-Trinity (Plateau) aquifer (Figure 1-10) underlies the Edwards Plateau east of the Pecos River and the Stockton Plateau west of the Pecos River. It provides water to all or parts of 38 Texas counties. The aquifer extends from the Hill Country of Central Texas to the Trans-Pecos region of West Texas, where it is a source of water in Culberson, Jeff Davis, Brewster and Terrell Counties. There is relatively little pumpage from the aquifer over most of its extent. Consequently, water levels have remained constant or have fluctuated in response to seasonal precipitation. The City of Sanderson in Terrell County is the only municipality in the region that pumps water from this aquifer.

**1.3.1.5 Bone Spring-Victorio Peak Aquifer**

The Bone Spring-Victorio Peak aquifer (Figure 1-10) is located along the eastern edge of the Diablo Plateau west of the Guadalupe Mountains in northeast Hudspeth County. It extends northward into the Crow Flats area of New Mexico. The Bone Spring and Victorio Peak Formations are composed of nearly 2,000 ft of limestone beds. Water occurs in joints, fractures and solution cavities. Permeability of the limestones is highly variable, and well yields differ widely from about 150 gallons per minute (gal/min) to more than 2,000 gal/min.

The aquifer is used primarily as a source of irrigation water. Dell City is the only municipality that relies on the aquifer as a source of public supply. Although the water table has declined since pre-irrigation development, water levels have remained relatively constant since the late 1970=s.

**1.3.1.6 Capitan Reef Aquifer**

The Capitan Reef aquifer (Figure 1-10) consists of arcuate strips of limestone (10 to 14 miles wide) that formed along the shelf edge of the Central Basin Platform during the late Permian Period. The formation is exposed in the Guadalupe, Apache and Glass Mountains. The reef trends northward into New Mexico, where the aquifer is a source of abundant fresh water for the City of Carlsbad. Within the planning region, the aquifer underlies sections of Culberson County and a small area of northern Brewster County.

Most of the ground water pumped from the aquifer in Texas is withdrawn from wells in Ward and Winkler Counties and used for oil reservoir water-flooding operations. A small amount of water is used for irrigation of salt-tolerant crops in Pecos and Culberson Counties.

### 1.3.1.7 Igneous Aquifer

The Igneous aquifer (Figure 1-10) occurs in three areas within Brewster, Presidio and Jeff Davis Counties. Ground water is stored in the fissures and fractures of tuffs and related intrusive and extrusive rocks. The rocks reach an average thickness of 900 ft to 1,000 ft. The Cities of Alpine, Fort Davis and Marfa rely on the aquifer as a source of municipal supply.

Well yields are moderate to large in the Marfa area and are small to moderate in the Alpine and Fort Davis areas. Water quality is generally considered to be good for municipal and domestic uses. Elevated levels of silica and fluoride have been found in some wells.

### 1.3.1.8 Marathon Aquifer

The Marathon aquifer (Figure 1-10) is located entirely within north-central Brewster County. Ground water is used primarily as a municipal water supply by the City of Marathon, and for domestic and livestock purposes. Ground water occurs in numerous crevices, joints and cavities at depths ranging from 350 ft to about 900 ft, and well yields range from 10 gal/min to more than 300 gal/min. Many of the shallow wells in the region actually produce water from alluvial deposits that overlie rocks of the Marathon aquifer. Ground water is typically of good quality but hard. Total dissolved solids range from 500 milligrams per liter (mg/l) to 1,000 mg/l.

### 1.3.1.9 Rustler Aquifer

The Rustler Formation is exposed in eastern Culberson County. The formation plunges eastward into the subsurface of the Delaware Basin. The aquifer (Figure 1-10) is principally located beneath Loving, Pecos, Reeves, and Ward Counties, where it yields water for irrigation, livestock and water-flooding operations in oil-producing areas. Water occurs in highly permeable solution zones in dolomite, limestone and gypsum beds of the Rustler Formation. Large concentrations of dissolved solids render the water unsuitable for human consumption.

**1.3.1.10 West Texas Bolsons Aquifer**

Several deep bolsons, or basins, filled with sediments of both igneous and sedimentary origin of Quaternary age underlie Far West Texas (Figure 1-10). The bolsons contain significant quantities of ground water. These bolsons are referred to as Red Light Draw, Eagle Flat, Green River Valley, Presidio-Redford, and the Salt Basin. The Salt Basin is subdivided into the Wild Horse, Michigan, Lobo, and Ryan Flats. The upper part of the Salt Basin extending north of Wild Horse Flat contains ground water with total dissolved solids well in excess of 3,000 mg/l. The bolson aquifers provide variable amounts of water for irrigation and municipal water supplies in parts of Culberson, Hudspeth, Jeff Davis, and Presidio Counties. The communities of Presidio, Sierra Blanca, Valentine and Van Horn rely on the bolson aquifers for municipal water supplies.

**1.3.1.11 Unexplored Areas and Undeveloped Ground-Water Resources**

Also shown in Figure 1-10 are large areas of Far West Texas that are not underlain by major or minor aquifers (e.g., the Diablo Plateau of central and northern Hudspeth County). The map, however, should not be interpreted as an indication that such areas are devoid of ground water as much as a reflection of the current level of understanding of the extent of known ground-water resources in the region. The rocks that make up the subsurface of the Diablo Plateau of central and northern Hudspeth County, for example, may in fact have large volumes of ground water in storage. The plateau, however, has not been sufficiently evaluated by hydrogeologists to warrant definite conclusions regarding its status as a potential source of ground water at this time.

Relatively few exploration wells have been drilled on the plateau. Consequently, factors such as hydrostratigraphy and important hydraulic parameters (e.g., porosity, hydraulic conductivity, and transmissivity) are largely unknown.

Similarly, very little is known about the potential of many of the igneous and volcanic rocks of Brewster, Jeff Davis and Presidio Counties to support anything other than the current level of interpretation. Further evaluation will be needed to arrive at a better understanding of the water-resource development potential in these areas.

**1.3.1.12 Recharge of Aquifers and Residence Time of Ground Water**

Precipitation recharge of the aquifers in Far West Texas is limited by the substantial regional evaporation excess and by local geology. The U.S. Geological Survey (USGS) has assumed that recharge to these aquifers can be estimated from the relationship between the surface area of a basin and the amount of precipitation within the basin. The amount of precipitation available for recharge is assumed to be one percent of average annual precipitation (Gates et al., 1980). However, the results of research on recharge areas and pathways in the Eagle Flat and Red Light Basins of Hudspeth County indicate that the aquifers of the westernmost regions of the state might receive less than one-fifth of the amount of precipitation recharge assumed by the USGS. Recharge areas appear to be associated with exposures of fractured bedrock and areas where fractured bedrock is covered by a thin layer of highly porous and permeable basin-fill (Darling, 1997).

It is uncertain how or to what extent the results of the Hudspeth County investigation (Darling, 1997) may be applicable in other areas of the Far West Texas region. The study, however, underscores the possibility that the USGS=s rule-of-thumb assumption about recharge is likely to be a significant overestimate of the volume of fresh water that replenishes the major and minor aquifers of the region. The location of recharge areas, understanding of recharge pathways and the volume of precipitation available for recharge are significant unknowns in the development of conceptual and numerical flow models of the aquifers. At a minimum, hydrogeologic data from the region indicate that the amount of recharge is very low and insufficient to flush high-TDS ground waters from many of the aquifers. A more complete discussion of the significance of recharge as it relates to ground-water supply is covered in Chapter 3.

**1.3.1.13 Other Significant Unknowns about Regional Aquifers**

Other than the Mesilla and Hueco Bolsons, the hydrogeology of the aquifers of Far West Texas is probably not as well understood as the hydrogeology of ground-water bolsons/basins in other areas of the state.

Most of this uncertainty can be traced to the following factors:

- the comparatively small number of wells drilled in the region,
- the relatively undeveloped nature of many of the so-called minor aquifers,
- uncertainty regarding the extent of recharge areas and recharge pathways in specific basins,
- uncertainty regarding the average annual volume of recharge attributable to precipitation in specific basins,
- the absence of well-defined discharge zones within most of the basins that are not dissected by the Rio Grande,
- uncertainty regarding the degree of hydraulic interconnection (if any) between basins, and
- the lack of data to support reasonable intrabasin and interbasin water-balance calculations.

Resolution of the above issues lies beyond the scope of work related to this phase of Senate Bill 1 planning.

**1.3.1.14 Ground-Water Quality**

All ground water contains minerals carried in solution and their concentration is rarely uniform throughout the extent of an aquifer. The degree and type of mineralization of ground water determines its suitability for municipal, industrial, irrigation and other uses. The ground-water resources of Far West Texas vary from potable to nonpotable, often within the same aquifer. A detailed quality characterization and discussion of specific quality issues related to each aquifer can be found in Chapter 3.

Quality issues in the region are generally related to naturally high concentrations of total dissolved solids (TDS) or to the occurrence of elevated concentrations of individual dissolved constituents. High concentrations of TDS in Far West Texas are primarily the result of the lack of sufficient recharge and restricted circulation. Together, they retard the flushing action of fresh water moving through the aquifers.

However, some aquifers have a low TDS but may contain individual constituent levels that exceed safe drinking-water standards. Some wells in the Igneous aquifer have exceptionally low TDS but contain unsatisfactory levels of fluoride, while water from some wells in the Study Butte-Terlingua area have elevated levels of radioactivity.

Ground-water quality changes are often the result of man's activities. In agricultural areas, aquifers such as the Bone Spring-Victorio Peak have increased in TDS. Irrigation water applied on the fields percolates back to the aquifer carrying salts leached from the soil. Beneath El Paso and Ciudad Juarez, the concentration of dissolved solids in the Hueco Bolson aquifer has increased as the fresher water in the aquifer is being depleted. Although local instances of ground-water quality degradation have occurred in the region, there are no major trends that suggest a widespread water-quality problem due to the downward percolation of surface contaminants.

**1.3.2 Rio Grande**

The Rio Grande originates in southwestern Colorado and northern New Mexico, where it derives its headwaters from snowmelt in the Rocky Mountains. The Elephant Butte Dam and Reservoir in New Mexico is approximately 125 miles north of El Paso and can store over two million acre-feet of water (Figure 1-11). Water in the reservoir is stored to meet irrigation demands in the Rincon, Mesilla, El Paso, and Juarez valleys and is released in a pattern for power generation. Above El Paso, flow in the river is largely controlled by releases from Caballo Reservoir located below Elephant Butte; while downstream from El Paso to Fort Quitman, flow consists of treated municipal wastewater from El Paso, untreated municipal wastewater from Juarez and irrigation return flow.

Below the El Paso-Hudspeth County Line, flow consists mostly of return flow and occasional floodwater and runoff from adjacent areas (Miyamoto et al., 1995). Channel losses are significant enough that the Rio Grande is often dry from below Fort Quitman to the confluence with the Mexican river, the Rio Conchos, upstream of Presidio. There are no significant tributaries, other than the Rio Conchos, in the 350 miles between Elephant Butte Reservoir and Presidio.

The Texas Natural Resource Conservation Commission's inventory of water quality in the state (TNRCC, 1996) cites drainage area and a wide range of geologic and climatic conditions in Far West Texas as factors responsible for water-quality conditions in the Rio Grande. Heavy metals and pesticides have been identified sporadically throughout the river's reach within the region. Elevated fecal coliform levels occur in the river downstream of border cities, due primarily to the release of untreated wastewater to the River in Mexico. Elevated nutrient levels are also common in the Rio Grande.

The Rio Grande is unique in its complexity of distribution management. Because the waters of the river must be shared between three U.S. states and the nation of Mexico, a system of federal, state and local programs has been developed to oversee the equitable distribution of water. The compacts, treaties and projects that currently provide the river's management framework are discussed in Chapter 3.

### 1.3.3 Pecos River

The Pecos River forms the eastern boundary of the Far West Texas Region at the northeast corner of Terrell County (Figure 1-11). As a major tributary to the Rio Grande, the headwaters of the Pecos River originate as snowmelt east of Santa Fe, New Mexico in the Sangre de Cristo Mountains. The River flows southward through eastern New Mexico, where Red Bluff Lake impounds it in Loving County, Texas. The Pecos River Compact provides the apportionment and division of Pecos River waters between New Mexico and Texas and is administered by the Pecos River Compact Commission. Although Pecos River water is typically too salty for human consumption, it has been a source for irrigation in Pecos, Reeves and Ward Counties.

### 1.3.4 Springs of the Region

Springs and seeps are found in all seven of the counties of Far West Texas. Brune (1981) divided springs into seven classes, based on average discharge:

| Magnitude | Discharge (liters per second) | Discharge (gallons per minute) |
|---|---|---|
| Very large | More than 2,800 | More than 44,380 |
| Large | 280 to 2,800 | 4,483 to 44,380 |
| Moderately large | 28 to 280 | 448.3 to 4,483 |
| Medium | 2.8 to 28 | 44.38 to 448.3 |
| Small | 0.28 to 2.8 | 4.44 to 44.38 |
| Very small | 0.028 to 0.28 | 0.44 to 4.44 |
| Seeps | Less than 0.028 | Less than 0.44 |

None of the Far West Texas springs catalogued by Brune (1981) falls within either the large or very large class. Springs with moderately large discharges are found in Terrell, Jeff Davis, and Presidio Counties, and most springs with medium discharges are associated with the mountainous terrain of Brewster, Presidio, Jeff Davis, and Culberson Counties. Small springs, very small springs, and seeps are the most common types. Most of these are found in the mountainous areas of Far West Texas, especially in Brewster, Presidio, Jeff Davis, and Hudspeth Counties. Brune also identifies the locations of a number of “former springs.” In most cases, the former springs have ceased to flow because of lowered water tables or because of diminished recharge associated with drought (Brune, 1981).

Springs have played an important role in the development of Far West Texas. They were important sources of water for Native Americans, as indicated by the artifacts and petroglyphs found in the vicinity of many of the springs. The path of the Old Spanish Trail through Far West Texas was largely determined by the occurrence of springs that issued from locations in the mountains and along mountain fronts. These springs were also significant sources of water for early settlers, ranchers, and the 19th century stage lines (Brune, 1981).

Although the springs are not sources of water for the larger cities of the Far West Texas Region, they provide drinking water for ranches and smaller communities, such as the village of Kent in southeastern Culberson County. Phantom Spring of Jeff Davis County - one of the Balmorhea Springs - is a source of water used to support irrigation in Reeves County. Springs contribute to the esthetic and recreational value of private land and parkland in Far West Texas - especially in the Big Bend, where a number of thermal springs discharge along the banks of the Rio Grande. Springs are significant sources of water for wild game, and they also form small wetlands that attract migratory birds and other fowl that inhabit the region throughout the year. Finally, springs also provide habitats for threatened or endangered species of fish (such as the Pecos Gambusia and the Big Bend Gambusia), according to the Texas Parks and Wildlife Department.

### 1.3.5 Ecologically Unique Stream Segments and Springs

Under the guidelines of Senate Bill 1, each planning region may recommend certain stream segments for designation as ecologically unique as a means of protecting the segments from activities that may threaten their environmental integrity. A list of stream segments recommended by the Texas Parks and Wildlife Department (TPWD) as potential candidates was reviewed for designation. The information reviewed as part of this program includes state and federal threatened and endangered species lists, water-resources data, topographic maps, aquifer maps and characteristics, and other environmental resource information.

For each segment, TPWD lists qualities of each segment that support the stream's candidacy. Qualities influencing the potential for listing a stream segment are derived from one or more ecological characteristics that may set a stream apart from other stream segments in the region. These qualities may include but are not limited to biological function, hydrological function, location with respect to conservation areas, water quality, the presence of state- or federally-listed threatened or endangered species, and the critical habitat for such species. All of the proposed stream segments have characteristics that warrant environmental protection. However, these qualities currently offer the streams protection by promoting intense regulatory scrutiny for any and all projects that may be proposed for these areas.

In reviewing the provisions of Senate Bill 1, the effects on future uses of designating a stream segment are not clear. The bill does not outline potential restrictions of uses or development along designated waters. Therefore, the activities that will be allowed or disallowed under such a designation are unclear. The Texas Legislature might attempt to clarify these restrictions during the 77th session; this is one of the recommendations of the Far West Texas Water Planning Group in Chapter 6.

Because of the regulatory protection of these sites by other agencies and laws and also because the subsequent ramifications of designation are unknown, representatives of the Far West Texas Water Planning Area have chosen to refrain from proposing the sites for designation as ecologically unique stream segments until the state legislature clarifies the actions associated with designation.

## 1.4 WATER DEMAND

### 1.4.1 Demand Centers

Although they occupy less than two percent of the total land area in Far West Texas, municipal (27 percent) and irrigation (67 percent) are expected to represent the two major areas of water demand in the year 2000. The City of El Paso, with a water-use projection of 101,928 acre-feet, represents 74 percent of the total municipal water use in the region. Total municipal water use in El Paso County (131,184 acre-feet), which includes all other communities and rural domestic supply, represents 95 percent of the regional total.

Irrigation surface-water demand is centered along the Rio Grande valley in El Paso and Hudspeth Counties and to a lesser extent in Presidio and Brewster Counties. Irrigation using ground-water sources occurs primarily in the Dell City area in Hudspeth

County and in the Salt Basin from Van Horn to Valentine in Culberson, Jeff Davis and Presidio Counties. In the year 2000, a total of 342,848 acre-feet of water is projected to be applied to approximately 80,000 acres in the region.

Industrial and manufacturing use (14,793 acre-feet), which represents only three percent of the total regional water use, is located almost exclusively in El Paso County. Current and projected water demand for all water-use types are discussed in detail in Chapter 2.

### 1.4.2 Categories of Demand

Based on the regional planning group revisions to the TWDB 1997 Consensus State Water Plan, the total projected year 2000 water consumptive demand in the Far West Texas region is 509,426 acre-feet. The TWDB has identified six categories of water demand. These are:

- **Municipal**. This category of demand consists of both residential and commercial water uses. Commercial water consumption includes business establishments, public offices, and institutions, but does not include industrial water use. Residential and commercial uses are categorized together because they are similar types of uses, i.e.: they both use water primarily for drinking, cleaning, sanitation, air conditioning, and landscape watering.
- **Irrigation**. This category of demand consists of all water used by the agricultural industry to support the cultivation of crops. Where ground water is the source of irrigation water, the TWDB defines irrigation use as “on farm demand.” Where surface water is the source of irrigation water, the TWDB defines irrigation use as both “on farm demand” and “diversion loss.” Diversion loss, also referred to as conveyance loss, is the amount of water lost during the delivery of surface water from the point of diversion on the river or stream to the point of use on the farm. Surface water is typically conveyed by an open canal system, which exposes the water supply to possible loss from seepage, breaks, evaporation, and uptake by riparian vegetation.

- **Livestock**. This category of demand consists of all water used by farms and ranches to support livestock production.
- **Manufacturing**. This category of demand consists of all water used in the production of goods for domestic and foreign markets. Manufactured products in Texas range from food and clothing to refined chemical and petroleum products to computers and automobiles. Some processes require direct consumption of water as part of the manufacturing process. Others require very little water consumption, but may require large volumes of water for cooling or cleaning purposes. In some manner or another, water is passed through the manufacturing facility and used either as a component of the product or as a transporter of waste heat and materials.
- **Steam-Electric**. This category of demand consists of all water used by steam-electric generating plants as part of the boiler feed and cooling requirements in the production of electricity. For plants that use ground water or diverted surface water, the TWDB's survey of water use provided actual reported withdrawals. For plants that use cooling ponds or other water impoundments, water use was calculated by adding reported ground-water use for boiler feed and sanitary uses to net natural evaporation and forced evaporation estimates.
- **Mining**. This category of demand consists of all water used in the production and processing of nonfuel (e.g., sulfur, clay, gypsum, lime, salt, stone and aggregate) and fuel (e.g., oil, gas, and coal) natural resources by the mining industry. In all instances, water is required in the mining of minerals either for processing, leaching to extract certain ores, controlling dust at the plant site, or for reclamation. This also includes the production of crude petroleum and natural gas.

The consumption of water in acre-feet for each of the above sources of demand is illustrated by Figure 1-12. The largest category of demand is irrigation (342,848 acre-feet), followed by municipalities (137,956 acre-feet), manufacturing (14,793 acre-feet), steam-electric cooling (6,000 acre-feet), livestock (4,463 acre-feet), and mining (3,366 acre-feet). The significance of irrigation as a source of demand is further underscored by the accompanying pie chart (Figure 1-12), which shows that 67 percent of water is used by the agricultural sector in support of irrigation. Twenty-seven percent is used by municipalities, and the remaining six percent supports manufacturing, steam-electric cooling, livestock and mining.

#### 1.4.2.1 Municipal Water Demand

Total municipal demand for water in the seven counties of the region (Figure 1-13) is 137,956 acre-feet. The largest center of municipal demand is, of course, El Paso County, where 131,184 acre-feet of water is used to support all areas of residential, commercial and public consumption. This is 95 percent of total municipal water use in the region. Per capita demand within the region varies from a high of 228 gallons per person per day (gpd) in Terrell County to a low of 97 gpd in Hudspeth County.

#### 1.4.2.2 Irrigation Water Demand

Total irrigation demand (Figure 1-14) in the region is 342,848 acre-feet. El Paso and Hudspeth Counties account for the greatest amount of irrigation with 179,842 and 124,521 acre-feet of usage, respectively. Along the Rio Grande corridor in these two counties, all irrigation water is diverted from the River, except during years when flow in the River is significantly below normal. In northeastern Hudspeth County, the Dell City farming community irrigates cropland with water pumped from the underlying Bone Spring-Victorio Peak aquifer (TWDB, 1996). TWDB (1996) reports that the amount of irrigated acreage in the Dell City area has varied from as much as 40, 081 acres in 1979 to 19,491 acres in 1984. In 1994, the last surveyed year, 29,500 acres were irrigated.

Irrigation in El Paso and Hudspeth Counties represents 89 percent of total irrigation water use in the region. Most of the remaining 11 percent of demand is centered in Presidio and Culberson Counties, where 25,678 and 8,947 acre-feet, respectively, are used to support irrigated agriculture.

### 1.4.2.3 Livestock Water Demand

The total volume of water used in livestock production (Figure 1-14) in the region is 4,463 acre-feet. The largest area of demand is El Paso County, where 1,729 acre-feet (39 percent of total livestock demand) are used by ranches and dairy farms. In the six rural counties of the region, total livestock demand ranges from a high of 571 acre-feet in Brewster County to a low of 320 acre-feet in Culberson County. The lower numbers associated with the rural counties may be a reflection of the lack of dairy farms outside of El Paso County.

### 1.4.2.4 Manufacturing and Steam-Electric Cooling Water Demand

Total demand for water by the manufacturing sector (Figure 1-14) is 14,793 acre-feet. Nearly all of this demand is concentrated in El Paso County (14,786 acre-feet). El Paso County also accounts for all of the water used in the region for steam-electric cooling (6,000 acre-feet) (Figure 1-14).

### 1.4.2.5 Mining Water Demand

The mining sector (Figure 1-14) accounts for the smallest area of demand, with 3,366 acre-feet of total usage in the region. Most of the mining sector=s demand for water has been centered in Culberson County to support the Freeport-McMoran sulfur mine. The 1997 Consensus Water Plan projects mining water usage in Culberson County to be 2,240 acre-feet, or 66 percent of the regional mining total, by the year 2000. Freeport-McMoran, however, ceased production in 1999. The closure of the mine will likely lead to a significant reduction in the short-term volume of water used by the mining industry in Culberson County. The shutdown of the mine may be offset somewhat by the development of other mining operations in the region, especially aggregate mining near Sierra Blanca (Hudspeth County).

Oil and gas production accounts for most of the mining water use in Terrell County. TWDB projections indicate that mining water use in the County will decline from 42 acre-feet in 1990 to 27 acre-feet in the year 2000. This is likely a result of lower oil and gas production since 1990.

## 1.5 MAJOR WATER PROVIDERS

### 1.5.1 Definition of Major Water Providers

Regional Water Planning Groups (RWPG) are required under 31 TAC Chapter 357 to identify and include Major Water Providers (MWPs) in their regional water plans. The Texas Water Development Board suggests a definition of MWP as an entity which delivers and sells a significant amount of raw or treated water for municipal and/or manufacturing use on a wholesale and/or retail basis. The entity can be either public (nonprofit) or private (for profit) and may include municipalities with wholesale customers, river authorities and water districts.

For the purposes of this planning exercise, the Far West Texas Water Planning Group has defined an MWP as an entity which sells 50 acre-feet or more per year of raw or treated water for municipal, industrial and/or manufacturing uses on a wholesale and/or retail basis.

### 1.5.2 Major Water Providers

Based on this definition, five MWPs were identified in the region:

- El Paso County Water Improvement District #1
- El Paso Water Utilities/Public Service Board (El Paso WU/PSB)
- El Paso County Water Control and Improvement District #4
- El Paso County Water Authority
- Town of Van Horn

Four of the five MWPs are located in El Paso County (Figure 1-15). The El Paso County Water Improvement District #1 primarily delivers water from the Rio Grande to area irrigators. However, it also sells water from the Rio Grande to the City of El Paso through the El Paso Water Utilities/Public Service Board. In 1997, the District provided 54,198 acre-feet to the City (TWDB).

The City of El Paso Water Utilities/Public Service Board obtains raw surface water from the El Paso County Water Improvement District #1 as explained above, and ground water from its own wells in the Hueco and Mesilla Bolson aquifers. While most of this water was used within the City, as much as 6,263 acre-feet was sold in 1997 to numerous other public supply, manufacturing and industrial entities (TWDB). One of the primary buyers is the Lower Valley Water Authority who likewise distributes water to other entities. Although the Lower Valley Water Authority is a significant supplier of water to other entities, it is not listed as an MWP because its water source originates from the El Paso WU/PSB.

The El Paso County Water Control and Improvement District #4 obtains water from its own wells in the Hueco Bolson aquifer. In 1997, the District provided 61 acre-feet (TWDB) of water to the communities of Fabens, San Elizario, the Quadrilla MUD, and to other buyers.

The fourth MWP in the county is the El Paso County Water Authority. The Authority's water supply is derived from its own wells and is delivered to a number of entities, Horizon City being the most prominent.

The fifth MWP is the Town of Van Horn in Culberson County. Besides supplying water to its own community from wells located in the Wild Horse Flat section of the Salt Basin aquifer, Van Horn sells water to the Town of Sierra Blanca through the Hudspeth County Water Control and Improvement District #1. In 1997, 115 acre-feet were sold to Sierra Blanca (TWDB).

## 1.6 WATER MANAGEMENT PLANNING

### 1.6.1 State Water Plan

The Texas Water Development Board adopted the amended *Texas Water Plan, Water for Texas* on August 20, 1997 as the official water plan for Texas. The Texas Water Code directs the TWDB to update this comprehensive water plan which is used as a guide for the management of the State's water resources. This State plan was the result of a consensus planning process that included efforts by the Texas Natural Resource Conservation Commission (TNRCC), the Texas Parks and Wildlife Department, and community and professional leaders. Based on water-resource availability and for planning purposes, the state was divided into 16 regions. All seven counties in the current Far West Texas region were included in the State plan's Upper Rio Grande region analysis.

The State plan provides a brief narrative of the TWDB's evaluation of the following entities, programs, treaties and compacts:

- International United States-Mexico Treaty
- Rio Grande Compact
- Pecos River Compact
- Watermaster Office of the TNRCC
- Economically Distressed Area Program (EDAP)
- Programs of El Paso
- Programs of Alpine and Fort Davis

The State plan briefly identifies the water-conservation efforts that the El Paso area will undertake to protect the ground-water and surface-water resources. El Paso will continue to rely on the Rio Grande for surface water and on the Hueco and Mesilla Bolson aquifers for ground water. The greater use of water from the aquifers is for municipal use in the El Paso area. Therefore, management of the aquifers is crucial since the amount of ground water needed to supply the projected future demands in the El Paso area exceeds the estimated annual effective recharge to the aquifers. El Paso will conduct aquifer recharge projects in an effort to stop the drawdown effect of the aquifers. Blending fresh and brackish water, desalination pilot projects, expansion of the Mesilla Bolson aquifer well field, wastewater reuse, acquisition of additional water rights, and ongoing studies and negotiations to maximize development of the Rio Grande Project are all expectations included in this plan. Communities located in the rural counties will continue to rely on ground-water sources.

According to the State Water Plan, the Upper Rio Grande region is expected to experience an overall decline in total water use from 1990 to 2050. Conservation efforts in the municipal and irrigation sector are each projected to save about 46,000 acre-feet of total water by the year 2020. Presently, the municipal sector comprises 27 percent of the total water used in the region (both ground water and surface water), while the irrigation sector comprises 67 percent of the water used. By the year 2050, municipal use is expected to increase to about 44 percent and irrigation use is expected to decrease to about 50 percent.

The State plan (page 3-103) discusses two water-related problems and needs that are significant to the Far West Texas region. The first issue concerns the projected shift in Rio Grande water use from irrigation to municipal and the need to complete the process of adjudicating water rights within the Upper Rio Grande Basin to prevent conflicts between the different uses and between individual water-rights holders. The second matter of concern to the region is the salinity of the Pecos River. The plan discusses the Malaga Bend Salinity Control Project in New Mexico and its intent to minimize the intrusion of saturated brine into the river.

A City of El Paso pipeline from the Rio Grande is the only major water-supply recommendation in the State water plan (Figure 3-14, page 3-33) listed for the Far West Texas region. The conveyance project will allow the City to expand its reliance on Rio Grande waters delivered by New Mexico per the Rio Grande Compact. The State water plan (Figure 3-15, page 3-34) also lists Alpine Lake in Brewster County as an alternative water-supply development site.

**1.6.2 Water Management and Drought Contingency Plans**

Far West Texas is perennially under drought or near-drought conditions compared with more humid areas of the state of Texas. Although residents of the region are generally accustomed to these conditions, the low rainfall and the accompanying high levels of evaporation underscore the necessity of developing plans that respond to potential disruptions in the supply of ground water and surface water caused by drought conditions. The following water management and drought contingency plans were provided by several entities. County Commissioners' Courts have not enacted water conservation ordinances, nor have they promulgated water availability requirements for new developments.

The *El Paso Water Resource Management Plan* was commissioned by El Paso Water Utilities and the El Paso County Water Improvement District #1. The plan establishes preferred alternatives to meet the future water-supply management needs for much of the county. A number of other management reports have been prepared by the City that consider specific management strategies. The City of El Paso has also developed a comprehensive drought contingency plan.

Water-supply management/conservation plans have also been prepared by the Town of Van Horn and by the Terrell County Water Control and Improvement District #1 for supplies provided to the Town of Sanderson. The two entities have also prepared drought contingency plans. Both the El Paso County Water Improvement District #1 and the Hudspeth County Conservation and Reclamation District #1 irrigation districts have prepared drought contingency plans. A summary of these plans is contained in Appendix 1A.

**1.6.3 El Paso Water Utilities/Public Service Board (El Paso WU/PSB) as the Declared Regional Water Supply Planner**

In 1995, the Texas Legislature passed Senate Bill 450 designating the El Paso WU/PSB as the regional water and wastewater planner for El Paso County. The purpose of the Bill is to improve regional water and wastewater planning for El Paso County and encourage increased consultation, coordination, and cooperation in the management of regional water resources. The City of El Paso would serve a pivotal role in all future planning and expansion projects. The City, through the El Paso WU/PSB, is to receive priority consideration for public funding for the planning, design, and construction of water supply and wastewater systems within the county. The intent of Senate Bill 450 is to address regional planning issues by the following seven actions:

- Coordinate water and wastewater management on a regional watershed basis.
- Address water quality and quantity conditions adversely affecting the public health and the environment.
- Provide efficient planning and management of water resources to remediate existing and avoid future colonia conditions.

- Participate in water and wastewater planning with adjacent counties and the border states of New Mexico and Chihuahua, Mexico, to address transboundary water issues.
- Encourage conjunctive management for the protection and preservation of the limited surface-water and ground-water resources.
- Maximize the amounts and provide for the efficient use of public funding to implement the purposes of Senate Bill 450.
- Provide intergovernmental cooperation with water utilities to encourage their planning to be consistent with the regional plan.

### 1.6.4 Irrigation District Management Plans

The El Paso County Water Improvement District #1 and the Hudspeth County Conservation and Reclamation District #1 have developed management plans for their operations. Summaries of these plans are shown in Appendix 1C.

### 1.6.5 Underground Water Conservation District Plans

The Texas Legislature has established a process for local management of ground-water resources through ground-water conservation districts. Ground-water conservation districts are charged to manage ground water by providing for the conservation, preservation, protection, recharging and prevention of waste of the ground water within their jurisdictions. An elected board governs these districts and establishes rules, programs and activities specifically designed to address local problems and opportunities. Texas Water Code §36.0015 states, in part, "Groundwater conservation districts created as provided by this chapter are the state's preferred method of groundwater management." Four districts are currently in operation within the planning region.

#### 1.6.5.1 Hudspeth County Underground Water District #1

The Hudspeth County Underground Water District #1 was created in 1956 and is located in the Dell Valley irrigation area of northeast Hudspeth County, with the City of Dell City lying approximately in the center of the District. District activities primarily include the monitoring of water levels in the aquifer and advising local irrigators of pending problems.

The District's management plan includes the following goals:

- Provide for the most efficient use of ground water
- Control and prevent the waste of ground water
- Address natural-resource issues

**1.6.5.2 Jeff Davis County Underground Water Conservation District**

The Jeff Davis County Underground Water Conservation District was formed in August 1994 (HB 2866) and includes all of Jeff Davis County within its jurisdiction. District activities include the registration of all new wells and the permitting of wells that are capable of producing 25,000 gallons per day or more. State well construction standards are enforced and water levels are monitored in 28 observation wells located in high use areas. The District is involved with the Fort Davis Water Supply Corp. in a wellhead protection program and also provides educational programs for schools and the public.

The District has identified the following goals in its management plan:

- Improve the basic understanding of ground-water conditions in the district
- Provide for the most efficient use of ground water
- Protect and enhance the quantity of usable quality water by controlling and preventing waste
- Address conjunctive surface-water management issues
- Regulate the production of ground water to ensure adequate water for the future

### 1.6.5.3 Culberson County Groundwater Conservation District

The Culberson County Groundwater Conservation District occupies the southwestern half of Culberson County and was confirmed in May 1998. The District has recently adopted a management plan, along with associated rules and regulations, and has established the following management goals:

- Improve the basic understanding of ground-water conditions in the District
- Implement management strategies that will provide for the most efficient use of ground water
- Strive to prevent the waste of water
- Minimize the influence of pumping of wells on the degradation of the aquifers by regulating the spacing of wells and by use of a Production Use Measurement Area
- Minimize the potential for contamination of ground water by new or existing wells
- Monitor the water leaving the District through exportation for the purpose of planning and data inventory

### 1.6.5.4 Presidio County Underground Water Conservation District

Presidio County residents approved the formation of the Presidio County Underground Water Conservation District in an election held August 31, 1999. The District includes all of Presidio County and will be developing rules and management plans in the near future.

### 1.6.5.5 El Paso County Priority Groundwater Management Area

In 1985, the 69th Texas Legislature recognized that certain areas of the state were experiencing or were expected to experience critical ground-water problems. House Bill 2 directed the Texas Department of Water Resources (later to become the Texas Water Commission (TWC) and the Texas Water Development Board (TWDB)) to identify the critical ground-water areas, to conduct studies in those areas, and to make recommendations on whether a ground-water conservation district should be established in critical areas.

The TWC and TWDB evaluated ground-water supply conditions in El Paso County in 1990 as part of the "Critical Area" program. An overview evaluation (TWDB Report 324) recognized that the Hueco Bolson aquifer had a long history of water-level decline and water-quality deterioration, and stated that the expected life of the aquifer, under then current conditions, was about 60 years at best. Rather than declaring the area "Critical," the TWC chose to place a moratorium over the declaration until after a 50-year water management plan for the City of El Paso was completed.

Senate Bill 1 changed the name of "Critical Area" to "Priority Groundwater Management Area" (PGMA) and mandated that the Texas Natural Resource Conservation Commission (TNRCC - successor agency to the TWC) complete reviews of all pending PGMA studies. The TNRCC requested a technical update study of El Paso County (TWDB Open-File Report, Preston 1998) and (TP&W Report, El-Hage and Moulton, 1998). These studies were completed in the spring of 1998. The TWDB report concluded that water-level declines and quality deterioration are still present in the Hueco Bolson, but did not address El Paso's plans to remedy the problems and provide long-term management. The TP&W reported no known effect on wildlife as a result of water-level declines in the Hueco Bolson aquifer. TNRCC staff then completed their analysis and recommended to their Commissioners that the area identified by the TWDB as the Hueco Bolson aquifer in El Paso County be declared a PGMA (TNRCC File Report, Musick, 1998).

The Commissioners, subsequently, declared "the area of El Paso County overlying the Hueco Bolson aquifer, including its subcrops and outcrops" as a Priority Groundwater Management Area. However, the Commissioners stated that "El Paso has clearly demonstrated a significant effort toward regional cooperation, planning, and voluntary implementation of actions to address water supply problems" and that "it is not clear that creating a groundwater conservation district for the area of El Paso County overlying the Hueco Bolson aquifer would be in the public interest, meet a public need, or benefit the property therein at this time" (TNRCC Docket No. 98-0999-MLM, SOAH Docket No. 582-98-1540).

### 1.6.6 Water-Supply Problem Areas without Management Plans

The City of El Paso, through El Paso Water Utilities, is the only entity in the county with a management plan. El Paso County has a feasibility plan for recommended facilities to provide water and wastewater to areas outside the City of El Paso. The time frame for providing services would be established based on the availability of surplus funds. Other entities within the county are working on similar plans, but none were available at the time of this report.

Regional water management plans in the rural counties are primarily the responsibility of the underground water conservation districts and these are restricted to their individual counties. Because of the remoteness of the individual communities in the rural counties, regional plans linking facility needs are presently impractical.

## 1.7 NEW MEXICO/TEXAS WATER COMMISSION

The New Mexico/Texas Water Commission was formed in 1992 with the members listed below, and with a commitment to regional long-term planning for the region below Elephant Butte Dam through El Paso.

| **New Mexico** | **Texas** |
|---|---|
| Elephant Butte Irrigation District | El Paso County Water Improvement District # 1 |
| City of Las Cruces | El Paso Public Service Board |
| New Mexico State University | University of Texas at El Paso |
| Dona Ana County | |

The El Paso County Water Improvement District # 1 is no longer a member of the Commission.

In 1994, the Commission retained the services of Boyle Engineering Corporation and Engineering-Science, Inc. to prepare what is called the Conjunctive Water Resource

Management Plan (1994 Plan). This study was completed in December of that same year and was funded by members of the Commission with help from the New Mexico Interstate Stream Commission and the Texas Water Development Board. The objective of this study was to "examine surface water conveyance and treatment alternatives from Caballo Dam to the City of El Paso to increase the municipal and industrial use of surface water, improve the quality of surface water for all users, and extend the ground-water resources of the region."

Other efforts to provide a sustainable water supply to users within the Rio Grande Project area are presently being examined by the Commission. Currently, the Commission is working on the El Paso/Las Cruces Regional Sustainable Water Project that will involve new surface-water treatment plants for the New Mexico Cities of Hatch, Las Cruces and possibly Anthony, as well as El Paso. Additional alternatives that will impact both Las Cruces, New Mexico and El Paso County, Texas have been developed and the final Environmental Impact Statement should reach a Record of Decision for the project by the fall of 2000.

## 1.8 INTERNATIONAL WATER ISSUES

### 1.8.1 Ciudad Juarez Water Issues

The role of Ciudad Juarez, Chihuahua as a major source of municipal water demand and as a source of untreated wastewater into the Rio Grande cannot be ignored. Ciudad Juarez, one of the largest cities on the U.S./Mexico border, is 100 percent dependent on the Hueco Bolson aquifer to satisfy all of the municipal and industrial sectors of its economy. El Paso, also one of the largest cities on the U.S. side of the border, is dependent on the Hueco Bolson aquifer to satisfy approximately 40 percent of its municipal and industrial needs. The two cities, however, appear to be headed in different directions with regard to their reliance on the aquifer.

Between the years 1990 and 1997, El Paso=s annual consumption of water from the Hueco Bolson aquifer decreased from approximately 72,300 acre-feet to 50,900 acre-feet, a reduction of about 21,400 acre-feet. The large reduction in El Paso=s dependence on ground water can be traced to (1) the City=s increasing use of surface water (Figure 1-16a), (2) the adoption of water-conservation programs, and (3) the initiation of pricing strategies that discourage excessive water consumption.

Over the same period of time, Ciudad Juarez=s annual production of water from the Hueco Bolson aquifer increased from 97,200 acre-feet to 112,900 acre-feet, an increase of 15,700 acre-feet (Figure 1-16b). The increased production of ground water from the Hueco Bolson by Ciudad Juarez is, however, offset by the slightly larger reduction of withdrawal from the aquifer by El Paso.

Ciudad Juarez has 142 Hueco Bolson water wells that supply both domestic and industrial needs. As of February 1999, the City had 224,633 domestic connections representing 95 percent of the total connections; the remaining 11,792 or five percent are industrial and commercial connections. 1,122,331 or 92 percent of the total city population is connected to the water system, while 84 percent is connected to the sewer system. Water service to the remaining population is through water tank truck delivery.

With a rapidly growing population that is currently estimated to be over 1.3 million, Ciudad Juarez is faced with a diminishing water supply from its current source, the Hueco Bolson aquifer. The City is currently undertaking the preparation of a Water Master Plan to address population projections, water demands and identification of sources to meet the projected water demands over the next 20 years. The City is exploring additional ground-water sources west of the Sierra Juarez in the Conejos Medanos. However, this supply source is considered a short-term solution. Potentially larger ground-water sources to the south are also being explored. Long term solutions will likely focus on alternative management of allotted water from the Rio Grande (Rio Bravo).

#### 1.8.1.1 Transboundary Effects of Ground-Water Pumpage

In the shallow portion of the Hueco Bolson aquifer beneath the State of Texas and the adjoining areas of the State of Chihuahua (Mexico), groundwater generally flows away from the river, or toward the center of the established drawdown cones in Cd.

Juarez and in El Paso. In the deeper reaches of the aquifer, the river has little or no influence on the direction of ground-water flow. In these deeper zones, the direction of flow is also toward the center of the established cones of depression caused by the pumping-induced diversions of ground water. Between the years of 1910 to 1960, regional groundwater underflow proceeded from Mexico to the U.S., due to the greater withdrawal rate on the El Paso side. Since 1960, groundwater has generally flowed from the U.S. to Mexico. Figure 1-17 displays this phenomenon graphically. This more recent underflow to Mexico is considered to be brackish, with water quality similar to that of the Lower Valley of El Paso.

With continuous pumping from both Ciudad Juarez and El Paso, both cites have experienced extensive water-level drawdowns and water-quality degradation due to lateral brackish water intrusion into the fresh water zones. Pumping by Ciudad Juarez since 1997 has simply continued this trend. Brackish water intrusion from irrigation return flow drains continues to expand laterally and vertically, and to degrade water quality in the shallow alluvium along the Rio Grande. This situation cannot be rapidly eliminated. Even totally eliminating pumping leaves behind cones of depression, which draw in the brackish water for many years. Figure 1-18 is a regional potentiometric surface map showing current conditions in the Hueco Bolson for the City of El Paso and Cd. Juarez. This figure is an update of Figure 3.8 in the October 1997 transboundary aquifer study (Hibbs and others, 1997). This figure is based on data generated by a numerical (finite difference) model of the ground-water conditions in the El Paso/Ciudad Juarez area. The approximate boundaries of cone of depression as modeled for the years 2000 and 2010 are marked on the figure. The cone of depression is projected to expand northward and eastward beyond its present limits. This will place greater stress on both El Paso and Ciudad Juarez, as it will promote the inflow of more saline water.

### 1.8.2 Local and International Water Issue Surveys

#### 1.8.2.1 Economic Development Strategy for the Sustainable Use of Water Survey

In April of 1996, the Center for Environmental Resource Management (CERM) undertook a comprehensive effort to identify the critical water issues in order to create an economic development strategy for the region. This strategy is based on a sustainable approach to the region's water resources. A stakeholder taskforce was formed that included researchers and individuals representing a cross section of interests throughout the region. The concerns of this collective group were compiled, and the results are presented in a report, *An Economic Development Strategy for the Sustainable Use of Water in the Paso del Norte Region,* and a series of technical papers written addressing these issues. The results of this survey are shown in Appendix 1C.

#### 1.8.2.2 Far West Texas Water Management Issues Survey

Early in the regional water-management planning process, LBG-Guyton Associates prepared and delivered a survey to numerous individuals with water-related interests. The purpose of the survey was to assist the Far West Texas Regional Water Planning Group in identifying a common long-range vision for a successful regional water plan. The survey contained questions relating to water-supply adequacy, water management and drought contingency plans, and water-related issues of concern. Thirty-six responses were received. A summary of the survey conclusions follows.

- Current water-supply sources are inadequate to meet 50-year supply needs.
- Greatest problems with water supplies are:
    - shortage of supply,
    - lack of planning for the future,
    - cost,
    - inadequate distribution facilities,
    - rapid growth creating greater demand, and
    - State and Federal regulations.

- Concern for specific environmental water needs.
- Insufficient drought contingency planning.
- Concern about exporting water away from source area.
- Moderate response to need for mandatory water-conservation policies.
- Cities and underground water conservation districts should enforce conservation policies.
- Reuse of water supplies should be encouraged.
- Regional water supply and wastewater facilities are appropriate for El Paso County but not for rural counties.
- The state and underground water conservation districts should enforce stricter well-construction requirements.
- Activities of concern outside the planning region are:
    - population and water-demand increases across the international border,
    - upstream use of the Rio Grande,
    - potential low-level radioactive waste and other hazardous waste sites, and
    - State and Federal regulations.
- Factors most important in the planning process are:
    - keeping the cost of water low,
    - keeping the quality of water high, and
    - making sure the supply is sufficient and reliable.

## 1.9 COLONIAS

Colonias represent a special, and growing, subset of municipal demand in the region, and a challenge to water suppliers. Most colonias are subdivisions in unincorporated areas located along the United States/Mexico international border and typically consist of small land parcels sold to low-income people. These subdivisions often lack basic services, such as potable water, sewage disposal and treatment, paved roads, and proper drainage. Public health problems are often associated with these colonias (El Paso WU/PSB, 1998).

The Economically Distressed Area Program (EDAP) was created by the Texas Legislature in 1989 and is administered by the TWDB. The intent of the program is to provide local governments with financial assistance for bringing water and wastewater services to the colonias. An economically distressed area is defined as one in which water supply or wastewater systems do not meet minimal state standards, financial resources are inadequate to provide services to meet those needs, and 80 percent of dwellings in the area were occupied on June 1, 1989. Affected counties are counties adjacent to the Texas/Mexico border, or that have per capita income 25 percent below the state average and unemployment rates 25 percent above the state average for the most recent three consecutive years for which statistics are available (TWDB EDAP Paper, 1996).

**1.9.1 El Paso County Colonias**

In December 1998, the TWDB estimated that there were 172 colonias within the El Paso region (Figure1-17). In El Paso County alone, 156 colonias were recognized by the TWDB. Culberson County was the only county within the region that did not have a colonia within its boundaries.

The EPWU has served as a program manager to assist outlying water districts in applying for funding, master planning, design, and construction management. As regional planner for El Paso County, EPWU continues to work with various water districts in an effort to consolidate efforts in securing adequate water supplies and to capitalize on economies of scale.

**1.9.1.1 Infrastructure**

To date, the TWDB has committed $120 million to fund infrastructure development in 104 colonias in El Paso County. As of June 2000, 30 projects have been funded. Twenty-one projects are complete, eight are under construction, and one is under design. A total of $65 million in projects had been completed through 1999, and $23 million in projects is under construction. Both the TWDB and the North American Development Bank (NAD Bank) are funding two Lower Valley Water District projects that are under bid. The TWDB is funding the design and construction administration, and NAD Bank is funding the construction. The estimated value of the two construction contracts is $8 million.

**1.9.1.2 Connections**

Additional funding from NAD Bank ($1.9 million) and the Paso Del Norte Health Foundation ($1 million) and excess Lower Valley EDAP Phase II funds from TWDB ($0.85 million) is being used to fund qualified private (customer) wastewater service line and connection projects within the Lower Valley Water District. A total of 1,193 households will be provided service by the two projects that are under construction. Construction consists of installing the pipeline from a house to a collector line located at the street, associated clean-outs, and emptying and abandoning the existing septic tank.

Similarly, El Paso County has received $0.9 million from the Texas Department of Housing and Community Affairs (TDHCA) earmarked for qualified private (customer) water and wastewater service line and connection projects in the communities of Westway and Canutillo. It is estimated that 280 wastewater and 33 water connections will be made in Westway, and approximately 700 wastewater connections in Canutillo.

Within El Paso County, an estimated 52,000 residents now have water service available, while an estimated 20,600 resident now have wastewater service available.

As of 1998, of the 40 colonias without water or sewer service in El Paso County, an estimated 4,200 residents were without water, and an estimated 14,500 residents were without wastewater service. An estimated $27 million is needed to provide these services. A recent federally funded initiative of $25 million called the Texas Plan can be used to provide water and sewer connections to the 13 Texas border county colonias by 2001.

### 1.9.2 Rural County Colonias

Fewer colonias occur in the rural counties. However, their needs are of similar importance. The following is a summary of each rural county's colonias, associated projects and costs where available (source: TWDB EDAP database and local input).

- Brewster County
  - Marathon - Water Supply/Wastewater $112,600
  - Study Butte - Water Supply $1,257,000
- Culberson County
  - No Colonias
- Hudspeth County
  - Acala - Planning Studies/Water Supply $521,208
  - Sierra Blanca - Wastewater $2.23 million
  - Villa Alegre - Wastewater
  - Fort Hancock East Unit #1 and Unit #2
- Jeff Davis County
  - Fort Davis - Wastewater $462,534
  - Valentine - Wastewater
- Presidio County
  - Candelaria - Water Supply/Wastewater $300,000
  - Shafter - Water Supply/Wastewater
  - Las Pampas (Larson Ranch) - Water Supply/Wastewater
  - Ruidosa - Water Supply/Wastewater $315,000
  - Loma Pelona (Bald Hills) - Water Supply $515,000
  - Redford - Water Supply/Wastewater $572,200
  - Pueblo Nuevo (Millington Addition) - Water Supply $500,000
- Terrell County
  - Sanderson – Wastewater $2.95 million

### 1.9.3 Reports on Colonias

The following is a list of reports on colonias in Far West Texas:

- *Water and Wastewater Management Plan*; by Parkhill, Smith & Cooper, in association with CH2M Hill, May 1988.

- *Water and Wastewater Needs of Colonias in Texas*; by Texas Water Development Board; October 1992.

- *EDAP Phase I Facilities Engineering Community of San Elizario, Texas Water & Wastewater Plan*; by Moreno Cardenas, Inc. Consulting Engineers; Jan. 1992.

- *EDAP Phase I Facilities Engineering, City of Socorro, Texas Water and Wastewater Plan*; by Moreno Cardenas, Inc. Consulting Engineers; Dec. 1992.

- *East Montana Area Facility Engineering Plan for the TWDB EDAP*; by Parkhill, Smith & Cooper, Inc.; Sept. 1994.

- *Final Canutillo Water and Wastewater Facility Plan*; by John Carollo Engineers; May 1995.

- *Amendment to the Facility Plan for City of Socorro, Texas Water and Wastewater Facilities*; by Parkhill, Smith & Cooper, Inc.; July 1995.

- *Amendment to the Facility Plan for Community of San Elizario, Texas Water & Wastewater Facilities*; by Parkhill, Smith & Cooper, Inc.; July 1995.

- *Technical Memorandum No. 2 – Comprehensive Planning Document Socorro EDAP Facilities*; by Parkhill, Smith & Cooper, Inc.; July 1995.

- *Amendment to the Environmental Information Document for San Elizario, Texas Water & Wastewater Facilities*; by Parkhill, Smith & Cooper, Inc.; July 1995.

- *Amendment to the Environmental Information Document for City of Socorro, Texas Water & Wastewater Plan*; by Parkhill, Smith & Cooper, Inc.; July 1995.

- *Colonias Projects in El Paso County*; by EPWU/PSB, March 1998; prepared for EPWU/PSB.

- *Water Facilities Master Plan for the Lower Valley Water District*; prepared by Parkhill, Smith & Cooper, Inc.; August 2000.

In addition to the above reports, information on colonias in Far West Texas can be found at the following website: http://www.twdb.state.tx.us/colonias/.

**1.10 PROJECTS AND STUDIES**

The El Paso-Las Cruces Regional Sustainable Water Project was created in 1991 as a result of the lawsuit settlement agreement over water transfers between the City of El Paso and New Mexico. Per the agreement, the EPWU/PSB was designated as the lead agency. The goals and objectives of the Sustainable Water Project are to mutually explore alternatives for sustainable development of the region's water resources. For over a year, the project has been evaluating various elements to determine the best viable alternative meeting the overall goals and objectives. Some of the project's benefits include:

- Improving and protecting the quality of ground and surface water
- Preserving the Hueco and Mesilla ground-water bolson/basin aquifers
- Ensuring a year-round water supply of quality water from the Rio Grande
- Providing efficient water treatment alternatives to increase surface-water supply
- Continuing to meet Treaty and Compact requirements for delivery of Rio Grande Project water

The EPWU/PSB, in an effort to adequately manage the water resources in the region, has conducted several pilot projects in the areas of aquifer storage and recovery, desalination, microfiltration, and nanofiltration. The pilot projects listed below are summarized by reports and studies and are briefly described in Appendix 1D.

- Concept Design of ASR Wellfield and Collection Facilities
- Brackish Water Reverse Osmosis Pilot Plant
- Anthony/Canutillo Membrane Treatment Pilot Plant
- Desalination Feasibility Study – Phase I

The Texas Water Development Board, in conjunction with the New Mexico Water Resources Research Institute, the International Boundary and Water Commission, the Comision Nacional del Agua, the Junta Municipal de Agua y Saneamiento de Ciudad Juarez, and the Comision International de Limites y Aguas, conducted an intensive study of the common aquifers of the El Paso, Ciudad Juarez, and Las Cruces region. The study, which involved nearly three years of work, was published by the TWDB in 1997 under the title *Transboundary Aquifers of the El Paso/Ciudad Juarez/Las Cruces Region* (Hibbs, et al., 1997). Observations and recommendations made in this report are also summarized in Appendix 1D.

## 1.11 FUNCTIONS OF STATE AND FEDERAL AGENCIES

### 1.11.1 Texas Water Development Board (TWDB)

The TWDB, especially the Water Resources Planning Division, is at the center of the Senate Bill 1 planning effort. The agency has been given the responsibility of directing the effort in order to ensure consistency and to guarantee that all regions of the state submit plans in a timely manner.

### 1.11.2 Texas Natural Resource Conservation Commission (TNRCC)

The TNRCC strives to protect the state’s natural resources, consistent with a policy of sustainable economic development. TNRCC’s goal is clean air, clean water, and the safe management of waste, with an emphasis on pollution prevention. The TNRCC is the major state agency with regulatory authority over state waters in Texas. The TNRCC has inventoried the water-right filings and claims within the Upper Rio Grande Basin as part of the water-rights adjudication process, but has not completed this process. To make this process complete, the adjudication would have to be evaluated and ruled upon by District Court. The TNRCC is also responsible for ensuring that all public drinking-water systems are in compliance with the strict requirements of the State of Texas.

### 1.11.3 Texas Parks and Wildlife Department

The Texas Parks and Wildlife Department provides outdoor recreational opportunities by managing and protecting wildlife and wildlife habitat and acquiring and managing parklands and historic areas. The agency currently has 10 internal divisions: Wildlife, Coastal Fisheries, Inland Fisheries, Law Enforcement, State Parks, Infrastructure, Resource Protection, Communications, Administrative Resources, and Human Resources. Three senior division directors provide special counsel to the Executive Director in the areas of water policy, land policy and administrative matters. The department has automatic status as a recognized party in any water right contested hearing case.

### 1.11.4 Texas Department of Agriculture (TDA)

The TDA was established by the Texas Legislature in 1907. The TDA has marketing and regulatory responsibilities and administers more than 50 separate laws. The current duties of the department include: (1) promoting agricultural products locally, nationally, and internationally (2) assisting in the development of the agribusiness in Texas; (3) regulating the sale, use and disposal of pesticides and herbicides; (4) controlling destructive plant pests and diseases; and (5) ensuring the accuracy of all weighing or measuring devices used in commercial transactions. The department also collects and reports statistics on all activities related to the agricultural industry in Texas.

### 1.11.5 Texas State Soil and Water Conservation Board (TSSWCB)

The TSSWCB is charged with the overall responsibility for administering the coordination of the state's soil and water conservation program with the state's soil and water conservation districts. The agency is responsible for planning, implementing, and managing programs and practices for abating agricultural and forest nonpoint source pollution. Currently, the agricultural/forest nonpoint source management program includes problem assessment, management program development and implementation, monitoring, education, and coordination.

### 1.11.6 International Boundary and Water Commission (IBWC)

The IBWC administers the international waters of the Rio Grande according to the two treaties between Mexico and the U.S., which govern these waters; the treaties are discussed in detail elsewhere in this report. The IBWC is currently involved in discussions with Mexico as to how or when Mexico will be able to make up its "water debt" under the 1944 treaty. Drought within the interior of Mexico, especially the Rio Conchos watershed that flows to the Rio Grande in the vicinity of Presidio, Texas, has in recent years resulted in the inability of Mexico to make the agreed-upon delivery amounts.

### 1.11.7 United States Bureau of Reclamation

The stretch of the Rio Grande from Elephant Butte Dam (approximately 100 miles north of El Paso) to Fort Quitman, Texas, is within a federal reclamation project known as the Rio Grande Project. The Bureau manages the Elephant Butte Dam and the Caballo Reservoir, and determines the amount and timing of all water releases to Texas, with the input of the El Paso County Water Improvement District #1. The Bureau is guided by the terms of the Rio Grande Compact. The Bureau has asserted title to all of the water in the Project in a lawsuit styled United States v. EBID, et al, which is currently being litigated.

### 1.11.8 United States Geological Survey (USGS)

The USGS serves the nation by providing reliable scientific information to (1) describe and understand the Earth; (2) minimize loss of life and property from natural disasters; (3) manage water, biological, energy, and mineral resources; and (4) enhance and protect quality of life.

The USGS's Water Resources Division has played a major role in the understanding of the ground-water resources of Far West Texas. Scientists with the USGS have conducted regional studies of water availability and water quality. Many of these studies have been conducted in conjunction with the TWDB. These studies have provided much of the data for more recent investigations conducted by graduate students and faculty members of the geology departments of many Texas universities. Most recently, the USGS has worked with EPWU to develop a new numerical ground-water flow model of the Hueco Bolson.

**1.11.9 United States Environmental Protection Agency (EPA)**

The mission of the EPA is to protect human health and the environment. Programs of the EPA are designed (1) to promote national efforts to reduce environmental risk, based on the best available scientific information; (2) ensure that federal laws protecting human health and the environment are enforced fairly and effectively; (3) guarantee that all parts of society have access to accurate information sufficient to manage human health and environmental risks; and (4) guarantee that environmental protection contributes to making communities and ecosystems diverse, sustainable and economically productive.

**1.11.10 United States Fish and Wildlife Department (USFWS)**

The USFWS enforces federal wildlife laws, manages migratory bird populations, restores nationally significant fisheries, conserves and restores vital wildlife habitat, protects and recovers endangered species, and helps other governments with conservation efforts.  It also administers a federal aid program that distributes money for fish and wildlife restoration, hunter education, and related projects across the country.

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# CHAPTER 2

# CURRENT AND PROJECTED POPULATION AND WATER DEMAND DATA FOR THE REGION

## 2.1 INTRODUCTION

Planning for the wise use of the existing water resources in Far West Texas requires a reasonable estimation of current and future water needs for all water-use categories. The Texas Water Development Board (TWDB) Regional Planning Rules specify in Section 357.5 (d) that in developing regional water plans, the Regional Water Planning Groups shall use for population and water demand projections one of the following:

- *State population and water demand projections contained in the state water plan or adopted by TWDB after consultation with the Texas Natural Resource Conservation Commission and Texas Parks and Wildlife Department in preparation for revision of the state water plan; or*
- *Population or water demand projection revisions that have been adopted by TWDB, after coordination with Texas Natural Resource Conservation Commission and Texas Parks and Wildlife Department, based on changed conditions and availability of new information.*

State data provided by the TWDB based on the first criteria were developed during the consensus water-planning process involved in the 1997 state water plan, "Water for Texas, A Consensus-Based Update to the State Water Plan," (TWDB, August 1997). In accordance with the above guidelines, the Far West Texas Regional Water Planning Group requested and was given approval to revise specific population and water demand data for use in the regional plan. Thus, the population and water demand projections shown in this chapter are derived from a combination of TWDB data and approved revisions. The following two sections discuss the development of these two sets of data. The remaining two sections specifically discuss population and water demand projections in the region. Population and water demand are presented in both tabular and graphic form at the end of the chapter.

Lastly, projected population by city and county and water demand by county and category are presented in Tables 2-1 and 2-2. Water demand by the major water providers identified in Chapter 1 is presented in Table 2-3. These tables are formatted as required by the TWDB and modified with adopted values from the Regional Water Planning Group.

## 2.2 CONSENSUS-BASED POPULATION AND WATER DEMAND PROJECTIONS

Brief discussions of the methods and assumptions used in the state's consensus water-planning process for each water demand category are found in Subsections 2.2.1 through 2.2.6. This material has been extracted from the 1997 Consensus State Water Plan, Volumes II and III. Detailed discussions on methodologies, assumptions, data sources, and modeling scenarios are primarily found in Volume III. Both volumes can be found on the TWDB's web page located at: http://www.twdb.state.tx.us/wrp/state-plan/wat-plan-iii.htm.

### 2.2.1 Municipal

The quantity of water used for municipal purposes in Texas is heavily dependent on population growth, climatic conditions, and water-conservation measures. For planning purposes, municipal water use comprises both residential and commercial water uses. Commercial water use includes business establishments, public offices, and institutions, but does not include industrial water use. Residential and commercial uses are categorized together because they are similar types of uses; i.e., they both use water primarily for drinking, cleaning, sanitation, air conditioning, and landscape watering. Water use within a city limit that is not included in the quantification of municipal demand is that used in manufacturing and industrial processes. See Section 2.2.2 Manufacturing for a definition of this type of water use.

The 1997 Consensus Water Plan gives population projections for all cities and towns with 1,000 or more residents and for the rural populations (County Other) within counties. The development of the consensus population projections for the 1997 Plan incorporated data from the State Data Center and from the U.S. Bureau of the Census' 1990 census counts. The population forecasting scenarios identified for use in the state water-planning process during development of the Consensus Water Plan – termed "growth scenarios" – varied in terms of migration rate. The Consensus Technical Advisory Committee identified the *most likely growth scenario* for each county given recent growth rates and likely development trends; regional and state totals termed "recommended" are an aggregated mix of these individual county selections.

The municipal water-use forecasts rely on population, per capita water use and on potential conservation-saving projections. The municipal water-use forecasting scenarios used two different weather assumptions and three different water-conservation assumptions (a total of six possible combinations or scenarios). The weather assumptions involved:

- per capita water use associated with below normal rainfall, and
- per capita water use associated with normal rainfall.

For statewide water-supply planning, using the normal rainfall assumption to calculate per capita use is not appropriate, as water demands projected using this average weather statistic will likely fall short of the water demands that may actually occur during dry times, resulting in water-supply shortages. The Consensus Water Plan utilizes per capita uses associated with below-normal rainfall. However, in Far West Texas, especially in El Paso County, it should be realized that there is little difference between normal and below-normal rainfall as it affects consumptive use. In El Paso County, drought is measured by reservoir levels and not by local rainfall quantities. For the purpose of being consistent and conservative, the Far West Texas region is following the state trend and using the below-normal rainfall scenario.

The water-conservation assumptions involved:

- Expected Conservation - assumes levels of water savings that are likely to occur from both market forces and regulatory requirements. It assumes households will use more efficient plumbing fixtures and appliances already on the market, as well as employ more water-efficient outdoor irrigation and landscape practices. In addition, expected conservation assumes that plumbing-fixture standards required under the 1991 State Water Efficient Plumbing Act will be in place. The Act requires improved water-use efficiency in toilets, shower heads, urinals, faucets and drinking fountains. Expected conservation represents feasible strategies for water-conservation savings that are economically sound.
- Advanced conservation - assumes the same improvements in water conservation as listed under expected conservation. The primary difference between the expected and advanced cases is one of timing. The advanced case assumes that municipal utilities and individuals engage in water-conservation activities at an accelerated rate. Advanced conservation represents the maximum technical potential for water-conservation savings.

- Conservation Due to the Plumbing Code Only - These scenarios incorporate improvements in water-use efficiency due solely to the 1991 State Water Efficient Plumbing Act. These include improvement in water use efficiency in toilets, shower heads, urinals, faucets and drinking fountains, but does not include conservation resulting from using more water-efficient appliances or employing improved outdoor watering and landscape practices.

The usual scenario utilized in the Consensus Water Plan for most cities was the combination of below-normal rainfall with the "expected conservation" shown above. Some exceptions occur (e.g., some cities in large metropolitan areas such as El Paso are expected to undergo advanced conservation).

**2.2.2 Manufacturing and Industrial**

Because of the importance of the state's manufacturing and industrial sector to local and regional economies in terms of income and employment, analyses of future water use and availability of water for these industries are necessary to ensure the continued economic vitality of many regional economies. It is important to note that manufacturing and industrial water use is quantified separately from municipal use even though the demand centers may be located within a city limits. A listing of industries in the region is available from the TWDB web page: http://www.twdb.state.tx.ux.

Future manufacturing water use is largely dependent on technological changes in the production process, on improvements in water-efficient technology, and on the economic climate (expansion/contraction) of the marketplace. Technological changes in production affect how water is used in the production process, while improvements in water-efficient technology affect how much water is used in the production process. As older production facilities and accompanying production processes are modernized or retooled, the new production processes are anticipated to be more resource efficient.

The manufacturing water-use projections are based on three specific assumptions regarding industry growth:

- Industry growth assumes future expansions of existing capacity within an industry, as well as new manufacturing facility locations within the state.
- Historical interactions of oil price changes and industry activity are assumed to continue over the projection period.
- The types of industries that comprise a county's current manufacturing base are assumed to comprise the county's manufacturing base in the future.

Because of the need to develop manufacturing water-use projections at the county level, and because of the absence of pertinent, and often confidential, industry production information at the local level, a "top-down" approach was used for developing projections of potential industry growth.

**2.2.3 Agriculture**

The Texas Water Development Board, with technical assistance from the staff of Texas A&M University, developed a linear programming model for use in evaluating the many factors affecting irrigation water demand for the Texas agricultural sector. Linear programming models are based on mathematical techniques for systematically determining solutions for maximizing or minimizing values of linear functions under various variable (resource) constraints. For the development of the irrigation water demand projections, the objective function of the model was structured to solve for the maximization of farm income based on the profitability of specific crops grown in Texas using the resources necessary for the production of these crops. To simplify the modeling process, the TWDB used Texas A&M University's delineation of major agricultural production regions in the state.

Several types of variables are used in the modeling procedure to determine future irrigation water demands by geographical location. These variables include crop prices, yields, production costs, water costs, and six types of irrigation delivery systems. These data are crop-specific and reflect the major crops grown in Texas, which include cotton, grain sorghum, wheat, corn, rice, peanuts, alfalfa hay, fruits, vegetables, and nuts. As part of the revenue stream, federal farm deficiency payments for specific crops and land set-aside requirements for compliance with federal farm programs are included in the model. Crop enterprise budgets, developed by Texas A&M University, provided crop-specific information such as current crop prices, variable production costs, fixed production costs, yields, deficiency payments, irrigation water applications, land restrictions for participation in federal programs, and irrigation delivery systems. Because the Texas A&M University crop enterprise budgets are planning budgets, variable costs for the crops were, in some instances, adjusted (increased or decreased) in the modeling procedure to calibrate the water demand calculated by the model to the actual published water use for each of the 14 agricultural regions. The variable costs were adjusted because these costs were the basic unknown variables in contrast to published crop prices, yields, harvested and planted acres per crop, and water use.

### 2.2.4 Steam-Electric Power Generation

Water-use projections for steam power generation have two major components: power generation capacity and water use for that projected capacity. Power generation projections were based on current per capita electric power demand for the reported residential, commercial, governmental, and other sectors on a utility-specific basis. Similarly, industrial power demand was based on each utility's reported sales by Standard Industrial Classification. A composite growth factor was estimated for the remaining unaccounted sales.

For existing plants, future water use was assumed to remain constant at the average of 1988-1991 historical water-use patterns, unless information indicated that plants were scheduled for closure. For planned plants and facilities, water-use permits and/or plant-design data were used to determine future water needs. If permit or plant design information was unavailable, it was assumed that additional generation would use water at the same gallons-per-kilowatt-hour rate as the current average use for that utility. Upper and lower case scenarios were developed to reflect different conservation and technology assumptions. The lower case uses a lower estimate of gallons-per-kilowatt-hour than the upper case.

Historical water use was estimated by aggregating water-use data from several sources. For plants that use ground water or diverted surface water, the TWDB’s survey of water use provided actual reported withdrawals. For plants that use cooling ponds or other water impoundments, water use was calculated by adding reported ground-water use for boiler feed and sanitary uses to net natural evaporation and forced evaporation estimates. Net natural evaporation is the gross evaporation minus the total unadjusted precipitation. Forced evaporation, due to the heat load, is a function of the plant's thermodynamics and electric power generation.

In developing steam-electric power generation projections, the following assumptions were made:

- Power generation demands will grow in direct proportion to population growth for residential, commercial, governmental, and other sectors. The power generation demands are based on the most likely population growth scenario.
- Industrial power generation demands will grow in direct proportion to industrial and manufacturing growth projections for each of the major electric power use Standard Industrial Classifications (SICs).
- For the upper case, no change in electric power generation capacity is assumed. In addition, a constant water-use rate, equal to the average of water use between 1988 and 1991, is assumed for the water-use projections.
- For the lower case, a combination of technological advances, conservation measures, and other factors are assumed to reduce total water use by 5 percent by 2000, 10 percent by 2010, and 15 percent from 2020 to 2050.

### 2.2.5 Livestock

Texas is the nation's leading livestock producer, accounting for approximately 11 percent of the total United States production. Livestock production was valued at approximately $8 billion in 1993 and represented more than half of the total value derived from all agricultural operations in Texas. Although livestock production is an important component of the Texas economy, the industry consumes a relatively small amount of water. In 1990, total livestock production consumed approximately 274,000 acre-feet of water in Texas, representing less than two percent of the total water use.

Estimating livestock water consumption is a straightforward procedure that consists of estimating water consumption for a livestock unit and the total number of livestock. Texas A&M University Agricultural Extension Service provided information on water-use rates, estimated in gallons per day per head, for each type of livestock: cattle, poultry, sheep and lambs, and hogs and pigs. The Texas Agricultural Statistics provided current and historical numbers of livestock by livestock type and county. Water-use rates were then multiplied by the number of livestock for each livestock type for each county. In counties where the number of head of livestock was unavailable, historical livestock distribution patterns were assumed. County livestock water use was then aggregated to the state level to estimate total water consumption by livestock type. The United States Department of Agriculture, Soil Conservation Service provided information on the source of water supply for range livestock. Water supply for confined livestock operations, such as poultry, hogs, dairy and feedlots, are assumed to be supplied by ground-water sources.

### 2.2.6 Mining

Although the Texas mineral industry is foremost in the production of crude petroleum and natural gas in the United States, it also produces a wide variety of important nonfuel minerals. Texas is the only state to produce native asphalt and is the leading producer nationally of Frasch-mined sulfur. It is also one of the leading states in the production of clay, gypsum, lime, salt, stone, and aggregate. In all instances, water is required in the mining of these minerals either for processing, leaching to extract certain ores, controlling dust at the plant site, or for reclamation.

Projections of fresh water use for mineral production in Texas were developed for the categories of fuels and nonfuels. Derived from an examination of recent and historical data, trends in production, estimated total mineral reserves currently accessible, and rates of water use, these projections are tabulated by county, river or coastal basin, and climatic zones within basins. They represent the sum of estimated mining water use for the two categories of mineral products: fuels and nonfuels.

For each category of mineral products, the requirements for mining water were determined as a function of production. Estimates of future production were calculated by analyzing both recent data, and state and national production trends. A water-use coefficient, computed from data collected by the Texas Water Development Board's 1990 Water Use Survey, which reports the quantity of water used in the production of each increment of output, was applied to estimated mineral production levels. A rate of water consumption derived from U.S. Bureau of Mines data was then applied to the total water use for each mineral industry. In short, tabulations of water use for each basin, zone, and county represent the sum of estimated water use for the production of fuels and nonfuels where historically this mineral production has occurred, and where the estimated mineral reserves are sufficient to meet the demand.

Finally, the estimates of water use for mining require two basic assumptions. First, it was assumed that the location of mines within the basin zone would remain constant. Second, it was assumed that each region would retain its share of state production. For example, if the Canadian Basin produced 5 percent of the state's production of petroleum in 1990, it was assumed that it would produce 5 percent of state's output through the year 2050.

## 2.3 REVISED POPULATION AND WATER DEMAND PROJECTIONS

The Far West Texas Regional Water Planning Group was granted formal approval by the TWDB on August 18, 1999 to revise specific population and municipal water demand estimates for use in the regional planning process. The members of the RWPG solicited all entities within the Region to submit desired changes to population and water demand projections. Back-up documentation for changes was evaluated as to whether they qualified under TWDB's Rules. Documentation and revisions were prepared in the report "Far West Texas Region Revisions to Population and Water Demand Projections" dated June 28, 1999. The recommended changes were presented to the public at public meetings where public comment was solicited. This document was then submitted to TWDB and served as the basis for TWDB's approval of revised the population and demand projections.

The cities of Horizon City in El Paso County and Presidio in Presidio County have had their population forecasts increased based on the criteria that their current documented populations exceed the year 2000 population projection in the 1997 Consensus Water Plan. In the case of Presidio, the TWDB agreed to increase the city and county population by the revised amount. In the Horizon City case, the city population increased but the "County Other" or rural population was decreased by the same amount. "County Other" refers to the part of a county population and its associated water use that is in addition to those that are accounted for in cities of 1,000 or more population.

In addition to population changes, revisions in water demand were adopted and approved for the cities of Alpine, El Paso, Horizon City, Presidio and Van Horn. The revised population changes for Horizon City and Presidio resulted in a change in water demand projections for the two cities and for the El Paso "County Other" category. Revisions to water demand in Alpine and Van Horn were the result of inaccurate water-use reporting in the past that affected per capita water use calculations. Water demand revisions were increased in all four of these instances.

The City of El Paso demonstrated that they are achieving, through vigorous conservation planning, a significantly lower per capita water use than what is assumed in the Consensus Water Plan. The lowered per capita water use thus results in lower water demand projections for the City than projected in the 1997 State Consensus Water Plan. The reduced water demand for the City of El Paso with its larger population far overshadows the water demand increases incurred in the other four cities. As a result of the revisions, the total regional municipal water demand in the year 2000 is decreased by 25,321 acre-feet. By the year 2050 the demand decreases by 13,839 acre-feet.

## 2.4 PROJECTED POPULATION GROWTH (1990 - 2050)

### 2.4.1 Rural Counties

The projected growth of population for each of the six rural counties over the period 1990 - 2050 is found in Table 2-4. Total population growth for the counties is illustrated by Figure 1. The total population of the six rural counties is expected to increase by 103 percent from the 1990 census count of 24,996 to 50,674 by 2050 (Figure 2-1). The largest increases, with respect to total population and percent gain, are expected to occur in Brewster and Presidio Counties. The population of Brewster County is expected to grow from the 1990 figure of 8,681 to 18,059 in 2050, an increase of 108 percent over the 1990 census figure. Similarly, the population of Presidio County is projected to increase from the 1990 count of 6,637 to 20,211 in 2050. This is a robust increase of 204 percent over the 1990 population. Growth rates in other counties are expected to be 9 percent in Terrell County, 27 percent in Culberson County, 28 percent in Jeff Davis County, and 39 percent in Hudspeth County.

### 2.4.2 El Paso County

The population of El Paso County is projected to increase to 1,536,423 by 2050 - or by 160 percent over the 1990 census count of 591,610 (Table 2-5). Most of the population growth will occur in the City of El Paso (Figure 2-2), where the number of residents is expected to rise to 1,234,889. This represents a 140-percent increase over the 1990 census figure of 515,342. Although the City of El Paso's population will increase by 719,547, the percentage of the county's residents living within the city limits of El Paso will decrease from 87 percent based on the 1990 census to 80 percent, based on the figures in Table 2-2. Other incorporated areas will see modest growth. The largest percentage increase among incorporated areas will be in Horizon City, where the population is expected to grow by 465 percent from the 1990 census figure of 2,308 to 13,048 in 2050. The largest growth in population is expected to occur in unincorporated rural areas, which are listed as "County Other" in Table 2-5. The number of residents in these areas is expected to grow from 10,297 based on the 1990 census to 134,521 by 2050 - or by 1,206 percent.

## 2.5 PROJECTED WATER DEMAND (1990 - 2050)

### 2.5.1 Nonmunicipal Water Demand

Sources of nonmunicipal demand are identified as (1) irrigation, (2) manufacturing and industrial, (3) electric power cooling, (4) livestock, and (5) mining. Estimates of nonmunicipal water demand for the period 1990 - 2050 are presented in Table 2-6. The trend over this period of time is illustrated by Figure 2-3.

Within the five categories, irrigation, which accounts for the largest source of demand, is projected to decrease from a high of 374,372 acre-feet in 1990 to 298,848 acre-feet by 2050. This represents a 20-percent reduction (75,524 acre-feet) in demand as reported for the year

1990. Most irrigation demand is associated with farms in El Paso and Hudspeth Counties (Table 2-4). Irrigation demand in El Paso County is projected to decrease from the 1990 estimate of 190,761 acre-feet to 152,014 acre-feet by 2050, or a reduction of 38,747 acre-feet. It should be noted, however, that based on the City of El Paso's commitment to a very aggressive water purchase program for the rights to surface water from agricultural lands, the City believes that the conversion rate of water from agricultural lands to municipal use will be significantly greater than shown.

Irrigation demand over the same period in Hudspeth County is expected to drop from 140,622 acre-feet to 112,136 acre-feet. Demand in other counties is not expected to change as significantly as demand in El Paso and Hudspeth Counties (Table 2-7).

As noted in Chapter 1, although irrigated land makes up less than 1 percent of the total land area of Far West Texas, irrigation accounts for the single largest source of water demand in the region. Therefore, as agricultural land is taken out of cultivation, especially in El Paso and Hudspeth Counties, irrigation demand will correspondingly be replaced by municipal and industrial water demand.

Although demand from other nonmunicipal sources is expected to increase (Tables 2-6 and 2-7), the overall trend for the region will be a decrease in nonmunicipal consumption because of the substantial reduction in irrigation demand. Among the remaining nonmunicipal sources of demand, manufacturing and industrial and steam-electric power will account for most of the water usage. Both are centered in El Paso County (Table 2-7). Manufacturing demand will grow from the 1990 total of 13,239 acre-feet to 20,332 acre-feet by 2050. This is an increase of 7,093 acre-feet or 35 percent over the estimate for the year 1990. Water use associated with steam-electric power will level off at 6,000 acre-feet by the year 2000 and remain flat through the year 2050.

### 2.5.2 Municipal Water Demand

#### 2.5.2.1 Rural Counties

Municipal demand in the six rural counties (Table 2-8, Figure 2-4) will grow to 9,130 acre-feet by the year 2050. This represents an 84-percent increase over the estimate of 4,951 acre-feet for year 1990. The largest increases will occur in Brewster and Presidio Counties, where demand will reach 3,879 acre-feet and 3,257 acre-feet, respectively, by the year 2050. The combined municipal demand for Brewster and Presidio Counties will be 7,136 acre-feet - 77 percent of the estimated 9,130 acre-feet of total municipal consumption. Most of the projected growth in municipal demand for Brewster County will be concentrated in the City of Alpine (Table 2-8, Figure 2-5), which will account for 2,461 acre-feet or 66 percent of total demand in the county. Total municipal demand in Alpine during the year 1990 was estimated to be 1,085 acre-feet, or 57 percent of municipal demand.

In Presidio County, the cities of Marfa and Presidio (Figure 2-6) are the principal location of municipal demand. In 1990, Marfa and Presidio made up 88 percent (or 1,157 acre-feet) of the 1,316 acre-feet of municipal demand. Marfa is expected to account for most of the municipal demand through 2020. From 2030 through 2050, however, municipal demand in Presidio will grow faster than demand in Marfa (Table 2-5). By 2050, the two cities will account for 87 percent (or 2,841 acre-feet) of total county municipal demand (3,257 acre-feet). In three of the four remaining rural counties (Culberson, Jeff Davis and Terrell), 50 percent or more of municipal demand will be concentrated in the largest city in each county (Figures 2-7, 2-8 and 2-9). The exception will be Hudspeth County, where most of the municipal demand will be in "County Other" (Table 2-5, Figure 2-10).

#### 2.5.2.2 El Paso County

Municipal water demand in El Paso County will grow to 243,140 acre-feet by 2050 (Table 2-9, Figure 2-11). This will be a 98-percent increase over the 123,009 acre-feet of demand estimated in the year 1990. As with nonmunicipal demand, most municipal demand will be linked to the City of El Paso, which will account for 199,097 acre-feet - 82 percent of the county's municipal demand in 2050. El Paso's 1990 municipal demand estimate was 105,861 acre-feet. Consumption in 2050 will be 88 percent above reported consumption in 1990. The strongest growth in municipal demand outside of the City of El Paso will be in "County Other," where consumption will increase by 449 percent from the 1990 total of 5,259 acre-feet to 27,549 acre-feet by 2050 (Table 2-9, Figure 2-11). The 2050 figure for "County Other" is expected to be 11 percent of municipal demand in the county.

## References

Texas Water Development Board, 1990, Water Use Survey.

Texas Water Development Board, 1997, Water for Texas, Vols. 1 and 2.

# CHAPTER 3

# EVALUATION OF CURRENT WATER SUPPLIES IN THE REGION

## 3.1 INTRODUCTION

Chapter 3 explores the availability of surface-water and ground-water resources in Far West Texas. The demand and availability data of Chapters 2 and 3, respectively, form the basis for identifying in Chapter 4 the areas within Far West Texas that are likely to experience shortages over the years 2000 through 2050.

Water supplies available to meet the demands recognized in Chapter 2 are reported in Tables 3-1, 3-2 and 3-3. All estimates are reported in "acre-ft." The estimates in these tables represent quantities available during Drought-of-Record conditions only, and are based on the following assumptions:

- The Rio Grande water supply is divided at Ft. Quitman into an Upper Rio Grande section and a Lower Rio Grande section.
- The supply available in the Upper Rio Grande section is based on the lowest diversions according to U.S. Bureau of Reclamation (USBR) records.
- The supply available in the Lower Rio Grande section is based on the lowest gauged flow below the confluence of the Rio Conchos and the Rio Grande.
- Little return flow to the Rio Grande is expected during periods when there are no diversions from the river.
- Reuse of river water is calculated for the City of El Paso only during the period when supplies are available.
- Pecos River water is based on the absence of flow at the Langtry gauging station during a Drought-of-Record.
- No water is considered to be available in stock tanks and small lakes during Drought-of-Record conditions.
- The flow of water in Phantom Creek (Jeff Davis County) is affected by Drought-of-Record conditions.
- The availability of ground water is based on the percentage of recoverable water in storage in each aquifer and little or no recharge.

Table 3-1 indicates the maximum amount of water supply that could be obtained from each unique supply source. These quantities, especially in the case of ground water, are often significantly greater than the quantities that can be captured practicably by existing and potential water users.

Table 3-2 lists water supplies that are available to cities and water-user categories, based on the ability of each city to obtain water. Current infrastructure, legal limitations, and the physical availability of water from each source determine this availability. The amounts listed for cities and the "county other" category (representing small communities) are based on Texas Natural Resource Conservation Commission (TNRCC) estimates of infrastructure capabilities.

Estimates for county categories of irrigation, mining and livestock are based on the largest annual amount estimated to have been used from 1990 to 1996. This period of time encompasses both dry years and current infrastructure (wells, pipelines, canals, etc.).

Table 3-3 lists water supplies available to each of the Major Water Providers designated in Chapter 2. These supplies represent the total amount of water available to all the entities that each Major Water Provider serves as shown in Table 3-2. Again, the available water supplies listed in all three tables are based on Drought-of-Record conditions.

## 3.2 RIO GRANDE

### 3.2.1 Overview

Waters of the Rio Grande originate in the San Luis Valley, the principal drainage basin of the San Juan Mountains in southwestern Colorado, and in the mountain ranges of northern New Mexico. The river flows southward through New Mexico, and then forms the international boundary between the Mexican States of Chihuahua, Coahuila, Nuevo Leon, Tamaulipas, and the State of Texas. The Rio Grande's total length is approximately 1,896 miles. Approximately 1,248 miles make up the international boundary between Texas and Mexico.

The water supply available from the Upper Rio Grande is affected by climatic conditions in Colorado and northern New Mexico. Although dams have been built on the River in New Mexico to provide a degree of control, floods and droughts still take their toll in the region. The stretch from below Fort Quitman, Texas, to Presidio, Texas, is often a dry riverbed. The River becomes a permanent stream again at the point where the Mexican river, the Rio Conchos, enters upstream of Presidio. From Presidio downstream through the Big Bend region, the Rio Grande generally contains sufficient water flow to support recreational use at almost any time of the year. Some of the better rapids on the Rio Grande are located in the vicinity of and below Redford (Presidio County). In addition, diversions on the Texas side between Presidio and Redford are used to support irrigation.

### 3.2.2 American Heritage River Initiative

The Rio Grande, from El Paso to Laredo, is one of only 14 rivers in the United States, and the only river in Texas, to receive the American Heritage River designation. Established in 1997, the American Heritage River Initiative recognizes rivers, or segments of rivers, that have played a significant role in the history and culture of the region it traverses. The initiative gives federal support to voluntary community-led work that benefits riverfront communities. Some of the possible benefits of being designated an American Heritage River are increased opportunities in commerce and trade, recreational improvements along the river, incorporation of wildlife habitats, and cultural stimulation. The American Heritage River Initiative does not conflict with matters of state and local government jurisdiction, such as water rights, land-use planning and water-quality standards. Also, the initiative does not impair the authority of each state to allocate quantities of water within its jurisdiction.

### 3.2.3 Treaties and Compact

Demand related to irrigation use and population growth has affected the River since the 1800's. Water appropriations and shortages have spawned lawsuits, as well as the involvement of the federal government in the management of the river. The following sections describe efforts by state and national governments to address many of the complex issues associated with the Rio Grande.

#### 3.2.3.1 1906 International Treaty

Under this treaty, the United States is obligated to deliver 60,000 acre-ft of water annually from the Rio Grande to Mexico, except in the cases of extraordinary drought or serious accident to the irrigation system in the United States. The 60,000 acre-ft must be delivered, at no cost to Mexico and in accordance with a monthly distribution schedule from February through November, in the bed of the Rio Grande at the headworks of the Acequia Madre (International Dam). The International Boundary and Water Commission (IBWC)/Comision International de Limites y Aguas (CILA) is the designated binational agency that makes the yearly delivery of international waters to Mexico. The U.S. Bureau of Reclamation (USBR) calculates the allocations in coordination with the IBWC.

**3.2.3.2 Rio Grande Compact**

The Rio Grande Compact is a tri-state agreement, approved by the U.S. Congress and ratified by the states of Colorado, New Mexico and Texas. The Rio Grande Compact Commission administers the Compact. The Commission is comprised of a Commissioner from each of the states of Colorado, New Mexico and Texas and a nonvoting chairman appointed by the President of the United States. The Compact addresses only surface-water apportionment between States.

The Compact provides for the distribution of the waters of the Rio Grande between Colorado, New Mexico and Texas, above Fort Quitman, Texas. It sets out a schedule of the water-delivery obligation of Colorado at the Colorado/New Mexico state line and the obligation of New Mexico to deliver water to Rio Grande Project reservoirs at Elephant Butte and Caballo as the deliveries to Texas. Releases from the reservoirs are measured downstream of Caballo Reservoir.

**3.2.3.3 1944 International Treaty**

This treaty addresses the waters in the international segment of the Rio Grande from Fort Quitman, Texas to the Gulf of Mexico. The treaty allocates water in the river based on percentage of flows in the river from each country's tributaries to the Rio Grande. The 1944 Treaty also stipulates that one-third of the flow of the Rio Conchos in Mexico is allotted to the United States. The Rio Conchos is by far the largest tributary of the Rio Grande. The treaty requires that the combined flow of the Rio Conchos and five other tributaries (San Diego, San Rodrigo, Escondido, Salado Rivers and Las Vacas Arroyo) shall have an annual average of not less than 350,000 acre-ft. The IBWC is responsible for implementing the treaties between the United States and Mexico. In recent years, the required minimum flow has not been met.

### 3.2.4 Rio Grande Project

The Rio Grande Project is primarily an irrigation storage and flood control federal reclamation project administered by the USBR. Elephant Butte and Caballo Reservoirs in New Mexico and the diversion dams at the headings of the main canals make up the Project's primary facilities. The Project delivers water to the Elephant Butte Irrigation District (EBID) and the El Paso County Water Improvement District No. 1 (EPCWID #1). The EBID encompasses all the project lands in New Mexico south of the Caballo Reservoir, while the EPCWID #1 encompasses the project lands in El Paso County, Texas. The Districts deliver water to farmlands in New Mexico and Texas. Since 1941, EPCWID#1 has delivered water to the City of El Paso for municipal and industrial (M&I) use through contracts among the District, the City and the USBR. The City of El Paso also owns farmland with first class water rights, which it uses for municipal purposes. The Project also delivers water to Mexico in accordance with the Treaty of 1906. In 1979 and 1980, the two Districts took over the operation and maintenance responsibilities of most of the respective irrigation works within the boundaries of each entity. Legal titles to the rights-of-way of irrigation canals and drains were transferred from the United States to the Districts in January 1996.

### 3.2.5 Watermaster Office of the Texas Natural Resource Conservation Commission

A binational commission determines the allocation of Rio Grande water below Ft. Quitman. The TNRCC Rio Grande Watermaster administers the allocation of Texas' share of international waters. Two reservoirs located in the middle of the Lower Rio Grande, the Amistad and the Falcon, store the water allocated by the Watermaster. The Watermaster oversees Texas' share of water in the Lower Rio Grande and its Texas tributaries from Fort Quitman to Amistad Dam, excluding the drainage basins of the Pecos and Devils Rivers.

**3.2.6 Rio Grande Water Quality**

The TNRCC's inventory of water quality in the state (TNRCC, 1996) cites drainage area and a wide range of geologic and climatic conditions in Far West Texas as factors responsible for water-quality conditions in the Rio Grande. Most of the Rio Grande's flow above El Paso is diverted at the Mesilla Dam in New Mexico to support irrigation in Dona Ana County, New Mexico and at the American Dam in Texas to supply irrigation and municipal demand in Texas. Water is also diverted at the International Dam for delivery through the Acequia Madre to supply irrigation demand in Mexico.

Downstream from El Paso, most of the flow consists of irrigation return flow, and small amounts of treated and larger amounts of untreated municipal wastewater. Flow is intermittent to Presidio, where the Rio Conchos augments flow. Heavy metals and pesticides have been identified along the course of the Rio Grande. Elevated fecal coliform levels occur in the river downstream of border cities, primarily because of untreated wastewater from Mexico. Elevated nutrient levels are also common.

TNRCC identifies the levels of pollutants in water bodies by water segment numbers. Some of the tracked pollutants are lead, cadmium, diazinon, nickel and copper. The pollutants are classified based on exceeding the chronic and/or acute criteria for protection of aquatic life (TNRCC, 1996, Vol. 1). These criteria are defined in terms of toxic substances in ambient water. The specific water quality segments within Far West Texas are 2314, 2306, 2308 and 2307 (TNRCC, 1996, Vol. 4). Also, water quality segment 2310 forms the easternmost border of Region E's Terrell County. Segment 2314 includes the Rio Grande from International Dam in El Paso County to the New Mexico State Line in El Paso County. Segment 2306 includes the Rio Grande from a point 1.1 miles downstream of the confluence of Ramsey Canyon in Val Verde County to the confluence of the Rio Conchos (Mexico) in Presidio County. Segment 2308 encompasses the Rio Grande from the Riverside Diversion Dam in El Paso County to International Dam in El Paso County. Segment 2307 includes the Rio Grande from the confluence of the Rio Conchos (Mexico) in Presidio County to Riverside Diversion Dam in El Paso County. Segment 2310 includes the Lower Pecos River from a point 0.4 miles downstream of the confluence of Painted Canyon in Val Verde County to a point immediately upstream of the confluence of Independence Creek in Crockett/Terrell County.

*Segment 2314 of the Rio Grande Basin*

Elevated fecal coliform levels cause partial support of the contact recreation use. All other water quality standards and uses are supported. Elevated orthophosphorus and total phosphorus are a concern. Manganese in sediment is elevated. High nutrient levels have the potential to cause increased algal growth and subsequent oxygen depletion, especially during warm summer months. An intensive survey conducted in 1992 will provide a basis for developing a waste load evaluation. This segment was included in the multiphase Binational Rio Grande Toxic Substance Study (TNRCC, 1996, Vol. 4).

*Segment 2306 of the Rio Grande Basin*

Total phosphorus concentrations are elevated. All other water quality standards and uses were supported. Elevated concentrations of selenium in fish tissue are a concern throughout the entire segment. Elevated levels of arsenic, barium, selenium and DDE in sediment are a concern in the area below the Rio Conchos confluence. This segment was included in the multi phase Binational Rio Grande Toxic Substance Study (TNRCC, 1996, Vol. 4).

*Segment 2308 of the Rio Grande Basin*

Fecal coliform concentrations exceed the screening level for contact recreation, but the non-contact recreation use is supported throughout the segment. All other uses and water quality standards are supported. Elevated ammonia nitrogen, nitrite plus nitrate nitrogen, total phosphorus, and orthophosphorus levels are elevated above the screening levels. High nutrient levels have the potential to cause increased algal growth and subsequent oxygen depletion, especially during warm summer months. Copper in sediment is elevated. A waste load evaluation completed for this segment recommends secondary treatment for wastewater discharges. An intensive survey for the segment was conducted in 1992 to provide a basis for revisions of the waste load evaluation. This segment was included in the multiphase Binational Rio Grande Toxic Substance Study (TNRCC, 1996, Vol. 4).

*Segment 2307 of the Rio Grande Basin*

This upper third of the segment is partially supporting the contact recreation use due to elevated fecal coliform levels. Ammonia nitrogen is also a concern in the same area. Total phosphorus, orthophosphorus, and chlorophyll *a* are a concern in the entire segment. Average chloride, sulfate, and total dissolved solids concentrations exceed the segment criteria. River flow in the segment is reduced due to irrigation withdrawals in the El Paso area and evaporation throughout the segment. Manganese in sediment is a concern. This segment was included in the multiphase Binational Rio Grande Toxic Substance Study (TNRCC, 1996, Vol. 4).

*Segment 2310 of the Rio Grande Basin*

Average chloride, sulfate, and total dissolved solids levels exceed the segment criteria. Natural contributions of salts from the soil, as well as saline groundwater seeps and springs, contribute to these elevated levels (TNRCC, 1996, Vol. 4).

### 3.2.7 Dissolved Pollutants Identified by TNRCC

*Fecal Coliform*

The presence of fecal coliform bacteria in aquatic environments indicates that the water has been contaminated with the fecal material of man and other animals. At the time this occurred, the source water may have been contaminated by pathogens or disease producing bacteria or viruses which can also exist in fecal material. Some waterborne pathogenic diseases include typhoid fever, viral and bacterial gastroenteritis and hepatitis A. The presence of fecal contamination is an indicator that a potential health risk exists for individuals exposed to this water. Fecal coliform bacteria may occur in ambient water as a result of the overflow of domestic sewage or nonpoint sources of human and animal waste.

*Nitrate and Nitrite*

Nitrogen-containing compounds act as nutrients in streams and rivers. Nitrate reactions in fresh water can cause oxygen depletion. Thus, aquatic organisms depending on the supply of oxygen in the stream will die. The major routes of entry of nitrogen into bodies of water are municipal and industrial wastewater, septic tanks, feedlot discharges, animal wastes (including birds and fish) and discharges from car exhausts. Bacteria in water quickly convert nitrites to nitrates. Some content that nitrate contamination due to agricultural fertilizers may occur.

Nitrites can produce a serious condition in fish called "brown blood disease." Nitrites also react directly with hemoglobin in human blood and other warm-blooded animals to produce methemoglobin. Methemoglobin destroys the ability of red blood cells to transport oxygen. This condition is especially serious in babies under three months of age. It causes a condition known as methemoglobinemia or "blue baby" disease. Water with nitrite levels exceeding 1.0 mg/l should not be used for feeding babies. Nitrite/nitrogen levels below 90 mg/l and nitrate levels below 0.5 mg/l seem to have no effect on warm water fish.

*Chlorides*

Chlorides in reasonable concentrations are not harmful to humans. At concentrations above 250 mg/l, chlorides impart a salty taste to water. For this reason, chlorides are generally limited to 250 mg/l in supplies intended for public use.

*Sulfate*

Sulfate in reasonable concentrations is not harmful to humans. At concentrations above 250 mg/l, sulfate affects the taste of water. For this reason, sulfate is generally limited to 250 mg/l in supplies intended for public use.

*Phosphates*

Phosphates are not toxic to people or animals unless they are present in very high levels. Digestive problems could occur from extremely high levels of phosphate. Rainfall can cause varying amounts of phosphates to wash from farm soils into nearby waterways. Phosphate will stimulate the growth of plankton and aquatic plants that provide food for fish. This increased growth may cause an increase in the fish population and improve the overall water quality. However, if an excess of phosphate enters the waterway, algae and aquatic plants will grow wildly, choke up the waterway and use up large amounts of oxygen. This condition is known as eutrophication or over-fertilization of receiving waters. The rapid growth of aquatic vegetation can cause the death and decay of vegetation and aquatic life because of the decrease in dissolved oxygen levels.

### 3.2.8 Impact of Water Quality on Water Treatment Costs

The impact of water quality problems on public health varies depending on parameters and levels identified. Treatment costs associated with reducing biochemical parameters may increase, depending on the parameters and levels identified.

### 3.2.9 Impact of Water Quality on Agriculture

Total dissolved solids (TDS) are a measure of the salinity status of water. Salinity is an issue associated with the Rio Grande River. River flows arriving at El Paso contain a substantial salinity contribution from irrigation return flow and municipal wastewater return in New Mexico. Under current conditions, approximately 25% of the applied irrigation water is needed to move through the project in El Paso County to keep the salt loading at reasonable and manageable levels given average surface flow rates.

Increasing water salinity has a negative impact on agricultural. The amount of impact depends on the amount of salinity and amount of sodium in a given water source. With respect to animal agriculture, increased salinity of drinking water creates additional stress on animals, particularly young or lactating animals. As irrigation water salinity increases, potential crop yield decreases, and salts build up in soils and thus can have a long term effect. Most crop production practices in El Paso County have been modified to deal with the use of saline irrigation water. If salinity levels increase, the mixture of crops grown may change to reflect crops with greater tolerance to soil salinity. Unfortunately, many of those salt tolerant crops are not high value crops.

Elevated concentrations of chloride and sulfate in the Rio Grande should only be considered indicators of elevated irrigation water salinity. Since very little sprinkler irrigation takes place in the valley, chloride should have little impact on agriculture.

### 3.2.10 Water Allocations

The Rio Grande Compact governs the obligations of the states of Colorado and New Mexico for eventual delivery of water to the Rio Grande Project at Elephant Butte Reservoir. Deliveries of Rio Grande Project waters are based upon irrigation requirements authorized for the Project and are agreed upon by the two irrigation districts and the USBR. The annual allotment of Rio Grande Project water downstream of the Caballo Reservoir is determined by the USBR based on the amount of usable water in storage. Through data obtained from the measurement of snowpacks and river gauging stations along the upper reaches of the Rio Grande, the USBR determines the projected inflow to Elephant Butte Reservoir. The USBR measures storage available in the Elephant Butte and Caballo reservoirs and projects volumes using a 30-year moving average.

Total releases from Project storage during a full-allotment year average 790,000 acre-ft. Total diversions, however, average approximately 932,000 acre-ft per year. Total average diversions exceed average total releases by 142,000 acre-ft. The difference between the two is attributable to irrigation and municipal return flows, operations spills from upstream users, and rainfall runoff. Total diversion allocations are 495,000 acre-ft to EBID, 376,000 acre-ft to EPCWID#1, and 60,000 acre-ft to Mexico.

Currently, the City of El Paso's right to use water from the Project arises from its ownership of 2,000 acres of land with rights to use water, approximately 5,700 acres of 50- and 75-year term City of El Paso Irrigation Water Assignments (Leases) for rights to use water from urbanized land parcels, and approximately 4,100 acres of Lower Valley Water District Authority (LVWD) Leases. The rights to use water from the LVWD Leases are transferred to the City of El Paso on an annual basis in exchange for a wholesale supply of water from the City. Also, EPCWID#1 has historically sold to the City small amounts of Allotment 3 (Non-allotment) and Allotment 4 (Loan) water on an annual basis. In 1999, the City diverted approximately 56,500 acre-ft of Project water based on the above rights to use water. The conversion of rights to use water from agricultural to M&I use must be contracted with the EPCWID#1 and the USBR. The cost of obtaining additional rights to use water is expected to increase as EPWU continues its efforts to increase its use of surface water and decrease its reliance on ground water.

The City of El Paso is currently negotiating a Third Party Implementing Contract with EPCWID#1 that would convert to M&I use Project water saved from canal lining, operational efficiencies, and other miscellaneous water sources to supply the Jonathan Rogers 20 mgd expansion. The City is also anticipating entering negotiations in the near future for a Third Party Implementing Contract that would allow it to negotiate the conversion of rights to use water directly from farmers through the use of "Forbearance Contracts."

### 3.2.11 Availability of Rio Grande Water during Drought-of-Record Conditions

Under drought conditions, flows in the Rio Grande are significantly reduced and are allotted by the USBR in accordance with a prearranged schedule. The lowest total release from Caballo Dam was 206,081 acre-ft in 1964, and the second lowest release was 219,156 acre-ft in 1955. The lowest diversion by EPCWID#1 is estimated to be 72,746 acre-ft in 1964. A diversion of 72,746 acre-ft is not sufficient to meet the needs of water users in the El Paso area. Low releases and diversions significantly affect downstream water users who are highly dependent on a steady source of river water. In addition, such low diversions would result in a decrease in the water quality to the extent that it would be unsuitable for M&I or agricultural use. Under these conditions, ground water becomes the major source of supply.

The amount of water available to the Lower Rio Grande segment is determined by the lowest gauged amount below the confluence of the Rio Conchos and the Rio Grande. Gauging records show that the lowest yearly flow has been 35,438 acre-ft.

### 3.2.12 Re-channelization of the Rio Grande and Control of Phreatophytes

Most persons refer to re-channelization of the Rio Grande in general terms; however the term is often misused as an all-inclusive term. Re-channelization must be understood in the context of historical work done on the Rio Grande, the purposes for such work and the work's effect on river channel and geometry.

In 1933 the United States and Mexico signed a Convention entitled, "Rectification of the Rio Grande", in which the two countries agreed to provide flood protection to urban, suburban and agricultural lands and stabilize the international boundary line. Construction work authorized by this Convention addressed channel aggrading due to the flat gradient and low velocities of the Rio Grande and the new channels that tended to form on lower ground during flood flows. The rectified channel between its upper end at Cordova Island, near El Paso, to its lower end reduced the original river channel length from 155.2 miles to 85.6 miles and increased the gradient from about two feet per mile to 3.2 feet per mile. The Rectification Project also included the construction of three toll-free bridges, Caballo Dam and Riverside Dam and Heading. Construction commenced in March 1934 and was completed in 1938. In June of 1987, Riverside Dam failed. El Paso County Water District constructed a temporary rock cofferdam immediately downstream of Riverside Dam as a temporary means of diverting irrigation water through Riverside Heading, with the stipulation that the temporary dam would be removed once the American Canal Extension, scheduled for completion in February 1999, was constructed.

Recent events include the completion of the American Canal Extension, a currently ongoing Biological Assessment of the Rectification Project (resulting from a Memorandum of Understanding between IBWC and the Southwest Environmental Center), and IBWC's commitment to prepare an Environmental Impact Statement of the Rectification Project in fiscal year 2001.

The other important joint project with Mexico, the Rio Grande Boundary Preservation Project, carries out the provisions of Article IV of the 1970 "Treaty to Resolve Pending Boundary Differences and Maintain the Rio Grande and Colorado River as the International Boundary". The project covers the Rio Grande's 194-mile reach between Fort Quitman, Texas and Haciendita, Texas and addresses sedimentation as well as the phenomenon of salt cedars choking the channel. In some places the channel is nearly obliterated, and lands on both sides of the river are subject to periodic flooding from flash floods of tributary arroyos. The final Environmental Impact Statement for the Boundary Preservation Project was completed in 1978.

In the United States, the Boundary Preservation Project was constructed in reaches based on contracts issued and inspected by the IBWC's United States Section.

Construction was completed for Reach I but was interrupted for other reaches by an extended period of flooding in 1981. Subsequent work done by IBWC's United States Section was tied to the Mexican Section's schedule; February of 1986 marked the end of U.S. Section construction work anywhere within the Boundary Preservation Project. Funding to continue maintenance of the completed channel work has not been received since 1985; consequently, sediment plugs on the large tributary arroyos and high flows in the river have caused overtopping of the banks with the result that the channel has deviated from its original alignment. It is this deviation from channel alignment that concerns IBWC and which is properly termed "re-channelization".

IBWC's perspective is that re-channelization of the Rio Grande is a treaty requirement, and that re-channelization offers some water salvage potential when combined with removal of salt cedar (since salt cedar, in addition to choking the channel, is also a known phreatophyte). IBWC has proposed a feasibility study and notes that the Army Corps of Engineers has authority to fund such studies under the federal Water Resources Development Act of 1986.

The Far West Texas Regional Water Planning Group acknowledges the importance of the re-channelization issue and awaits the outcome of the decision regarding federal funding for the feasibility study. Such a study, if funded, will likely be completed during the next regional water planning cycle and the study results will then be incorporated into the Far West Texas Regional Water Plan.

## 3.3 PECOS RIVER

### 3.3.1 Overview

The Pecos River, a tributary of the Rio Grande, flows southerly through New Mexico and Texas, and discharges into the channel of the Rio Grande near Langtry, Texas, in Val Verde County. The Pecos River forms the easternmost border of Far West Texas along the northeast corner of Terrell County. Flows of the Pecos River are controlled by releases from the Red Bluff Reservoir. Storage in the reservoir is affected by the delivery of water from New Mexico. The

USGS' river gauge at Girvin (Pecos County) shows that the average daily discharge at Girvin varies between 4 to 15 cubic ft per second (cfs).

### 3.3.2 Pecos River Compact

The Pecos River Compact provides for the apportionment and diversion of the Pecos River waters. The interstate administrative agency known as the Pecos River Compact Commission administers the Compact. This Compact repeatedly refers to the "1947 Condition," which is a Pecos River Basin situation defined in the Compact Commission's Report of the Engineering Advisory Committee. The term "unappropriated flood waters" includes Pecos River waters originating above the Red Bluff Dam located in Texas at the New Mexico/Texas border. The impoundment will not deplete the water usable by the storage and diversion facilities under the 1947 condition. If not impounded, the water will flow past Girvin, Texas.

The terms of the Pecos River Compact can be summarized by the following four points:

- New Mexico cannot decrease the Pecos flow at the New Mexico/Texas border to a point less than that of the 1947 condition. (When determining the quantity of Texas water for the 1947 condition, waters of the Delaware River are apportioned to Texas.)
- Of the beneficial consumptive use of water salvaged in New Mexico on the River, Texas shall receive 43 percent and New Mexico 57 percent.
- Any water salvaged by beneficial use, but which is not beneficially consumed, shall be apportioned to New Mexico. Any water salvaged in Texas shall go to Texas.
- Beneficial consumptive use of unappropriated floodwaters shall go equally to Texas and to New Mexico.

The Pecos River Compact allows Texas and New Mexico to build additional reservoir capacity to replace unusable reservoir capacity, for the utilization of salvaged water and unappropriated floodwaters as apportioned by the Compact and for making more efficient use of water. Each state shall work with agencies to solve the salinity problem in the Pecos, and each may construct and operate facilities to prevent flood damage.

The two states were involved in a lawsuit that was decided in March 1988. The decree required New Mexico to abide by the terms of the Pecos River Compact. It also resulted in the appointment of a Pecos Rivermaster.

### 3.3.3 Pecos River Water Quality

The Pecos River is not a source of drinking water for communities in Far West Texas. The concentrations of chloride, sulfate, and total dissolved solids exceed the drinking-water standards recommended by the U.S. Environmental Protection Agency. Natural contributions of salts from the soil, as well as numerous saline ground-water seeps and springs, contribute to the high concentration of dissolved solids.

### 3.3.4 Water Allocation

Waters delivered to Texas are stored in Red Bluff Reservoir and are allocated by a master irrigation control district to seven other irrigation districts downstream. Each district apportions the waters to individual farmers. The irrigation districts are located in Loving, Ward, Reeves and Pecos Counties, which lie in Far West Texas' neighboring Senate Bill-1 region, Region F. The issues for the Pecos River, in both regions, are salinity and the potential of reducing surface flow as a result of lowered ground-water levels.

### 3.3.5 Water Rights

The TNRCC water-rights master file lists two water rights on unnamed tributaries of the Pecos River. These water-rights holders, both located in Terrell County, are authorized to divert water for irrigation purposes. Their authorizations are for 44.6 and 0.6 acre-ft per year.

### 3.3.6 Availability of Pecos River Water during Drought-of-Record Conditions

Gauging records from the lower segment of the Pecos River indicate virtually no flow during major drought conditions. Thus, Table 3-1 lists no available water supply from the Pecos under these conditions along the Terrell County border.

## 3.4 PHANTOM CREEK

### 3.4.1 Overview

Phantom Creek originates from the water discharging at Phantom Spring in Jeff Davis County. The creek flows northeastward into Reeves County, where it gains additional flow from San Solomon, Giffin, Saragosa, East Sandia and West Sandia Springs. Phantom Creek is an important source of water for irrigation in southern Reeves County.

Hydrogeologists have surmised that flow in the creek is affected by two sources of water that discharge at Phantom Spring. The first source is thought to be related to a regional system that originates in Culberson County and flows eastward through Permian rocks in southeastern Culberson County, southwestern Reeves County, and northern Jeff Davis County (Harden, 1972; Couch, 1978; LaFave, 1987; and Sharp, 1989). This system provides relatively constant baseflow to all of the springs. The second component of flow at Phantom Spring is traceable to rain water that infiltrates Lower Cretaceous rocks along the northern margins of the Davis Mountains near Balmorhea (Pearson, 1985; LaFave, 1987). The discharge associated with this local system is more variable than that of the regional system that accounts for baseflow. Gauging records indicate that average annual discharge from Phantom Spring has decreased from approximately 13,000 to 15,000 acre-ft in the early 1930's to approximately 1,500 acre-ft in the 1990's (Ashworth, Coker and Tschirhart, 1997).

### 3.4.2 Water Quality

The total dissolved solids (TDS) of Phantom Spring water varies according to the amount of baseflow relative to the amount of locally derived flow. Under baseflow conditions, TDS are typically in the range of 2,000 to 2,500 milligrams per liter (mg/l). TDS decrease as rainfall and discharge increase. Depending on the amount of precipitation, TDS have dropped to approximately 1,000 mg/l or less for short periods of time.

### 3.4.3 Water Rights

The USBR holds two water-rights authorizations from the TNRCC on Phantom Creek in Jeff Davis County. The authorizations provide for the annual diversion of as much as 18,900 acre-ft of water for irrigation.

## 3.5 WATER QUANTITY THREATS

Water quantity threats are evident within Table 3-1; generally, under drought-of-record conditions, the Upper Rio Grande River and Pecos River are dry or very low. Of special note is the available water supply of Phantom Creek. Phantom Creek's available water supply has been rapidly declining in recent years. Before this rapid decline, Phantom Creek was able to maintain roughly 15,000-18,000 acre-feet of available water.

### 3.5.1 Long-Term Availability of Surface Water

The long-term availability of water in the Rio Grande and in Phantom Creek may be in question. Factors that might account for the uncertainty of flow in these two streams are discussed below:

*Rio Grande*

Aside from the legal mechanisms governing allocation of the water from Elephant Butte and the allocation of water between the two nations of Mexico and the United States, the meteorologic and hydrologic reality is that the El Paso area is supplied by the Rio Grande, which has its headwaters in a climatic regime totally disparate from the climatic regime of Far West Texas. If a drought occurs in Colorado, then the El Paso area is essentially thrown into a drought-like scenario. Drought prediction modeling, although attempted by climatologists worldwide, is still in its infancy and therefore the likelihood of a sure knowledge of long-term availability of water in the Rio Grande headwaters is slim.

*Phantom Creek*

Phantom Creek is supplied by Phantom Creek Spring. Within the last year, the flow of water from the spring has reach its lowest level in more than 40 years, and on several occasions, the spring has ceased flowing (Radu Bogichi, direct communication to Bruce K. Darling). Two sources of water discharging from the spring have been identified: local precipitation over the nearby rocks of the Davis Mountains, and baseflow supplied by what is hypothesized to be a regional ground-water flow system (LaFave, 1987). During times of drought, springflow often drops sharply in response to decreased local rainfall. Despite diminished rainfall during drought, baseflow has been sufficient to sustain flow from the spring. The recent condition of the spring is related to the lack of local rainfall and to other unknown factors that have lowered baseflow. These factors may include the effects of ground-water pumpage or the long-term effects of severe drought in the region.

**3.5.2 Surface Water Availability and Recreation Use of the Rio Grande**

The Rio Grande is almost a dry riverbed in the stretch between El Paso and Presidio. Stream flow records at the USGS-IBWC gage 08370500 located at Fort Quitman, TX for the time period 1889 through 1975 indicate an average discharge of 289,030 acre-feet per year - or approximately 396 cfs. Stream flow records at USGS 08371500 near Presidio, TX for the same time period indicate an average discharge of 375 cfs. The latter gage is located approximately eight miles upstream of the confluence of the Rio Grande and its Mexican tributary the Rio Concho. The Texas Parks and Wildlife Department has determined that this stretch contains insufficient water for recreational use.

The river becomes a permanent stream again where Rio Concho enters upstream from Presidio, TX. From Presidio to Lajitas, the Rio Grande contains sufficient water levels for recreational use; the large rapids in the vicinity of and below Redford are some of the better rapids on the Rio Grande. In addition, diversions on the Texas side between Presidio and Redford are currently used to irrigate crops.

The segment of the Rio Grande from Lajitas to Castolon (including Santa Elena Canyon) offers recreational use at almost any time, although water levels above five feet are considered hazardous. The segment from Castolon to Talley is an excellent recreational waterway, offering water levels that are adequate and safe at most times for recreational use. In the segment from Talley to Solis (including Mariscal Canyon), the best recreational use has been reported to be three feet.

## 3.6 GROUND-WATER CONDITIONS IN MUNICIPAL WELL FIELDS

**Brewster County**

City of Alpine

The City of Alpine owns 20 municipal supply wells in two principal well fields (the Musquiz and Sunny Glen well fields). Water levels have remained relatively stable in the vicinity of the well fields, and there are no reported major water quality problems. The Musquiz field produces approximately 66 percent of the city's municipal water, but the Sunny Glen field is regarded as having greater storage capacity. Recently, several wells within the Sunny Glen field were deepened, and yields are reported to have increased from less than 100 GPM to as much as 500 GPM.

Community of Marathon

The Marathon Water and Sewer Service Corporation provides water to the community from two wells screened in the Marathon aquifer. Water levels have remained stable in the vicinity of the community, and there are no reported major water quality problems. There are no other sources of ground water in the vicinity of the community.

Communities of Terlingua and Study Butte

The Study Butte Water Supply Corporation supplies water to the communities of Terlingua and Study Butte from one well completed in the Cretaceous limestone formations north of the old ghost town. Water levels have remained relatively stable, but the Corporation is interested in drilling a second well in the area. Elevated levels of radiological activity in ground water (probably related to igneous rocks in the subsurface of the Bib Bend region) are a source of concern.

Resort of Lajitas

The Resort of Lajitas owns and operates one well to meet part of its public water-supply needs. The well produces ground water from the Cretaceous limestone formations in the vicinity of Lajitas, and the water level in the well has remained stable. Dissolved constituents are within their respective drinking-water standards, but elevated radiological activity in ground water of the Big Bend region is a potential source of concern to regulatory authorities.

**Culberson County**

Town of Van Horn

Municipal supply for the Town of Van Horn is derived from five city-owned wells in the Wild Horse Flat aquifer. Water levels in the vicinity of Van Horn have remained stable. Other than fluoride concentrations that have been reported to range from 2.3 to 3.1 mg/l, all other dissolved constituents are within their respective drinking-water standards. The current well field has significant expansion capability if additional production is needed to meet increased demand.

**El Paso County**

City of El Paso and Vicinity

The production of ground water from well fields in the vicinity of El Paso and in Ciudad Juarez has created a large cone of depression in the potentiometric surface beneath each city. Average declines in wells in the upper portion of the Lower Valley in El Paso are in excess of 100 ft. These declines, in combination with deteriorating water quality, have prompted the City to discontinue pumping from certain wells. Elsewhere, average water-level declines are generally in the range of 60 to 80 ft. Recent water-level data indicate a slight rise of water levels in the valley. This is probably traceable to lower pumpage in some areas. The total decrease in the potentiometric surface beneath Ciudad Juarez has been significant enough to cause the cone beneath Ciudad Juarez to migrate north of the Rio Grande. The lowering of the potentiometric surface not only has reversed the predevelopment hydraulic gradient in the westernmost regions of the Hueco Bolson, but also is thought to have been a major factor underlying the deterioration of water quality in part of the El Paso area.

The concentrations of chloride and other dissolved ions have increased in many of the municipal wells of both cities. In El Paso County, for example, the TDS in production wells have risen to more than 1,000 mg/l. In recent years, the City of El Paso has taken out of service approximately 30 wells due to elevated levels of chloride and TDS. In many cases, the greatest increases in TDS are associated with wells that have had large, sustained drawdowns, but similar changes have also been observed in some wells from which much less pumping has occurred.

**Hudspeth County**

Community of Sierra Blanca

The Hudspeth County Water Control and Improvement District #1 purchases water from the Town of Van Horn, located in northwestern Eagle Flat. Production is from two wells in the Wild Horse Flat well field of Culberson County. Water levels in the Wild Horse Flat well field have remained constant, and water quality has not been reported to be a problem for the Community. The Wild Horse well field has substantial room for expansion if an additional well is needed to meet demand. Since 1970, Sierra Blanca has drilled as many as five wells in Hudspeth County in unsuccessful attempts to develop local sources of ground water.

City of Dell City

Dell City relies on three wells completed in the Bone Spring-Victorio Peak aquifer for municipal water. Ground water from the aquifer is brackish and must be desalinated. Water levels in the well field have not decreased in recent years. The Bone Spring-Victorio Peak aquifer is capable of supporting production from additional municipal supply wells.

Communities of Fort Hancock and McNary

Fort Hancock and McNary have relied on ground water provided by one well owned by the Fort Hancock WCID and on 11 wells owned by the Esperanza FWSD#1. All production is from the Rio Grande alluvium. Water levels fall in response to extended drought conditions in the region, but the owner of the Esperanza FWSD #1 reports that water levels usually recover quickly after periods of rainfall. Water quality is a problem in the area, as TDS ranges from approximately 1,000 mg/l to as much as 2,500 mg/l. Other dissolved solids in excess of drinking water standards are fluoride and manganese. The possibilities for expansion are limited by the occurrence of saline ground water in both the Rio Grande alluvium and the Hueco Bolson aquifer.

**Jeff Davis County**

Community of Fort Davis

The Fort Davis Water Supply Corporation (FDWSC) provides water to the Community of Fort Davis and the surrounding area from three wells completed in the Tertiary volcanics and associated alluvium of the Igneous aquifer. One of the wells is used only as a backup. Water levels in the vicinity of the wells have remained stable; and other than elevated fluoride, there are no reported problems with water quality. The FDWSC has also looked at other areas in the vicinity of Fort Davis for future well development.

Town of Valentine

The Town of Valentine relies on one municipal water supply well completed in the Ryan Flat aquifer. A second well owned by the Valentine Independent School District provides water to the school and to a small number of residences occupied by teachers. Water levels in the vicinity of Valentine have remained stable, and there are no reported problems with water quality. Under consideration is a proposal to drill a second municipal water-supply well. The Ryan Flat aquifer appears to have ample capability to support additional well development for the Town of Valentine.

**Presidio County**

City of Marfa

The City of Marfa depends on three city-owned wells for all of its municipal water needs. Two of the wells are capable of producing as much as 1,100 GPM, and the third well yields and additional 450 GPM. The Tertiary volcanics of the Igneous aquifer are the source of ground water. Other than fluoride, which has been reported at concentrations ranging from 2.5 to 3 mg/l, all other dissolved solids are below their respective drinking-water standards, and TDS are typically less than 400 mg/l. The well field has significant expansion capability if other wells are needed to meet additional demand.

<u>City of Presidio</u>

The City of Presidio derives all of its municipal water from three wells completed in the thick basin fill deposits of the Presidio Bolson aquifer. Two wells are located within the city limits, and the third well is located approximately 7 miles to the southeast of town. Water levels have remained stable in the vicinity of the wells; and other than fluoride concentrations from2 to 3 mg/l, all other dissolved solids are within their respective drinking-water standards. There is ample expansion capability in the vicinity of the city, and the city expects that additional wells will be needed to satisfy increased demand.

**Terrell County**

<u>Community of Sanderson</u>

The Community of Sanderson owns 18 public supply wells that produce ground water from the Edwards-Trinity Plateau aquifer. Ten of the wells provide most of the community's water needs, and the Water Department plans to drill an additional well in the near future to replace the two lowest producing wells. Water levels have remained stable; and water quality is not reported to be a problem for the community.

## 3.7 GROUND WATER

### 3.7.1 Introduction

This section of Chapter 3 presents information on the availability of ground water in the aquifers of Far West Texas (Figure 3-1). The availability estimates cover a 50-year period, 2000 through 2050. The estimates are based on data extracted from a number of hydrogeologic studies, evaluations of the availability of ground water in the region, and data provided by the

TWDB on the demand for water in the municipal, industrial, manufacturing and agricultural sectors of the region's economy.

This analysis of the availability of ground water is based on data from studies of the hydrogeology of the basins of Far West Texas, especially as related to: (1) the location and extent of the major and the minor aquifers of the region; (2) the estimation of the effective annual recharge of each aquifer; and (3) the estimation, where possible and by the best available method, of the volume of recoverable ground water (fresh water and brackish water) in each aquifer.

### 3.7.2 Methods of Estimating Ground-Water Availability

#### 3.7.2.1 Recharge

"Recharge" is a term that encompasses all of the sources by which an aquifer is replenished with water. This includes precipitation, infiltration of water from perennial streams or ephemeral streams, inflow of ground water from areas adjacent to an aquifer, and irrigation return flow. The relative impact of each source of water is determined by a number of factors – including, but not limited to, average annual rainfall, average annual evaporation, the distribution of recharge-prone areas within a basin, and the volume of pumpage.

The arid to semi-arid climate of Far West Texas is a significant limiting factor in the amount of precipitation that can be converted to recharge. Throughout the region, evaporation typically exceeds precipitation by as much as 70 inches per year (Larkin and Bomar, 1983). Because most of the rainfall in the region occurs during the hottest months of the year (Larkin and Bomar, 1983), most of what reaches the ground is lost very quickly to evaporation. In addition to high evaporative losses, a significant amount of moisture is exhausted by desert plants, which have developed highly efficient mechanisms of extracting moisture from soils. Although desert plants retain most of this water, a portion of this moisture is transpired back to the atmosphere through the plant surface.

U.S. Geological Survey (USGS) hydrogeologists have estimated recharge in the basins of Far West Texas based on the assumption that 1 percent of average annual rainfall within the boundaries of a watershed is converted to recharge (Gates and others, 1980). This approach, though widely used, leads to overestimates of recharge as it factors in areas where recharge does not occur. For the bolson aquifers of Far West Texas, the approach used in this chapter is a modification of the method used by the USGS. Only the highlands that form the boundaries of the bolson aquifers are considered to be primary recharge zones. For example, the extent of a bolson aquifer, as shown in this chapter, is interpreted to be a delineation of the storage zone, and not the primary recharge area of the basin. Recharge occurs where fractured and permeable rocks are either exposed or covered only by a thin veneer of basin fill (Darling, 1997). One percent of average annual rainfall distributed over the highlands is assumed to contribute to recharge within these areas. Everything that falls over the storage zone either runs off or is removed by evaporation and transpiration. Estimates of recharge for the Hueco and Mesilla Bolsons are taken from studies by Meyer (1976) and Leggat and others (1962).

Different assumptions are used for the Igneous aquifers of Brewster, Jeff Davis and Presidio Counties and the Marathon aquifer of Brewster County. These aquifers consist of thick sections of fractured rocks that are exposed over broad areas of the surface. The fractures act as conduits for the rapid infiltration of precipitation. Because many of these areas lie at higher elevations than the bolson aquifers, average annual precipitation is higher (Larkin and Bomar, 1983; Bomar, 1995), and a larger amount of precipitation is converted to recharge. Estimates in these areas range from 2.5 percent to 6 percent of average annual rainfall (Hart, 1992; LBG-Guyton Associates, 1998). To ensure conservative estimates for each area, a value of 2.5 percent was used in this evaluation.

#### 3.7.2.2 Recoverable Storage

The volume of ground water in an aquifer is referred to as “storage.” Storage is determined by the thickness of the saturated section and by the porosity of the aquifer. Not all of the water in storage is recoverable. Much of the water is considered “immovable” – that is, bound by capillary forces within pore spaces. The amount that is assumed to be recoverable is determined by the “specific yield” of an aquifer. This term refers to the percentage of water that will drain, under the force of gravity, from the pore spaces of an aquifer. “Specific retention” refers to the percentage of undrained (retained) water. Specific yield and specific retention are equal to the effective porosity of an aquifer.

Specific yield is related to the permeability of an aquifer. Coarse-grained rocks and fine-grained rocks may both hold very large volumes of water, but aquifers that are composed of coarse-grained (or fractured) rocks may be more productive than aquifers that consist of thick sections of fine-grained sand and/or silt.

Values of specific yield for the aquifers of Far West Texas typically range from 5 percent to 7.5 percent for the bolson aquifers to as much as 10 percent for the Igneous aquifers and the Marathon aquifer (Gates and others, 1980). Estimates of saturated thickness are taken from studies such as those of Gates and others (1980), Gabaldon (1991), Hart (1992), Black (1993), Darling and others (1994), and Darling (1997).

Finally, to provide a more conservative estimate of the volume of recoverable ground water, 30 to 60 percent of the volume estimated from the specific yield of the aquifer is assumed to be ultimately recoverable. Gates and others (1980) assumed a value of 75 percent in their study of the availability of ground water in the basins of westernmost Texas. The smaller 30 to 60 percent numbers are based on financial and not hydrologic limitations.

**3.7.2.3 Ground-Water Availability Estimates**

For any aquifer for which an estimate could be made of the volume of recoverable ground water in storage, a second set of calculations was undertaken as a basis for estimating the volume of water (fresh and brackish) remaining (available) in the aquifer at 10-year intervals for the period 2000 through 2050. The calculations required an accounting of municipal and other sources of demand (as described in Chapter 2) and recharge. Severe drought conditions were assumed to be present across the region at the beginning of each decade, and recharge for all aquifers during these years was assumed to be zero. The objective of the exercise was to determine whether an aquifer is likely to experience severe reduction of water in storage based on the input and output values used in the scenario. For cases in which recharge exceeded total withdrawals from an aquifer during a normal year, the maximum amount of storage during years between drought conditions is assumed to be equal to the initial volume calculated for the aquifer. The available amount during drought years is equal to the initial volume minus the amount withdrawn during that year. Estimates of availability for the Hueco and Mesilla bolsons are based on data provided by EPWU.

It should be noted that "availability" – as used in this report – does not suggest that all of the recoverable water remaining in storage in an aquifer is either accessible to or producible by all users or potential users for the year for which an estimate is made. In most of the basins of Far West Texas, demand is dominated by municipal and irrigation requirements (Chapter 2). The greatest impact within a basin, therefore, is centered in areas of heaviest pumping. Although the amount of water available may seem very large based on estimated storage within an aquifer, the localized effects of heavy pumping may affect availability (both in terms of quantity and quality) more adversely among the heaviest users (e.g., cities and irrigators) than among users whose demands are small by comparison (e.g., ranchers). Hence, there are two approaches to understanding the term "availability." In the broadest sense, availability is an estimate of all of the recoverable fresh water and brackish water remaining in an aquifer at the end of a given year. These estimates are found in Table 3-1. In the narrowest sense, availability is an estimate of the volume of ground water that a specific user or group of users may reasonably expect to pump from an aquifer, based on limitations imposed by factors such as the depth to water, infrastructure, cost of pumping, and water quality. These estimates are found in Table 3-2.

### 3.7.3 Aquifer Availability Analyses

### 3.7.3.1 Hueco Bolson and Rio Grande Alluvium

#### *3.7.3.1.1 Hueco Bolson Aquifer*

The Hueco Bolson aquifer (Figure 3-1) is a major source of ground water for cities in El Paso and Hudspeth Counties, as well as Ciudad Juarez. The Hueco Bolson extends toward the southeast from the Franklin Mountains in El Paso County to the southern end of the Quitman Mountains in Hudspeth County. The northeastern boundary of the bolson is established by the Diablo Plateau in El Paso and Hudspeth Counties and the Malone and Quitman Mountains in Hudspeth County.

The Hueco Bolson extends northward into New Mexico to about 7 miles north of the Texas/New Mexico state line. It is separated from the Tularosa Basin to the north by a topographic divide. The topographic divide, however, does not correspond to a ground-water divide, and the two basins are hydrogeologically interconnected by interbasin ground-water flow from New Mexico into Texas (Wilkins, 1986). Because of the interconnection between the two basins, the TWDB considered both to be one regional aquifer (Hueco-Tularosa aquifer) in a study of the transboundary aquifers of the El Paso/Las Cruces/Ciudad Juarez area (Hibbs and others, 1998). The Hueco Bolson also extends southward into the Mexican State of Chihuahua, where it is bounded by a series of mountain ranges that trend toward the southeast from Ciudad Juarez to near the southernmost point of the Quitman Mountains in Texas. TWDB's transboundary aquifer study included approximately 4,160 square miles ($mi^2$) of the Hueco-Tularosa aquifer. Of the total area, approximately 67 percent (2,790 $mi^2$) of the land area is in New Mexico, 22 percent (920 $mi^2$) is in Texas, and 11 percent (450 $mi^2$) is in Mexico (Hibbs and others, 1998).

The Hueco Bolson consists of deposits of basin fill with a maximum thickness of approximately 9,000 ft. The upper part of the basin fill consists of silt, sand and gravel. The lowermost deposits are made up largely of clay and silt. Only portions of the upper several hundred feet of the bolson fill are known to contain fresh to slightly saline water. A wedge of fresh water increases to a maximum depth at or near the western edge of the aquifer. There is no fresh water on the eastern edge of the aquifer.

**Recharge**

Recharge in El Paso County has been estimated to be 5,640 acre-ft per year (Meyer, 1976). This has been attributed to runoff along the base of the Organ and Franklin Mountains in New Mexico and Texas and the Sierra de Juarez in Mexico. It has also been estimated that leakage into the bolson from the Rio Grande alluvium along the trace of the river/international boundary is approximately 33,300 acre-ft (Meyer, 1976). The USGS has been working on the development of a three-dimensional numerical flow model of the Hueco Bolson. The model, which is in the latter stages of development, will provide a new set of recharge estimates for the bolson.

**Storage**

Demand for ground water in the Hueco Bolson is substantially greater than the rate at which the basin is being recharged. The result is rapid mining of the water resource. The EPWU estimates that recoverable freshwater in storage as of the year 2000 is approximately 3 million acre-ft (Table 3-1). EPWU also estimates that 2.5 million acre-ft of slightly saline (1,000 to 2,000 mg/l, as defined by EPWU) water is available for desalination (Table 3-1).

**Water Quality**

The quality of Hueco Bolson ground water differs according to location and depth. The concentration of dissolved solids in the upper part of the bolson ranges from less than 500 mg/l to more than 1,500 mg/l. The average concentration is reported to be approximately 640 mg/l. Water quality in the bolson, however, is also affected by pumping. The drawdown of ground water by pumping wells induces the flow of brackish water into parts of the aquifer that contain freshwater.

**Availability**

Because of the rapid depletion of the aquifer, the Hueco Bolson in Texas is not expected to be a source of fresh water beyond the year 2030 (Table 3-1) under Drought-of-Record conditions. Of more immediate concern, is a statement from Mexican officials of the expectation that the Ciudad Juarez water supply from the Hueco Bolson will be depleted by the year 2004 unless new sources are brought on line.

***3.7.3.1.2 Rio Grande Alluvium***

Although hydrogeologically integrated with the Hueco Bolson along the trace of the river/international boundary, the Rio Grande Alluvium (Figure 3-1) is identified in this report as a separate aquifer because it is a source of irrigation water in El Paso and Hudspeth Counties whenever flow in the Rio Grande is insufficient to support agricultural operations. Because of high concentrations of dissolved solids (typically greater than 2,000 mg/l), the aquifer is not a source of drinking water. Approximately 1.2 million acre-ft of water is available in the Rio Grande Alluvium of El Paso County, and another 626,00 acre-ft may be available in Hudspeth County.

### 3.7.3.2 Mesilla Bolson Aquifer

**Location**

The Mesilla Bolson aquifer is located west of the Franklin Mountains (Figure 3-1). The bolson deposits consist of approximately 2,000 feet of clay, silt, sand, and gravel. Three water-bearing zones have been identified based on water levels and quality. The shallow zone includes the overlying Rio Grande Alluvium.

The Mesilla Bolson in Texas is part of a larger bolson that extends from southern New Mexico to northern Mexico. The bolson is bounded by mountains on all sides, and is not hydrogeologically integrated with the Hueco Bolson.

**Recharge**

Leggat and others (1962) estimated that recharge in the Mesilla Bolson is approximately 18,000 acre-ft per year in the lower Mesilla Valley. Recharge occurs by (1) infiltration of precipitation in the valley, (2) mountain- and slope-front recharge, (3) seepage from canals, laterals, the Rio Grande and recycled irrigation water, and (4) by ground-water underflow from New Mexico.

**Storage**

Like the Hueco Bolson, the Mesilla Bolson is being rapidly depleted of fresh water. EPWU estimates that as of the year 2000 only 500,000 acre-ft of fresh water is in storage (Table 3-1).

**Water Quality**

Water quality in the Mesilla Bolson varies according to location and depth. The freshest water is found in the deeper zones of the bolson. TDS increase in the shallower depths of the basin. The increase in TDS in the shallower zones is related to the concentration of salts by evapotranspiration.

**Availability**

Under Drought-of-Record conditions, mining of the Mesilla Bolson aquifer in Texas would proceed more rapidly and could reach depletion of all freshwater supplies by the year 2020 (Table 3-1).

**3.7.3.3 West Texas Bolson Aquifers**

The West Texas Bolson aquifers (Figures 3-1 and 3-2) consist of a number of fault-bounded basins that began to form during the onset of Basin-and-Range extensional faulting about 30 million years before present. The bolsons are filled with sediments eroded from the surrounding highlands. The basins delineated in Figure 3-2 are (1) the Presidio-Redford Bolson, (2) Ryan Flat, (3) Lobo Valley, (4) Wild Horse-Michigan Flat, (5) Green River Valley, (6) Red Light Draw and (7) Eagle Flat. Red Light Draw, Green River Valley and the Presidio-Redford Bolson have been incised by the Rio Grande, and extend southward for short distances into the Mexican State of Chihuahua. Surface water and ground water in these basins drain toward the river. The other basins are farther removed from the River and also stand at higher elevations than Red Light Draw, Green River Valley and the Presidio-Redford Bolson. Ground water in these basins does not flow toward the river. Flow in these basins is thought to be part of a deeper regional system that moves toward the east through the porous and permeable rocks of the Apache Mountains (Nielson and Sharp, 1985; Sharp, 1985; Darling and others, 1994; Darling, 1997).

### *3.7.3.3.1 Presidio-Redford Bolson*

**Location**

In Texas, the Presidio-Redford Bolson (Figure 3-2) extends along the Rio Grande from Candelaria, Texas, to outcrops of volcanic rocks 6 to 10 miles southeast of Presidio, Texas. The Redford extension of the bolson continues along the Rio Grande for another 12 miles. The bolson is bounded along the northeast by the Chinati Mountains and along the southeast by the Cienega Mountains, the Black Hills and the Bofecillos Mountains. The southwestern boundary of the bolson in Texas is the Rio Grande. The drainage area in Texas is estimated to be 1,100 $mi^2$ (Gates and others, 1980). Figure 3-2 delineates only that part of the bolson that lies outside of the recharge areas. This is an area of approximately 480 $mi^2$.

The Presidio-Redford Bolson is the source of municipal supply water for the Town of Presidio. It is also the source of domestic water, irrigation water and stock water for ranches and farms.

**Recharge**

Recharge occurs primarily from precipitation that infiltrates through alluvial fans and faults along the Chinati Mountains and along tributaries of the Rio Grande, such as Cibolo and Alamito Creeks. The faults create zones of higher permeability through which precipitation infiltrates (Gabaldon, 1991). The tributaries consist of permeable sediments that allow rain and runoff to infiltrate quickly to the water table. If 11 inches of annual precipitation is distributed over the 620-$mi^2$ recharge area of the bolson and assuming 1 percent of the average annual precipitation is available for recharge, then the total recharge is an average of 3,630 acre-ft per year.

**Storage**

The volume of recoverable ground water in the Presidio and Redford Bolson is estimated only with respect to the 480-$mi^2$ area shown in Figure 3-2. Based on studies by Gates and others (1980) and Gabaldon (1991), saturated thickness is conservatively estimated to be 500 feet beneath this area. Specific yield is 7.5 percent (Gates and others, 1980; and Gabaldon, 1991), and the recovery factor is assumed to be 60 percent. On the basis of these assumptions, the volume of recoverable ground water in storage at the beginning of the year 2000 may be as much as 6.9 million acre-ft.

**Water Quality**

According to Gates and others (1980), nearly all of the ground water above the floodplain of the Rio Grande, both in the bolsons and in the adjacent hills and mountains, is fresh. In the area northwest of Cibolo Creek, resistivity data indicated the occurrence of fresh ground water only in the alluvium along the stream channels. Water in much of the fine-grained bolson fill is moderately saline. Gates and others (1980) concluded, based on additional resistivity data, that the entire section of coarse-grained bolson fill in the Cibolo-Alamito Creek area is another source of fresh water. Ground water in the alluvium of the Rio Grande is moderately saline to highly saline. The elevated salinity is a result of the discharge of ground water by evapotranspiration along the floodplain of the river.

**Availability**

The availability scenario for the Presidio-Redford Bolson consists of the following input and output values:

- No recharge for drought years,
- Recharge of 3,630 acre-ft for other years,
- Irrigation demand of 2,500 acre-ft per year,
- One-third of the livestock demand of Table 2-4 (Chapter 2), and
- All of the municipal demand for the Town of Presidio and one-third of the County-Other demand of Table 2-5 (Chapter 2).

For the period 2000 through 2050, the volume of recoverable water in the aquifer decreases by 42,000 acre-ft (or by 0.61 percent of the initial volume of 6.9 million acre-ft). This represents a small degree of depletion that should not have an adverse impact on the availability of ground water over this period of time. Recoverable volumes at the end of each drought year are shown in Table 3-1 of this chapter.

### *3.7.3.3.2 Ryan Flat*

**Location**

Ryan Flat is the southernmost extension of the Salt Basin in Texas (Figure 3-2). The basin is bounded by mountains along its western, southern and eastern margins and is hydrogeologically integrated with Lobo Valley to the north-northwest. The bolson watershed covers an area of 1,410 $mi^2$, and the storage area is 525 $mi^2$. The largest part of the storage area (360 $mi^2$) is in Presidio County, and a smaller area (165 $mi^2$) extends northward into Jeff Davis County. The bolson is the source of municipal supply for the Town of Valentine (Jeff Davis County). It is also the source of domestic water, stock water for ranches and a source of irrigation water for farms.

**Recharge**

Recharge occurs primarily from precipitation that infiltrates through alluvial fans that border the surrounding mountains. If 12 inches of annual precipitation is distributed over the 880-$mi^2$ recharge area of the bolson and assuming 1 percent of the average annual precipitation is available for recharge, then the total recharge is an average of 5,630 acre-ft per year.
Partitioning this amount into recharge within Presidio and Jeff Davis Counties yields 3,810 acre-ft per year in Presidio County, and 1,820 acre-ft per year in Jeff Davis County.

**Storage**

The volume of recoverable ground water in the Ryan Flat aquifer is estimated only with respect to the 525-$mi^2$ area shown in Figure 3-2. Based on data from the studies by Gates and others (1980) and Black (1993), the average saturated thickness of the bolson is approximately 1,000 feet. Specific yield is 6.6 percent (Cliett, 1992), and the recovery factor is assumed to be 60 percent. On the basis of these assumptions, the volume of recoverable ground water in Ryan Flat may be as much as 13.3 million acre-ft. Of this amount, 8.9 million acre-ft are in storage beneath the floor of the basin in Presidio County, and 4.4 million acre-ft are in storage beneath the floor of the basin in Jeff Davis County (Table 3-1). However, drill log, well completion information and pumping records from the Antelope Valley Ranch owned by EPWU indicates that a zone of saturated, permeable, fractured volcanic rocks from 1,000 to as much as 3,000 feet thick underlies the bolson fill in Ryan Flat. This formation yields potable water in economical quantities, and if extrapolated over the area of Ryan Flat could increase water reserve another 10 to 30 million acre-ft.

**Water Quality**

Ground water in the basin fill is fresh, with TDS typically in the range of 200 mg/l to 400 mg/l. The low TDS concentrations are probably related to the high proportion of relatively insoluble volcanic rock in the basin fill (Gates and others, 1980).

**Availability**

The availability scenario for Ryan Flat consists of the following input and output values:

- No recharge for drought years,
- Recharge of 5,630 acre-ft for other years,
- Irrigation demand beginning at 8,120 acre-ft for the first 10 years and decreasing by steps to a final value of 7,330 acre-ft by 2050,
- For Presidio County, 33 percent of the Livestock demand in Table 2-4 (Chapter 2); for Jeff Davis County, 35 percent of the Livestock demand in the same table, and
- For Presidio County, 33 percent of the County-Other demand in Table 2-5 (Chapter 2); for Jeff Davis County, 35 percent of the County-Other demand in the same table.

For the period 2000 through 2050, the volume of recoverable water in the aquifer decreases by 164,000 acre-ft (or by less than 1 percent of the initial volume of 13.3 million acre-ft). The total depletion attributed to production in Presidio and Jeff Davis counties is estimated to be 118,000 acre-ft and 46,000 acre-ft, respectively. Recoverable volumes at the end of each drought year are shown in Table 3-1 of this chapter.

### *3.7.3.3.3 Lobo Valley*

**Location**

Lobo Valley lies to the north of Ryan Flat. (Figure 3-2). The basin is bounded by mountains along its western and eastern margins, and is hydrogeologically integrated with Wild Horse Flat to the north-northwest. The bolson watershed covers an area of 350 $mi^2$, with a ground-water storage area of 130 $mi^2$. The largest part of the storage area (75 $mi^2$) is in Culberson County, and a smaller part (55 $mi^2$) lies within Jeff Davis County. The bolson is not a source of municipal supply for any town in Jeff Davis County or Culberson County. It is, however, a source of domestic water and stock water for ranches and is also a source of irrigation water.

**Recharge**

If 11 inches of annual precipitation is distributed over the 220-$mi^2$ recharge area of the bolson and assuming 1 percent of the average annual precipitation is available for recharge, then the total recharge is an average of 1,290 acre-ft per year. The amount of recharge that occurs within Jeff Davis County is estimated to be 545 acre-ft per year. The estimate for the larger area in Culberson County is 750 acre-ft.

**Storage**

The volume of recoverable ground water in the Lobo Valley aquifer is estimated only with respect to the 130-$mi^2$ area shown in Figure 3-2. Based on data from the studies by Gates and others (1980) and Black (1993), the average saturated thickness of the bolson is approximately 500 feet. Specific yield is 5 percent (Gates and others, 1980), and the recovery factor is assumed to be 60 percent. On the basis of these assumptions, the volume of recoverable ground water beneath Lobo Valley may be as much as 1.3 million acre-ft. Of this amount, 746,000 acre-ft are in storage beneath the floor of the basin in Jeff Davis County, and 519,000 acre-ft are in storage beneath the floor of the basin in Culberson County.

**Water Quality**

Ground water in the Lobo Valley aquifer is uniformly fresh. The TDS concentration is generally in the range of 300 to 400 mg/l. As with the Ryan Flat aquifer, the low TDS is probably related to the relatively insoluble volcanic debris that makes up much of the basin fill (Gates and others, 1980). Gates and others (1980) noted the occurrence of slightly saline water from two wells producing from depths as shallow as 80 feet to 100 feet. They attributed the slightly higher salinity to the infiltration of irrigation water in which salts had been concentrated by evapotranspiration.

**Availability**

The availability scenario for Lobo Valley consists of the following input and output values:

- No recharge for drought years,
- Recharge of 1,290 acre-ft for other years,
- Irrigation demand beginning at 2,000 acre-ft for the first 10 years and decreasing to a final value of 1,800 acre-ft by 2050,
- For Jeff Davis County, 10 percent of the Livestock demand in Table 2-4 (Chapter 2); for Culberson County, 17 percent of the Livestock demand of the same table, and
- For Jeff Davis County, 10 percent of the County-Other demand in Table 2-5 (Chapter 2); for Jeff Davis County, 17 percent of the County-Other demand of the same table.

Using these values over the period 2000 through 2050, the volume of recoverable water in the aquifer is estimated to decrease by 45,000 acre-ft (or less than 3 percent of the initial volume of 1.3 million acre-ft). Recoverable volumes at the end of each drought year are shown in Table 3-1 of this chapter.

### *3.7.3.3.4 Wild Horse Flat and Michigan Flat*

**Location**

Wild Horse Flat and Michigan Flat lie to the north and northeast, respectively, of Lobo Valley (Figure 3-2). Lobo Valley is hydrogeologically integrated with the southernmost part of Wild Horse Flat. Mountains bound the Wild Horse-Michigan Flat area along its western, eastern and southeastern margins. The basins extend toward the north, where they are bordered by the Salt Flat Graben.

The Wild Horse-Michigan Flat watershed covers an area of approximately 1,000 $mi^2$ (Gates and others, 1980). The storage area delineated in Figure 3-2 is estimated to be 375 $mi^2$. The Wild Horse Flat area of the basin is a source of municipal supply for the Towns of Van Horn (Culberson County) and Sierra Blanca (Hudspeth County). The Wild Horse-Michigan Flat aquifer is a major source of domestic and stock water for ranches and of irrigation water for farms in the valley.

**Recharge**

If 11 inches of annual precipitation is distributed over the 620-$mi^2$ recharge area of the bolson and assuming 1 percent of the average annual precipitation is available for recharge, then the total recharge is an average of 3,700 acre-ft per year.

**Storage**

The volume of recoverable ground water in the aquifer is estimated only with respect to the 375-$mi^2$ area shown in Figure 3-2. Based on data from the studies by Gates and others (1980), it is estimated that the average saturated thickness is approximately 500 feet. Specific yield is probably 10 to 15 percent (Gates and others, 1980). A value of 10 percent is used in this report, and the recovery factor is set at 60 percent. On the basis of these assumptions, the volume of recoverable ground water beneath the floor of Wild Horse Flat and Michigan Flat may be as much as 7.2 million acre-ft.

**Water Quality**

Where Wild Horse Flat and Michigan Flat are bordered by the Salt Basin to the north, ground water ranges from fresh (less than 1,000 mg/l) to slightly saline (1,000 to 3,000 mg/l). Along the western side of Wild Horse Flat and in Michigan Flat, ground water is fresh. TDS are generally in the range of 350 to 500 mg/l in Michigan Flat and in the area around Van Horn, and 600 to 1,000 mg/l in northwestern Wild Horse Flat (Gates and others, 1980).

**Availability**

The availability scenario for the Wild Horse-Michigan Flat area consists of the following input and output values:

- No recharge for drought years,
- Recharge of 3,700 acre-ft for other years,
- Irrigation demand beginning at 7,400 acre-ft for the first 10 years and decreasing to a final value of 6,700 acre-ft by 2050,
- Eighty-three percent of the projected Livestock demand (Culberson County) in Table 2-4 (Chapter 2), and
- Eighty-three percent the projected County-Other demand (Culberson County) in Table 2-5 (Chapter 2).

Using these values over the period 2000 through 2050, the volume of recoverable water in the aquifer is estimated to decrease by 250,000 acre-ft (or by approximately 3.5 percent of the initial volume of 5.8 million acre-ft). The recoverable volume at the end of each drought year is shown in Table 3-1 of this chapter.

***3.7.3.3.5 Green River Valley***

**Location**

The Green River Valley Bolson lies in parts of Hudspeth, Jeff Davis and Presidio Counties. It is bordered by the Eagle Mountains on the west, the Van Horn Mountains on the east, and the Rio Grande on the south. The Green River Valley watershed covers an area of 160 $mi^2$ (Gates and others, 1980). The storage area delineated in Figure 3-2, however, is only 40 $mi^2$.

Green River Valley is the smallest of the West Texas Bolsons. The bolson is a source of water only for ranches in the basin.

**Recharge**

Recharge occurs around the margins of the basin and along the channels of ephemeral streams that drain the mountains. Using a rough relation between recharge and drainage area, annual recharge within the 120-$mi^2$ recharge zone is estimated to be 700 acre-ft per year. This is based on the assumption that 1 percent of the average annual precipitation of 11 inches is converted to recharge.

**Storage**

Assuming that (1) average saturated thickness is 450 feet beneath the 40-$mi^2$ area shown in Figure 3-2 (Gates and others, 1980), (2) specific yield is 7.5 percent (Gates and others, 1980), and (3) the recovery factor is 30 percent, the volume of recoverable water in Green River Valley may be as much as 266,000 acre-ft.

**Water Quality**

Ground water in the Green River Valley basin fill typically contains less than 500 mg/l of dissolved solids (Gates and others, 1980). The low concentration of dissolved solids is related to the high percentage of insoluble volcanic debris that makes up much of the basin fill. Ground water in the Rio Grande Alluvium along the southern boundary of Green River Valley is slightly saline to very saline. The elevated TDS is probably related to the buildup of salts by evapotranspiration along the floodplain of the River (Gates and others, 1980).

**Availability**

Only scattered ranch wells produce ground water from the Green River Valley Bolson. Furthermore, the small size and the remoteness of the basin render the bolson an unlikely target for development of its ground-water resources. The bolson aquifer, therefore, is not expected to manifest any depletion over the period 2000 through 2050. Hence, availability is likely to remain constant (Table 3-1).

#### *3.7.3.3.6 Red Light Draw*

**Location**

Red Light Draw is located in Hudspeth County. It is situated between the Eagle Mountains along the north-northeast and the Quitman Mountains along the southwest. The Rio Grande is the southern border of the basin. The drainage area of the Red Light Draw watershed is estimated to be 370 $mi^2$ (Gates and others, 1980). The area depicted in Figure 3-2, however, covers an area of 185 $mi^2$. Only the lower two-thirds of the basin are regarded as having any potential for the development of ground water (Gates and others, 1980). The Red Light Bolson is a source of water only for ranches in the basin.

**Recharge**

Recharge occurs around the margins of the basin and along the channels of ephemeral streams that drain the mountains. Using a rough relation between recharge and drainage area, annual recharge within the 125-$mi^2$ recharge zone of the southern two-thirds of the bolson yields an estimated 730 acre-ft of recharge per year. This is based on the assumption that 1 percent of the average annual precipitation of 11 inches is converted to recharge within this area.

**Storage**

The storage zone within the lower two-thirds of Red Light Draw covers an area of 125 $mi^2$. Assuming that saturated thickness beneath this area is 450 feet on average, along with a specific yield of 7.5 percent (Gates and others, 1980) and a recovery factor of 30 percent, Red Light Draw yields an estimated 708,000 acre-ft of recoverable water.

**Water Quality**

With the exception of areas within the floodplain of the Rio Grande, ground water in the bolson fill of Red Light Draw is fresh. TDS are typically in the range of 300 to 500 mg/l

(Darling, 1997). The low concentration of dissolved solids is related to the high percentage of insoluble volcanic debris. Shallow wells in the floodplain, however, produce saline to very saline ground water. TDS in this area are commonly greater than 2,000 mg/l, and the highest concentration reported is 10,000 mg/l (Darling, 1997). The higher salinity in this part of the basin is attributable to the buildup of salts by evapotranspiration (Gates and others, 1980; Darling, 1997).

**Availability**

Only scattered ranch wells produce ground water from the Red Light Bolson. The bolson aquifer, therefore, is not expected to manifest any depletion over the period 2000 to 2050, such that availability is likely to remain equivalent to total recoverable storage (Table 3-1).

### *3.7.3.3.7 Eagle Flat*

**Location**

The Eagle Flat Bolson is located in Hudspeth County (Figure 3-2). The basin is situated between the Eagle Mountains along the south-southwest, the Diablo Plateau along the north, and the Carrizo and Van Horn Mountains along the east. The drainage area of the bolson watershed is estimated to be 560 mi$^2$ (Gates and others, 1980), and the basin fill covers an area of 156 mi$^2$. Only the southeastern part of the basin is regarded as having potential for the development of ground-water resources (Gates and others, 1980; Darling and others, 1994; Darling, 1997). The Eagle Flat Bolson is not a source of supply for municipalities in Hudspeth County. The unincorporated Town of Sierra Blanca, located in the western region of the basin, gets water from a wellfield operated by the Town of Van Horn in Wild Horse Flat.

**Recharge**

The southeastern part of the Eagle Flat watershed covers an area of 250 mi$^2$. The recharge zone within this area is estimated to cover an area of 180 mi$^2$. Using a rough relation between recharge and drainage area, annual recharge within the 180-mi$^2$ recharge zone of southeastern Eagle Flat yields an estimated 1,060 acre-ft of recharge per year. This is based on the assumption that 1 percent of the average annual precipitation of 11 inches is converted to recharge within this area.

**Storage**

The storage zone within southeastern Eagle Flat covers an area of 70 $mi^2$. Assuming that saturated thickness beneath this area is 400 feet on average, along with a specific yield of 7.5 percent (Gates and others, 1980) and a recovery factor of 30 percent, Eagle Flat yields an estimate of 409,000 acre-ft of recoverable water in the basin.

**Water Quality**

Ground water in southeastern Eagle Flat typically contains less that 500 mg/l of dissolved solids (Gates and others, 1980; Darling and others, 1994; Darling, 1997). The low concentration of dissolved solids is probably related to the high percentage of insoluble volcanic debris that makes up much of the basin fill.

**Availability**

Only scattered ranch wells produce ground water from southeastern Eagle Flat. The bolson aquifer, therefore, is not expected to manifest any depletion over the period 2000 through 2050, such that availability should be equal to the volume of recoverable water in storage (Table 3-1).

**3.7.3.4 Bone Spring-Victorio Peak Aquifer**

**Location**

The Bone Spring-Victorio Peak aquifer underlies the Dell Valley area of northeastern Hudspeth County (Figure 3-1). Dell Valley lies between the Salt Flat Basin and the Guadalupe Mountains on the east and the Diablo Plateau on the west. The aquifer, which extends northward into the Crow Flats area of New Mexico, is used primarily for irrigation. It is also the public water-supply source for Dell City (Ashworth, 1994).

The aquifer consists of carbonate rocks (limestone and dolomite) of early Permian age. Ground water in the aquifer occurs under water-table conditions in interconnected solution cavities that formed along joints, fractures and bedding planes. The solution cavities are of variable size and dimension. Water-bearing zones have been encountered in wells as deep as 2,000 ft. The productivity of a well completed in the aquifer is related to the number and size of cavities penetrated by the well bore. Well yields are reported to range from 150 gallons per minute (gpm) to as much as 2,200 gpm. The depth to ground water within the irrigated region of Dell Valley ranges from approximately 35 ft along the eastern side of the valley to 325 feet on the west (Ashworth, 1994).

**Recharge**

There are four principal components of recharge to the Bone Spring-Victorio Peak aquifer (Ashworth, 1994):

- Precipitation that falls over watersheds that drain toward Dell Valley infiltrates rapidly along fractures and solution features such as sinkholes;
- The Sacramento River, which drains the Sacramento Mountains of New Mexico, discharges large volumes of water to the subsurface in the lowlands that border the mountain catchments;
- Lateral inflow of ground water from areas to the north and the west; and
- Return flow from irrigation in Dell Valley.

Average annual recharge from all of the above sources is estimated to be within the range of 90,000 to 100,000 acre-ft (Ashworth, 1994). This estimate was based on Ashworth's (1994) observation that water levels in the Dell Valley area appeared to stabilize at rates of withdrawal of between 90,000 to 100,000 acre-ft. Lower water levels appeared to be associated with higher pumping rates.

**Storage**

There is no reliable published estimate of the volume of recoverable ground water stored in the Bone Spring-Victorio Peak aquifer.

**Water Quality**

Ground water of the Bone Spring-Victorio Peak aquifer is slightly saline to moderately saline. Total dissolved solids range from approximately 1,000 to more than 6,500 mg/l. The average is about 3,500 mg/l. The highest concentrations occur along the eastern half of the valley, where concentrations exceed 5,000 mg/l.

During the irrigation season, the flow of ground water is highly influenced by pumping wells, which create cones of depression in the water table. The cones of depression may induce the flow of highly saline water from the Salt Flats toward the pumping wells by reversing the flow of ground water along the eastern side of the valley. Chemical analyses of wells along the eastern border of the valley have not indicated a significant influx of saline water (Ashworth, 1994).

**Availability**

The volume of ground water available on an annual basis in the Dell Valley region is related to rates of water-level decline and water quality. Ashworth (1994) concluded that annual withdrawals of 90,000 to 100,000 acre-ft could be maintained without lowering the water table so much it induced the flow of saline water from the Salt Flats. During times of drought, production of as much as 141,000 acre-ft may be maintained for one season without risking the encroachment of highly saline ground water from the Salt Flats to the east.

### 3.7.3.5 Igneous Aquifer

**Location**

The Igneous aquifer, as shown in Figure 3-1, occurs in three separate areas of Far West Texas (Brewster, Presidio, and Jeff Davis Counties). The figure is deceptive; however, as it creates the impression that the designated areas are separated by large sections of land with little or no potential for ground-water storage or development. The depiction in Figure 3-1, however, is an artifact of the limited amount of information between each of the shaded areas. Each delineated area, for example, is the primary source of water for a county seat, e.g., Alpine (Brewster County), Marfa (Presidio County), or Fort Davis (Jeff Davis County). It is highly likely that large volumes of water are stored beneath other sections of land that are not colored on the map (Hart, 1992), such that the boundaries of each of the shaded areas should ultimately be expanded as more is learned about the hydrogeology of other parts of the Davis Mountains.

The Igneous aquifer consists of many layers of highly fractured and faulted igneous rocks. Ground water occurs under water-table conditions in fractures and also in the coarse-grained debris that fills the bottoms of canyons and also forms alluvial fans that spread out into small basins. The area of each delineated zone as shown in Figure 3-1 is: Brewster County, 270 $mi^2$; Presidio County, 400 $mi^2$; and Jeff Davis County, 115 $mi^2$.

**Recharge**

Recharge occurs as a result of the rapid percolation of precipitation along the fractures in the igneous rocks and in the coarse-grained detritus shed from the mountains. It is assumed that average rainfall over the area is approximately 16 inches, based on measurements at Alpine, Marfa and Fort Davis (Bomar, 1995). The amount of precipitation converted to recharge is 2.5 percent of average annual precipitation. Based on the above relationships, it is estimated that average annual recharge is 5,800 acre-ft in Brewster County, 8,500 acre-ft in Presidio County and 2,500 acre-ft in Jeff Davis County.

**Storage**

Municipal and industrial supply wells drilled to depths of 800 feet indicate that the average saturated thickness of the Igneous aquifer is at least 600 feet. Assuming a specific yield of 10 percent, the volume of recoverable ground water would be 3.1 million acre-ft in Brewster County, 4.6 million acre-ft in Presidio County and 1.3 million acre-ft in Jeff Davis County.

**Water Quality**

Ground water from the Igneous aquifer is considered acceptable for municipal and industrial uses. Dissolved solids are generally within the range of 300 to 500 mg/l, but elevated levels of fluoride, a common constituent of igneous rocks, are common. Fluoride has been cited as a cause of dental fluorosis (mottling and pitting of teeth).

**Availability**

For all years over the period 2000 through 2050, the recharge calculations in this report exceed total demand for ground water. Thus, on a regional basis, there is no indication that the aquifer will be depleted (Table 3-1).

**3.7.3.6 Edward-Trinity (Plateau) Aquifer**

**Location**

The Edwards-Trinity (Plateau) aquifer of Far West Texas (Figure 3-1) is the westernmost extension of a vast ground-water system that underlies the Edwards Plateau east of the Pecos River and the Stockton Plateau west of the River. The aquifer is exposed over an area of 4,690 $mi^2$ in Terrell (2,350 $mi^2$), Brewster (1,460 $mi^2$), Jeff Davis (530 $mi^2$) and Culberson (350 $mi^2$) Counties (Figure 3-1). It is the source of municipal water for the City of Sanderson (Terrell County); a source of domestic water in Brewster, Culberson, and Terrell Counties; a source of irrigation water in Brewster and Terrell Counties; a source of stock water in all four counties; and a source of water for oil and gas operations in Terrell County. Total production from the aquifer in 1996 was 1,935 acre-ft. Of this amount, Brewster and Terrell Counties accounted for 780 and 1,040 acre-ft of production, respectively.

The aquifer consists of saturated sediments of the Cretaceous age Trinity Group formations and the overlying carbonate rocks (limestone and dolomite) of the Comanche Peak, Edwards, and Georgetown formations. Ground water occurs under water-table conditions in the four Far West Texas counties.

The hydrogeology of the Edwards-Trinity (Plateau) aquifer in Far West Texas is not understood as well as in areas to the east, where the aquifer is a major source of supply for the municipal, industrial and agricultural sectors of the economy. Much of the uncertainty regarding the aquifer in Far West Texas is a direct result of the region's low population density and the access that residents of the region have to other sources of ground water.

**Recharge**

There is no reliable published estimate of the amount of average annual recharge to the Edwards-Trinity (Plateau) aquifer in Far West Texas. In Brewster, Jeff Davis and Culberson counties, the aquifer is probably recharged by the infiltration of water from streams draining mountains and highlands bordering the aquifer and by infiltration of precipitation that falls directly on outcrops. In Terrell County, recharge probably occurs by infiltration of precipitation through fractures and sinkholes. The Edward-Trinity (Plateau) aquifer recharge estimates in this report are based on the assumption that 1 percent of average annual precipitation is converted to recharge. Assuming precipitation averages of 14 inches for Terrell County, 12 inches for Brewster County, 14 inches for Jeff Davis County, and 10 inches for Culberson County yields the following estimates of recharge: Terrell County, 17,500 acre-ft; Brewster County, 9400 acre-ft; Jeff Davis County, 3,900 acre-ft; and Culberson County, 1,800 acre-ft.

**Storage**

Because of the small number of wells producing from the Edwards-Trinity (Plateau) aquifer in Far West Texas, Barker and Ardis (1996) did not project saturated thicknesses into western Terrell County, or into any of the areas where the aquifer is found in Brewster, Jeff Davis, and Culberson Counties. Throughout the central and eastern areas of Terrell County, however, the saturated thickness of the formation was shown as varying from 300 feet in the northernmost area of the county to more than 1,000 feet along the border with Mexico. The average for this part of Terrell County is probably 500 feet. It is assumed, in this report, that average saturated thickness in the westernmost extent of the aquifer is 100 feet. Specific yield is 4 percent (Muller and Price, 1979), and the recovery factor is assumed to be 30 percent. Based on the inferred thicknesses and the specific yield, the volume of recoverable water in storage in the Edwards-Trinity (Plateau) aquifer is estimated to be: 9.02 million acre-ft for Terrell County, 1.123 million acre-ft for Brewster County, 406,000 acre-ft for Jeff Davis County and 266,000 acre-ft for Culberson County.

**Water Quality**

The quality of most ground water in the Edwards-Trinity (Plateau) aquifer in most of Far West Texas is acceptable for human consumption. TWDB well records indicate that the TDS of most ground water is less than 1,000 mg/l.

**Availability**

Because total demand in each of the four counties is less than the estimated average annual recharge, it is unlikely that the aquifer will be depleted during periods of drought. Hence, the volume of water available should be equal to the volume of recoverable water in storage (Table 3-1).

### 3.7.3.7 Capitan Reef Aquifer

**Location**

The Capitan Reef (Figure 3-1) formed along the margins of the Delaware Basin, a Late Paleozoic sea. In Texas, the reef formed along the western and eastern edges of the basin in arcuate strips 10 to 14 miles wide. The reef is exposed in the Guadalupe and Apache Mountains of Culberson County and in the Glass Mountains of Brewster County. In other areas, the reef is found only in the subsurface. It extends northward into New Mexico, where it is a source of fresh water for the City of Carlsbad. The aquifer is not a source of municipal supply for cities in Texas. Most of the ground water pumped from the aquifer in Far West Texas is used for irrigation in Culberson and Hudspeth Counties.

The Capitan Reef aquifer is composed of up to 2,000 feet of massive, vuggy to cavernous dolomite and limestone, bedded limestone and reef talus. In many areas of Culberson and Hudspeth Counties, the yields of wells are commonly more than 1,000 gpm. Further to the south, in the Apache Mountains of Culberson County, well yields appear to be in the range of 400 gpm. There is no reported production data for the Glass Mountains portion of the Capitan Reef.

### Recharge

Muller and Price (1979) estimate that effective annual recharge of the Capitan Reef is 12,500 acre-ft. Of this amount, 2,500 acre-ft were attributed to the infiltration of precipitation in the Diablo Farms area of Culberson County, and 10,000 acre-ft were estimated for the Apache Mountains. In Brewster County, 110 $mi^2$ of Capitan Reef is exposed in the Glass Mountains. If average annual precipitation over the mountains is approximately 14 inches (Larkin and Bomar, 1983), and if approximately 2.5 percent of total precipitation is converted to recharge, then about 2,100 acre-ft of recharge can be added to the total.

### Storage

There is no reliable published estimate of the volume of recoverable ground water stored in the Capitan Reef aquifer.

### Quality

Muller and Price (1979) reported that TDS in the vicinity of the Diablo Farms in Culberson County is 850 to 1,500 mg/l. In the Apache Mountains area, ground water may be fresh in the central areas of the mountains and slightly saline in other areas.

### Availability

Because of the difficulty estimating the volume of water in storage in the Capitan, Muller and Price (1979) defined availability for the aquifer as the sum of recharge and the amount withdrawn from storage. This approach yielded an estimate for Culberson County of 383,000 acre-ft per year (Table 3-1). Another 5,000 acre-ft of availability has been estimated by LBG-Guyton for parts of the Capitan Reef that lie beneath Hudspeth County. Production from the Capitan aquifer in Brewster County has not been reported by the TWDB. However, the aquifer in this county is a source of water only for ranches in the Glass Mountains, and it is likely that total production is 100 acre-ft or less per year. Hence, at a minimum, availability in Brewster County is probably about 2,000 acre-ft per year (Table 3-1).

### 3.7.3.8 Marathon Aquifer

**Location**

The Marathon aquifer is located entirely within the north-central area of Brewster County (Figure 3-1). It is the source of municipal supply for the Town of Marathon, and of domestic and stock water for ranches in the area.

The Marathon area is underlain by complexly faulted and folded Paleozoic rocks having a total thickness of 21,000 feet. Figure 3-1 delineates the 390-mi$^2$ area in which the rocks that make up the Marathon aquifer are exposed in Brewster County. The aquifer ranges in thickness from 350 to 900 feet. Ground water occurs under unconfined conditions in crevices, joints and cavities. The most significant water-bearing formation of the aquifer is the Marathon Limestone (early Ordovician age). Artesian conditions are common in areas where the Paleozoic rocks are buried beneath younger formations. The depth to ground water is generally less than 150 feet, and depths less than 50 feet are not uncommon. Most wells are generally less than 250 feet deep (DeCook, 1961; TWDB, 1997).

**Recharge**

The aquifer is recharged by infiltration of precipitation that falls directly on the area in which the Paleozoic rocks are exposed, by stream runoff and by underground inflow from outside the area. Muller and Price (1979) estimated that recharge attributable to precipitation is as much as 18,300 acre-ft per year, or 2.5 percent of average annual precipitation. This would require a recharge area nearly three times the size of the 390-mi$^2$ area delineated in Figure 3-1. Recharge attributable to precipitation directly over the area shown in Figure 3-1 is 7,280 acre-ft, based on average annual rainfall of 14 inches and infiltration of 2.5 percent of average annual precipitation. The lower recharge estimate is used in the availability analysis.

**Storage**

There are no reliable published estimates of the volume of recoverable ground water in the Marathon aquifer. If, however, it can be assumed that (1) at least 200 feet on average of saturated thickness exists beneath the 390-mi$^2$ outcrop area, (2) the specific yield of the aquifer is

10 percent, and (3) the recovery factor is 30 percent, then the volume of recoverable ground water may be as much as 1.5 million acre-ft.

**Quality**

Ground water of the Marathon aquifer is generally of good quality. TDS are in the range of 500 to 1,000 mg/l, and the water is considered to be very hard. Fluoride may also exceed recommended limits in many areas.

**Availability**

Total annual production from the Marathon aquifer is less than annual recharge, using either the 18,300 acre-ft estimated by Muller and Price (1979) or the lower estimate of 7,280 acre-ft in this report. Hence, annual availability during drought years should be equal to total storage, or 1.5 million acre-ft (Table 3-1).

**3.7.3.9 Rustler Aquifer**

**Description**

The Rustler aquifer is located in eastern Culberson County, where it is exposed in a southwest-trending belt that begins at the northeast corner of the county (Figure 3-1). The aquifer dips toward the east, and is found in the subsurface in easternmost Culberson County and Jeff Davis County. Approximately 803 $mi^2$ of land in Far West Texas are underlain by the Rustler aquifer. The Rustler aquifer is a source of water for irrigation and livestock. High concentrations of dissolved solids render the formation unsuitable as a source of municipal and domestic supply. The Rustler aquifer consists mainly of dolomite, limestone, and gypsum of the Rustler Formation (Permian age). Ground water is produced primarily from solution channels, caverns and collapsed breccia zones. The aquifer is under water-table conditions in the recharge zone of the Rustler aquifer in eastern Culberson County and is under artesian conditions elsewhere (TWDB, 1997).

**Recharge**

The Rustler aquifer is recharged by infiltration of precipitation that falls directly over the outcrop area in Culberson County and by stream runoff. Muller and Price (1979) estimated annual effective recharge at approximately 4,000 acre-ft.

**Storage**

There are no reliable published estimates of the volume of recoverable ground water in the Rustler aquifer.

**Water Quality**

Ground water of the Rustler aquifer is not suitable for human consumption. However, it can be used for irrigation, livestock and oil reservoir water-flooding operations. Dissolved solids typically range from 2,000 to 6,000 mg/l. The highest TDS concentrations occur in the subsurface of counties to the east of Far West Texas. The TWDB (1997) reports only one area within the recharge zone of southern Culberson County where TDS is less than 1,000 mg/l.

**Availability**

The TWDB (1997) estimated that average annual availability of ground water from the aquifer is equal to the amount of average annual recharge, 4,000 acre-ft (Table 3-1).

**3.7.3.10 Unaccounted Ground-Water Resources**

Also shown in Figure 3-1 are large areas of Far West Texas that are not underlain by major or minor aquifers (e.g., the Diablo Plateau of central and northern Hudspeth County). The map, however, should not be interpreted as an indication that such areas are devoid of ground water as much as a reflection of the current level of understanding of the extent of known ground-water resources in the region. The rocks that make up the subsurface of the Diablo Plateau of central and northern Hudspeth County, for example, may in fact have large volumes of ground water in storage. The plateau, however, has not been sufficiently evaluated by hydrogeologists to warrant definite conclusions regarding its status as a potential source of ground water at this time. Relatively few exploration wells have been drilled on the plateau. Consequently, factors such as hydrostratigraphy and important hydraulic parameters (e.g., porosity, hydraulic conductivity and transmissivity) are largely unknown.

Similarly, very little is known about the potential of many of the igneous and volcanic rocks of Brewster, Jeff Davis and Presidio Counties to support anything other than the current level of interpretation. Further evaluation will be needed to arrive at a better understanding of the water-resource development potential in these areas.

### 3.8 WATER EXPORTED FROM FAR WEST TEXAS

Jeff Davis County is the only county from which water is exported to other areas within or outside of the region. As shown by the table below, the City of Alpine pumps approximately 960 acre-ft per year from five wells in the Musquiz field of southern Jeff Davis County. All other exports go to Reeves County. In 1998, the City of Balmorhea and the Madera Valley WSC extracted about 95 acre-ft and 101 acre-ft respectively, from the Balmorhea Alluvium, and the USBR has rights for diversions of up to 18,900 acre-ft from Phantom Creek for irrigation use in Reeves County.

| Received By | Receiving County | Source | Amount (Acre-ft/Year) | Remarks |
|---|---|---|---|---|
| City of Alpine | Brewster | Igneous Aquifer | 958 | Pumpage from five wells in Musquiz field |
| City of Balmorhea | Reeves | Balmorhea Alluvium | 95 | Pumpage from one well |
| Madera Valley WSC | Reeves | Balmorhea Alluvium | 101 | Pumpage from two wells |
| U.S. Bureau of Reclamation | Reeves | Phantom Creek | 18,900 | Permitted diversion for irrigation |

## 3.9 THREATS TO NATURAL RESOURCES

Eighteen species of mussels in the Rio Grande and the Pecos River are endangered. A few species of plants in the area have been placed on the "watch list" of the Texas Organization for Endangered Species (TOES), a group of professionals formed in 1972 to study the plight of vanishing plant and animal species in Texas and to educate the public about the conservation of these species. From this watch list, plants that grow in or near the Rio Grande streambed or which require moistness from a stream are listed below. It is not known exactly what the effects of reduced flows of the Rio Grande would have on these plants, if any. The information is presented as extracted from TOES website (www.csdl.tamu.edu/FLORA/toes/toeshome.htm) for those to whom it would be of interest:

- *Aquilegia longissima* Gray - *Ranunculaceae* - ('longspur columbine') -- populations low or restricted. Known from Brewster, Jeff Davis, and Presidio counties; also Chihuahua, Coahuila, and Nuevo Leon. Typical habitat is cooler, wetter areas near waterfalls, perennial seeps, springs, etc., in humus and leaf litter over alluvium or on limestone or igneous bedrock walls in mountain canyons.
- *Populus angustifolia* James - *Salicaceae* - ('narrowleaf cottonwood') -- populations low or restricted. Known from Brewster and Culberson counties; widespread in western North America. Typical habitat is well-watered soils along streams, along the Rio Grande and at higher elevations in the Guadalupe Mountains.
- *Rorippa ramosa* Rollins - *Brassicaceae* - ('canyon watercress') -- populations low or restricted. Known from Brewster and Terrell counties; also Chihuahua, Coahuila, and Durango. Typical habitat is moist, fine textured, alluvial soils on floodplains and in beds of intermittent streams.

## 3.10 CLEAN RIVER PROGRAM AND FEDERAL CLEAN WATER ACT

The state's Clean River Program administers federal Clean Water Act directives through TNRCC's Water Quality Inventories. TNRCC is the responsible agency for identifying water quality problems within the Water Quality Inventory. Detailed excerpts from the Water Quality Inventory are included within the Appendix; these excerpts give information on stream segments within the region. However, the Inventory does not identify sources of water quality problems, as in most cases the problems are "non-point source" pollutants. TNRCC, EPA and other agencies have discussed and researched methodologies by which non-point source pollution could be located and quantified through modeling, but thus far modeling efforts have been less than satisfactory.

## 3.11 WATER SUPPLY AVAILABILITY SUMMARY

Tables 3-1, 3-2 and 3-3, generated as part of the availability evaluations in Chapter 3, provide summary information under Drought-of-Record conditions for surface-water and ground-water resources in Far West Texas. Table 3-1 presents information by county on the water supply that can be obtained from four surface-water sources and 16 ground-water sources in the region. The Rio Grande is divided into an "Upper" segment with supply allotted to the Rio Grande Project from Elephant Butte Reservoir. Water supply in the "Lower" segment, from Fort Quitman downstream, is derived primarily from flows of the Rio Conchos in Mexico. The third surface-water supply source is the Pecos River, and the fourth is Phantom Creek in Jeff Davis County. Based on the Drought-of-Record assumption that underlies the availability analysis, the following Table 3-1 observations can be made:

- Surface-water supply in the Upper Rio Grande reflects the lowest historical annual allotment from Elephant Butte Reservoir. In 1964, this amount was 22,773 acre-ft. An insufficient amount of flow occurs in the channel at this release level to meet the needs of water users in the El Paso area.
- Flow in the Lower Rio Grande is not dependent on releases from Elephant Butte. The amount of water available to the Lower Rio Grande is largely related to the discharge of water from the Rio Conchos and other tributaries. Texas holds rights to 28,274 acre-ft of water from the Lower Rio Grande. The annual average lower limit required release from Mexican tributaries by the 1944 Treaty is 350,000 acre-ft. However, the lowest flow recorded by a gauge below the confluence of the Rio Conchos with the Rio Grande is 35,438 acre-ft per year.

- Historical flow measurements from gauging stations along the lower segment of the Pecos River indicate virtually no flow under Drought-of-Record conditions.
- The lowest flow in Phantom Creek is estimated to be 1,460 acre-ft per year.

The right to use water from the navigable streams and lakes is permitted through the State of Texas. Current permit holders in the region and reported diversions from 1990 through 1999 are listed in the Chapter 3 appendices. No permits are listed as expiring during the 50-year planning period.

Maximum available ground-water supplies are estimated for aquifers that occur in bolson deposits, river alluvium, igneous rocks and limestone formations. It is important to note that, with respect to ground water, the large numbers for most aquifers listed in Table 3-1, exceed by many orders of magnitude, the amount of ground water that can be extracted by all users in any given year, under the demand projections of the TWDB (Chapter 2). As such, these numbers indicate the total volume of recoverable water (fresh and brackish) in storage. Observations made on Table 3-1 ground-water estimates, as assumed under Drought-of-Record conditions are as follows:

- Both the Hueco and Mesilla Bolson aquifers in El Paso County have been developed principally for municipal and industrial uses. Both basins have experienced water-level declines over time. With the assumption that little surface water will be available during a Drought-of-Record, the mining of these aquifers will advance at a more rapid pace. Table 3-1 assumes Drought-of-Record conditions and no new water-supply development. Under these conditions, the Mesilla Bolson aquifer would be depleted by 2020, and the Hueco Bolson aquifer would be depleted by 2030.
- Among the six rural counties, the volume of recoverable ground water in storage varies from a low of approximately 267,000 acre-ft in Green River Valley to more than 13 million acre-ft in the Ryan Flat aquifer.
- The amount of recoverable water in storage should remain relatively constant over the planning period for the Edwards-Trinity, Bone Spring-Victorio Peak, Capitan Reef, Igneous, Marathon, Rustler, Red Light Draw, southeast Eagle Flat

and Green River Valley aquifers. Total demand in these areas is not projected to exceed total recharge.

- Small reductions in recoverable storage are projected for the Presidio-Redford Bolson, Wild Horse-Michigan Flats, Lobo Valley and Ryan Flat aquifers.

Table 3-2 reflects the amount of water that would be available in future decades from specific existing water-supply sources for each city and water-use category as defined in Table 2-8 (Chapter 2). This is dependent on the current physical ability of each entity to retrieve, store, treat and deliver water through transmission lines. This includes the number of producing wells, age and condition of storage and transmission facilities, water treatment capacity, and other related factors. Table 3-3 shows the amount of water from unique existing supply sources that will be available in future decades during Drought-of-Record conditions to the Major Water Providers.

In Chapter 4, water-supply data in Chapter 3 are compared with water-demand data in Chapter 2 to identify cities and water-use categories that may experience water-supply shortages in the future. Strategies to meet any potential supply shortages are developed in Chapter 5.

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# CHAPTER 4

# COMPARISON OF WATER DEMANDS WITH WATER SUPPLIES TO DETERMINE NEEDS

## 4.1 INTRODUCTION

The objective of Chapter 4 is to identify the communities and nonmunicipal water-use groups in the counties of Far West Texas that are likely to experience either water surpluses or shortages over the period 2000 through 2050 during Drought-of-Record conditions. Expected water-supply availability, as listed in Table 4-1, is a comparison of the demand projections in Chapter 2 with the supply projections in Chapter 3. The quantities represent annual projections and are predicated on the following assumptions:

- Drought-of-Record conditions are characteristic for each of the years shown in Table 4-1. Normal climatic conditions are characteristic of intervening years.
- No new infrastructure development over the period 2000 through 2050. All demands must be serviced by currently existing infrastructure.
- No changes in water rights occur over the period 2000 through 2050.
- The total supply is terminated when it exceeds the supply source in Table 3-1.

Table 4-1 was constructed by subtracting demand from supply. Positive numbers indicate surpluses (acre-ft), and negative numbers indicate shortages (also in acre-ft). An entry of "0" (zero) indicates that supply and demand are balanced for that year. Small shortages (e.g., less than 6 acre-ft) were calculated for the Manufacturing sector of Brewster, Culberson and Hudspeth Counties, and the Mining sector of Presidio County. These deficits were balanced out to zero to show no shortage of water. This was based on expectations that deficits of 6 acre-ft or less probably lie within the margin of error of the estimates in Chapters 2 and 3 and, as such, may not indicate real shortages under Drought-of-Record conditions. Table 4-1 should be regarded as a general guide to the amount of potential water-supply shortages and should be used to assist planners in their efforts to develop strategies that will ensure access to adequate quantities of water to meet the future needs of all users in Far West Texas.

## 4.2 RURAL COUNTIES SUMMARY

All cities in the six rural counties (Brewster, Culberson, Jeff Davis, Hudspeth, Presidio and Terrell) are projected to have adequate supplies of water for the planning period. The largest surpluses within this group are calculated for the Cities of Alpine, Marfa and Presidio. The smallest surpluses are calculated for Dell City. Thus, the basic water needs of all cities in the Rural Counties category appear to be assured, provided the assumptions on which the projections are based remain unchanged over the period 2000 through 2050.

Shortages are projected within the County-Other sector for Brewster, Hudspeth, Jeff Davis, Presidio and Terrell Counties. These deficits are related to population growth in unincorporated areas and to the requirement that only existing wells be used in the calculation. Culberson County shows small surpluses over this interval.

For the Manufacturing sector, supply and demand are projected to be equal in Brewster, Culberson and Hudspeth Counties – that is, neither surpluses nor shortages are foreseen for this area of economic activity. This sector is not listed as a user group in Hudspeth, Jeff Davis, and Presidio Counties.

In Brewster County, the Mining sector is projected to be in a state of shortage for each of the six Drought-of-Record years. Small surpluses are shown for Hudspeth and Terrell counties, and supply and demand are balanced in Presidio County. The largest surpluses within this sector are listed for Culberson County. This surplus is of special interest, as it was calculated based on demand projections that TWDB made before McMoran's sulfur mine north of Van Horn closed in 1999. Thus, the Mining sector surplus for Culberson County should be larger than shown for each year in Table 4-1.

Within the Rural Counties agricultural sector, irrigation users have overall countywide surplus amounts of water for each Drought-of-Record year. However, not all specific sources will be reliable. In Hudspeth County, Rio Grande water is not expected to be available, and amounts of ground water available from the Rio Grande Alluvium are limited due to quality restrictions. During drought-of-record conditions, irrigated agriculture in the Hudspeth County Conservation and Reclamation District #1 will be severely impacted and a shortage of 90,000 acre-feet of water is expected. Surplus ground water in the Dell Valley area of Hudspeth County creates the positive supply shown in Table 4-1. Surplus supplies are indicated in Culberson and Jeff Davis Counties, which both rely only on ground water. Brewster, Presidio and Terrell Counties are projected to have surplus irrigation supplies derived from ground-water sources and the Lower Rio Grande. With regard to water availability for livestock, all of the Rural Counties should have adequate water, except Jeff Davis County. This deficit in Jeff Davis County is attributable to slightly higher projected livestock water demand than what was historically used.

**4.3 EL PASO COUNTY SUMMARY**

Most of the municipal areas of El Paso County are shown to have sufficient water through the year 2020. The largest surpluses during this period of time are projected for the City of El Paso. Deficits are shown for Fort Bliss in the years 2000 and 2010; however, these shortages would likely be met by purchasing additional water from El Paso.

By the year 2030, both the Hueco and Mesilla Bolsons may be depleted of fresh water, based on the Drought-of-Record scenario. From 2030 through 2050, deficits are shown for all but two cities in El Paso County. The deficits indicate the large volumes of water that will be needed to replace the exhausted sources of fresh ground water and the sharply diminished supplies of surface water. The two exceptions during this period of time are Hacienda del Norte and Horizon City. Both of these municipalities will rely on a mix of fresh water and brackish water up to 2030 and will switch to desalting brackish water after the fresh-water source is depleted.

Shortages are listed for all other nonmunicipal user-groups in El Paso County for most or all of the 50-year planning period. Increasing deficits for the County-Other and the Manufacturing sectors reflect growing demand throughout this period of time. Shortages for Steam Electric demand decrease over the period 2000 through 2020, and then remain constant at 6,000 acre-ft for the rest of the planning period. In reality, surplus supplies from El Paso would likely cover the shortages from 2000 to 2030. The Mining sector is in a deficit position for the year 2000 but is shown to have sufficient resources for the years 2010 and 2020. After 2020, the sector returns to a deficit situation, but the projected shortages decrease consistently through the end of the planning period.

The large shortages for the Irrigation sector are a result of markedly diminished flow in the Rio Grande during a Drought of Record. Deficits for the Livestock sectors are projected to remain constant at 78 acre-ft for each of the six Drought-of-Record years.

## 4.4 WATER SHORTAGES IN CIUDAD JUAREZ

Ciudad Juarez is developing a master plan to address population projections and water demand, and to identify sources of water needed to meet the projected demands over the next 20 years. Juarez expects population growth of 4.3 percent (more than 50,000 persons) per year. Based on this rate of growth, the City expects to have a water deficit by the year 2004. This scenario is based on the assumption that no new wells will be drilled. The City also does not expect to shut down wells that produce brackish water, especially in the high-demand area of downtown Juarez.

## 4.5 POSITIONS OF THE MAJOR WATER PROVIDERS

The positions of the Major Water Providers with respect to current water supplies are shown in Table 4-2. The large deficits listed for the El Paso County Water Improvement District #1 for the period 2000 through 2050 are attributable to no-flow conditions in the Rio Grande during each Drought-of-Record year. The surpluses shown for the El Paso Water Utilities/Public Service Board through the year 2020 reflect the use of fresh ground water when surface water is not available. Deficits from 2030 through 2050 will occur after the Hueco and Mesilla Bolsons are mined of all fresh water. Except for the year 2010, the El Paso County Water Control and Improvement District #4 is in balance with respect to both supply and demand. After depletion of all fresh ground water, deficits will occur for the remaining Drought-of-Record decade years. Supply and demand for the El Paso County Water Authority are shown as being in balance for all six Drought-of-Record decade years, based on the Authority's plans to meet all of the demand by desalinating brackish water. Finally, the Town of Van Horn is in a surplus position throughout the planning period because of its wellfield at Wild Horse Flat.

## 4.6 SOCIAL AND ECONOMIC IMPACT OF NOT MEETING WATER-SUPPLY NEEDS

A major task of this regional water plan is to describe the social and economic implications of not acting to meet anticipated water-supply needs, or conversely, the potential benefit to be gained from devising a strategy to meet a particular need. Collectively, the summation of all the impacts gives the region a view of the ultimate magnitude of the impacts caused by not meeting the entire list of needs. These summations should be considered a worst-case scenario for the region, since the likelihood of not meeting the entire list of needs is very small. The Regional Water Planning Group received technical assistance from the Texas Water Development Board (TWDB) in quantifying this socioeconomic impact through the methodology described below in Section 4.6.1.

Assessing the socioeconomic impacts of not meeting water-supply needs required the input of representatives of the different economic sectors of Far West Texas. To elicit comments from representatives of each economic sector, copies of the plan were made available to members of the RWPG and to the public as each chapter was completed. Written comments were requested, and oral comments were recorded at public hearings. A discussion of written and oral comments is found in Chapter 7, and responses to public comments are found in the appendix to Chapter 7. Meeting some demands may not be economically feasible.

Each water user group with a need is evaluated in terms of direct and indirect economic and social impacts on the region resulting from the shortage. Economic variables chosen by TWDB for this analysis include gross economic output (sales and business gross income), employment (number of jobs) and personal income (wages, salaries and proprietors net receipts). The effects of shortages on population and school enrollments are the social variables of the analysis. Declining populations indicate a deprecation of social services in most, but not all case, while declining school enrollment indicates loss of younger cohorts of the population and possibilities of strains on the tax bases, when combined with economic losses. The Regional Water Planning Group has the opportunity of identifying other impacts which may not be quantifiable but which certainly are important to the region.

### 4.6.1 Methodology

The Far West Texas Regional Water Planning Group submitted the identified water shortages to the TWDB by user group, in terms of acre-feet of water per year and the year in which the shortage first appears. The user groups evaluated were irrigation, livestock, mining, steam-electric, manufacturing and municipal water users. The Far West Texas Region listed specific user groups within each county/river basin combination that will likely experience a shortage in Table 4-1. TWDB staff then determined production responses by sector, or water use type. In the case of irrigation, impacts of irrigation water shortages are determined through the use of a linear programming model called GAMS developed by Texas A & M University (TAMU). This model projects the number of acres that would be profitable (under the more ideal condition of adequate water) and therefore gives a baseline of comparison to the number of acres that cannot be profitable due to lack of irrigation water. For the other water use types, TWDB staff calculated water use coefficients specific to each water use type based on in-house data or data provided by the firm of Minnesota Implan Group. This firm also developed a model used by TWDB – the IMPLAN regional socioeconomic model, which gives the impact of the water shortage on employment (in terms of number of persons who would lose jobs if the water shortage were not met) and the impact of the water shortage on gross business output (in terms of 1999 US dollars).

These impacts are compared to baseline. Another TAMU model, called TAMS developed by the university's Department of Rural Sociology, outputs the impact of the water shortage on population and on school enrollment. These impacts are purely social. The final economic impact of lost income is also quantified.

### 4.6.2 Impacts of Unmet Water Needs

The Far West Texas Regional Water Planning Group identified individual water user groups that showed an unmet need during drought-of-record supply conditions for each decade from 2000 to 2050. The region projected that total water demands would grow from 509,000 acre-feet in 2000 to 554,000 acre-feet in 2030, rising steadily to 586,000 acre-feet in 2050.

Under extreme supply limitations and with no management strategies in place, water shortages would amount to 159,000 acre-feet in 2000, rising to 381,000 acre-feet in 2030 and to 418,000 acre-feet by 2050. The projected water shortages of the region amount to about 23 percent of the forecasted demand by 2020, rising to 70 percent of demand in 2040, and to 71 percent of demand in 2050. This means that by 2050 the region would be able to supply only 29 percent of the projected demand unless supply development or other water management strategies are implemented. (See Figure 4-1 and Table 4-3)

**Economic Growth Limitations**

The difference between expected future growth, unrestricted by water shortage, and expected growth restricted by unmet water demands provides the measure of impact.

**Employment**

Left entirely unmet, the level of shortage in 2010 results in 43,000 fewer jobs than would be expected in unrestricted development (without water shortages) by 2010. The gap between unrestricted and restricted job growth grows to 319,000 by 2030, and to 383,000 jobs that the restricted economy could not create by 2050.

**Population**

The forecasted population growth of the region would be economically restricted by curtailed potential job creation. This in turn causes both an outmigration of some current population and an expected curtailment of future population growth. Compared to the baseline growth in population, the region could expect 101,000 fewer people in 2010, growing to 709,000 fewer in 2030 and 851,000 fewer in 2050. The expected 2050 population under the severe shortage conditions would be 54 percent lower than projected in the region's most likely growth forecast.

**Income**

The potential loss of economic development in the region amounts to 12 percent less regional income than the projected baseline income in 2010, with the gap growing to 67 percent less than baseline in 2030. By 2050 the region would have 64 percent less income than is currently projected assuming no water restrictions.

**Water User Groups with Shortages**

The economic and social impact of an unmet water need varies greatly depending on the type of Water User Group for which the shortage is anticipated. On a per acre-foot basis, the largest impacts will generally result from shortages in manufacturing and municipal uses, while shortages for irrigation will typically result in the smallest impact. Table 4-4 presents the impacts of unmet water needs summarized for each of the six types of Water User Group by decade. The detailed results for each city and water-use category by region and basin are presented in TWDB Tables 9 and 10 in the Appendices.

The largest economic and social impacts of unmet water needs in the Far West Texas Region result from municipal and manufacturing water shortages, through 2020. Beginning in 2030, municipal needs, primarily of the city of El Paso, begin to dominate. In 2010, municipalities have unmet needs of 18,000 acre-feet, 10 percent of the total unmet needs. The economic impacts of this shortage (24,000 jobs, $1.6 billion in output, and $667,000 of income) represent approximately 54 percent of the total employment and income impacts. Beginning in 2030, unmet municipal needs increase to over 50 percent of total unmet needs and to close to 90 percent of total economic and social impacts. By 2050, unmet municipal needs total 242,000 acre-feet (58 percent of the total) resulting in 346,000 jobs not created, and reductions of $22 billion in potential output and $9.6 billion in potential income.

The impact of unmet manufacturing needs increases with each decade. In 2010, manufacturing has unmet needs of 10,000 acre-feet, 8 percent of the total unmet needs. The economic impacts of this shortage include loss of 17,000 jobs (40 percent of the total employment impact) and $2 billion in output (52 percent of the total output impact). In 2050, unmet manufacturing needs are just over 20,000 acre-feet (5 percent of the total) resulting in 34,000 jobs not created and reduction of $3.9 billion in output (15 percent of the total output impact).

Unmet irrigation needs represent the largest category of need through 2020, but due to the relatively small value of economic output added per acre-foot, the impacts of not meeting irrigation needs are considerably less. In 2010, irrigation has unmet needs of 101,000 acre-feet, 76 percent of the total. The economic impacts of the shortage (505 direct and indirect jobs,

$28.9 million in output, and $7.1 million in income) represent only about one percent of the total economic impact.

### 4.6.3 Interpretation of the Results

Users are cautioned not to assume that the entire list of needs with impacts is a prediction of future water disasters. These data simply give regional planners one source of information by which to develop efficient and effective means to meet the needs and avoid calamities.

Some clarification is needed to understand the impact numbers. The following points must be kept in mind when using the data:

- The impacts are expressed in terms of regional impact. Thus, individual water user group shortages are shown as they influence the entire region's economy and not just the limits of the direct impact. The total impact of municipal shortage for a particular city, for example, includes the direct impact within the city limits and the impact indirectly through the region. The indirect linkages were derived from regional economic models. There are no models for individual water user groups.
- While the entirety of an estimated impact applies to the region as a whole, a significant portion will generally be felt in the local area where the shortage occurs. An impact that is of a small magnitude relative to impacts of other shortages on other areas may be extremely severe if its magnitude is large relative to the size of the local economy. For example, while the absolute magnitude of agricultural shortages may appear to be small, the true severity of the impact may be much more significant to the surrounding rural area.
- Water supplies are calculated on drought-of-record levels. Shortages that show up for the 2000 decade and beyond are considered to be mostly the result of severe dry conditions; this contributes to the apparent abnormally large size of some impacts. This approach to supply analysis results in a worst-case scenario. Historically, most water user groups have at least partially met their needs through management of the remaining supplies, either by conservation, limitations on lower-valued uses such as lawn watering, or finding alternative

sources of water. The results in this report assume no applied management strategies. The entirety of the needs is not met in any fashion.

- The analysis begins by calculating water use coefficients–defined as production (dollars of sales to final customers, or final demand) resulting from use of an acre-foot of water. This measure is considered an average, not marginal, measure of water use. Thus, the analysis does not attempt to measure the market forces that would tend to drive the price of water higher or reserve limited water for the highest-valued uses, as it becomes scarce. The average value approach was used because the analysis is intended to show the present value in today's regional economies of differing amounts of water use. With this information analysts can answer the question, "How much water does it take to support the current level and structure of economic activity and population?" The baseline projections for the future of regional economies assume a continuation of this known relationship of volumes of water use to economic output, under current structures of use. The models do not attempt to estimate the market allocation of the resource among competing activities because this change in structure is considered a possible management strategy–relying on market forces to work in a water-marketing system. Marginal cost analysis would be necessary for evaluating such an approach.
- The municipal water use category includes commercial establishments. The impacts from even small shortages in many such establishments are considerably higher on a per-acre-foot basis than in any other category. Thus, relatively small Municipal shortages can have a very large amount of economic impact, since the analysis assumes a direct relationship between curtailed water use and lost economic production. Since this analysis is intended to provide impacts without assuming any strategies, the normal response of conservation programs is not assumed. The impact data appear to overstate the Municipal category, but the results are consistently measured, since no response to the shortage is assumed

that would mitigate loss of critical water used in commercial and residential settings.

- The sizes of the projected impacts do not represent reductions from the current levels of economic activity or population. That is, the data are a comparison between a baseline forecast, assuming no water shortages, and a restricted forecast, based on the assumption of future water shortages. In some cases with severe water shortages, the regional economy could actually decline dropping employment below current levels. For most regions, however, the measurement of impact represents an opportunity cost, or lost potential development that would be foregone in the absence of water management strategies.

# CHAPTER 5

# IDENTIFICATION, EVALUATION AND SELECTION OF WATER MANAGEMENT STRATEGIES

## 5.1 INTRODUCTION

In the previous chapter, cities and water-use categories were identified that have, under drought-of-record conditions, water demands in excess of currently available supplies. The purpose of this chapter is to provide an evaluation of potential strategies that might be used by each of these entities and categories to meet potential supply deficits. The evaluation of each strategy presented in this chapter is an estimate of the potential benefit that might result from its implementation. Strategy evaluations are preliminary and, in most cases, have not had the benefit of a full feasibility study. Cost estimates in particular should be considered preliminary. Strategies presented in this plan represent recommendations; it remains the responsibility of each entity to implement the strategy if it so chooses.

## 5.2 STRATEGIES AVAILABLE FOR CONSIDERATION

Numerous strategies are available for water-supply planning. While some strategies are designed to reduce water use, others are intended to produce additional supplies. A combination of the two types often leads to the greatest benefit. The following general strategy alternatives were considered during the evaluation and selection process. A degree of overlap may be observed in a number of the strategies.

- Water conservation - Water conservation includes those practices, techniques, and technologies that reduce the consumption of water, reduce the loss or waste of water, and improve the efficiency in the use of water. Examples of water conservation may include such practices as the use of water-efficient turf irrigation equipment, the use of water-saving plumbing fixtures in the home, and the detection and repair of leaks in water conveyance systems. TWDB water-use projections listed in Chapter 2 incorporate per capita water use estimates that reflect below normal rainfall conditions and an expected level of conservation. Expected conservation assumes levels of water savings that are likely to occur from both market forces and regulatory requirements. Advanced conservation measures are thus required under this strategy to generate additional water savings beyond those generated by expected conservation measures.

- Drought response planning – Water use can be reduced at critical times by establishing low-supply indicators and resulting supply curtailment procedures. A drought response plan developed in advance will allow the public to anticipate expected water shortages.
- Expanded use or acquisition of existing ground-water supplies – Additional water may be available by drilling additional wells in existing well field areas. Ground water may also be acquired through purchase or lease from existing well field areas.
- Enhancement of yields of existing supplies – Altering current delivery procedures may generate additional water. For ground water, additional pumping time or resizing pumps may increase the amount of water generated from existing wells. Coordinated reservoir operations can increase surface-water yields by reducing surface evaporation, capturing flood flows normally lost as spills, or reducing stream-bank losses. This strategy also includes any practice that may result in increasing the volume of water within a specific source. This may include brush control or weather modification.
- Conjunctive use of resources – The use of both surface and ground water may provide for the extended use of each source. Waters from the two sources may be blended to enhance overall quality of the combined supply. Conjunctive use can also increase water-supply availability by using surface supplies as much as possible and using ground-water supplies to meet peak demands and when surface water is not available.
- Conversion of rights to use water – The existing use of surface water may be converted to alternative uses by the voluntary alteration of the permit. This practice often occurs when the current permit holder chooses to market all or a portion of his water right. In the case of Rio Grande Project water between the New Mexico State line and Ft. Quitman Texas, the water rights have not yet been adjudicated, and the conversion of the use of Project water from agricultural to municipal use must be contracted with EPCWID #1 and the Bureau.

- Voluntary redistribution of water resources – this strategy is similar to "conversion of rights" but may include any water source including ground water.
- Brush control – Certain land-management practices such as brush control, native grass seeding, and prevention of over-grazing may benefit water supplies by increasing natural recharge to aquifers and sustained spring flows to generate higher base flows in surface water tributaries.
- Rainfall harvesting – The capture of rainfall from roofs or in small surface impoundments can provide water not normally available.
- Weather Modification – The artificial inducement of precipitation by injecting nuclei into potential rain-producing clouds is not a proven process; however, increasing evidence suggests that the technology may indeed generate additional rainfall under appropriate climatic conditions. Another form of weather modification is "hail suppression". The theory of hail suppression is to encourage the moisture in the air to condense and fall from the sky over a larger area before it has a chance to gather into a super-cell that might drop hail and rain over a smaller area but with greater intensity. Since the effectiveness of this process is still uncertain, it is suggested that before the procedure is implemented within the region, that all possible effects, both positive and negative, be considered. Insofar as either technique is already being utilized, the Planning Group recommends that it be suspended pending further research.
- Desalination – Technologies exist for treating water of marginal quality to a level of acceptability. Significant quantities of brackish water exist in Texas that can be effectively desalinated. Current limitations to the technology include cost and the disposal of the concentrate.
- Aquifer storage and recovery – ASR is a method of discretely storing surplus water harvested during periods of low demand or peak availability which is later retrieved to meet peak demand. With ASR, water is captured when it is abundant, rather than when it is needed. ASR does not increase the total available water supply but allows greater flexibility in determining when it is used.

- Irrigation conservation technology and equipment – Latest innovations in irrigation equipment combined with current knowledge of crop water needs allows for irrigation management practices that make the most efficient use of water supplies without generating unnecessary waste.
- Ground water transport – Ground water pumped from wells in specific aquifers may be transported to areas of need outside the boundary of the aquifer.
- Lining of irrigation canals – Lining of irrigation canals with an impervious layer of material (usually concrete) may significantly reduce seepage.
- Development and use of modern water treatment facilities – The development and use of state-of-the-art treatment technology can make available significant quantities of marginal quality water.
- Reuse of wastewater – Water is capable of being used numerous times before it moves out of the current system of use. Treated effluent may be reused for various purposes including industrial and power generating water supply, landscaping and agricultural irrigation, direct recharge of aquifers, and aesthetic and environmental uses.
- Protection of ground and surface water from contamination – Significant quantities of potentially usable water can be lost by activities that lead to the contamination of water. Management practices aimed at protecting water supplies from potential contamination are an effective form of water conservation.
- International water resource sharing – In certain locations specific water sources may be shared across international boundaries. In these circumstances, it is to the benefit of the citizens of both nations to work together to find ways to protect, conserve, and wisely use the shared resource.

## 5.3 REGIONAL WATER SUPPLY STRATEGY OPTIONS BY WATER-USE CATEGORY

While all water-use strategies are important, not all strategies are appropriate for all water-user needs. Various water-use categories have different quantity and quality requirements. Even within a single water-use category the strategy needs may vary. Likewise, there is variability in the ability to finance the implementation of certain strategies. The following discussions summarize significant strategies appropriate to each water-use category as they pertain to the Far West Texas Planning Region.

### 5.3.1 Municipal and County Other

Of all use categories, water used for human consumption generally has the most critical limitations. Water required for public supply and rural domestic consumptive use must meet relatively stringent quality standards. The volume of water needed is directly related to the population served, although this quantity can be modified to a degree by efforts aimed at conservation. Strategies of importance for municipal and rural domestic use can be divided into two categories. The first category represents those strategies concerned with the acquisition of sufficient water supplies of acceptable quality. These strategies may include expanded use or acquisition of existing ground-water supplies, ground water transport, desalination, and conversion of rights to use water. Water requirements for new homes established in rural areas are typically achieved by the drilling of domestic wells. The second category includes those strategies that more efficiently make use of existing supplies, such as water conservation, drought response planning, conjunctive use of resources, aquifer storage and recovery, and reuse of wastewater.

### 5.3.2 Manufacturing and Industrial

Although some manufacturing and industrial activities require extremely pure water, quality requirements for most uses are less stringent. Strategies thus include consideration of acquiring needed quantities that meet specific minimal quality limitations. The City of El Paso will continue to make water available to meet a portion of demand from the manufacturing and industrial sector of the local economy in El Paso County. The acquisition and treatment cost of the water supply is of considerable concern to most industries. Water supply acquisition may be self-supplied from privately held sources or may be purchased from municipal or private water suppliers. The improvement of water use systems within the manufacturing process may conserve water. Some industries may be able to use treated reuse supplies generated from municipal suppliers or may be able to develop techniques of reusing their own supply. The City of El Paso will continue to make water available to meet a portion of demand from the manufacturing and industrial sector of the local economy.

### 5.3.3 Mining

While the sulfur mining operations in Culberson County shut down in 1999, Presidio County is witnessing the reopening of the Shafter mine. Water used in the Shafter mining operation will be generated from supplies pumped (de-watered) from the mineshaft. Elsewhere, aggregate mining operations generally require water primarily for washing and dust suppression purposes and thus have less stringent quality restrictions. Most mining operations develop their own water supplies; however, in El Paso County, water for mining use is purchased from the El Paso PSB. Strategies of importance to the mining industry are those associated with the acquisition of sufficient water supplies at reasonable cost and, if appropriate, the reuse of supplies to lessen the economic impact of generating new water supplies.

### 5.3.4 Steam-Electric Power

Steam electric power facilities require water for the generation of steam and for cooling purposes. As new facilities are built, additional water supply sources will be required. Imposed water-quality standards are primarily intended to prevent corrosion and plugging. Other than supply acquisition, pertinent water strategies for the power generating industry primarily involve system improvement. The possible expansion of electric power generating facilities outside of El Paso County will create the need to identify and secure new supplies of water. If water of sufficient quantity and quality become unavailable, alternative energy sources such as wind or solar, will likely be considered.

### 5.3.5 Irrigation

Water used for agricultural irrigation in the Region is currently significantly greater than all other water-use categories. However, in the future this balance may shift to M&I use in El Paso County. The quantity and quality of water needed for agricultural irrigation is dependent on the type of crop grown and on soil characteristics. Although a minimal amount of agriculture can persist on limited water supplies, most crops require significantly larger water applications to remain profitable. Irrigated farms along the Rio Grande corridor in El Paso and Hudspeth Counties are almost entirely dependent on water supplies derived from the river. When Rio Grande water is limited or not available, most farming temporarily ceases until water supplies once again become available. Irrigated farms in other areas within the region are dependent on ground-water supplies. Availability of these supplies depends on localized pumping, water-bearing formation characteristics and energy cost.

Irrigation strategies principally involve various forms of conservation. Irrigation application equipment has been developed to insure that greater amounts of applied water reach the root system while minimizing loss to evaporation. Proper application timing is also critical in avoiding over-watering. The lining of canals that transport water from its source to the fields reduces losses due to seepage. Drought tolerant crop selection is also important when faced with limited water supplies.

Farmers across the region are using saline water for irrigation. In order to maintain long-term soil productivity with saline waters, producers must over irrigate to maintain a leaching fraction that minimizes salt buildup in the crop root zone. In some areas, high levels of sodium have reduced soil infiltration rates, and producers manage through application of soil amendments (such as gypsum or organic residues) or through mechanical mixing of the soil.

### 5.3.6 Livestock

Range livestock require water principally for drinking, while dairy operations require additional water for washing purposes. Additional water needed for range livestock can often be met by additional withdrawals from existing wells or the drilling of new wells. For dairy and feedlot operations, additional water may also be generated by increased withdrawals and new wells, and also by the purchase of additional supplies. An important point to note is that during times of severe drought, livestock forage may become significantly diminished resulting in the necessity to reduce the size of herds. Herd reductions will obviously result in reduced water demands. To a degree, effectively applying brush control and other appropriate land-use measures may ease this situation. Effective land-use practices, including clearing of brush, may generate such benefits as increasing recharge potential, enhancing the growth of desirable grasses, and providing easier access to forage at higher elevations. Appendix 5B contains a more detailed discussion on strategies concerning range management.

## 5.4 WATER SUPPLY STRATEGY CONSIDERATIONS BY COUNTY

Although many of the entities and areas of the Far West Texas Region are not expected to experience water shortages based on the water demand and supply projections, all entities and areas could experience unanticipated shortages, some of which could be significant. In fact, since all of Far West Texas is arid, and since the desert environment is fragile and unpredictable, water shortages are anticipated. This water plan specifically recognizes the need to include strategies to meet anticipated shortages and the discussion that follows for each county incorporates that assumption.

One of the reasons identified by the Far West Texas Water Planning Group for the expected occurrence of unanticipated shortages is the inadequacy of available data. This problem will be addressed more directly in Chapter 6 dealing with recommended legislative and regulatory changes. In the meantime, the Planning Group believes that each entity and area within the Far West Texas Planning Area must have the flexibility to deal with unanticipated shortages as they arise and not be penalized because the available data leads to a false sense of security. This section is neither intended to abrogate the responsibility of each entity to plan thoroughly for its water needs nor to circumvent the 5-year planning cycle.

### 5.4.1 Brewster County

Increasing water demands resulting from anticipated municipal growth, and growth in the unincorporated areas, top the strategy considerations for Brewster County. Also, water needed for the ranching and tourist sectors of the economy must be maintained.

City of Alpine

Although the City of Alpine's population and water demand are expected to more than double over the next 50 years, the city is not identified as having a future supply deficit. Sufficient ground water is available from the Igneous aquifer; however, additional wells will likely be needed to meet future demands. Infrastructure improvement, transmission leak repairs, and possible rate structure revisions may be necessary to maintain satisfactory supply levels. Competition for water between the City of Alpine and surrounding developments outside of the City may cause pressure on existing supplies.

Community of Marathon

The Marathon Water and Sewer Service Corporation provides water to the Community of Marathon from two wells in the Marathon aquifer. Maintenance of the existing system is sufficient to meet expected needs.

Communities of Terlingua and Study Butte

The Communities of Terlingua and Study Butte have had a history of limited water supplies; however, Study Butte Water Supply Corporation has recently completed a public-supply well which should bring some relief. The Study Butte/Terlingua Water System, with an initial capacity of 80,000 gallons per day, will be servicing part of this area including Study Butte and the Terlingua Ghost Town. The new water system will also replace Poncho's Water System. Elevated radioactivity in local ground water requires specific treatment considerations.

Resort of Lajitas

The Resort of Lajitas relies on both ground water from a single well and surface water from the Rio Grande as sources to meet its public-supply needs. The Resort intends to expand its use of surface water by the conversion of existing irrigation rights on the Rio Grande to provide additional water for expansion of the local golf course.

Big Bend National Park

A major goal of both the Big Bend National Park and Big Bend Ranch State Park is the preservation of natural ecosystems that are endemic to the region. Unique desert ecological habitats have developed in conjunction with local water environments, specifically around springs and perennial stream segments. Maintaining flows in these environments is critical to the survival of dependent species. Similarly, flows in the Rio Grande provide recreational activities within the region. The ecological and recreational tourism generated from these unique environments is a major component of the local economy.

Rural Areas of Brewster County

Elsewhere in the extensively rural area of the county, a number of private domestic wells have gone dry as a result of drought induced water-level declines. Well owners will need to deepen their wells to recover ground water existing at deeper depths.

### 5.4.2 Culberson County

Culberson County is totally dependent on ground-water sources. Irrigated agriculture is the principal water-use category in the county, while supplies for range livestock watering and municipal-supply needs for Van Horn are also important. Current water-supply sources are adequate to meet the long-term needs of current water users in the county. The City of El Paso may in the future transport ground water out of the county from properties owned by the city. Depending on the amount and conditions of export, ground water could be depleted at a much higher rate than its recharge potential.

Town of Van Horn

Water supply for the Town of Van Horn is produced from wells in the Wild Horse Flat portion of the West Texas Bolson aquifer system. Van Horn also provides water to the Community of Sierra Blanca in Hudspeth County. Maintenance and possible replacement of existing wells should be adequate to maintain water supplies for both communities.

Guadalupe Mountains National Park

Similar to the national park in Brewster County, remote springs and perennial streams in Guadalupe Mountains National Park create unique habitats. Besides the wildlife species that depend on these watering holes, these habitats are of significant interest to those who visit and hike the many trails in the park.

Rural Areas of Culberson County

In other areas of this large rural county, a number of private domestic wells have gone dry as a result of drought induced water-level declines. Well owners will need to deepen their wells to recover ground water that exists at deeper depths.

### 5.4.3 El Paso County

El Paso County has large water demands from both agricultural uses and the City of El Paso and surrounding urban areas. It is anticipated that urban demands will increase due to population growth, and agricultural demands will decline over time due to urbanization and conversion of some agricultural water supply to municipal uses.

City of El Paso

The water demands within the City are almost entirely supplied by El Paso Water Utilities (EPWU). EPWU also has a regional role as the Senate Bill 450 designated regional planner for meeting M&I water demands and as a wholesale supplier to many surrounding water districts.

In addition to this regional role in support of El Paso County, EPWU is also engaged in planning initiatives with southern New Mexico through the El Paso-Las Cruces Sustainable Water Project and with the Junta Municipal de Agua Y Sanamiento (JMAS) in Ciudad Juarez through a Memorandum of Agreement to coordinate surface water resource planning. The New Mexico planning is part of a regional effort to switch to sustainable surface water as further discussed in the El Paso strategies. The joint planning with Juarez will consider concepts such as treating some of the 60,000 acre-feet per year of Rio Grande surface water delivered to Mexico under treaty obligations. The water could be treated at El Paso water treatment plants for delivery to points of high municipal demand in Juarez.

The intent of EPWU is to reserve the fresh portions of the Hueco and Mesilla Bolsons for use as drought contingency. Surface water use will be increased over time to provide the majority of the Utility's supply. Supplemental sources of supply are expected to be developed to make up shortfalls in surface supply. Shortfalls may occur as a result of difficulty in converting the right to use water from the Rio Grande Project. Other strategic sources of supply are importation of groundwater from outside El Paso County and desalination of existing brackish sources in El Paso County. How importation and desalination will be intertwined depends on the results of ongoing planning and feasibility studies.

Strategies to maintain achievements in water conservation (demand side conservation) and to continue toward the goal of per capita usage of 160 gallons per day per person will continue. Active programs to reduce usage through replacement and changes in plumbing fixtures and codes will be advanced. Further reduction will be achieved through promotion of water saving appliances and replacement of evaporative coolers with refrigerated air conditioners. Demand reduction will also be achieved by developing water wise landscaping codes and promotions. Growth Management will be used to the degree possible to control demand. It is important to remember, however, that El Paso County growth is fueled by the surplus of births over deaths, rather than immigration. Controls will be used to limit high demand industrial and other uses and promote low water use by residential development. Actual limitation of population growth will be difficult if not impossible. The cost of these programs varies considerably and limitations exist for achieving further large-scale reductions. Even the most cost effective program areas only yield marginal amounts of water.

Reclamation strategies are being implemented and will continue to be implemented. Replacing large- scale use of potable water with reclaimed wastewater for industrial, commercial, and landscape watering will continue to provide approximately 10 percent of the water needed throughout the region. Reclaimed water not put to M&I use is commingled with irrigation flows and reused for agricultural purposes. The high and variable cost of infrastructure and impracticality of implementation in some situations limits the potential of expanding reclaimed water use. M&I uses near the source (wastewater treatment/reclamation plant) are more economical than those which require long reclaimed water line extensions.

Water conserved by improving the agricultural supply system (supply side conservation) may be converted to municipal usage if mutually agreed to by the El Paso County Water Improvement District #1, Bureau of Reclamation and El Paso Water Utilities. The lining of canals is the primary action for this strategy. Based on the complexity of institutional conversion of conserved water from agricultural to municipal use, and the high cost of the projects, in-depth cost planning has not been fully explored. Cost for this activity is therefore undetermined although specific projects have been identified. The American Canal Extension and Lining Project is complete but the Bureau of Reclamation, United States Geological Survey, the EPCWID#1 and EPWU are still analyzing the amount of savings that have been achieved; until this is determined, the cost of the water cannot be calculated. This project and potential canal lining projects face significant institutional, legal and hydrologic issues, both to establish the amount of water saved and allow it's conversion to M&I uses.

Similarly, surface water treatment involves the conversion of Project rights to use water from agriculture to municipal use through various mechanisms, such as the purchase of water right lands and the conversion of rights to use water associated with such lands to municipal use, the leasing of small (two acres or less) urbanized land tracts under existing contracts, and future execution of forbearance contracts (partial and complete) with farmers. These conversions are based on contractual agreements among El Paso County Water Improvement District #1, Bureau of Reclamation and El Paso Water Utilities.

Sizable brackish water deposits surround the fresh water zone of the Hueco and Mesilla Bolsons. These water sources are usable f the total dissolved solids content in the water can be treated to below 1,000 milligrams per liter (mg/l). Desalination of these waters is possible. Three very distinct issues keep this option from being a preferred source. The quality of the water is not stable, the desalination is energy intensive and expensive, and the brine reject (concentrated solution) is highly regulated, increasing the expense and technical feasibility to a point that makes any project very risky. Therefore, desalination by treatment may only be able to provide a small portion of the projected demand.

Blending (classified as a desalination technique) can be utilized with either imported waters or waters desalinated by treatment. Blending involves mixing brackish water with low TDS waters to expand the supply. Any low TDS source can be mixed with local or regional waters. This is the basis for the blended amounts in the desalination and importation categories in the tables of this report. The cost of both strategies has been adjusted to account for the final product water amount after blending. If either strategy did not include blending the cost would be two hundred percent higher than stated.

Importation of ground water from outside El Paso County is another possible strategy. One option for ground-water transfer from a water ranch owned by EPWU at Valentine Texas is being considered. Cost estimates include a preliminary assessment for construction of a pipeline and blending when the water reaches El Paso. Further detailed analysis is under way using a public/private partnership including EPWU. This analysis will consider importation of Dell City desalinated ground water and other potential sources as well as the EPWU water ranches. A detailed statement that includes basic information and a cost estimate, following TWDB guidance, is provided for each strategy. Within the current context of variability in the outcome of rights to use water negotiations and the assumptions specified by Texas Water Development Board, each strategy is as complete as practically feasible at this time.

Each of these strategies has been combined to present a possible scenario in Figure 5-1 entitled "Plausible Mixed Source Scenario." The relative quantities of water from various source categories depend on results of feasibility studies, negotiations and implementation and are, therefore, hypothetical. If these strategies are implemented, as stated in this approximation and given these cost constraints, El Paso Water Utilities will be able to reserve the Hueco and Mesilla Bolsons for drought contingency. Thus the supply shortages represented in chapter four of the plan can be successfully overcome.

Haciendas Del Norte

The Haciendas Del Norte Water Improvement District (HDN) currently has a distribution system with 220 connections of potable water. The connections are supplied through a combination of blended reverse osmosis desalinated-water and water purchased from the City of El Paso (EPWU). Currently, all of EPWU purchased water is put into the distribution system. The HDN is gradually growing at a rate of approximately 14 connections per year. The district currently has 530 platted lots and could have an additional 52 lots with further subdivision in accordance with the subdivision covenants and restrictions. It is the HDN's plan to purchase more water from EPWU or the County of El Paso, and thus reduce its dependency on the desalination of well water produced from the Hueco Bolson. If the HDN cannot obtain more water from EPWU or the County of El Paso, it will pursue a more pro-active desalination plan as well as drill as many wells into the Hueco Bolson as necessary to supply the ultimate growth within the HDN. Although the HDN's preference is to acquire wholesale potable water from the regional supply provided by EPWU, the HDN must continue to produce potable drinking water from its reverse osmosis (RO) plant. EPWU confirms that additional supply will be available. Availability from EPWU will depend on the outcome of ongoing negotiations for acquisition of additional rights to use Rio Grande water, feasibility studies addressing importation of ground water and feasibility studies relative to desalination of brackish Hueco Bolson ground water. Availability will also depend on any necessary changes in EPWU 'outside of the City service' policy.

A joint resolution was signed between Haciendas del Norte Water Improvement District and Homestead Municipal Utility District in September 2000. The resolution states that it is in the best interest of the Districts to develop and pursue strategies and plans to identify existing and potential water and wastewater problems and solutions. The resolution also states that it is in the best interest of the Districts to act jointly and in concert with other entities in addressing various other water-related issues of common interest.

Homestead

The Homestead Municipal Utility District (HMUD) currently has a distribution system with 1,230 existing connections of potable water. The connections are supplied through wholesale water purchased from the City of El Paso (EPWU). Currently, all of EPWU purchased wholesale water is put into the distribution system. The district has a build out potential for an additional 730 connections for an ultimate total of 1,960 connections. It is the HMUD's plan to purchase more wholesale water from EPWU to supply this increased demand. Currently, the HMUD has 1,532 allocated connections from EPWU through the EDAP Phase 0, East Montana Water Improvement Contract. In the event of an emergency or any other supply deficiency, the HMUD can produce well water to blend with EPWU wholesale water. Although the HMUD's preference is to acquire wholesale potable water from the regional supply provided by EPWU, the HMUD could produce potable drinking water from blending its well water with available EPWU supplies. Availability of additional wholesale supply from EPWU depends on the outcome of current EPWU efforts to acquire more water resources. It is anticipated for the next fifty years that if the HMUD cannot obtain more water from EPWU, the HMUD will rely on the desalination of well water produced from the Hueco Bolson through an RO process and will drill as many wells into the Hueco Bolson as necessary to supply the ultimate fifty year growth within the HMUD. The quality of the water from this portion of the Hueco Bolson is predominantly brackish.

A joint resolution was signed between Haciendas del Norte Water Improvement District and Homestead Municipal Utility District in September 2000. The resolution states that it is in the best interest of the Districts to develop and pursue strategies and plans to identify existing and potential water and wastewater problems and solutions. The resolution also states that it is in the best interest of the Districts to act jointly and in concert with other entities in addressing various other water-related issues of common interest.

Community of Fabens (EPCWID#4)

Currently, approximately 0.75 mgd of potable water are introduced into the Fabens water distribution system via three ground water wells (a total of five wells exist, but two were removed from service due to high TDS levels). The El Paso County Water Improvement District No. 4 (EPCWID#4) serves 1,350 connections in the Fabens area and is a wholesale water provider to the Cuadrilla Water Supply Corporation (32,000 gal/month) and to the San Elizario Municipal Utility District (964,000 gal/month). Due to deteriorated water quality from its wells, the EPCWID#4 had intended to acquire wholesale potable water from EPWU. However, because of the lack of water pipeline infrastructure and EPWU's need to acquire additional water resources, EPWU denied service in the short term. The EPCWID#4 will continue to produce potable drinking water by drilling as many wells into the Hueco Bolson as necessary to meet the supply demand for its growth and will eventually install filtration and RO facilities to reduce levels of TDS and iron and manganese minerals. The EPCWID#4's estimated average and peak demand for the year 2020 is 1.53 mgd and 3.21 mgd, respectively.

Community of Tornillo

The Tornillo Water Supply Corporation (TWSC) currently supplies potable water to approximately 500 connections in the Tornillo area. Water is drawn via two groundwater wells (a total of three wells exist, but one was removed from service due to high TDS levels) from the southwestern fringes of the Hueco Bolson Aquifer where it meets the Rio Grande Flood Plain. The existing elevated storage capacity of 200,000 gallons can supply 2,000 connections based on the TNRCC standard of 100 gallons of elevated storage per connection. The TWSC will continue to produce potable drinking water by drilling as many wells into the Hueco Bolson as necessary to supply for its growth and will eventually install filtration and RO facilities to reduce levels of TDS and iron and manganese minerals. There are no immediate plans to acquire water from EPWU.

Town of Anthony

The existing Anthony water supply system consists of three ground-water supply wells (1-800 gal/min and 2-700 gal/min), a 600,000 gallon ground storage tank, a 125,000 gallon stand pipe, a 150,000 gallon elevated storage tank, booster pump stations and distribution system piping. Anthony will continue to rely on the Mesilla Bolson Aquifer and additional storage capacity for producing and supplying potable water to the area. Increasing future water demand may be met by adding additional wells to the existing well field. There are no immediate needs for acquiring water from EPWU.

City of Socorro

The Lower Valley Water District (LVWD) supplies potable water to the City of Socorro. All potable water supplied by the LVWD is purchased from EPWU. The LVWD will continue to rely on EPWU as the regional water provider to meet potable water supply needs for its growth.

Community of Elizario

The Lower Valley Water District and the El Paso County Water Control and Improvement District #4 supply potable water to most of San Elizario. EPWU is supplying and will continue to supply potable water to the LVWD.

Town of Clint

EPWU supplies potable water to Clint through an existing 8-inch water transmission line. Clint will continue to rely on EPWU for the purchase of potable water.

Fort Bliss

Fort Bliss' water distribution system is supplied by a combination of self-supplied treated ground water produced from the Hueco Bolson within the installation and water purchased from EPWU. Fifteen ground-water wells operate within the installation and produce more than 5,300 acre-ft/year of water. Fort Bliss will continue to use its wells and treat ground water within the installation to meet existing and future water demands. The current 488 acre-ft/year of potable water provided by EPWU is anticipated to continue. Strategies being considered to meet future needs include desalination, reclaimed wastewater use, purchase of El Paso reclaimed water, and distribution system maintenance.

Community of Westway

EPWU currently supplies potable water to Westway. Westway will continue to rely on EPWU for its water supply.

Community of Canutillo

EPWU currently supplies potable water to Canutillo. Canutillo will continue to rely on EPWU for its water supply.

The Ponderosa and Western Village Water Supply Corporation (PWV) is a small water supply corporation that services the Western Village area in the vicinity of Canutillo. The PWV does not buy water from EPWU. The corporation owns two wells in the Mesilla Bolson. Within the last year, PWV has attempted to purchase water on a wholesale basis from PSB because PWV's system is not in compliance with TNRCC's requirements for public water supply systems. Until the PWV can negotiate a long-term water supply contract with EPWU, PWV's strategy is to request funding to drill two additional wells in the Mesilla Bolson to provide water to the approximately 325 customers of the corporation.

Town of Horizon City

The existing water service area of the El Paso County Water Authority Municipal Utility District (EPCWA) encompasses approximately 91,000 acres bounded by Interstate 10 to the west, US Highway 62 to the north, and the eastern El Paso County line to the east. The majority of land within EPCWA's boundaries has been platted as single family lots with individual owners. Many of the lots are currently undeveloped and there is potential for significant future growth. As of June 2000 EPCWA provides water service to 3,630 connections. The number of connections is expected to double in the next five years. The EPCWA is currently building a RO

Water Treatment Plant. The first phase of blended water production is 4.0 MGD (800 TDS) expandable to 8.0 MGD. Raw water (1600 TDS) is supplied by four new wells. The EPCWA will continue to rely on the desalination of well water produced from the Hueco Bolson through an RO process, as well as the drilling of as many wells into the Hueco Bolson as necessary to supply the ultimate fifty-year growth within the district.

Village of Vinton

The Village of Vinton does not have a community water system. Four private water companies provide water service to those residents who are provided water service. Three of them provide water service within mobile home parks. The fourth water company provides water service to residents within a few subdivisions. Other residents in non-subdivided land rely on private water wells. The population of the Village of Vinton based on 1997 estimates was 1,586. The estimated buildout population is estimated at 3,847.

The Village of Vinton would like to have El Paso Water Utilities be the provider of water to the community. This could be through coming into the El Paso water service area or purchase of water at wholesale rates. The estimated water needs for the Village of Vinton at buildout population is 1,500 acre-feet per year. The estimated cost to provide the infrastructure needed to serve the buildout population assuming water service from the El Paso Water Utilities is $3,143,043 as reported in the draft 1998 Water and Wastewater Facilities Plan prepared for the Village of Vinton. The draft facilities plan has not been adopted to date.

Lower Valley Water District

The Lower Valley Water District (LVWD) provides water to residents in the Lower Valley including the towns of Socorro, San Elizario and Clint. In addition to water purchased from EPWU, the District is considering alternative water supplies from ground-water wells and desalination.

### 5.4.4 Hudspeth County

Irrigated agriculture and ranching are the predominant water-use categories in Hudspeth County. Public-supply water sources of sufficient quantity and quality have been a major problem and have been dealt with in a variety of ways. Irrigation occurs in two separate areas within the county. Significant volumes of ground water are withdrawn from the Bone Spring–Victorio Peak aquifer in the Dell Valley area of northeastern Hudspeth County. Due to the large volume of water in storage in the aquifer, well production and irrigation activity is not immediately affected during initial drought periods.

The second agricultural area exists along the Rio Grande flood plain where water from the river is used for irrigation. During extended drought periods in the upper Rio Grande drainage basin, water available for irrigation may not exist. Given the arid nature of the region, dryland farming is not an alternative and irrigating with high salinity water with a potential of a high level of sodium content can significantly reduce soil productivity. Remaining farming alternatives under these circumstances are (1) to irrigate with effluent from the City of El Paso for those farms within the Hudspeth County Conservation and Reclamation District #1, or (2) cease growing operations until river water becomes available.

<u>Community of Sierra Blanca</u>

As many as five wells have been drilled in unsuccessful attempts to supply the municipal water needs of Sierra Blanca. Sierra Blanca, through the Hudspeth County Water Control and Improvement District #1, purchases water from the Town of Van Horn. Production is from the Wild Horse Flat well field of Culberson County. Production from the Wildhorse Flat well field should be sufficient to meet the projected demand for water over the period 2000 – 2050. Sierra Blanca recently installed a sewer system. Projects that are in the planning stages include replacement of water distribution lines and replacement of water storage tanks.

<u>City of Dell City</u>

The small population of Dell City is reliant on ground water that has been desalinated. Sufficient ground water exists from the Bone Spring-Victorio Peak aquifer for municipal use;

however, the desalination plant must be continuously maintained. Disposal of the byproduct is of minor concern as its quality is generally fresher than much of the local ground water being extracted for irrigation use.

<u>Communities of Fort Hancock and McNary</u>

Communities located along the Rio Grande in southern Hudspeth County have historically relied on ground water provided by the Fort Hancock WCID and the Esperanza FWSD#1. Public supply wells in this area are currently failing in their ability to supply water of acceptable quantity and quality; and thus the entities are being required to find alternative means of providing water supplies to local communities. The entities are currently working with the Hudspeth County Conservation and Reclamation District #1 to study the feasibility of desalination and surface water treatment.

<u>Rural Areas of Hudspeth County</u>

Elsewhere in the rural area of the county, a number of private domestic wells have gone dry as a result of drought induced water-level declines. Well owners will need to deepen their wells to recover ground water existing at deeper depths.

### 5.4.5 Jeff Davis County

Except for public-supply use in Fort Davis and Valentine, most water used in Jeff Davis County is for irrigation, range livestock, and rural domestic needs. A portion of the City of El Paso’s Antelope Valley Farm, which may eventually supply water to El Paso, lies in the western part of the county. A large greenhouse tomato growing operation in the county utilizes hydroponic-irrigation water in a highly efficient manner. There is also a flower farm that uses substantial amounts of water, perhaps less efficiently at present than the tomato farm.

<u>Community of Fort Davis</u>

The Fort Davis Water Supply Corporation provides water for the Community of Fort Davis and the surrounding community. Ongoing expansion of the system to serve parts of the town that are currently without water will require an additional well, storage tank, and extended transmission lines. Repair and replacement of existing transmission lines will also likely be required.

Town of Valentine

Water supply for the Town of Valentine is sufficient; however, the system is not in compliance with TNRCC regulations for water pressure. The Town plans to address this problem, and a new well may be drilled as an alternate source of supply. The Valentine Independent School District operates one well. This well supplies water to the school and to a small number of residences occupied by teachers. The Town does not have a sewer system. Plans are underway to seek funding to develop a wastewater system.

Rural Areas of Jeff Davis County

Elsewhere in the extensively rural area of the county, a number of private domestic wells have gone dry as a result of drought induced water-level declines. Well owners will need to deepen their wells to recover ground water existing at deeper depths.

### 5.4.6 Presidio County

Most water used in Presidio County is for public-supply use in Marfa, Presidio and other small communities. Elsewhere in the County, water is used for irrigation, range livestock and rural domestic needs. A portion of the City of El Paso's Antelope Valley Farm, which may eventually supply water to El Paso, lies in the northern part of the county. A large greenhouse tomato growing operation, similar to one near Fort Davis, is located just outside of Marfa and utilizes hydroponic-irrigation water in a highly efficient manner.

City of Marfa

The City of Marfa is entirely dependent on ground water. Production is from three wells owned by the city. Two of the wells are capable of producing as much as 1,100 GPM, and the third well yields an additional 450 GPM. The wells, all of which are in good working order, are expected to supply all of Marfa's projected needs for water for the foreseeable future. In addition to providing water for the residents and businesses in Marfa, the city also provides water to a large greenhouse tomato-farming operation and to a local golf course.

City of Presidio

Of all the communities in the six rural counties of Far West Texas, the City of Presidio is expected to have the largest increase in population over the 50-year planning period. Additional wells will likely be needed to meet the expected increase in demand. The city relies exclusively on ground water produced from thick deposits of the Presidio Bolson. Two wells within the city limits have provided all of the town's water needs. A third well was recently completed approximately 7 miles to the southeast of town. This well is expected to have the potential to add as much as 1,500 gpm to the existing production.

Big Bend Ranch State Park

Similar to Big Bend National Park, a major goal of the Big Bend Ranch State Park is the preservation of natural ecosystems that are endemic to the region. Unique desert ecological habitats have developed in conjunction with local water environments, specifically around springs and perennial stream segments. Maintaining flows in these environments is critical to the survival of dependent species. Similarly, flows in the Rio Grande provide recreational activities within the region. The ecological and recreational tourism generated from these unique environments is a major component of the local economy.

Mining Operations

The Rio Grande Mining Company plans to reopen the Shafter mine, which will be de-watered, or lower the water level in the mine, at a rate of 350 GPM on a continuous basis (564 acre-ft/year). Approximately 100 GPM will be used as makeup water in processing the ore and the remaining water would be available for irrigation on adjacent lands. The company will convert approximately 47.5 acre-ft/year for a community water system and 0.6 acre-ft/year for non-community system use.

County Other Areas of Presidio County

Presidio County has several colonias (see Section 1.9.2 in Chapter 1) with their own water systems. These colonia water systems will require monitoring to assure public health and safety. Elsewhere in this largely rural county, a number of private domestic wells have gone dry as a result of drought induced water-level declines. Well owners will need to deepen their wells to recover ground water existing at deeper depths.

### 5.4.7 Terrell County

Community of Sanderson

The Community of Sanderson owns and operates 18 public water supply wells. Production from the wells ranges from 30 GPM to 80 GPM. Ten of these wells provide most of the community's water needs. The Water Department plans to drill an additional well in the near future to replace two of the community's lowest producing wells. Additional projects in the planning stages are the addition of a 250,000-gallon storage tank, and development of a wastewater system.

Rural Areas of Terrell County

Elsewhere in the extensively rural area of the county, a number of private domestic wells have gone dry as a result of drought induced water-level declines. Well owners will need to deepen their wells to recover ground water that exists at deeper depths.

## 5.5 NATURAL RESOURCES AND ENVIRONMENTAL ISSUES

Natural and environmental resources are often overlooked when considering the consequences of prolonged drought conditions. As water supplies diminish during drought periods, the balance between both human and environmental water requirements becomes increasingly competitive. A goal of this plan is to provide for the health, safety, and welfare of the human community, with as little detrimental effect to the environment as possible. To accomplish this goal, the evaluation of strategies to meet future needs includes a distinct consideration of the effect on the environment that the implementation of each strategy might have.

A review of the strategy evaluations reveals that while some strategies may contain variable levels of negative impact, other strategies may likely have a positive effect. Negative environmental impacts were generally associated with the lowering of aquifer water-levels due to increased ground-water withdrawals and its potential to cause springs to cease flowing. Also of concern is that lowered water levels could deplete supplies in shallow livestock wells which are often the only available source of water for some wildlife. The positive environmental aspect of the strategies is that during severe drought conditions when normal wildlife water supplies may naturally diminish, new supply sources might be developed such that wildlife could benefit.

## 5.6 EMERGENCY TRANSFER CONSIDERATIONS

The Texas Legislature has established a statute (Texas Water Code 11.139) by which non-municipal surface-water rights may temporarily be interrupted in order to make supplies available for public-supply needs during times of emergencies. The intent of this measure is to reduce the health and safety impact to communities that have run short of water due to unexpected circumstances. The statute was specifically enacted as an emergency process to bring relief to several communities that had been affected by drought conditions that had severely diminished their water-supply sources. A more detailed discussion concerning this topic can be found in Appendix 5A. The Far West Texas RWPG considered the potential for emergency transfers of surface water for communities in the region, but chose not to recommend this strategy for this planning period.

## 5.7 EXISTING WATER DISTRICT MANAGEMENT OBJECTIVES

### 5.7.1 Water Management Objectives

The current water management and drought contingency plans of irrigation districts and underground water conservation districts were drafted to ensure responsible development and management of surface-water and ground-water resources not only during normal climatic conditions, but also during various stages of drought in Far West Texas. As such, the plans are designed to provide reasonable guidelines and equitable access to water by promoting public awareness of water-resource issues and by spelling out specific conservation programs and emergency management procedures.

### 5.7.2 Irrigation Districts

The El Paso County Water Improvement District No.1 (EPCWID#1) and the Hudspeth County Conservation and Reclamation District No.1 (HCCRD#1) were established to provide irrigation water from the Rio Grande to farmers in El Paso and Hudspeth counties.

<u>El Paso County Water Improvement District #1 (EPCWID#1)</u>

The principal focus of the EPCWID#1 is to provide high-quality Rio Grande irrigation water to farmers in El Paso County in amounts that allow for maximum flexibility and enhanced opportunity for increased farm revenue. In order to meet this objective, EPCWID#1 operates a system of project works, ditches, laterals, canals, and drains, and has instituted a program to minimize losses beginning at the District's first diversion structure. Water is allotted according to a schedule that includes a base allotment with take-or-pay provisions, additional allotments for which irrigators are charged only for water used, and emergency allotments that involve higher unit rates.

With the development of the City of El Paso within the boundaries of EPCWID#1, the number of small tract parcels (two acres or less in size) has increased to represent 90 percent of the accounts on the irrigation district tax rolls, although they irrigate only 18 percent of the irrigable acres of the District. (El Paso County Water Improvement District #1 Water Guide – 2000). Since the 1940's the District and the Bureau have allowed the City of El Paso to convert District water for municipal uses, and today the City is the largest single customer of the District.

<u>Hudspeth County Conservation and Reclamation District No.1 (HCCRD#1)</u>

The HCCRD#1 provides water to irrigators in Hudspeth County by consolidating water diversions from the Rio Grande. Through a Contract authorized under the Warren Act, the District has been making a diversion of drainage and wastewater from the Rio Grande Project since 1925. This Contract extends only to the return water as it occurs in the normal operation of the Rio Grande Project and puts no obligation on the Project for delivery of any specific amounts of water.

HCCRD#1 maintains a system of canals, drains, and regulating reservoirs to distribute irrigation water. The District also has instituted a program to reduce canal losses. The District taxes customers on a per-acre basis of irrigable land. Additional assessments are made on acres watered in order to equate taxes with benefits delivered. Water supplied to HCCRD#1 can be used only for irrigation of lands in the District unless the Bureau grants the right to use a portion of the water on lands outside the District.

### 5.7.3 Underground Water Conservation Districts

There are four underground water conservation districts in Far West Texas:

- Hudspeth County Underground Water District #1 (HCUWD#1)
- Jeff Davis County Underground Water Conservation District (JDCUWCD)
- Culberson County Groundwater Conservation District (CCGCD)
- Presidio County Underground Water Conservation District (PCUWCD)

Hudspeth County Underground Water District #1 (HCUWD#1)

Created in 1956, the HCUWD#1 is located in the Dell Valley area of northeast Hudspeth County. The district monitors water levels and advises irrigators of potential problems. The district also seeks to prevent the waste of ground water by developing programs to encourage efficient use of water.

Jeff Davis County Underground Water Conservation District (JDCUWCD)

The JDCUWCD was established in 1994, and includes all areas of Jeff Davis County and some parts of Presidio County. The district is charged with the responsibility of registering all new wells and issuing permits to owners of wells that are capable of producing at least 25,000 gallons per day. The district also enforces state well construction standards and monitors water levels in 28 observation wells. The goals of the JDCUWCD are (1) to improve the public's understanding of ground-water conditions in the county; (2) promote programs that encourage efficient use of ground water; (3) maintain the availability of high-quality water by controlling and preventing waste; and (4) regulate the production of ground water to ensure adequate water for the future. To accomplish these goals the District requires all production wells to be metered and pumpage to be reported to the District. All new wells must follow spacing and production rules.

Culberson County Groundwater Conservation District (CCGCD)

The CCGCD was created in 1998. The jurisdiction of the district is the southwestern half of Culberson County. The CCGCD seeks (1) to improve the public's understanding of ground water conditions in southwestern Culberson County; (2) implement strategies to prevent waste and to maximize efficient use; (3) regulate the spacing of wells; (4) minimize the potential for contamination of ground water; and (5) monitor exports of water for the purpose of planning and data inventory.

Presidio County Underground Water Conservation District (PCUWCD)

The establishment of the PCUWCD was approved by a countywide confirmation election in 1999. The district adopted a management plan in October 2000, which has been submitted to the TWDB for review and approval.

## 5.8 DROUGHT RESPONSE TRIGGERS

Droughts typically develop slowly and insidiously over a period of months or even years and can have a major impact on the region. Water shortages may also occur over briefer periods as a result of water production and distribution facility failures. Drought contingency plans provide a structured response that is intended to minimize the damaging effects caused by the water shortage conditions. A common feature of drought contingency plans is a structure that allows increasingly stringent drought response measures to be implemented in successive stages as water supply diminishes or water demand increases (TNRCC, 1999). This measured or gradual approach allows for timely and appropriate action as a water shortage develops. The onset and termination of each implementation stage should be defined by specific "triggering" criteria. Triggering criteria are intended to ensure that timely action is taken in response to a developing situation and that the response is appropriate to the level of severity of the situation.

Each water-supply entity is responsible for establishing its own drought or emergency contingency plan that includes appropriate triggering criteria. Depending on the water use category, the plan may ultimately affect the health and welfare of a large population or it may only affect the property of a single owner.

Drought response triggers should be specific to each water supplier and should be based on an assessment of the water user's vulnerability. For instance, a user on a surface-water source is likely to experience shortage from a drought sooner than a user on a ground-water source, simply due to the nature of the supply source. In some cases it may be more appropriate to establish triggers based on a supply source volumetric indicator such as a lake surface elevation or an aquifer static water level. Similarly, triggers might be based on supply levels remaining in a storage tank. However, this type of trigger will likely come too late for the entity to know it is in trouble; therefore, a supply source trigger is preferable. Triggers based on demand levels can also be effective as long as the entity does not overestimate how far it can stretch its supply or how much water its retail customers can manage to conserve. Whichever method is employed, trigger criteria should be defined on well-established relationships between the benchmark and historical experience. If historical observations have not been made then common sense must prevail until such time that more specific data can be presented.

### 5.8.1 Surface-Water Triggers

The annual allotment of Rio Grande Project water is determined by the U.S. Bureau of Reclamation (USBR) based on the amount of usable water in storage in Elephant Butte and Caballo reservoirs. Based on the amount of storage remaining in Elephant Butte and Caballo Reservoirs at the end of the primary irrigation season (early to mid October), the USBR determines the amount of water that will be delivered the following year. In general, a one-year drought in the Upper Rio Grande drainage basin will have little effect on overall storage in the reservoirs. However, a long-term drought would have a significant effect on water releases downstream. Downstream users, both irrigation and–municipal, are thus aware in advance of coming surface-water supply shortages and can react accordingly.

The City of El Paso's Drought and Emergency Management Plan is administered through El Paso Water Utilities (EPWU) and is based on three Drought or Water Emergency Stages (EPWU – PSB 1999): (1) A Stage I water emergency is triggered when the Rio Grande Allotment (Allotment) is less than or equal to 3.0 acre-feet per acre; or when demand is projected to exceed 90 percent (but less than 95 percent) of available capacity; (2) A Stage II water emergency is triggered when the Allotment is less than or equal to 2.5 acre-feet per acre; or when demand is projected to exceed 95 percent (but less than 100 percent) of available capacity; (3) A Stage III water emergency is triggered when the Allotment is less than or equal to 2.0 acre-feet per acre; or when the demand is projected to exceed 100 percent of available capacity. Once any stage is declared, the General Manager of the EPWU can implement a variety of response measures designed to conserve water. These range from use restrictions to citations for noncompliance.

Most of the other communities in El Paso County receive their water supplies from EPWU or from other water-supply entities including the El Paso County Water Authority (EPCWA), El Paso County Water Control and Improvement District #4 (EPCWCID #4), and the Lower Valley Water District (LVWD) (see Figure 1-15 in Chapter 1). Because of their reliance on the Upper Rio Grande, the EPCWCID #4 and LVWD drought contingency triggers and responses should be similar to the triggers and responses developed by EPWU. EPCWA relies on ground water and is discussed under the following Ground Water Triggers section.

Irrigation districts depend on runoff from watersheds in the Upper Rio Grande drainage basins of New Mexico and southern Colorado to provide surface water to support irrigation in El Paso and Hudspeth Counties. Hence, drought triggers for the El Paso County Water Improvement District #1 (EPCWID #1) and the Hudspeth County Conservation and Reclamation District #1 (HCCR #1) are established based on storage levels in Elephant Butte and Caballo Reservoirs, which are in turn dependent on meteorological and hydrological conditions in these water sheds.

Drought conditions which impact the EPCWID No.1 are those which affect the headwaters of the Rio Grande and its tributaries, such that Rio Grande Compact water deliveries into Elephant Butte Reservoir are reduced. The district's board of directors determines when a drought exists and establishes the yearly delivery allotment to its water users based on its diversion allocation from the USBR. Generally, when water storage in Elephant Butte Reservoir is less than 0.9 million acre-ft during the irrigation season (March through September), the USBR declares drought conditions and sets its diversion allocations (using the D1 and D2 curves) to the irrigation districts based on a delivery allotment of less than its normal (non-drought) 3 acre-foot per acre. During times of drought, the district will lower its delivery allotment based on the amount of its reduced diversion allocation from the USBR and its delivery commitments to its users. The extent of the reductions in the water allotments will be dependent on the severity of the drought conditions, and will remain in effect until the conditions that triggered the drought contingency no longer exist.

The HCCRD #1 bases drought contingency planning on evaluation of the water supply projected and received by the EPCWID #1, since all waters received by HCCRD #1 are return flows and operational spills for El Paso County. Since conditions, to a degree, can be predicted prior to a crop season, the drought mitigation plan largely affects agricultural producers cropping plan. When a mild or moderate predicted shortage occurs, the HCCRD #1 will notify its clientele of the amount of the expected shortage. For a severe shortage, where the water supply will provide less than 50 percent of the expected demand, agricultural producers will be asked to prioritize their water requests based upon crop needs.

Water in the Lower Rio Grande segment is used principally for irrigation, recreation, and environmental needs. A drought trigger for this segment of the river is based on flows of less than 35,438 acre-feet. The TNRCC Rio Grande Watermaster administers the allocation of Texas' share of the international water and is responsible for informing water-rights users of expected diversions during drought years.

Only two water-rights holders, both located in Terrell County, are authorized to divert water from tributaries of the Pecos River for irrigation purposes. Drought triggers for these water-rights holders are based on flows that are insufficient to meet required irrigation needs

(44.6 and 0.6 acre-feet per year). Responsibility for monitoring these flow triggers rests with the water-rights holders, and their likely response will be to cease diversions until ample flow is resumed.

Water rights on Phantom Creek in Jeff Davis County are for diversions to be used in Reeves County. Because no diversions are authorized in Jeff Davis County (Far West Texas Region), it is the responsibility of Region F to establish required drought triggers.

### 5.8.2 Ground-Water Triggers

Ground-water triggers that indicate the onset of drought in Far West Texas are not as easily identified as factors related to surface-water systems. This is attributable to (1) the rapid response of stream discharge and reservoir storage to short-term changes in climatic conditions within a region and within adjoining areas where surface drainage originates, and (2) the typically slower response of ground-water systems to recharge processes. Although climatic conditions over a period of one or two years might have a significant impact on the availability of surface water, aquifers of the same area might not show comparable levels of response for much longer periods of time, depending on the location and size of recharge areas in a basin, the distribution of precipitation over recharge areas, the amount of recharge, and the extent to which aquifers are developed and exploited by major users of ground water.

Several ground-water basins were identified in Chapter 3 as aquifers that will likely not experience consistent water-level decline, or mining, based on comparisons between projected demand, recharge and storage. In these areas, water levels might be expected to remain constant or relatively constant over the 2000 to 2050 planning period. Because of minimal water-level changes in these aquifers, water levels are not recommended as a drought-condition trigger. Atmospheric conditions are a better indicator for these areas.

Basins that do not receive sufficient recharge to offset natural discharge and pumpage may be depleted of ground water (e.g., mined). The rate and extent of ground-water mining are related to the timeframe and the extent to which withdrawals exceed recharge. In such basins, water levels may fall over long periods of time, eventually reaching a point at which the cost of lifting water to the surface becomes uneconomic. Thus, water levels in such areas may not be a satisfactory drought trigger. Instead, communities might consider the rate at which water levels decline in response to increased demand during drought as a sufficient indicator.

Because of the above described problems with using water levels as drought-condition indicators, most municipal water-supply entities in Far West Texas that rely on ground water generally establish drought-condition triggers based on levels of demand that exceed a percentage of the systems production capacity. Table 5-3 provides a list of ground-water dependent entities, their supply source, their type of trigger, and their associated responses.

Water levels in observation wells in and adjacent to municipal well fields, especially where wells are completed in aquifers that respond relatively quickly to recharge events, may be established as drought triggers for municipalities in the future providing a sufficient number of measurements are made annually to establish a historical record. Water levels below specified elevations for a pre-determined period of time might be interpreted to be reasonable ground-water indicators of drought conditions. Until such historical water-level trends are established, municipalities will likely continue to depend on demand as a percentage of production capacity as their primary drought trigger.

Water-use categories in the Region other than municipal that are dependent on ground water as their primary or only source of supply must rely on a number of factors to identify drought conditions. In most cases, atmospheric condition (days without measurable rainfall) is the most obvious factor. Various drought indices (Palmer, Standard Precipitation, and Keetch-Byram) are available from State and local sources. Groundwater conservation districts, agricultural agencies, as well as individuals can access these indices for use in determining local drought conditions and appropriate responses.

As discussed earlier in this section, ground-water levels in this part of the State have only limited use as drought triggers. Although numerous water-level measurements are available on a number of wells in the Region, most of this data represents only one measurement a year. This does not allow for observation of seasonal fluctuation or response to recharge events. However, Table 5-4 provides a selection of wells (one per aquifer) with a history of measurements and a proposed drought trigger level. Most of these wells are measured annually by staff of the

TWDB. Wells selected for drought contingency triggers should be re-evaluated for appropriateness during the next planning period.

Groundwater conservation districts are generally responsible for monitoring conditions within their boundaries and making appropriate public notification. Outside of existing districts, the TWDB should assume responsibility of public notification of drought conditions based on their water-level monitoring network. Appropriate drought responses are the responsibility of and at the discretion of private well owners.

## 5.9 FAR WEST TEXAS REGIONAL STRATEGIES

Strategies intended to provide solutions to both short-term and long-term drought-contingency water-supply shortages are the major aspect of this regional water management plan. Short-term strategies are those that are needed to meet deficits in the next 30 years. These strategies are identified in sufficient detail to allow state agencies to make financial and regulatory decisions. Long-term strategies are less precise and are intended to meet water needs occurring 30 to 50 years into the future.

The evaluation of each individual water management strategy requires an identification of the legal and regulatory issues that will directly impact the feasibility of the strategy. With its northern and western border adjoining other states, and its entire western and southern border adjoining another country, the Far West Texas Region presents one of the most complex interplays of multi-state and international laws and regulations in the entire United States. The fact that natural resources such as rivers and aquifers do not conform to jurisdictional boundaries makes the legal challenges even greater.

Two international treaties, the 1906 International Treaty in the El Paso and Hudspeth County areas, and the 1944 International Treaty below Ft. Quitman govern the primary surface water resource in the Region, the Rio Grande. In the El Paso area, the use of the Rio Grande must also comport with the Rio Grande Compact among Colorado, New Mexico and Texas, and with Federal Reclamation laws enforced by the Bureau of Reclamation. From the New Mexico/Texas state line south to Ft. Quitman, the status of surface water rights is further complicated by the fact that this area has never been adjudicated by Texas, so no one has "adjudicated rights" to sell. There is also pending two New Mexico federal lawsuits in which the ownership of this Rio Grande surface water in Texas and New Mexico is the central issue.

As to the regulatory restraints on the use of ground water, New Mexico, through its New Mexico State Engineer's office, strongly asserts regulatory power of ground-water pumping in the Mesilla and Hueco Bolsons and the Bone-Spring-Victorio Peak. The New Mexico State Engineer is currently conducting hydrographic surveys in the southern New Mexico region as part of a pending New Mexico adjudication which will affect Texas as the downstream state. Historically, ground water has not been regulated in Texas except in relatively few areas, but pursuant to Senate Bill 1, groundwater districts are now the legislature's preferred method to regulate ground water. Within the Far West Texas region there are four underground or groundwater conservation districts, each with statutory rule-making and management authority within their respective jurisdictional boundaries. In summary, no management strategy in the Far West Texas Region should be pursued without a careful consideration of the legal issues impacted by that strategy.

### 5.9.1 Strategy Decision Process

Entities and water-use categories with drought-contingency supply shortages were identified in Chapter 4 and are listed in Table 5-1. A preliminary list of strategies to meet these shortages was developed and assigned to the consulting team for evaluation. The evaluation process is described in the following section. Following review of the strategy evaluations, the regional planning group selected the preferred strategies that are contained in this plan. Non-voting representatives of the following federal and international agencies also contributed to the development of the plan:

- U.S. Section, International Boundary and Water Commission;
- U.S. Bureau of Reclamation;
- CILA Mexico; and
- Municipal Juarez.

### 5.9.2 Strategy Evaluation Process

Each strategy evaluation is based on an equitable comparison and consistent application of criteria. The evaluations represent preliminary overviews and should not be considered as detailed feasibility analyses. Cost analyses in particular are speculative. Each evaluation lists the strategy name, description, portion of strategy intended for implementation during short- and long-term periods, and comparative criteria. Total capital cost, cost by decade, and available supply by decade were recorded in TWDB Table 11. The Regional Planning Group members then equitably compared each evaluation criteria, along with the cost and volume comparison in TWDB Table 11 to determine the feasibility of each strategy in relation to other strategies proposed for each shortage. Where appropriate, the Group specifically considered cost-effective water-management strategies that are environmentally sensitive. The Planning Group chose not to prioritize the strategies because many are too preliminary for a realistic determination of economic and environmental feasibility; rather than prioritizing among strategies of different maturities, the Group chose to retain all feasible strategies. Planning decisions are intended to be made locally whenever possible. Strategy evaluations are presented in Section 5.11. Following is a list of significant evaluation criteria.

- Quantity of water expected to be delivered and treated for the end user's requirements.
- Reliability of water supply including its quality suitability and expected life.
- Cost of water treated and delivered for end user requirements, including factors used in calculating infrastructure debt retirement.
- Environmental factors including effects on environmental water needs, wildlife habitat, endangered species, and cultural resources.
- Impact on other water resources including other water management strategies and ground-water surface-water relationships.
- Consideration of threats to agriculture.
- Consideration of threats to natural resources.
- Other factors deemed relevant by the regional planning group including recreation.

- Consideration of transport of water outside of its river basin of origin (interbasin transfer).
- Consideration of third party social and economic impacts resulting from voluntary redistribution of water.
- Consideration of existing water rights, water contracts, and option agreements.
- Consideration of effect on navigation.

## 5.10 SUMMARY

A primary goal of this regional water management plan is the recommendation of specific water-supply strategies that can be implemented during times of severe drought conditions. A listing of the preferred strategies to meet projected water-supply shortages during drought-of-record conditions is listed in Table 5-2. In the process of identifying strategies to meet water-supply deficits of each entity or water use category, it became apparent that, in many cases, no one single strategy was sufficient within itself to satisfy the shortage. The combined implementation of two or more strategies often results in the best solution.

A portion of the "County Other" water use category represents water shortages that are the result of projected increase in rural population. Although strategies are shown for this category, the implementation and cost of providing the water supply necessary for future rural homes is recognized as the responsibility of the private homeowner.

Although strategies are developed for the agricultural related categories of irrigation and livestock, it is important to understand the realistic effect that drought has on these activities. In the case of livestock, diminished forage generally occurs before water supply actually becomes a problem. Ranchers generally react by reducing the size of their herds, thus minimizing the overall impact on both the remaining forage and on water supplies.

Drought impact on irrigation is highly dependent on the type of water-supply source used. Irrigated farms dependent on ground water are much less susceptible to droughts than are those reliant on surface-water sources. Ground water, such as in the Del Valley area of Hudspeth County, will continue to be available even during drought intervals. On the other hand, prolonged droughts in the headwater areas of the Rio Grande result in a depletion of the water storage in Elephant Butte Reservoir and subsequent reduction in the yearly allotment to water users. Common reaction by farmers reliant on river water under these circumstances is to switch to lower water use crops, temporarily fallow some of their farmland, or pump ground water from the shallow aquifer until the Rio Grande Project allotments are again available.

The Far West Texas Regional Planning Group determined that surface water uses that will not have a significant impact on the region's water supply are consistent with the regional water plan even though not specifically recommended in the plan. Also, the Group determined that water supply projects that do not involve the development of or connection to a new water source are consistent with the regional water plan even though not specifically recommended in the plan.

The strategies discussed in this chapter are intended to identify projects or processes that can be employed to offset water-supply shortages during drought-of-record conditions. In Chapter 3, available water-supply sources were quantified based on drought-of-record conditions. Within the Far West Texas Water Planning Region it is apparent that most recognized temporary water-supply shortages in the rural counties can be met primarily by increased withdrawals of local ground-water resources. However, in El Paso County a more severe supply problem could exist. Municipal, industrial and power generation needs in the county are currently met by water withdrawn from the Rio Grande and local ground-water sources. During drought-of-record conditions the Rio Grande is expected to not have sufficient flow for withdrawals, and the resulting reliance on local ground water will cause the Hueco and Mesilla Bolson aquifers to become depleted of fresh water by 2030. Desalination of brackish local ground water and importation of ground water from eastern counties is not sufficient to meet the total expected deficit. Based on drought-of-record conditions and strategies developed in this plan, the following communities, facilities and other water use categories will be unable to meet expected water supply needs by the year 2030.

- City of El Paso
- Town of Anthony
- Community of Canutillo
- Town of Clint

- Community of Fabens
- Community of San Elizario
- City of Socorro
- Village of Vinton
- Community of Westway
- County Other (El Paso County)
- Fort Bliss
- Manufacturing (El Paso County)
- Steam Electric Power (El Paso County)

Likewise, irrigation along the Rio Grande corridor in El Paso and Hudspeth Counties will also be unable to meet expected water demands. Local brackish ground-water supplies from the Rio Grande Alluvium aquifer would only provide temporary benefit.

## 5.11 SUPPLY DEFICIT STRATEGIES

Strategies begin on page 5-41.

**STRATEGY # 22-7**

**WATER USER NAME:**
**County:** Brewster
**River Basin:** Rio Grande
**User Name:** City of Alpine

**STRATEGY NAME:**
Wastewater reuse

**STRATEGY DESCRIPTION:**
The City intends to construct a flood channel and run treated wastewater from its 6.4 mgd wastewater treatment plant through the channel in the downtown area, allowing some of the water to recharge a shallow perched zone of the local Igneous aquifer.

**TIME INTENDED TO IMPLEMENT:**
Short term (prior to the year 2030): Facilities will be built within the short term.
Long term (from 2030 to 2050): Continuation of the process.

**QUANTITY OF WATER:**
The City intends to run from 200,000 to 250,000 gallons per day of treated wastewater through drainage channels in the downtown area. Assuming that half of this water (250 acre-feet) percolates down and recharges the shallow perched aquifer, and that local municipal wells could capture 25 percent of this recharged water, the amount available would be approximately 62 acre-feet per year.

**RELIABILITY OF WATER:**
The source of supply – wastewater - is very reliable year-round.

**COST OF WATER:**
The project cost is estimated at $1,000,000. The City will realize some savings in that the expansion of the wastewater treatment plant may be delayed if this project is completed.

**ENVIRONMENTAL ISSUES:**
There are always water-quality issues involved with using wastewater, including coliform bacteria, any metabolic wastes that are byproducts of human-consumed pharmaceutical products, etc. Coliform bacteria levels are currently monitored by state requirement; chemical compounds that are metabolic byproducts of human-ingested pharmaceuticals are not. However, it is noted that some environmental groups support this method of aquifer recharge.

**IMPACT ON OTHER WATER RESOURCES:**
Increased recharge to the local aquifer system will extend the useful life of the aquifer and lessen the pressure on other City well fields.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

The City's current grant from the TWDB is for a flood protection study. This study will not quantify the amount of recharge, but does marginally address the concept of a constructed flood channel to serve as both a flood control and wildlife habitat channel. The amount of water actually recharging the aquifer is highly dependent on the hydraulic pressure, which in turn depends on the volume of water and on the shape of the channel selected. Soil properties of the project also play a very large role.

**INTERBASIN TRANSFER:**

None

**SOCIAL AND ECONOMIC IMPACTS:**

Local recharge of aquifers will help lessen the need for immediate additional infrastructure; thus holding down the cost of delivered water to the end customer. Maintaining a higher water table may also benefit vegetation along the drainage channels and provide the community with improved park space and wildlife viewing opportunities.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 22-1**

**WATER USER NAME:**
**County:** Brewster
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**
Additional wells

**STRATEGY DESCRIPTION:**
Drilling of new wells into the Igneous and other local aquifers will provide additional water that is needed in excess of water that can be obtained from the maximum practical withdrawals from existing wells (strategy 22-3). Individual, low volume wells will be drilled to serve each new rural home, and moderate volume new public-supply wells will serve increased demands in primarily the Study Butte / Terlingua, Big Bend and Marathon areas.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Approximately 400 new individual domestic wells and three new public-supply wells will be needed.
Long Term (from the year 2030 to the year 2050): Only maintenance and replacement wells needed to meet deficit.

**QUANTITY OF WATER:**
3 PS wells x 100gpm x 60min x 12 hrs x 365 days ÷ 325,851 = 242 ac-ft/yr
400 domestic wells x 7gpm x 60min x 3 hrs x 365 days ÷ 325,851 = 565 ac-ft/yr
Total volume = 807 ac-ft/yr

**RELIABILITY OF WATER:**
Sufficient ground water is available from local aquifers in most parts of the County; however, many dry holes have been drilled in the past in the County and more should be anticipated since the Igneous aquifer does not underlie all parts of the County. Proper well spacing and pump sizing should be considered to prevent interference between wells and to keep wells operating at acceptable capacity. Chemical quality of the water is generally acceptable; however, care should be taken in the Study Butte / Terlingua are to avoid high levels of naturally occurring radioactivity and heavy metals in the water.

**COST OF WATER:**
The estimated cost of installing a 900-ft deep public water supply well with 8-in ID casing is $63,200. The pump, motor, drop pipe, cable, and control panel will cost an additional $8,250. The total cost is $71,450. For three wells, the total cost is $214,350.
The average depth of a domestic well is estimated to be 400 ft. The cost of drilling and setting surface casing is approximately $6,000. The pump, motor, drop pipe, cable, control

panel, and pressure tank should cost an additional $2,500. Total cost for one domestic well is approximately $8,500. For 400 domestic wells, the total cost is $3,614,350.

**ENVIRONMENTAL ISSUES:**

Additional ground-water withdrawals could potentially decrease flow in local springs and streams, which could have a negative impact on water-dependent species.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

No effects on other water resources are anticipated. However, the data available is insufficient to state this with any degree of certainty. Additional data from new studies of the Igneous and other local aquifers is needed.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

No effects on agricultural activities are anticipated except insofar as local springs may be affected, in which cases some ranchers could be severely impacted.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

The drilling of public-supply wells must be in compliance with state regulations. Potential disposal of radioactive filters may require specific consideration.

Additional hydrological studies of the aquifers in the county, including modeling where appropriate, are necessary to assess the impact of this strategy. If the hydrology does not verify the impacts and assumptions of this strategy, it should be reconsidered.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

The development of additional water supplies, especially through public-supply systems, will encourage additional population growth.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

Wells will be drilled and water withdrawn with the consent of landowners.

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 22-2**

**WATER USER NAME:**
**County:** Brewster
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**
Distribution system maintenance

**STRATEGY DESCRIPTION:**
Identify and repair water-supply transmission leaks.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Leaks repaired as identified
Long Term (from the year 2030 to the year 2050): Leaks repaired as identified

**QUANTITY OF WATER:**
This strategy does not generate new water but rather extends existing supply by eliminating water losses.

**RELIABILITY OF WATER:**
Water saved by the repair of transmission leaks was previously being produced and is therefore guaranteed as being an available addition supply.

**COST OF WATER:**
Expected cost of identifying and repairing transmission leaks is highly variable and is primarily dependent on size and length of the required pipeline replacement. Potential for pipeline leaks increases with age of the existing pipeline. Assuming a replacement of 1,000 feet of 12-inch pipeline with appurtenances plus 20% markup for urban repairs (1,000 x $32 x 1.2), annual cost would be approximately $38,400.

**ENVIRONMENTAL ISSUES:**
Limited environmental effects may be expected as a result of required excavation.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**
The water savings achieved will offset the total quantity of water previously required to be withdrawn. No effect is anticipated on other water resources.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**
None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**
None

**OTHER FACTORS:**

None

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

An efficient water system with limited to no water loss conserves the water supply source and may lower the overall cost of delivered water to the end user.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 22-3**

**WATER USER NAME:**
**County:** Brewster
**River Basin:** Rio Grande
**User Name:** County other

**STRATEGY NAME:**
Expanded use of existing wells

**STRATEGY DESCRIPTION:**
Existing public and private wells may be capable of being pumped for a longer period of time each day to meet increased needs. Increased demand from new rural domestic homes will be met by strategy 22-1.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Additional pumping time will occur as needed.
Long Term (from the year 2030 to the year 2050): Additional pumping time will occur as needed.

**QUANTITY OF WATER:**
Assuming that water-supply entities operate three moderate-capacity wells at an average 50 gpm, increasing the pumping time of each well by two hours will generate 20 ac-ft/yr. Assuming 200 private domestic wells operating at 7 gpm, increasing the pumping time of each well by one hour will generate 94 ac-ft/yr. A total of 114 ac-ft/yr would be generated from this strategy.

**RELIABILITY OF WATER:**
Sufficient ground water is available from the Igneous and other local aquifers, however, local water-level declines may increase. Temporary water shortages may occur during drought periods, which may require the lowering of pumps or deepening of wells.

**COST OF WATER:**
Additional energy cost and cost for lowering some pumps is approximately $30,000 per year.

**ENVIRONMENTAL ISSUES:**
Additional ground-water withdrawals could potentially decrease flow in local springs and streams, which could have a negative impact on water-dependent species.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

No effects on other water resources are anticipated. However, the data available is insufficient to state this with any degree of certainty. Additional data from new studies of the Igneous and other local aquifers is needed.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

No effects on agricultural activities are anticipated except insofar as local springs may be affected, in which cases some ranchers could be severely impacted. If the water level declines, some ranches may not be able to deepen their wells given the increased cost of producing the wells, together with the capital required. At this point ranching may cease to be viable in some areas of the county.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

Additional hydrological studies of the aquifers in the county, including modeling where appropriate, are necessary to assess the impact of this strategy. If the hydrology does not verify the impacts and assumptions of this strategy, it should be reconsidered.

**INTERBASIN TRANSFER:**

No interbasin transfer is required.

**SOCIAL AND ECONOMIC IMPACTS:**

Local increased water-level declines may occur which potentially may affect water levels in wells on surrounding properties.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 22-4**

**WATER USER NAME:**
**County:** Brewster
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**
Purchase/Transfer of existing water rights

**STRATEGY DESCRIPTION:**
This strategy involves development of contracts and agreements that change approximately 300 acre-feet per year of existing Lower Rio Grande water use from agricultural to municipal or golf course turf irrigation for communities near the river. The strategy does not involve determining the need for associated treatment plants and conveyance systems. The community of Lajitas would most likely benefit from this strategy.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Immediate implementation is desirable.
Long Term (from the year 2030 to the year 2050): No additional transfers anticipated.

**QUANTITY OF WATER:**
The quantity of additional surface water available is dependent on which irrigation rights on the Rio Grande are interested in selling their water rights to Lajitas. Approximately 300 acre-feet per year may be needed.

**RELIABILITY OF WATER:**
The reliability of this source of supply is reliant on the natural availability of water in the Rio Grande at the time of the desired diversion. There is currently 2,099 acre-feet per year of water permitted for use from the Lower Rio Grande in Brewster County.

**COST OF WATER:**
Cost of water for this strategy will have to be negotiated. The market value of water rights in Texas typically has ranged from $1,200 to $1,800 per acre-foot (although it has been significantly higher in other areas and other states, based on information provided by several river authorities and districts. The sale of an existing right might require the estimated Present Value of income expected by the owner of the right from the use of water for irrigation over a period of 10 to 20 years. 300 acre-feet at $1,500 per acre-foot is $450,000.

**ENVIRONMENTAL ISSUES:**
Although the construction and expansion of a golf course alters the original landscape and pre-existing habitat, the irrigation of the new golf course landscape creates a new and possibly beneficial habitat. Negative environmental impact on the portion of the river

downstream from the point of diversion will only occur if the quantity of water diverted is in excess of the quantity historically diverted for other uses.

**IMPACT ON OTHER WATER RESOURCES:**

Provided Lajitas does not divert any more water from the Rio Grande than is authorized under its purchased rights' authorizations, there should not be any effect on Rio Grande flows.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

There is no anticipated threat to agriculture since the water use remains irrigation.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

Agreements will have to be reached with upstream water rights holders, and regulatory authorization may be needed to allow the utilization of an upstream water right down stream.

**INTERBASIN TRANSFER:**

No interbasin transfer is required.

**SOCIAL AND ECONOMIC IMPACTS:**

Expansion of the golf course is a desired project in social and economic terms.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

There is no impact on existing water rights. Additional water may be negotiated with other water rights holders in the future.

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 22-5**

**WATER USER NAME:**
**County:** Brewster
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**
Rainfall Harvesting

**STRATEGY DESCRIPTION:**
Rainfall harvesting involves capturing rainfall from roofs or in small surface impoundments, providing water that is usually lost to the rural homeowner.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): This strategy could be implemented relatively easily, inexpensively and quickly for immediate to short-term benefit.

Long Term (from the year 2030 to the year 2050): The strategy would continue in place as long as the homeowner desired and/or the home remained intact.

**QUANTITY OF WATER:**
The Texas Water Development Board's "Texas Guide to Rainwater Harvesting" gives the methodology to calculate rainfall harvest amounts using average precipitation for the time period 1940 through 1990 at selected rain stations across Texas. However, this Regional Water Plan must be based on water supply amounts that could be yielded during drought-of-record. Therefore, average water yield amounts produced by the methodology using average precipitation amounts should be adjusted. The TWDB publication gives minimum precipitation, maximum precipitation and 10th percentile, 25th percentile, and 50th percentile (median) amounts as well as the average precipitation amounts. Investigation of National Climatic Data Center precipitation data for West Texas stations shows that the drought-of-record in 1956 closely approximates the 25$^{th}$ percentile precipitation amounts. Therefore, if one substitutes the 25$^{th}$ percentile precipitation amounts for the average precipitation amounts within the methodology, the quantity of water on an annual basis for a 1,500 square-foot residence near Alpine is 5,193 gallons, or only 0.016 acre-foot of water per year.

**RELIABILITY OF WATER:**
The quantity given above is on an annual basis; an efficiency of 100% is assumed. Also, the methodology is simplified from a monthly water balance. Both the efficiency and characteristic monthly water balance are site-specific and dependent on the individual homeowner's skill in designing and implementing his particular system.

**COST OF WATER:**
The ongoing cost of water is negligible, as operation and maintenance would involve nothing more than regular application of chlorine, iodide or other sanitizing chemicals or

methods, regular inspection of the system for leaks or deterioration, and costs for operating a small pump. A residential system in Far West Texas, using metal roofing and above-ground polyethylene cisterns costs approximately $4,000.

**ENVIRONMENTAL ISSUES:**

None

**IMPACT ON OTHER WATER RESOURCES:**

Minimal loss of water to aquifer recharge and an associated decrease in surface water flows may result, as the water reaches the homeowner rather than the region in general.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

None

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

This could be an extremely beneficial water management strategy in terms of reviving a local economy and/or encouraging people to settle in a very water-scarce area.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 22-6**

**WATER USER NAME:**

**County:** Brewster
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**

Water production management

**STRATEGY DESCRIPTION:**

The Brewster County Groundwater Water Conservation District will be created and will establish rules to regulate the production of ground water from the county aquifers to insure adequate water for the future.

**TIME INTENDED TO IMPLEMENT:**

Short Term (prior to the year 2030): Rules will be established.
Long Term (from the year 2030 to the year 2050): Rules will continue to be enforced.

**QUANTITY OF WATER:**

This strategy does not generate additional water but rather insures efficient and prudent use of existing supplies.

**RELIABILITY OF WATER:**

Prudent management and use of ground-water resources will improve the long-term reliability of this supply.

**COST OF WATER:**

The cost to enforce the rules is incurred by the District and indirectly by the property owners from fees or property taxes levied by the Groundwater District.

**ENVIRONMENTAL ISSUES:**

The prudent management of ground water has a positive effect on local and regional water-level declines and, thus, may have a positive effect on habitats that benefit from springflows.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

Water production management will result in the conservation of all ground-water sources over which the rules have been established.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

This strategy generally does not impact low yielding livestock wells but could impact higher-yielding irrigation wells.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

The implementation of management rules is subject to district board approval and may be reversed at the discretion of the district board. Groundwater District Rules must be consistent with the State and Federal Constitution and with State ground-water laws and regulations.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Although production management rules may impact specific water users, the overall intent is to ensure adequate, long-term water availability to benefit the social and economic needs of the region.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 55-1**

**WATER USER NAME:**
**County:** Culberson
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**
Water production management

**STRATEGY DESCRIPTION:**
The Culberson County Groundwater Water Conservation District will establish rules to regulate the production of ground water from the Bolson and other local aquifers to insure adequate water for the future.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Rules are currently in force.
Long Term (from the year 2030 to the year 2050): Rules will continue to be enforced.

**QUANTITY OF WATER:**
This strategy does not generate additional water but rather insures efficient and prudent use of existing supplies.

**RELIABILITY OF WATER:**
Prudent management and use of ground-water resources will improve the long-term reliability of this supply.

**COST OF WATER:**
The cost to enforce the rules is incurred by the District and indirectly by the property owners from fees or property taxes levied by the Groundwater District.

**ENVIRONMENTAL ISSUES:**
The prudent management of ground water has a positive effect on local and regional water-level declines and, thus, may have a positive effect on habitats that benefit from springflows.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**
Water production management will result in the conservation of all ground-water sources over which the rules have been established.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**
This strategy generally does not impact low yielding livestock wells but could impact higher-yielding irrigation wells.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

The implementation of management rules is subject to district board approval and may be reversed at the discretion of the district board. Groundwater District Rules must be consistent with the State and Federal Constitution and with State ground-water laws and regulations.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Although production management rules may impact specific water users, the overall intent is to ensure adequate, long-term water availability to benefit the social and economic needs of the region.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 55-2**

**WATER USER NAME:**
**County:** Culberson
**River Basin:** Rio Grande
**User Name**: Mining

**STRATEGY NAME:**
Expanded use of existing wells.

**STRATEGY DESCRIPTION:**
Extending the period of time the estimated existing 10 wells are pumped will produce additional water from Other Aquifers.

**TIME INTENDED TO IMPLEMENT:**
Short term (prior to the year 2030): Additional increase pumping required at 2030.
Long term (from the year 2030 to 2050): Additional increased pumpage required.

**QUANTITY OF WATER:**
An additional 4 hours of pumping time for each of an estimated 10 existing wells at an average of 50 gpm for 240 days per year will generate 88 ac-ft/yr.

**RELIABILITY OF WATER:**
Sufficient ground water is available from Other Aquifers without excessive water-level declines. Long-term pumping may, however, result in water-level declines in the immediate pumping area.

**COST OF WATER:**
Additional energy cost and cost for lowering some pumps is approximately $9,600 per year.

**ENVIRONMENTAL ISSUES:**
No environmental effects are anticipated from this strategy; however, additional ground-water withdrawals could potentially decrease flow in local springs and streams, which could have a negative impact on water-dependent species. This assessment does not take into account the environmental effects resulting from the mining operation itself.

**IMPACT ON OTHER WATER RESOURCES:**
No effect on other water resources is anticipated from this strategy; however, additional ground-water withdrawals could potentially decrease flow in local springs and streams.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

No negative impact to agriculture is anticipated; however, if local springs are affected, some livestock operations could be severely impacted. If water levels in aquifers decline, some livestock operations may not be able to effectively deepen their wells given the cost and capital outlay for producing wells.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

No impact to natural resources is anticipated.

**OTHER FACTORS:**

The principal mining operation in Culberson County is in the process of closing down. If this occurs, the projected future water-demand estimate for mining will not be accurate and this strategy may not be necessary.

Additional hydrological studies of the aquifers in the county, including modeling where appropriate, are necessary to assess the impact of this strategy. If the hydrology does not verify the impacts and assumptions of this strategy, it should be reconsidered.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

A negative impact is possible if sufficient water-level declines occur in localized areas in Culberson County. These declines have the potential to affect water levels in wells on surrounding properties. If livestock operators do not have the economic resources to deepen or expand production from wells, ranching may cease to be viable in some areas of the county.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY #55-3**

**WATER USER NAME:**

**County:** Culberson
**River Basin:** Rio Grande
**User Name:** Mining

**STRATEGY NAME:**

Additional wells

**STRATEGY DESCRIPTION:**

Additional wells will be drilled and completed in Other Aquifers if expanded use of existing wells is insufficient to meet anticipated needs.

**TIME INTENDED TO IMPLEMENT:**

Short term (prior to the year 2030): Additional wells will be needed beginning in 2030.
Long term (from the year 2030 to 2050): Additional wells will be needed.

**QUANTITY OF WATER:**

Six new wells pumping at an average rate of 50 gpm for eight hours for 240 days per year will generate 106 acre-ft/yr.

**RELIABILITY OF WATER:**

Sufficient ground water is available from Other Aquifers without excessive water-level declines. Long-term pumping may, however, result in water-level declines in the immediate pumping area.

**COST OF WATER:**

Water well depths in Culberson County where mining is occurring range from 100 ft. to 1,000 ft. The estimated cost of installing a 500-ft deep industrial water supply well with 8-in ID casing is $50,000. The pump, motor, drop pipe, cable, and control panel will cost an additional $8,000 and energy costs will be approximately $1,000. The total cost is $59,000. For six wells, the total cost is $354,000.

**ENVIRONMENTAL ISSUES:**

No environmental effects are anticipated from this strategy; however, additional ground-water withdrawals could potentially decrease flow in local springs and streams, which could have a negative impact on water-dependent species. This assessment does not take into account the environmental effects resulting from the mining operation itself.

**IMPACT ON OTHER WATER RESOURCES:**

No effect on other water resources is anticipated from this strategy; however, additional ground-water withdrawals could potentially decrease flow in local springs and streams.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

No negative impact to agriculture is anticipated; however, if local springs are affected, some livestock operations could be severely impacted. If water levels in aquifers decline, some livestock operations may not be able to effectively deepen their wells given the cost and capital outlay for producing wells.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

No impact to natural resources is anticipated.

**OTHER FACTORS:**

The principal mining operation in Culberson County is in the process of closing down. If this occurs, the projected future water-demand estimate for mining will not be accurate and this strategy may not be necessary.

Where applicable, the drilling of new wells must be in compliance with the Culberson County Underground Water Conservation District rules. Additional hydrological studies of the aquifers in the county, including modeling where appropriate, are necessary to assess the impact of this strategy. If the hydrology does not verify the impacts and assumptions of this strategy, it should be reconsidered.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

A negative impact is possible if sufficient water-level declines occur in localized areas in Culberson County. These declines have the potential to affect water levels in wells on surrounding properties. If livestock operators do not have the economic resources to deepen or expand production from wells, ranching may cease to be viable in some areas of the county.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-1**

**WATER USER NAME**:
**County**: El Paso
**River Basin**: Rio Grande
**User Name**: City of El Paso

**STRATEGY NAME:**

Demand Side Conservation (includes water demand management and increased conservation)

**STRATEGY DESCRIPTION:**

Strategies to maintain achievements in conserving water and achieving the goal of per capita usage of 160 gallons per day per person will continue. Active programs to reduce usage through replacement and changes in plumbing fixtures and codes will be advanced. Reduction will be achieved through promotion of water saving appliances and replacement of evaporative coolers for refrigerated air conditioners. Enhanced reduction will be achieved by developing water wise landscaping codes and promotions. Aggressive use of market incentives to reduce use will be balanced against the need for social equity. These programs will be able to achieve and maintain water reductions. Costs for these programs vary considerably and limitations exist to achieving further large-scale reductions as even the most cost effective program areas can only yield marginal amounts of water.

**TIME INTENDED TO IMPLEMENT:**

Short Term (prior to the year 2030): Currently implemented and will be continued. Additional savings of 5 gallons per person per day are anticipated during this period.

Long Term (from the year 2030 to the year 2050): Implementation to be continued. New technology to be investigated.

**QUANTITY OF WATER:**

Quantities of water vary according to the actual type of activity. Labor intensive yet relatively inexpensive strategies such as public education are virtually impossible to quantify. Other strategies such as plumbing code changes and toilet exchanges can be estimated. A great degree of uncertainty exists as to the accuracy of the estimates. Showerhead replacement can yield from 500 to 7000 acre-feet per year and is in implementation. Toilet replacement can yield from 1000 to 5000 acre-feet per year. Turf rebate and landscaping changes may yield in the 5000 acre-foot range. Advanced washers may save 2000 acre-feet per year. Thus savings can be achieved. El Paso has reduced water usage from over 200 gallons per capita per day per person (GPCD) to close to 160 and will continue to strive to be one of the lowest water users in the southwestern United States. Additional gains will likely not reduce usage substantially but hopefully maintain pace with population growth.

**RELIABILITY OF WATER:**

Since a percentage of the water gained through demand suppression conservation is based on behavior change, the reliability of this amount varies based on weather and social conditions. The remaining percentage is gained through change in plumbing fixtures etc., and can be assumed to be a reliable reduction in usage. Gains made can be assumed stable.

**COST OF WATER:**

Not unlike the quantity of water, the cost varies according to the tactic used to achieve the conservation goal. Cost of showerhead replacement runs in the $50 per acre-foot range. Toilet replacement can cost upwards of $700 to $1000 per acre-foot. Landscaping change ranges from $100 to $300 per acre-foot. Thus the range for conservation is between $50 to $1,000 per acre-foot of water saved and is limited to a discreet amount achievable in the 5 to 10% of total usage when in the 160 GPCD range.

**ENVIRONMENTAL ISSUES:**

None

**IMPACT ON OTHER WATER RESOURCES:**

No impacts on other water resources are anticipated.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

None

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Continued public relations and education will be necessary by the EPWU Conservation Department to convey to the public the message of the importance and necessity for the Stage II Conservation Program. For some residents accustomed to large areas of turf grass landscaping that includes grasses as an ideal, this may require a period of adjustment. This may also be true for developers of office, apartment and warehouse complex landscaping that promote a greening of the desert.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-2**

**WATER USER NAME**

**County:** El Paso
**River Basin:** Rio Grande
**User Name:** City of El Paso

**STRATEGY NAME:**

Supply Side Conservation

**STRATEGY DESCRIPTION:**

Water conserved by improving the agricultural supply system (supply side conservation) may be converted to municipal usage if mutually agreed to by the El Paso Water Improvement District #1, Bureau of Reclamation and El Paso Water Utilities. The lining of canals is the primary action for this strategy. Based on the complexity of institutional conversion from agricultural to municipal use, and the high cost of the projects, in-depth cost planning has not been fully explored. Cost for this activity is therefore undetermined although specific projects have been identified. The American Canal Extension and Lining Project is complete but the Bureau of Reclamation and the irrigation district are still analyzing the amount of savings that have been achieved, but the savings are anticipated to be approximately 30,000 acre feet per irrigation season. Until they determine the amount of saved water the cost of the water cannot be calculated. This project and others in the future face significant institutional, legal and hydrologic issues.

**TIME INTENDED TO IMPLEMENT:**

Short Term (prior to the year 2030): The lining project to be completed prior to 2030.
Long Term (from the year 2030 to the year 2050): Maintenance only.

**QUANTITY OF WATER:**

Approximately 50,000 acre-feet per year could be saved through reduction of losses, primarily through canal lining and control structure replacement. This amount is for maximizing the efficiency in the canal system and does not include surface water evaporation over the irrigation season.

**RELIABILITY OF WATER:**

The amount conserved varies with the yearly allotment. The amount saved is stable as a percentage of the yearly allotment. Quality of this water is the same quality as other river water delivered for agricultural use.

**COST OF WATER:**

Based on the complexity of institutional conversion from agricultural to municipal use, and the high cost of the projects, in-depth cost planning has not been fully explored. Cost for this activity is therefore undetermined. It is believed that the upper range for conversion of an acre-foot of conserved supply side water is $600 per acre-foot or $30 million per year through 2030.

**ENVIRONMENTAL ISSUES:**

There would be some environmental impact from disturbance and earth-moving activities associated with canal lining. There is also a possibility of reducing the water supply of existing wetlands created by seepage from the canal and recharge to the alluvial aquifer.

**IMPACT ON OTHER WATER RESOURCES:**

Groundwater recharge to the Rio Grande alluvium would be reduced. However, due to the high Total Dissolved Solids (TDS) content of the ground water within the shallow alluvium in most areas of the El Paso Valley, such recharge by fresh water seepage from the canals is considered to be lost with respect to later recovery and reuse due to blending and reverse-dilution with the native brackish water.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

With the exception of water resources, there are no impacts to any natural resource.

**OTHER FACTORS:**

When in-depth cost analysis has been completed, and when the institutional, legal, and hydrological issues have been resolved, this strategy may have different impacts. If these issues are not resolved satisfactorily, this strategy may need to be revisited.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL & ECONOMIC IMPACTS:**

Other than the cost associated with concrete lining all of the canals and laterals, there is no other social & economic impact.

**IMPACT ON WATER RIGHTS, CONTRACTS, & OPTIONS AGREEMENTS:**

A conversion contract is required for all water converted out of agricultural use to municipal use in the Rio Grande Project.

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-3**

**WATER USER NAME:**
**County:** El Paso
**River Basin:** Rio Grande
**User Name:** City of El Paso

**STRATEGY NAME:**
Reclamation

**STRATEGY DESCRIPTION:**
Reclamation strategies are being and will continue to be implemented. Replacing large-scale use of potable water with reclaimed wastewater for industrial, commercial, and landscape watering will continue to provide approximately 10% of the water needed throughout the region. Reclaimed water not put to M&I use is commingled with irrigation flows and reused for agricultural purposes. The high and variable cost of infrastructure and impracticality of implementation in some situations limits the potential of expanding reclaimed water use.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Currently reuse from existing treatment plant.
Long Term (from the year 2030 to the year 2050): Expansion of treatment plant needed.

**QUANTITY OF WATER:**
Approximately 10% of total municipal use within the area will be reclaimed. New development will expand to maintain this percentage. The estimated quantity of reclaimed water could eventually amount to over 19,000 acre-feet per year to be used for turf irrigation, landscaping and process water for industries.

**RELIABILITY OF WATER:**
Very reliable source of water with dissolved solids (sulfates, chlorides, etc.) at levels exceeding drinking water standards. However, source water (Upper Rio Grande and ground water) is not considered available during drought-of-record conditions after 2030.

**COST OF WATER:**
Cost varies with the particular project. Projects are implemented into existing areas to piggyback on the existing infrastructure or are developed as sources in new industrial and landscaping projects. In all cases the two infrastructure systems will be developed in tandem. The capital cost for this strategy is $72,868,103. The annual cost is $8,651,631. The cost per acre-foot per year is $455. The cost to treat 1,000 gallons is $1.40.

**ENVIRONMENTAL ISSUES:**
For over fifteen years El Paso has had a reclaimed water system supplying water for industrial, agricultural, landscape and aquifer recharge uses. No associated health issues have

developed. Of minor concern is the loading of sodium in soil. This issue can be controlled by proper agronomic application of reclaimed water and landscape maintenance.

**IMPACT ON OTHER WATER RESOURCES:**

The use of reclaimed water is a net benefit to other regional water resource users.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

Reclaimed water is a usable to the agricultural sector by substantially expanding the available supply.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

Cost may make significant increased reclamation difficult.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Reclaimed water can be used to reduce the use of potable waters. The use of this water source can reduce water rates as reclaimed water is sold at a reduced rate. The economic impact is a positive impact to the water user.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-4**

**WATER USER NAME**

**County:** El Paso
**River Basin:** Rio Grande
**User Name:** City of El Paso

**STRATEGY NAME:**

Surface Water Treatment (includes conversion of rights to use water)

**STRATEGY DESCRIPTION:**

This strategy refers to the diversion and treatment of Rio Grande water from the fully appropriated Rio Grande Project ("Project") and also the conversion of rights to use water from the Project from agriculture to Municipal use. This strategy involves development of contracts and agreements that change existing water use from agricultural to municipal in the Rio Grande Project and determining the need for associated treatment plants and conveyance systems. All impacts for this strategy are associated with the Sustainable Water Project, which is a major effort by the City of El Paso to switch to a renewable surface water source.

**TIME INTENDED TO IMPLEMENT:**

Short Term (prior to the year 2030): This strategy is currently being negotiated and will be implemented as soon as possible.

Long Term (from the year 2030 to the year 2050): This strategy will be expanded in the long term if water supplies are available and negotiations are successful.

**QUANTITY OF WATER:**

At least 120,000 acre-feet of Rio Grande water converted by 2050.

**RELIABILITY OF WATER:**

Historically, the long-term reliability of surface water from the Project has been fairly good, even though the supply is prone to periodic droughts in New Mexico and Colorado. However, supply from the Upper Rio Grande is considered to be unavailable during drought-of-record conditions.

**COST OF WATER:**

Increasing the City's surface water treatment capacity depends on the conversion of Project rights to use water from agriculture to municipal use through various mechanisms, such as the purchase of water right lands and the conversion of rights to use water associated with such lands to municipal use, the leasing of small (two acres or less) urbanized land tracts under existing contracts, and future execution of forbearance contracts (partial and complete) with farmers. These conversions are based on contractual agreements among El Paso County Water Improvement District #1, Bureau of Reclamation and El Paso Water Utilities. The El Paso-Las Cruces Regional Sustainable Water Project has projected costs for construction of surface water treatment systems, but the cost estimates for water conversion for use in this project have not been completed. For purposes of this report the costs are based on assumed construction and rights to use water costs. Because of the complexity of the Environmental Impact Statement (EIS) for the El Paso-Las Cruces Regional Sustainable Water Project only cursory information was extracted.

The capital costs for this strategy are $273,445,428. The annual cost associated with this strategy is $43,550,220. The cost per acre-foot/year is $362. The cost to treat 1,000 gallons is $1.11.

**ENVIRONMENTAL ISSUES:**

Based on findings from El Paso-Las Cruces Regional Sustainable Water (SWP) Project Draft Environmental Impact Statement (DEIS), there would be some permanent and temporary adverse impacts on wildlife resources, including birds, mammal, and herptiles (amphibians and reptiles), as well as some benefits to the environment from the project. These impacts are discussed more fully in the DEIS for the SWP. The reader is referred to this document if a more detailed analysis of these impacts is desired. The record-of-decision for the draft EIS for this project is pending. However, it is important to recognize that the water supply source for this strategy (Upper Rio Grande) is considered to be unavailable during drought-of-record conditions, as flows would be insufficient for diversions to occur.

**IMPACT ON OTHER WATER RESOURCES:**

The amount of water production resulting from the successful implementation of the SWP would directly reduce the pumping from the Hueco Bolson and Mesilla Aquifers by a corresponding amount, thus significantly extending the life of these two aquifers.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

Full implementation of the SWP would result in significant and/or substantive adverse impacts on agricultural employment, earnings, and income, crop production value, and irrigated harvested cropland under each of the alternatives. For example, in El Paso County there would be a decrease of 14.8 percent ($5.1 million) in the total crop production value, and a 17.7 % (14,344 acres) decrease in the amount of irrigated harvested cropland. These impacts are discussed fully in the DEIS for the SWP. The reader is referred to this document if a detailed analysis of these impacts is desired.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

According to the DEIS, the SWP would have no significant adverse impacts on natural resources (oil, extractive minerals, energy generation, etc.). This topic is further discussed in the DEIS for the SWP. The reader is referred to this document if a more detailed analysis is desired.

**OTHER FACTORS:**

Under §11.139 of the Water Code and other applicable laws, if all of the statutory conditions are met, El Paso may be able to purchase surface water under specific Texas water permits.

This strategy depends on the consummation of an agreement between EPWU, EPCWID#1, the Bureau of Reclamation, and others. If no agreement is reached, this strategy may be impossible to fully implement.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

The only significant adverse social and economic impacts associated with the SWP are those on the agricultural community, because of the acreage taken out of production in order to obtain the right to use water for municipal purposes. There are also significant positive social and economic impacts from the SWP which are associated with the increased growth and economic output made possible by the water supply that it would provide. These positive economic impacts of securing sufficient water for the region's future needs are discussed in Section 4.6. of the Regional Water Plan. As discussed in this Section, the economic impacts of urban growth greatly outweigh the negative impacts of decreased agricultural production. As stated in the DEIS, mitigation of the adverse impacts on farm employment will include the implementation of a job retraining program for the affected individuals. This job retraining program could be funded from the excess economic benefits gained from the conversion of water from agricultural to municipal use.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

In 1998, a Conversion Contract was signed between EPCWID#1 and the Bureau of Reclamation outlining the framework and commitment to convert additional Rio Grande surface water to M&I uses. This can be accomplished by such methods as conservation, wastewater reclamation and reuse and municipal purchase of available and/or unused water directly from EPCWID#1 and individual landowners through forbearance and other means. EPWU, EPCWID#1 and the Bureau of Reclamation are currently negotiating one or more Implementing Agreements to carry forward the additional municipal conversions in a legal and socially and financially responsible manner that is agreeable to all parties.

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-5**

**WATER USER NAME:**
**County**: El Paso
**River Basin**: Rio Grande
**User Name:** City of El Paso

**STRATEGY NAME:**
Desalination

**STRATEGY DESCRIPTION:**
Desalination refers to any activity that reduces the salinity of a water source to below 1,000-ppm TDS. This includes desalination by physical means such as reverse osmosis, and membrane technology. For purposes of this plan it also refers to blending of higher TDS waters with lower TDS water to achieve a potable supply below 1,000 TDS. This strategy considers the desalination of brackish ground water in the Hueco Bolson aquifer (not currently being developed in the El Paso County area except by some small MUDs) and mixing this water with fresher water from the Hueco Bolson aquifer.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Development is under way to have at least 5 to 10 million gallons per day (15.3 to 30.7 acre-feet) of production by 2005.
Long Term (from the year 2030 to the year 2050): Increased treatment capacity may be needed.

**QUANTITY OF WATER:**
This strategy considers the desalination by treatment of up to 30,000 acre-feet of water by 2030. Of this amount approximately 10,000 acre-feet will be derived from treatment with the remaining amount being blended from Hueco brackish water sources. Total use of brackish resources in 2050 is estimated to be over 50,000 acre-feet per year.

**RELIABILITY OF WATER:**
The reserve of brackish water is equal or greater to the volume of fresh water left in the Hueco Bolson. Estimated reserve of brackish water of a quality between 1,000 and 1,500 TDS in 2050 is projected to be 780,000 acre-feet of water. These estimates need to be verified through extensive investigations and modeling.

**COST OF WATER:**
The capital costs for this strategy are $27,681,705. The annual cost associated with this strategy is $4,271,128. The cost per acre ft/year is $ 285. The cost to treat 1,000 gallons is $0.87. Cost estimate is based on a quantity of 15,000 acre-feet/year.

**ENVIRONMENTAL ISSUES:**

The major environmental issue related to the use of desalination is the disposal of the process by-product. Alternatives for disposal of the reject brine include deep well injection and the use of evaporation beds. Drying beds require the use of large land areas to accommodate the daily production of brine. Disposal using deep well injection is not very prevalent and there are numerous uncertainties relative to the practical disposal of large volumes by this method. Preliminary planning indicates viable disposal options exist that have environmentally benign impacts including disposal in existing salt flat environments or in lined pits.

**IMPACT ON OTHER WATER RESOURCES:**

Mining of brackish water aquifers is required under this strategy. New well field development programs would be undertaken to drill production wells in the aquifer for either treatment at desalination treatment plants or for blending with other sources of water. This strategy would prolong the existing fresh water aquifers by reducing the production from these reservoirs.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

No impact is anticipated.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

No impacts to natural resources are anticipated with well-engineered brine disposal.

**OTHER FACTORS:**

A method must be found to dispose of the by-product. Cost and environmental issues may result in this strategy being difficult to implement.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

None

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-6A**

**WATER USER NAME**

**County:** El Paso
**River Basin:** Rio Grande
**User Name: City** of El Paso

**STRATEGY NAME:**

Groundwater Transfers – Long Distance Pipeline from Antelope Valley Ranch.

**STRATEGY DESCRIPTION:**

Ground water would be transferred to El Paso from property owned by El Paso Water Utilities (EPWU) near Valentine, Texas. Cost estimates include a preliminary assessment for construction of a pipeline and blending with local brackish water resources when the imported water reaches El Paso. Further detailed analysis is under way using a public/private partnership between EPWU and the Hunt Corporation, a private sector developer (the Hunt Study). Detailed information is not yet available. The Hunt Summary Report is due to EPWU in March 2001.

**TIME INTENDED TO IMPLEMENT:**

Short Term (prior to the year 2030): Based on the availability of surface water conversions this strategy could be implemented within the next ten years.

**QUANTITY OF WATER:**

Although other aquifer sources may be considered in the Hunt study, currently EPWU needs to preserve the option of importing a minimum of 15,000 acre-feet per year from one or both of two Far West Texas Aquifers – Ryan Flat (Antelope Valley Ranch) and Bone Springs-Victorio Peak (Dell Valley) – with a possible eventual total peak importation of 50,000 acre-feet per year from both sources combined. A very preliminary feasibility analysis based on the latest data made available from the Hunt Study appears to indicate that development of ground water from the Wild Horse Ranch property may not be feasible in comparison to the other options, due to a combination of possible need for desalination and the length of pipeline required to import water from this source. However, Hunt Building Corporation has not completed the economic analysis of all the options and will not complete this study until November of 2000. If the completed study shows the importation of water from Wild Horse Ranch as a viable option, it will be submitted for inclusion as an additional import strategy at that time.

At Antelope Valley Ranch, actual pumping levels over time will depend on the results of modeling and/or analytical studies that will be done on the aquifer, and on establishing an acceptable level of impact on the aquifer and adjacent properties. Additional amounts of ground water may also be purchased from landowners near the proposed pipeline route, if and when such ground water is offered for sale. This may enhance the feasibility of the Wild Horse Ranch site in the future.

As previously outlined, EPWU proposes to export 15,000 acre-feet per year initially. The attached charts show the estimated levels of decline at various distances from the well field and can be used to estimate the offsite water level declines. The charts are based on assumed pumping rates of fifteen, thirty, and forty-five thousand acre-feet per year, and indicate, in EPWU's opinion, that severe water-level declines will not be a problem. As previously stated, EPWU will continue to collect data and do numerical modeling as its well fields are developed. EPWU will continue to work with the affected Groundwater Conservation Districts to define acceptable impacts and assure that operation of the well field remains within these parameters.

**RELIABILITY OF WATER:**

At the proposed pumping rates the Ryan Flat aquifer should prove to be a reliable supply for many years with acceptable impacts on the aquifer and adjacent properties. Therefore, this will be a reliable source for EPWU if it proves to be cost effective compared to other options.

**COST OF WATER:**

The following preliminary cost estimate for this strategy was developed using the assumed transport of water from Antelope Valley Ranch to El Paso, and is based on blending 1 part imported water with approximately 2 part Hueco Bolson brackish ground water. The following table outlines the cost of blending approximately 30,000 acre-feet per year of Hueco Bolson brackish water at an average TDS of 1,300 mg/l with 15,000 acre-feet per year of imported Antelope Valley water at not more than 400 mg/l TDS to result in blended water with an average TDS of just under 1,000. This estimate must be verified through rigorous feasibility analyses. The cost will be adjusted after acquiring additional information on the hydrology of both aquifers, chemical stability of water mixtures, source reliability, power costs and other factors. Assumptions drive the estimate and minor adjustments to source water TDS can change the cost substantially.

The capital costs for this strategy are $356,138,169. The annual cost associated with this strategy is $35,197,006. The cost per acre ft/year is $782. The cost to treat 1,000 gallons is $2.40. Cost estimate is based on a quantity of 45,000 acre-feet/year.

**ENVIRONMENTAL ISSUES:**

Considered to be minimal.

**IMPACT ON OTHER WATER RESOURCES:**

No other aquifers or surface water resources are expected to be affected by pumpage at Antelope Valley Ranch.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

Considered being minimal although minor mitigation may be required for areas with very shallow livestock wells. Areas adjacent to each proposed well field may experience a minor amount of water level decline in the aquifer being pumped.

EPWU, through the Hunt Study, will have access to numerical modeling of the Ryan Flats aquifer on a parallel schedule with the planning and design of the proposed pipeline. The Texas Water Development Board may wish to pursue an accelerated modeling effort of the Far

West Texas Aquifers. EPWU/Hunt Study data will be used to support any such efforts. The results of modeling efforts will be used as a tool to identify the likely effects over time of various pumping scenarios, and subsequently to assist EPWU and the Groundwater Conservation Districts in reaching agreement concerning acceptable pumping rates, their associated impact levels, and any necessary mitigation. Water level declines may be low enough that mitigation measures will be unnecessary.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

Not considered having the potential to impact on other natural resources.

**OTHER FACTORS:**

Additional hydrological studies of the aquifers, that are the subject of this strategy, including modeling where appropriate, are necessary to assess the impact of this strategy. If independent hydrology does not verify the impacts and assumptions of this strategy, it should be reconsidered. Development of a plan to mitigate excessive depletion of the aquifer is necessary prior to the full implementation of this strategy. Additionally, this strategy is dependent on more thorough cost analysis. The drilling of new public-supply wells must be in compliance with State regulations and the Rules and Regulations of the Jeff Davis County and Presidio County Groundwater Conservation Districts.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Minor local water-level declines may occur which may affect the water levels in wells on surrounding properties. Effects of any water level declines will be limited and can be mitigated under agreements between affected parties. The pipeline might be able to provide water to small communities along the pipeline route, which would be a direct benefit to those communities.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-6B**

**WATER USER NAME**

**County:** El Paso
**River Basin:** Rio Grande
**User Name:** City of El Paso

**STRATEGY NAME:**

Ground water Transfer via Long Distance Pipeline from Dell Valley

**STRATEGY DESCRIPTION:**

Ground water would be pumped and treated to a low total dissolved solids (TDS) level and transferred to El Paso from the Dell Valley area via a pipeline. Treatment would be performed near Dell City using desalinization water treatment technologies. Hunt Building Corporation is currently assessing the feasibility of this option. EPWU has entered into a public/private partnership with Hunt Building Corporation to evaluate the transfer of water from various sources, including Dell Valley. Hunt Building Corporation has agreed to conduct a feasibility analysis to provide the PSB with capital and operating costs as well as costs to deliver the water to El Paso. The agreement also addresses environmental, regulatory, and legal issues related to the use and transfer of Dell Valley water. The results of the Hunt Building Corporation evaluation are due to the EPWU in March 2001.

**TIME INTENDED TO IMPLEMENT:**

Short Term (prior to the year 2030): Based on the availability of surface water conversions this strategy could be implemented within the next ten years.

**QUANTITY OF WATER:**

Although other aquifer sources may be considered in the Hunt study, currently EPWU needs to preserve the option of importing a minimum of 15,000 acre-feet per year from one or both of two Far West Texas Aquifers – Ryan Flat (Antelope Valley Ranch) and Bone Springs-Victorio Peak (Dell Valley) – with a possible eventual total peak importation of 50,000 acre-feet per year from both sources combined. A very preliminary feasibility analysis based on the latest data made available from the Hunt Study appears to indicate that Wild Horse Ranch property may not be feasible in comparison to the other options, due to a combination of possible need for desalination and the length of pipeline required to import water from this source. However, Hunt Building Corporation has not completed the economic analysis of all the options and will not complete this study until November of 2000. If the completed study shows the importation of water form Wild Horse Ranch as a viable option, it will be submitted for inclusion as an additional import strategy at that time.

Based on the ongoing studies of the Dell Valley water resources, up to 50,000 acre-feet of total annual water production is likely available from the Dell Valley aquifer system. The Dell Valley aquifer system is comprised of a fractured limestone karst aquifer that is primarily recharged from precipitation and surface water in the Sacramento Mountains in southern New Mexico. Prior to agricultural development, ground water from the Dell Valley aquifer system evaporated in the salt basins east of Dell City. Agricultural development that has been ongoing since the 1950s, has essentially "captured" the ground water that had previously discharged into the salt basin.

Because there is limited storage potential in the Dell Valley aquifer system, total maximum ground-water production needs to be equivalent with recharge in order to maintain a balance. If total ground-water production exceeds the available recharge, water will be drawn from aquifer storage and water-level declines will occur. This relationship between total ground-water production was observed in the late 1970s when agricultural water use and associated water-level declines reached a maximum. Current estimates of available water quantity for the Dell Valley aquifer system range from approximately 45,000 to 60,000 acre-feet per year as a sustainable yield. Because the source of recharge is precipitation and surface water, the occurrence of any long-term drought conditions in the Sacramento Mountains could potentially affect the sustainable yield. EPWU will continue to work with the Hudspeth County Underground Water Conservation District to define acceptable impacts and assure that operation of the well field remains within these parameters.

**RELIABILITY OF WATER:**

If total ground-water production from the Dell Valley aquifer system is balanced with available recharge, the water source will be sustainable within and beyond the 50 year planning horizon. Extended drought conditions in the recharge areas would likely impact the water available for water production. Water quality of the Dell Valley aquifer system is classified as "slightly saline" and does not meet potable water quality standards without treatment. TDS concentrations range from 1,000 to 6,500 mg/l and sulfate concentrations range from approximately 650 to 2,500 mg/l. Water quality should remain consistent over time if sustainable yield water production is maintained. If water levels decline as a result of excessive water production, it is anticipated that the water quality will degrade over time.

**COST OF WATER:**

Costs are currently being prepared for this water development option. As part of the agreement with EPWU, Hunt Building Corporation has agreed to conduct a feasibility analysis providing the PSB with capital and operating costs as well as costs to deliver the water to El Paso. The agreement also addresses environmental, regulatory, and legal issues related to the use and transfer of Dell Valley water. The results of the Hunt evaluation are due to the EPWU in November 2000. Cost estimates will be prepared as data becomes available and the Far West Texas Region planning document can be adjusted accordingly. An initial assessment indicates that transport costs will be lower than those for transport from Antelope Valley Ranch due to the shorter (100 vs 150 miles) pipeline required. Pumping costs from the formation would also be less. These savings would be offset by the cost of desalination and the brine disposal system. It is impossible to quantify these cost tradeoffs at this time.

The capital costs for this strategy are $356,138,169. The annual cost associated with this strategy is $35,197,006. The cost per acre ft/year is $782. The cost to treat 1,000 gallons is $2.40. Cost estimate is based on a quantity of 45,000 acre-feet/year.

**ENVIRONMENTAL ISSUES:**

Environmental issues are anticipated to be limited to disposal of brine water from the proposed water treatment facility. The proposed water treatment for desalinization of Dell Valley groundwater is membrane treatment. The use of membrane treatment will require brine disposal to the adjacent salt basin. Preliminary discussions with regulatory agencies indicated that this is a feasible disposal alternative. However, further regulatory permitting discussions and permit applications will need to be submitted to understand that viability of this disposal option.

Based on initial assessments, desalination of ground water should not disturb the natural salt balance of the system. Although there will be brine discharged onto the salt flats resulting from desalination, the total salt load on the aquifer and salt flats will remain unchanged. The water extracted for municipal use would have been used in agriculture with a portion returned to the aquifer. This returned water (excess over evapotranspiration) carries salt back to the aquifer. As long as total consumptive use is less than total recharge, some salt water is eventually discharged into the salt flats and evaporated. Therefore, the total salt load remains the same and no significant environmental effects are expected.

Discharge of brine directly to the salt flats may actually extend the life of the aquifer (if any agricultural overdrafts are occurring) by reducing salt inputs back to the aquifer in the excess irrigation water, and carrying the salts directly to the salt flats.

**IMPACT ON OTHER WATER RESOURCES:**

Due to the limited aquifer storage in the Dell Valley ground-water system, water development will be limited to a water quantity that does not significantly exceed the available recharge. In this case, the aquifer can be managed as a sustainable resource and long-term water level declines are not predicted. Agricultural production has resulted in withdrawal of water from the Dell Valley aquifer system for approximately 50 years at a rate that is roughly equivalent to the available recharge. If the total ground-water production for exportation and agricultural production is maintained at a rate that is equivalent to the available recharge for the system, then effects to other water resources should remain consistent with existing conditions. Localized effects of ground-water pumping may be observed if the withdrawal locations are significantly different from current agricultural pumping locations.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

Net agricultural water production (ground-water pumping minus irrigation return flow) is approximately equal to the sustainable yield of the Dell Valley ground-water system. In order to maintain the long-term sustainability of the ground-water system, water exportation will need to be balanced with a commensurate reduction in net agricultural production.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

Agricultural ground-water production has been ongoing in the Dell Valley area since the 1950's. This ground-water production has "captured" the ground water that had previously discharged to the salt basin east of Dell City prior to agricultural development. Therefore, it is unlikely that ground-water exportation will result in any threat to natural resources that has not been previously observed due to past agricultural activity.

**OTHER FACTORS:**

Additional hydrological studies of the aquifers, that are the subject of this strategy, including modeling where appropriate, are necessary to assess the impact of this strategy. If independent hydrology does not verify the impacts and assumptions of this strategy, it should be reconsidered. Development of a plan to mitigate excessive depletion of the aquifer is necessary prior to the full implementation of this strategy. Additionally, this strategy is dependent on more thorough cost analysis. The drilling of new public-supply wells must be in compliance with State regulations and the Rules and Regulations of the Hudspeth County Underground Water Conservation District.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Local water-level declines are not expected to occur at surrounding properties if total groundwater production is within the sustainable yield of the Dell Valley aquifer system. Impacts of water exportation may be limited and/or mitigated under agreements between affected parties. Potential economic effects are currently being evaluated by Hunt Building Corporation and will be addressed in their November 2000 submittal.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

Potential effects of water exportation on water rights, contracts and option agreements are being evaluated by Hunt Building Corporation. Results of the evaluation will be included in their November 2000 submittal.

**IMPACT ON NAVIGATION:**

None

**STRATEGY #71-7**

**WATER USER NAME:**

**County:** El Paso
**River Basin:** Rio Grande
**User Name:** City of El Paso

**STRATEGY NAME:**

Growth Management

**STRATEGY DESCRIPTION:**

Any growth management strategy must be consistent with the City of El Paso's annexation policy, comprehensive plan for land development, zoning ordinance, landscape ordinance and conservation ordinance as well as City and Chamber of Commerce plans for economic development of the community and EPWU's rules and regulations and long-term water management plan. These rules provide both tools for and constraints to growth management. As growth management tools the ordinances and policies will be used to promote organized development of undeveloped lands in "infill" areas and allow only low water use industrial development. Any industries requiring significant process water will be required to locate in areas where reclaimed wastewater is available, and/or required to recycle process water. Potable water demand limits are already in place for industrial users. Parks and other open spaces will also be required to use reclaimed wastewater or low water use landscaping where possible.

The same ordinances and policies have the goal of promoting economic growth and quality of life in the City of El Paso. It is not reasonable to expect land use regulations so severe that they force El Paso citizens to move to other cities. Due to the large surplus of births over deaths, growth will continue to occur even without any net in-migration.

**TIME INTENDED TO IMPLEMENT:**

Short Term (prior to year 2030): Continued implementation.
Long Term (from year 2030 to year 2050): Continued implementation.

**QUANTITY OF WATER:**

Actual quantities will be consistent with EPWU's Water Management Plan as delineated in this Regional Plan. Quantities may vary according to the degree to which controlled growth occurs and the degree to which conservation rules and expansion of water reuse may mitigate growth related demand.

**RELIABILITY OF WATER:**

A growth control strategy helps to conserve existing supplies by reducing total demand. Reducing the demand will extend the life and reliability of the water supply sources.

**COST OF WATER:**

Cost to revise and implement new growth control regulations and strategies will be borne by the El Paso Water Utilities in conjunction with the City of El Paso and the communities being served. The actual cost per acre-foot of water saved is almost impossible to quantify

**ENVIRONMENTAL ISSUES:**

Minimal impacts are anticipated.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

Any growth related demand reductions achieved would reduce the necessity of acquiring rights to use additional agricultural water.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

Minimal impacts are anticipated.

**OTHER FACTORS:**

Political reality will make this strategy difficult to implement.

**INTERBASIN TRANSFERS:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Some impacts on the public's perceived quality of life and individual freedom may occur. Economic and lifestyle choices may be limited by forcing "infill" development, conservation and controls on types of industry.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

The volume of new supply required from conversion of rights to use water may be influenced by growth control policies.

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-10**

**WATER USER NAME:**
**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Town of Anthony

**STRTEGY NAME:**
Additional wells in existing well field

**STRATEGY DESCRIPTION:**
The addition of one new public-supply well will increase total withdrawals from the Anthony well field to meet future demands. Withdrawals would be from the Mesilla Bolson aquifer.

**TIME INTENDED TO IMPLEMENT:**
Short Term: An additional well is needed by 2020.
Long Term: Only maintenance needed.

**QUANTITY OF WATER:**
Existing wells can produce 3,549 acre-ft per year. Sufficient ground water will be produced to meet the 1,255 acre-ft per year long-term demand.

**RELIABILITY OF WATER:**
The reliability of water supply from the Mesilla Bolson becomes doubtful with the increased reliance on this source by many of the communities on the west side of El Paso and in southern New Mexico. Reliability of shallow alluvial aquifer source is doubtful during a prolonged drought where recharge from the Rio Grande is non existent.

**COST OF WATER:**
The capital costs for this strategy are $600,000. The annual cost associated with this strategy is $1,095,615. The cost per-acre foot/year is $873. The cost to treat 1,000 gallons is $2.68.

**ENVIRONMENTAL ISSUES:**
No environmental impact is anticipated.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**
None

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**
None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS**:

This strategy will be viable only as long as usable quality water from the Mesilla Bolson aquifer is available.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Local self-supplied water may not be adequate in the future due to both quantity and quality problems. Lack of water may limit growth and development of the community.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-12**

**WATER USER NAME:**

**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Community of Canutillo

**STRATEGY NAME:**

Purchase water from City of El Paso

**STRATEGY DESCRIPTION:**

Desired quantity of treated water derived from the Upper Rio Grande and the Mesilla Bolson aquifer would be purchased and delivered to the Community of Canutillo.

**TIME INTENDED TO IMPLEMENT:**

Short Term (prior to the year 2030): The purchase and delivery of water would continue indefinitely.

Long Term (from the year 2030 to the year 2050): Delivery of water would continue indefinitely.

**QUANTITY OF WATER:**

Up to 441 acre-feet would be purchased annually through 2030. Additional 73 acre-feet (for a total of 514 acre-feet) would be purchased annually through 2050.

**RELIABILITY OF WATER:**

Rio Grande water is unavailable during drought-of-record conditions and the reliability of ground water from the Mesilla Bolson becomes doubtful during drought-of-record conditions approximately after the year 2020. The successful implementation of City of El Paso strategies will enhance the reliability of available supply. Purchase of water from the City of El Paso must be approved by EPWU and must comply with all of the policies, provisions and guidelines of El Paso's Annexation Policy, Comprehensive Plan, and Drought Contingency Plan, as well as EPWU's Rules and Regulations and Growth Management Plan.

**COST OF WATER:**

The capital costs for this strategy are $0. The annual cost associated with this strategy is $620,400. The cost per acre-foot/year is $1,207. The cost to treat 1,000 gallons is $3.70.

**ENVIRONMENTAL ISSUES:**

Based on findings from El Paso-Las Cruces Regional Sustainable Water (SWP) Project Draft Environmental Impact Statement (DEIS), there would be some permanent and temporary adverse impacts on wildlife resources, including birds, mammal, and herptiles (amphibians and reptiles), as well as some benefits to the environment from the project. These impacts are discussed more fully in the DEIS for the SWP. The reader is referred to this document if a more detailed analysis of these impacts is desired. The record-of-decision for the draft EIS for this

project is pending. However, it is important to recognize that the water supply source for this strategy (Upper Rio Grande) is considered to be unavailable during drought-of-record conditions as flows would be insufficient for diversions to occur.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

None

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

El Paso Water Utilities has been serving portions of Canutillo through individual residential and commercial meters. Expansion of service is currently under way through an EDAP program. It is likely the additional service will continue in the future with possible annexation of the Community of Canutillo. Unless the implementation of El Paso's strategies is successful, this strategy will not be viable.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Local self-supplied water may not be adequate in the future due to both quantity and quality problems. The community's future livelihood may rely on the ability to purchase water supplies.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-13**

**WATER USER NAME:**

**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Town of Clint

**STRATEGY NAME:**

Purchase water from City of El Paso

**STRATEGY DESCRIPTION:**

Desired quantity of treated water derived from the Upper Rio Grande and the Mesilla Bolson aquifer would be purchased and delivered to the Town of Clint.

**TIME INTENDED TO IMPLEMENT:**

Short Term (prior to the year 2030): The purchase and delivery of water would continue indefinitely.

Long Term (from the year 2030 to the year 2050): Delivery of water would continue indefinitely.

**QUANTITY OF WATER:**

Up to 492 acre-feet would be purchased annually through 2030. Additional 116 acre-feet (for a total of 608 acre-feet) would be purchased annually through 2050.

**RELIABILITY OF WATER:**

Rio Grande water is unavailable during drought-of-record conditions and the reliability of fresh ground water from the Hueco Bolson becomes doubtful during drought-of-record conditions approximately after the year 2020. The successful implementation of City of El Paso strategies will enhance the reliability of available supply. Purchase of water from the City of El Paso must be approved by EPWU and must comply with all of the policies, provisions and guidelines of El Paso's Annexation Policy, Comprehensive Plan, and Drought Contingency Plan, as well as EPWU's Rules and Regulations and Growth Management Plan.

**COST OF WATER:**

The capital costs for this strategy are $0. The annual cost associated with this strategy is $773,000. The cost per acre-foot/year is $1,271. The cost to treat 1,000 gallons is $3.90.

**ENVIRONMENTAL ISSUES:**

Based on findings from El Paso-Las Cruces Regional Sustainable Water (SWP) Project Draft Environmental Impact Statement (DEIS), there would be some permanent and temporary adverse impacts on wildlife resources, including birds, mammal, and herptiles (amphibians and reptiles), as well as some benefits to the environment from the project. These impacts are discussed more fully in the DEIS for the SWP. The reader is referred to this document if a more detailed analysis of these impacts is desired. The record-of-decision for the draft EIS for this

project is pending. However, it is important to recognize that the water supply source for this strategy (Upper Rio Grande) is considered to be unavailable during drought-of-record conditions, as flows would be insufficient for diversions to occur.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**
None

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**
None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**
None

**OTHER FACTORS:**
Some areas of Clint that are experiencing development expansion will be served by the Lower Valley Water District ("LVWD") which purchases its water from EPWU. Further water expansion will require approval of EPWU as the Regional Water Provider and transfer of water rights to EPWU in exchange for additional water service. Unless the implementation of El Paso's strategies is successful, this strategy will not be viable.

**INTERBASIN TRANSFER:**
No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**
Local self-supplied water may not be adequate in the future due to both quantity and quality problems. The community's future livelihood may rely on the ability to purchase water supplies.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**
May require Third-Party Contract amendments.

**IMPACT ON NAVIGATION:**
None

**STRATEGY # 71-14**

**WATER USER NAME:**
**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Community of Fabens

**STRATEGY NAME:**
Purchase water from City of El Paso

**STRATEGY DESCRIPTION:**
Desired quantity of treated water derived from the Upper Rio Grande and the Mesilla Bolson aquifer would be purchased and delivered to the Community of Fabens.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): The purchase and delivery of water would continue indefinitely.
Long Term (from the year 2030 to the year 2050): Delivery of water would continue indefinitely.

**QUANTITY OF WATER:**
Up to 1,137 acre-feet would be purchased annually through 2030. Additional 212 acre-feet (for a total of 1,349 acre-feet) would be purchased annually through 2050.

**RELIABILITY OF WATER:**
Rio Grande water is unavailable during drought-of-record conditions and the reliability of fresh ground water from the Hueco Bolson becomes doubtful during drought-of-record conditions approximately after the year 2020. The successful implementation of City of El Paso strategies will enhance the reliability of available supply. Purchase of water from the City of El Paso must be approved by EPWU and must comply with all of the policies, provisions and guidelines of El Paso's Annexation Policy, Comprehensive Plan, and Drought Contingency Plan, as well as EPWU's Rules and Regulations and Growth Management Plan.

**COST OF WATER:**
The capital costs for this strategy are $0. The annual cost associated with this strategy is $1,714,000. The cost per acre-foot/year is $1,271. The cost to treat 1,000 gallons is $3.90.

**ENVIRONMENTAL ISSUES:**
Based on findings from El Paso-Las Cruces Regional Sustainable Water (SWP) Project Draft Environmental Impact Statement (DEIS), there would be some permanent and temporary adverse impacts on wildlife resources, including birds, mammal, and herptiles (amphibians and reptiles), as well as some benefits to the environment from the project. These impacts are discussed more fully in the DEIS for the SWP. The reader is referred to this document if a more detailed analysis of these impacts is desired. The record-of-decision for the draft EIS for this

project is pending. However, it is important to recognize that the water supply source for this strategy (Upper Rio Grande) is considered to be unavailable during drought-of-record conditions, as flows would be insufficient for diversions to occur.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

None

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

Fabens has previously requested purchase of water from EPWU. It is not economically feasible currently to provide direct service. Fabens lies south of the LVWD and any future service will probably be through the LVWD that purchases its water from EPWU. Unless the implementation of El Paso's strategies is successful, this strategy will not be viable.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Local self-supplied water may not be adequate in the future due to both quantity and quality problems. The community's future livelihood may rely on the ability to purchase water supplies.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

Service of water to Fabens either directly or through the LVWD will require Third-Party Contract Agreements or Amendments.

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-15**

**WATER USER NAME:**
**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Community of Fabens

**STRATEGY NAME:**
Desalination / Ground Water Treatment

**STRATEGY DESCRIPTION:**
This strategy will involve the treatment of the existing well production to remove iron and manganese and to lower the TDS in some wells to below 1,000 mg/l.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Immediate implementation is desirable.
Long Term (from the year 2030 to the year 2050): Only maintenance needed.

**QUANTITY OF WATER:**
The proposed water treatment process will salvage the existing well production capacity of 5,484 acre-ft per year to obtain 1,349 acre-feet per year that meets acceptable quality standards.

**RELIABILITY OF WATER:**
Sufficient reserves of similar quality water with tendencies to brackish and containing higher than normal levels of iron and manganese exist in the fringes of the Hueco Bolson over which Fabens lies. However treatment of this water is required to make it meet potable water standards.

**COST OF WATER:**
The capital costs for this strategy are $5,456,250. The annual cost associated with this strategy is $975,349. The cost per acre-foot/year is $723. The cost to treat 1,000 gallons is $2.22.

**ENVIRONMENTAL ISSUES:**
The major environmental issue related to the use of desalination is the disposal of the process by-product. Alternatives for disposal of the reject brine include deep well injection and the use of evaporation beds. Drying beds require the use of large land areas to accommodate the daily production of brine. Disposal using deep well injection is not very prevalent and there are numerous uncertainties relative to the practical disposal of large volumes by this method. Preliminary planning indicates viable disposal options exist that have environmentally benign impacts including disposal in existing salt flat environments or in lined pits.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

Mining of brackish water aquifers is required under this strategy. There is no impact to other water resources in the area.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

A method must be found to dispose of the by-product. Cost and environmental issues may result in this strategy being difficult to implement.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Treatments of ground water will result in higher water rates for the users. However, existing water supply sources are becoming undependable, and the inability to implement new water-supply strategies will have a severe negative social and economic impact on citizens and businesses of the Community of Fabens.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-16**

**WATER USER NAME:**
**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Fort Bliss

**STRATEGY NAME:**
Purchase water from City of El Paso

**STRATEGY DESCRIPTION:**
Desired quantity of treated water derived from the Upper Rio Grande and the Hueco Bolson aquifer would be purchased and delivered to the Fort Bliss Military Installation. By 2030 under drought-of-record conditions, self-supplied ground water would be unavailable or significantly limited. Fort Bliss would thus be dependent on water purchased from the City of El Paso.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): The purchase and delivery of water would continue indefinitely.
Long Term (from the year 2030 to the year 2050): Delivery of water would continue indefinitely.

**QUANTITY OF WATER:**
Approximately 5,700 acre-feet per year will be needed by the year 2030.

**RELIABILITY OF WATER:**
Rio Grande water is unavailable during drought-of-record conditions and the reliability of fresh ground water from the Hueco Bolson becomes doubtful during drought-of-record conditions approximately after the year 2020. The successful implementation of City of El Paso strategies will enhance the reliability of available supply. Purchase of water from the City of El Paso must be approved by EPWU and must comply with all of the policies, provisions and guidelines of El Paso's Annexation Policy, Comprehensive Plan, and Drought Contingency Plan, as well as EPWU's Rules and Regulations and Growth Management Plan.

**COST OF WATER:**
The capital costs for this strategy are $0. The annual cost associated with this strategy is $7,245,712. The cost per acre-foot/year is $1,270. The cost to treat 1,000 gallons is $3.90.

**ENVIRONMENTAL ISSUES:**
Based on findings from El Paso-Las Cruces Regional Sustainable Water (SWP) Project Draft Environmental Impact Statement (DEIS), there would be some permanent and temporary adverse impacts on wildlife resources, including birds, mammal, and herptiles (amphibians and reptiles), as well as some benefits to the environment from the project. These impacts are

discussed more fully in the DEIS for the SWP. The reader is referred to this document if a more detailed analysis of these impacts is desired. The record-of-decision for the draft EIS for this project is pending. However, it is important to recognize that the water supply source for this strategy (Upper Rio Grande) is considered to be unavailable during drought-of-record conditions, as flows would be insufficient for diversions to occur.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

Impacts are the same as those for the City of El Paso strategies.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

Impacts are the same as those for the City of El Paso strategies.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

Impacts are the same as those for the City of El Paso strategies.

**OTHER FACTORS:**

Unless the implementation of El Paso's strategies is successful, this strategy will not be viable.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Local self-supplied water may not be adequate in the future due to both quantity and quality problems. The Base's future water-supply needs rely on the ability to purchase water supplies.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

Will require amendment of current contract for water purchase.

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-17**

**WATER USER NAME:**

**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Fort Bliss

**STRATEGY NAME:**

Expanded use of existing wells

**STRATEGY DESCRIPTION:**

Withdrawals from existing wells operated by the Installation will be increased to partially meet future demands. However, by 2030 under drought-of-record conditions, self-supplied ground water would be unavailable or significantly limited. Fort Bliss would thus be dependent on water purchased from the City of El Paso (strategy 71-16).

**TIME INTENDED TO IMPLEMENT:**

Short Term (prior to the year 2030): Existing wells will be pumped for an extended period of time.

Long Term (from the year 2030 to the year 2050): Water from this supply source would no longer exist under the drought scenario.

**QUANTITY OF WATER:**

Existing wells currently produce approximately 500 acre-feet per year. Additional pumping may generate approximately another 200 acre-feet per year.

**RELIABILITY OF WATER:**

Rio Grande water is unavailable during drought-of-record conditions and the reliability of fresh ground water from the Hueco Bolson becomes doubtful during drought-of-record conditions approximately after the year 2020. The successful implementation of City of El Paso strategies will enhance the reliability of available supply.

**COST OF WATER:**

The capital costs for this strategy are $600,000. The annual cost associated with this strategy is $198,146. The cost per acre-foot/year is $991. The cost to treat 1,000 gallons is $3.04.

**ENVIRONMENTAL ISSUES:**

None

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

The eventual depletion of the Hueco Bolson aquifer under the drought scenario will increase dependency on river water delivered through EPWU.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

This is a short-term strategy that will not be viable long-term.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Local self-supplied water may not be adequate in the future due to both quantity and quality problems. The Installation's future water-supply needs rely on the ability to purchase water supplies.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-44**

**WATER USER NAME:**
**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Fort Bliss

**STRATEGY NAME:**
Desalination

**STRATEGY DESCRIPTION:**
This strategy will involve the treatment of groundwater to reduce the salinity below 1,000-ppm TDS. Desalination processes to be considered include reverse osmosis, electrodialysis and membrane technology. This strategy considers the desalination of brackish groundwater and includes the construction of the infrastructure for treatment and distribution of the supply. It also considers the blending of treated groundwater with potable groundwater. A Major Construction Activity (MCA) Funds request was submitted 11/3/00 for FY02 Congressional funding by Fort Bliss in the amount of $18M to its Headquarters for review and approval. Approved projects move forward for Congressional approval.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): To be implemented during this period.
Long Term (from the year 2030 to the year 2050): Continued

**QUANTITY OF WATER:**
This strategy considers the desalination of up to 6,000 acre-feet per year to meet future demands.

**RELIABILITY OF WATER:**
The availability of brackish water is greater than the volume of fresh water left in the Hueco Bolson. Estimated reserves of brackish water ranging in quality between 1,000 to 1,500 ppm TDS throughout El Paso County is estimated to be 780,000 acre-feet. The amount of brackish water available under military lands needs to be verified through extensive investigations and modeling.

**COST OF WATER:**
The capital costs for this strategy are $17,355,000. The annual cost associated with this strategy is $900,285. The cost per acre-foot/year is $150. The cost to treat 1,000 gallons is $0.46.

**ENVIRONMENTAL ISSUES:**
The major environmental issue related to the use of desalination is the disposal of the process by-product. Alternatives for disposal of the reject brine include transport to well injection points (600 foot depth) at high TDS aquifer on military lands and use of evaporation

ponds on military lands. Should disposal using deep well injection become necessary, this strategy may be difficult, as it is not a proven technology in Texas. There are numerous uncertainties relative to the practical disposal of large volumes of brine by this method and its impact on the geological and geophysical attributes of the underground formations. All federal projects require National Environmental Policy Act (NEPA) analysis.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

Mining of brackish water aquifers is required under this strategy. New well field development programs would be undertaken to drill production wells in the aquifer for either treatment at desalination treatment plants or for blending with other sources of water. This strategy would prolong the existing fresh water aquifers by reducing the production from these fresh water reserves.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

No impact is anticipated.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

No impact is anticipated with a properly engineered brine disposal system.

**OTHER FACTORS:**

The cost effectiveness of the brine disposal system selected will impact the overall cost effectiveness of this strategy. Drying beds require the use of large land areas to accommodate the daily production of brine. Location of these beds in the military maneuver areas may conflict with planned training.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

None

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-45**

**WATER USER NAME:**

**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Fort Bliss

**STRATEGY NAME:**

Wastewater reclamation

**STRATEGY DESCRIPTION:**

Presently, Fort Bliss does not own or operate a wastewater treatment plant. Wastewater flow generated by Fort Bliss is conveyed via pipeline to the Haskell R. Street Wastewater Treatment Plant. “Reclaiming water” will require Fort Bliss to build its own wastewater treatment plant. Privatization of wastewater utility services is mandated by the Department of Defense. A proposal for privatization of Fort Bliss wastewater services has been issued and responses from the private sector are due January 17, 2001. Construction of a wastewater and reclamation plant is expected to be incorporated into responses. The plant(s) will be contractor owned and contractor operated. The cost of infrastructure and implementation of the plant(s) will be developed.

**TIME INTENDED TO IMPLEMENT:**

Short Term (prior to the year 2030): To be implemented during this period.
Long Term (from the year 2030 to the year 2050):

**QUANTITY OF WATER:**

In 1992, the El Paso Water Utilities published the Feasibility Report On Wastewater Reuse Opportunities. This report identifies Fort Bliss’ irrigation demand to be 320 acre-feet/year for the Parade Grounds, 400 acre-feet/year for the Underwood Golf Course and 60 acre-feet/year for the cemetery. This total reclaimed water demand amounts to approximately 14% of the total potable water demand needed for Fort Bliss by the year 2030. Fort Bliss Energy and Utility Office is currently estimating 955 acre-feet/year for the Parade Grounds, 750 acre-feet/year for the Underwood Golf Course and 120 acre-feet/year for the cemetery. In addition, Kelly Park and Biggs Park combined estimated irrigation water demand is 60 acre-feet/year. Approximately 800 acre-feet/year is expected to be generated from this strategy.

**RELIABILITY OF WATER:**

Very reliable source of water with dissolved solids (sulfates, chlorides, etc.) at levels exceeding drinking water standards.

**COST OF WATER:**

The capital costs for this strategy are $6,021,000. The annual cost associated with this strategy is $500,494. The cost per acre-foot/year is $626. The cost to treat 1,000 gallons is $1.92. Estimated cost is based on a quantity of 800 acre-feet/year.

**ENVIRONMENTAL ISSUES:**

For over fifteen years El Paso has had a reclaimed water system supplying water for industrial, turf irrigation, landscape and aquifer recharge uses. No associated health issues have developed. Of minor concern is the loading of sodium in soil. This issue can be controlled by proper agronomic application of reclaimed water and landscape maintenance.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

The use of reclaimed water is a net benefit to other regional water resource users.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

Reclaimed water is usable to the agricultural sector by substantially expanding the available supply.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

Cost may make reclamation difficult because of other competing military projects at a time of scarce funding.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Reclaimed water can be used to reduce the use of potable waters and potentially reduce water rates.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-46**

**WATER USER NAME:**
**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Fort Bliss

**STRATEGY NAME:**
Purchase of City of El Paso reclamation water

**STRATEGY DESCRIPTION:**
The El Paso Water Utilities is in the process of implementing a Reclamation System to serve the central area of the City of El Paso. This system, presently in its design stage, will not accommodate the reclaimed water demands of Fort Bliss. Upgrades to the Haskell R. Street Wastewater Treatment Plant and new pipeline infrastructure are anticipated to produce and convey reclaimed water to Fort Bliss.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): To be implemented during this period.
Long Term (from the year 2030 to the year 2050): Continued

**QUANTITY OF WATER:**
In 1992, the El Paso Water Utilities published the Feasibility Report On Wastewater Reuse Opportunities. This report identifies Fort Bliss' irrigation water demand to be 320 acre-feet/year for the Parade Grounds, 400 acre-feet/year for the Underwood Golf Course and 60 acre-feet/year for the cemetery. Fort Bliss Energy and Utility Office is currently estimating 955 acre-feet/year for the Parade Grounds, 750 acre-feet/year for the Underwood Golf Course and 120 acre-feet/year for the cemetery. In addition, Kelly Park and Biggs Park combined estimated irrigation water demand is 60 acre-feet/year. This total reclaimed water demand amounts to approximately 35% of the total potable water demand needed for Fort Bliss by the year 2030. This strategy is expected to provide 780 acre-feet per year.

**RELIABILITY OF WATER:**
Very reliable source of water with dissolved solids (sulfates, chlorides, etc.) at levels exceeding drinking water standards.

**COST OF WATER:**
The capital costs for this strategy are $2,838,000. The annual cost associated with this strategy is $390,741. The cost per acre-foot/year is $501. The cost to treat 1,000 gallons is $1.54. Estimated cost is based on a quantity of 780 acre-feet /year.

**ENVIRONMENTAL ISSUES:**
For over fifteen years El Paso has had a reclaimed water system supplying water for industrial, turf irrigation, landscape and aquifer recharge uses. No associated health issues have

developed. Of minor concern is the loading of sodium in soil. This issue can be controlled by proper agronomic application of reclaimed water and landscape maintenance.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

The use of reclaimed water is a net benefit to other regional water resource users.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

Reclaimed water is usable to the agricultural sector by substantially expanding the available supply.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

Cost may make reclamation difficult because of other competing military projects at a time of scarce funding.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Reclaimed water can be used to reduce the use of potable waters and potentially reduce water rates.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-47**

**WATER USER NAME:**
**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Fort Bliss

**STRATEGY NAME:**
Distribution system maintenance

**STRATEGY DESCRIPTION:**
Identify and repair water-supply transmission and distribution main leaks.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Leaks repaired as identified.
Long Term (from the year 2030 to the year 2050): Leaks repaired as identified.

**QUANTITY OF WATER:**
This strategy does not generate new water but rather extends existing supply by eliminating water losses. Normally in a well-maintained distribution system water losses due to main breaks and leaks amount to about 5% of total water produced. The goal would be to reduce this number to around 2%.

**RELIABILITY OF WATER:**
Water saved by the repair of transmission and distribution system leaks is water that was previously produced and thus the savings increase the available water supply to the end user.

**COST OF WATER:**
The capital costs for this strategy are $0. The annual cost associated with this strategy is $172,840. The cost per acre-foot/year is $596. The cost to treat 1,000 gallons is $1.83. Estimated cost of this strategy is based on a quantity of 290 acre-feet/year.

**ENVIRONMENTAL ISSUES:**
No environmental issues are anticipated due to maintenance of the water system.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**
The quantity of water saved will offset the total quantity of water previously required to be withdrawn from the aquifer or purchased from the City of El Paso.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**
None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**
None

**OTHER FACTORS:**

None

**NTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

An efficient water system with limited or no water loss conserves the water supply sources and may lower the overall cost of delivered water the end user.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-18**

**WATER USER NAME:**

**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Homestead

**STRATEGY NAME:**

Purchase water from City of El Paso

**STRATEGY DESCRIPTION:**

Desired quantity of treated water derived from the Upper Rio Grande and the Hueco Bolson would be purchased and delivered to the Homestead MUD.

**TIME INTENDED TO IMPLEMENT:**

Short Term (prior to the year 2030): The purchase and delivery of water would continue indefinitely.

Long Term (from the year 2030 to the year 2050): Delivery of water would continue indefinitely.

**QUANTITY OF WATER:**

Up to 865 acre-feet would be purchased annually through 2030. Additional 77 acre-feet (for a total of 942 acre-feet) would be purchased annually through 2050.

**RELIABILITY OF WATER:**

Rio Grande water is unavailable during drought-of-record conditions and the reliability of fresh ground water from the Hueco Bolson becomes doubtful during drought-of-record conditions approximately after the year 2020. The successful implementation of City of El Paso strategies will enhance the reliability of available supply. Purchase of water from the City of El Paso must be approved by EPWU and must comply with all of the policies, provisions and guidelines of El Paso's Annexation Policy, Comprehensive Plan, and Drought Contingency Plan, as well as EPWU's Rules and Regulations and Growth Management Plan.

**COST OF WATER:**

The capital costs for this strategy are $0. The annual cost associated with this strategy is $1,197,000. The cost per acre-foot/year is $1,270. The cost to treat 1,000 gallons is $3.90.

**ENVIRONMENTAL ISSUES:**

Based on findings from El Paso-Las Cruces Regional Sustainable Water (SWP) Project Draft Environmental Impact Statement (DEIS), there would be some permanent and temporary adverse impacts on wildlife resources, including birds, mammal, and herptiles (amphibians and reptiles), as well as some benefits to the environment from the project. These impacts are discussed more fully in the DEIS for the SWP. The reader is referred to this document if a more detailed analysis of these impacts is desired. The record-of-decision for the draft EIS for this

project is pending. However, it is important to recognize that the water supply source for this strategy (Upper Rio Grande) is considered to be unavailable during drought-of-record conditions, as flows would be insufficient for diversions to occur.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

Homestead is outside the city limits of El Paso. Providing water or additional supplies will impact strategies planned for City of El Paso.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

Homestead also furnishes water to El Paso County for use in the East Montana District. Unless the implementation of El Paso's strategies is successful, this strategy will not be viable.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Local self-supplied water may not be adequate in the future due to both quantity and quality problems. The community's future livelihood may rely on the ability to purchase water supplies.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-48**

**WATER USER NAME:**
**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Homestead

**STRATEGY NAME:**
Additional wells and desalination

**STRATEGY DESCRIPTION:**
Ground water of acceptable drinking water quality from the Hueco Bolson aquifer in El Paso County will be produced from two wells. The produced ground water will require desalination to meet drinking water standards. This includes desalination by physical means such as reverse osmosis, and membrane technology. This strategy considers the desalination of brackish groundwater in the Hueco Bolson aquifer (not currently being developed to any significant extent), and includes the construction of the infrastructure for the treatment and distribution of the supply.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Immediate implementation is desirable.
Long Term (from the year 2030 to the year 2050): Only maintenance needed.

**QUANTITY OF WATER:**
This strategy considers the desalination of up to 1,000 acre-ft/year in the near future.

**RELIABILITY OF WATER:**
Sufficient reserves of brackish water exist in the Hueco Bolson aquifer.

**COST OF WATER:**
The capital costs for this strategy are $12,896,675. The annual cost associated with this strategy is $2,161,657. The cost per acre-foot/year is $2,162. The cost to treat 1,000 gallons is $6.63.

**ENVIRONMENTAL ISSUES:**
The major environmental issue related to the use of desalination is the disposal of the process by-product. Alternatives for disposal of the reject brine include deep well injection and the use of evaporation beds. Drying beds require the use of large land areas to accommodate the daily production of brine. Disposal using deep well injection is not very prevalent and there are numerous uncertainties relative to the practical disposal of large volumes by this method. Preliminary planning indicates viable disposal options exist that have environmentally benign impacts.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

Mining of brackish water aquifers is required under this strategy. There is no impact to other water resources in the area.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

No impacts to natural resources with well engineered brine disposal.

**OTHER FACTORS:**

A method must be found to dispose of the by-product. Cost and environmental issues may result in this strategy being difficult to implement.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Existing water supply sources are becoming undependable. The inability to implement new water-supply strategies will have a severe negative social and economic impact on citizens not served by the EPWU.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-49**

**WATER USER NAME:**

**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Homestead

**STRATEGY NAME:**

Rainfall Harvesting

**STRATEGY DESCRIPTION:**

Rainfall harvesting involves capturing rainfall from roofs or in small surface impoundments, providing water that is usually lost to the rural homeowner.

**TIME INTENDED TO IMPLEMENT:**

Short Term (prior to the year 2030): This strategy could be implemented relatively easily, inexpensively and quickly for immediate to short-term benefit.

Long Term (from the year 2030 to the year 2050): The strategy would continue in place as long as the homeowner desired and/or the home remained intact.

**QUANTITY OF WATER:**

The Texas Water Development Board's "Texas Guide to Rainwater Harvesting" gives the methodology to calculate rainfall harvest amounts using average precipitation for the time period 1940 through 1990 at selected rain stations across Texas. However, this Regional Water Plan must be based on water supply amounts that could be yielded during drought-of-record. Therefore, average water yield amounts produced by the methodology using average precipitation amounts should be adjusted. The TWDB publication gives minimum precipitation, maximum precipitation and 10th percentile, 25th percentile, and 50th percentile (median) amounts as well as the average precipitation amounts. Investigation of National Climatic Data Center precipitation data for West Texas stations shows that the drought-of-record in 1956 closely approximates the 25$^{th}$ percentile precipitation amounts. Therefore, if one substitutes the 25$^{th}$ percentile precipitation amounts for the average precipitation amounts within the methodology, the quantity of water on an annual basis for a 1,500 square-foot residence in El Paso County is approximately 4,000 gallons, or only 0.012 acre-foot of water per year per household.

**RELIABILITY OF WATER:**

The quantity given above is on an annual basis; an efficiency of 100% is assumed. Also, the methodology is simplified from a monthly water balance. Both the efficiency and characteristic monthly water balance are site-specific and dependent on the individual homeowner's skill in designing and implementing his particular system.

**COST OF WATER:**

The ongoing cost of water is negligible, as operation and maintenance would involve nothing more than regular application of chlorine, iodide or other sanitizing chemicals or methods, regular inspection of the system for leaks or deterioration, and costs for operating a small pump. A residential system in Far West Texas, using metal roofing and above-ground polyethylene cisterns costs approximately $4,000.

**ENVIRONMENTAL ISSUES:**

None

**IMPACT ON OTHER WATER RESOURCES:**

Minimal loss of water to aquifer recharge and an associated decrease in surface water flows may result, as the water reaches the homeowner rather than the region in general.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

None

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

This could be a beneficial water management strategy in terms of reviving a local economy and/or encouraging people to settle in a very water-scarce area.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-51**

**WATER USER NAME:**
**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Homestead

**STRATEGY NAME:**
Distribution system maintenance

**STRATEGY DESCRIPTION:**
Identify and repair water-supply transmission leaks.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Leaks repaired as identified
Long Term (from the year 2030 to the year 2050): Leaks repaired as identified

**QUANTITY OF WATER:**
This strategy does not generate new water but rather extends existing supply by eliminating water losses.

**RELIABILITY OF WATER:**
Water saved by the repair of transmission leaks was previously being produced and is therefore guaranteed as being an available addition supply.

**COST OF WATER:**
Expected cost of identifying and repairing transmission leaks is highly variable and is primarily dependent on size and length of the required pipeline replacement. Potential for pipeline leaks increases with age of the existing pipeline. Assuming a replacement of 5,000 feet of 12-inch pipeline with appurtenances plus 20% markup for urban repairs (5,000 x $32 x 1.2), annual cost would be approximately $192,000.

**ENVIRONMENTAL ISSUES:**
Limited environmental effects may be expected as a result of required excavation.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**
The water savings achieved will offset the total quantity of water previously required to be withdrawn. No effect is anticipated on other water resources.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**
None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**
None

**OTHER FACTORS:**

None

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

An efficient water system with limited to no water loss conserves the water supply source and may lower the overall cost of delivered water to the end user.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-19**

**WATER USER NAME:**

**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Community of San Elizario

**STRATEGY NAME:**

Purchase water from City of El Paso

**STRATEGY DESCRIPTION:**

Desired quantity of treated water derived from the Upper Rio Grande and the Hueco Bolson would be purchased and delivered to the Community of San Elizario through the Lower Valley Water District.

**TIME INTENDED TO IMPLEMENT:**

Short Term (prior to the year 2030): The purchase and delivery of water would continue indefinitely.

Long Term (from the year 2030 to the year 2050): Delivery of water would continue indefinitely.

**QUANTITY OF WATER:**

Up to 1,475 acre-feet would be purchased annually through 2030. Additional 178 acre-feet (for a total of 1,653 acre-feet) would be purchased annually through 2050.

**RELIABILITY OF WATER:**

Rio Grande water is unavailable during drought-of-record conditions and the reliability of fresh ground water from the Hueco Bolson becomes doubtful during drought-of-record conditions approximately after the year 2020. The successful implementation of City of El Paso strategies will enhance the reliability of available supply. Purchase of water from the City of El Paso must be approved by EPWU and must comply with all of the policies, provisions and guidelines of El Paso's Annexation Policy, Comprehensive Plan, and Drought Contingency Plan, as well as EPWU's Rules and Regulations and Growth Management Plan.

**COST OF WATER:**

Cost of Water to San Elizario would be based on water rights established and negotiated among EPWU, LVWD and the San Elizario Water District. The recent proposal by EPWU to the Lower Valley Water District to provide retail water and wastewater service to residence within the Lower Valley of El Paso will result in a considerable reduction in monthly water rates.

The capital costs for this strategy are $0. The annual cost associated with this strategy is $2,354,841. The cost per acre-foot/year is $1,271. The cost to treat 1,000 gallons is $3.90.

**ENVIRONMENTAL ISSUES:**

Based on findings from El Paso-Las Cruces Regional Sustainable Water (SWP) Project Draft Environmental Impact Statement (DEIS), there would be some permanent and temporary adverse impacts on wildlife resources, including birds, mammal, and herptiles (amphibians and reptiles), as well as some benefits to the environment from the project. These impacts are discussed more fully in the DEIS for the SWP. The reader is referred to this document if a more detailed analysis of these impacts is desired. The record-of-decision for the draft EIS for this project is pending. However, it is important to recognize that the water supply source for this strategy (Upper Rio Grande) is considered to be unavailable during drought-of-record conditions, as flows would be insufficient for diversions to occur.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

None

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

Transfer of water to LVWD for use by San Elizario could be dependent on the LVWD or San Elizario Water District securing surface water rights and transferring them to EPWU. Unless the implementation of El Paso's strategies is successful, this strategy will not be viable.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Local self-supplied water may not be adequate in the future due to both quantity and quality problems. The community's future livelihood may rely on the ability to purchase water supplies.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

LVWD or San Elizario Water District would need to secure water rights and transfer them to EPWU and a Third-Party Contract amendment might be required.

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-20**

**WATER USER NAME:**
**County:** El Paso
**River Basin:** Rio Grande
**User Name:** City of Socorro

**STRATEGY NAME:**
Purchase water from City of El Paso

**STRATEGY DESCRIPTION:**
Desired quantity of treated water derived from the Upper Rio Grande and the Hueco Bolson would be purchased and delivered to the City of Socorro through the Lower Valley Water District.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): The purchase and delivery of water would continue indefinitely.
Long Term (from the year 2030 to the year 2050): Delivery of water would continue indefinitely.

**QUANTITY OF WATER:**
Up to 1,535 acre-feet would be purchased annually through 2030. Additional 265 acre-feet (for a total of 1,800 acre-feet) would be purchased annually through 2050.

**RELIABILITY OF WATER:**
Rio Grande water is unavailable during drought-of-record conditions and the reliability of fresh ground water from the Hueco Bolson becomes doubtful during drought-of-record conditions approximately after the year 2020. The successful implementation of City of El Paso strategies will enhance the reliability of available supply. Purchase of water from the City of El Paso must be approved by EPWU and must comply with all of the policies, provisions and guidelines of El Paso's Annexation Policy, Comprehensive Plan, and Drought Contingency Plan, as well as EPWU's Rules and Regulations and Growth Management Plan.

**COST OF WATER:**
Cost of Water to Socorro is dependent on negotiated rates as established by EPWU at time of purchase. The recent proposal by EPWU to the Lower Valley Water District to provide retail water and wastewater service to residence within the lower valley of El Paso will result in a considerable reduction in monthly water rates. The capital costs for this strategy are $0. The annual cost associated with this strategy is $2,287,488. The cost per acre-foot/year is $1,271. The cost to treat 1,000 gallons is $3.90.

**ENVIRONMENTAL ISSUES:**

Based on findings from El Paso-Las Cruces Regional Sustainable Water (SWP) Project Draft Environmental Impact Statement (DEIS), there would be some permanent and temporary adverse impacts on wildlife resources, including birds, mammal, and herptiles (amphibians and reptiles), as well as some benefits to the environment from the project. These impacts are discussed more fully in the DEIS for the SWP. The reader is referred to this document if a more detailed analysis of these impacts is desired. The record-of-decision for the draft EIS for this project is pending. However, it is important to recognize that the water supply source for this strategy (Upper Rio Grande) is considered to be unavailable during drought-of-record conditions, as flows would be insufficient for diversions to occur.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

None

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

Additional funding of water to Socorro will be through the LVWD. The LVWD will need to secure and transfer water rights to EPWU. Unless the implementation of El Paso's strategies is successful, this strategy will not be viable.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Local self-supplied water may not be adequate in the future due to both quantity and quality problems. The community's future livelihood may rely on the ability to purchase water supplies.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

Transfer of water rights may require an amendment to Third-Party Contracts.

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-21**

**WATER USER NAME:**
**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Village of Vinton

**STRATEGY NAME:**
Purchase water from City of El Paso

**STRATEGY DESCRIPTION:**
Desired quantity of treated water derived from the Upper Rio Grande and the Hueco Bolson would be purchased and delivered to the Village of Vinton.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): The purchase and delivery of water would continue indefinitely.
Long Term (from the year 2030 to the year 2050): Delivery of water would continue indefinitely.

**QUANTITY OF WATER:**
Up to 106 acre-feet would be purchased annually through 2030. Additional 9 acre-feet (for a total of 115 acre-feet) would be purchased annually through 2050.

**RELIABILITY OF WATER:**
Rio Grande water is unavailable during drought-of-record conditions and the reliability of fresh ground water from the Mesilla Bolson becomes doubtful during drought-of-record conditions approximately after the year 2020. The successful implementation of City of El Paso strategies will enhance the reliability of available supply. Purchase of water from the City of El Paso must be approved by EPWU and must comply with all of the policies, provisions and guidelines of El Paso's Annexation Policy, Comprehensive Plan, and Drought Contingency Plan, as well as EPWU's Rules and Regulations and Growth Management Plan.

**COST OF WATER:**
Cost of Water will be dependent on established water rates by EPWU plus a percentage for Vinton being outside City water service area. The capital costs for this strategy are $0. The annual cost associated with this strategy is $146,145. The cost per acre-foot/year is $1,271. The cost to treat 1,000 gallons is $3.90.

**ENVIRONMENTAL ISSUES:**
Based on findings from El Paso-Las Cruces Regional Sustainable Water (SWP) Project Draft Environmental Impact Statement (DEIS), there would be some permanent and temporary adverse impacts on wildlife resources, including birds, mammal, and herptiles (amphibians and reptiles), as well as some benefits to the environment from the project. These impacts are

discussed more fully in the DEIS for the SWP. The reader is referred to this document if a more detailed analysis of these impacts is desired. The record-of-decision for the draft EIS for this project is pending. However, it is important to recognize that the water supply source for this strategy (Upper Rio Grande) is considered to be unavailable during drought-of-record conditions, as flows would be insufficient for diversions to occur.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

None

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

Vinton is a considerable distance from the immediate service area of the City of El Paso. It is possible that annexation may be required prior to water service being provided. Unless the implementation of El Paso's strategies is successful, this strategy will not be viable.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Local self-supplied water may not be adequate in the future due to both quantity and quality problems. The community's future livelihood may rely on the ability to purchase water supplies.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-22**

**WATER USER NAME:**
**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Community of Westway

**STRATEGY NAME:**
Purchase water from City of El Paso

**STRATEGY DESCRIPTION:**
Desired quantity of treated water derived from the Upper Rio Grande and the Hueco Bolson would be purchased and delivered to the Community of Westway.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): The purchase and delivery of water would continue indefinitely.
Long Term (from the year 2030 to the year 2050): Delivery of water would continue indefinitely.

**QUANTITY OF WATER:**
Up to 338 acre-feet would be purchased annually through 2030. Additional 13 acre-feet (for a total of 351 acre-feet) would be purchased annually through 2050.

**RELIABILITY OF WATER:**
Rio Grande water is unavailable during drought-of-record conditions and the reliability of fresh ground water from the Hueco Bolson becomes doubtful during drought-of-record conditions approximately after the year 2020. The successful implementation of City of El Paso strategies will enhance the reliability of available supply.

**COST OF WATER:**
Cost of water is dependent on established water rates by EPWU at time water is purchased. The capital costs for this strategy are $0. The annual cost associated with this strategy is $446,060. The cost per acre-foot/year is $1,271. The cost to treat 1,000 gallons is $3.90.

**ENVIRONMENTAL ISSUES:**
Based on findings from El Paso-Las Cruces Regional Sustainable Water (SWP) Project Draft Environmental Impact Statement (DEIS), there would be some permanent and temporary adverse impacts on wildlife resources, including birds, mammal, and herptiles (amphibians and reptiles), as well as some benefits to the environment from the project. These impacts are discussed more fully in the DEIS for the SWP. The reader is referred to this document if a more detailed analysis of these impacts is desired. The record-of-decision for the draft EIS for this project is pending. However, it is important to recognize that the water supply source for this

strategy (Upper Rio Grande) is considered to be unavailable during drought-of-record conditions, as flows would be insufficient for diversions to occur.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**
None

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**
None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**
None

**OTHER FACTORS:**
Westway is currently furnished water by EPWU through development of a well in the vicinity dedicated for service to Westway. EPWU is in the process of transferring the debts and assets of the Westway Water District to EPWU. Unless the implementation of El Paso's strategies is successful, this strategy will not be viable.

**INTERBASIN TRANSFER:**
No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**
Local self-supplied water may not be adequate in the future due to both quantity and quality problems. The community's future livelihood may rely on the ability to purchase water supplies.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**
Dissolution of the Water District will be required, and should occur in 2000-2001.

**IMPACT ON NAVIGATION:**
None

**STRATEGY # 71-23**

**WATER USER NAME:**
**County:** El Paso
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**
Purchase water from City of El Paso

**STRATEGY DESCRIPTION:**
Desired quantity of treated water derived from the Upper Rio Grande and the Hueco Bolson would be purchased and delivered to rural communities.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): The purchase and delivery of water would continue indefinitely.
Long Term (from the year 2030 to the year 2050): Delivery of water would continue indefinitely.

**QUANTITY OF WATER:**
Up to 23,342 acre-feet would be purchased annually through 2030. Additional 1,206 acre-feet (for a total of 27,549 acre-feet) would be purchased annually through 2050.

**RELIABILITY OF WATER:**
Rio Grande water is unavailable during drought-of-record conditions and the reliability of fresh ground water from the Hueco Bolson becomes doubtful during drought-of-record conditions approximately after the year 2020. The successful implementation of City of El Paso strategies will enhance the reliability of available supply. Purchase of water from the City of El Paso must be approved by EPWU and must comply with all of the policies, provisions and guidelines of El Paso's Annexation Policy, Comprehensive Plan, and Drought Contingency Plan, as well as EPWU's Rules and Regulations and Growth Management Plan.

**COST OF WATER:**
Cost of water will depend on rates established by EPWU at time of purchase. The capital costs for this strategy are $0. The annual cost associated with this strategy is $35,010,000. The cost per acre-foot/year is $1,271. The cost to treat 1,000 gallons is $3.90.

**ENVIRONMENTAL ISSUES:**
Based on findings from El Paso-Las Cruces Regional Sustainable Water (SWP) Project Draft Environmental Impact Statement (DEIS), there would be some permanent and temporary adverse impacts on wildlife resources, including birds, mammal, and herptiles (amphibians and reptiles), as well as some benefits to the environment from the project. These impacts are discussed more fully in the DEIS for the SWP. The reader is referred to this document if a more

detailed analysis of these impacts is desired. The record-of-decision for the draft EIS for this project is pending. However, it is important to recognize that the water supply source for this strategy (Upper Rio Grande) is considered to be unavailable during drought-of-record conditions, as flows would be insufficient for diversions to occur.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

None

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

Specific locations and needs would need to be identified. Unless the implementation of El Paso's strategies is successful, this strategy will not be viable.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Local self-supplied water may not be adequate in the future due to both quantity and quality problems. The rural community's future livelihood may rely on the ability to purchase water supplies.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None anticipated – dependent on other factors which would come into play.

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-24**

**WATER USER NAME:**

**County:** El Paso
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**

Desalination

**STRATEGY DESCRIPTION:**

Desalination refers to any activity that reduces the salinity of a water source to below 1000-ppm TDS. This includes desalination by physical means such as reverse osmosis, and membrane technology. This strategy considers the desalination of brackish ground water in the Hueco Bolson aquifer (not currently being developed to any significant extent), and includes the construction of the infrastructure for the treatment and distribution of the supply. This strategy will require a specific host entity to sponsor the facility.

**TIME INTENDED TO IMPLEMENT:**

Short Term (prior to the year 2030): Immediate implementation is desirable~~.~~
Long Term (from the year 2030 to the year 2050): Only maintenance needed.

**QUANTITY OF WATER:**

This strategy considers the desalination of up to 18,991 acre-ft/year in the near future. Over the long-term, up to 27,549 acre ft/year will be required. However, this quantity is not concentrated in a single community but scattered throughout rural El Paso County.

**RELIABILITY OF WATER:**

Sufficient reserves of brackish water exist in the Hueco Bolson aquifer.

**COST OF WATER:**

Desalination may be cost prohibitive for such widespread but relatively sparsely populated communities. The capital costs for this strategy are $55,246,500. The annual cost associated with this strategy is $6,766,979. The cost per acre-foot/year is $246. The cost to treat 1,000 gallons is $0.75.

**ENVIRONMENTAL ISSUES:**

The major environmental issue related to the use of desalination is the disposal of the process by-product. Alternatives for disposal of the reject brine include deep well injection and the use of evaporation beds. Drying beds require the use of large land areas to accommodate the daily production of brine. Disposal using deep well injection is not very prevalent and there are numerous uncertainties relative to the practical disposal of large volumes by this method.

Preliminary planning indicates viable disposal options exist that have environmentally benign impacts including disposal in existing salt flat environments or in lined pits.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

Mining of brackish water aquifers is required under this strategy. There is no impact to other water resources in the area.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

No impacts to natural resources with well engineered brine disposal.

**OTHER FACTORS:**

A method must be found to dispose of the by-product. Cost and environmental issues may result in this strategy being difficult to implement.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Existing water supply sources are becoming undependable. The inability to implement new water-supply strategies will have a severe negative social and economic impact on citizens in the rural parts of the county.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-25**

**WATER USER NAME:**
**County:** El Paso
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**
Rainfall Harvesting

**STRATEGY DESCRIPTION:**
Rainfall harvesting involves capturing rainfall from roofs or in small surface impoundments, providing water that is usually lost to the rural homeowner.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): This strategy could be implemented relatively easily, inexpensively and quickly for immediate to short-term benefit.
Long Term (from the year 2030 to the year 2050): The strategy would continue in place as long as the homeowner desired and/or the home remained intact.

**QUANTITY OF WATER:**
The Texas Water Development Board's "Texas Guide to Rainwater Harvesting" gives the methodology to calculate rainfall harvest amounts using average precipitation for the time period 1940 through 1990 at selected rain stations across Texas. However, this Regional Water Plan must be based on water supply amounts that could be yielded during drought-of-record. Therefore, average water yield amounts produced by the methodology using average precipitation amounts should be adjusted. The TWDB publication gives minimum precipitation, maximum precipitation and 10th percentile, 25th percentile, and 50th percentile (median) amounts as well as the average precipitation amounts. Investigation of National Climatic Data Center precipitation data for West Texas stations shows that the drought-of-record in 1956 closely approximates the 25$^{th}$ percentile precipitation amounts. Therefore, if one substitutes the 25$^{th}$ percentile precipitation amounts for the average precipitation amounts within the methodology, the quantity of water on an annual basis for a 1,500 square-foot residence in El Paso County is approximately 4,000 gallons, or only 0.012 acre-foot of water per year per household.

**RELIABILITY OF WATER:**
The quantity given above is on an annual basis; an efficiency of 100% is assumed. Also, the methodology is simplified from a monthly water balance. Both the efficiency and characteristic monthly water balance are site-specific and dependent on the individual homeowner's skill in designing and implementing his particular system.

**COST OF WATER:**

The ongoing cost of water is negligible, as operation and maintenance would involve nothing more than regular application of chlorine, iodide or other sanitizing chemicals or methods, regular inspection of the system for leaks or deterioration, and costs for operating a small pump. A residential system in Far West Texas, using metal roofing and above-ground polyethylene cisterns costs approximately $4,000.

**ENVIRONMENTAL ISSUES:**

None

**IMPACT ON OTHER WATER RESOURCES:**

Minimal loss of water to aquifer recharge and an associated decrease in surface water flows may result, as the water reaches the homeowner rather than the region in general.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

None

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

This could be a beneficial water management strategy in terms of reviving a local economy and/or encouraging people to settle in a very water-scarce area.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-26**

**WATER USER NAME**

**County:** El Paso
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**

Surface Water Treatment

**STRATEGY DESCRIPTION:**

This strategy (Surface Water Conversions) refers to the conversion of agricultural water to municipal use in the fully appropriated Rio Grande surface water system. This process involves development of contracts and agreements that change existing water use from agricultural to municipal in the Rio Grande Project and determining the need for associated treatment plants and conveyance systems. This strategy does not involve services provided through EPWU and will require the designation of a specific entity to negotiate the conversion.

**TIME INTENDED TO IMPLEMENT:**

Short Term (prior to the year 2030): Facilities to treat 24,000 acre-feet per year.

Long Term (from the year 2030 to the year 2050): Facility expansion to treat an additional 4,000 acre-feet per year.

**QUANTITY OF WATER:**

At least 24,000 acre-feet per year of water would be converted by 2030 and additional 4,000 acre-feet per year by 2050.

**RELIABILITY OF WATER:**

Supplies from the Upper Rio Grande are considered to be unavailable for diversions during drought-of-record conditions.

**COST OF WATER:**

The capital costs for this strategy are $40,943,250. The annual cost associated with this strategy is $15,532,305. The cost per acre-foot/year is $555. The cost to treat 1,000 gallons is $1.70.

**ENVIRONMENTAL ISSUES:**

Based on findings from the Environmental Impact Statement for the El Paso-Las Cruces Regional Sustainable Water Project there is virtually no impact for this project. However, it is important to recognize that the water supply source for this strategy (Upper Rio Grande) is considered to be unavailable during drought-of-record conditions, as flows would be insufficient for diversions to occur.

**IMPACT ON OTHER WATER RESOURCES:**

There are some impacts on the other water resources associated with the Sustainable Water Project. These impacts are discussed in the DEIS for the Sustainable Water Project. The reader is referred to this document for a detailed analysis of these impacts.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

The agricultural district has to accommodate the change in water use from agricultural to municipal use. Based on current plans not all conversions will impact the agricultural sector.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

There are some fairly minimal impacts to Natural Resources associated with the Sustainable Water Project. These impacts are discussed in the DEIS for the Sustainable Water Project. The reader is referred to this document for a detailed analysis of these impacts.

**OTHER FACTORS:**

The County of El Paso is not a party to an existing Third-Party Conversion Contract with EPCWID#1 or the Bureau of Reclamation for the conversion of irrigation water for municipal purposes. It would need to enter into a Contract before it conducts surface water treatment. EPWU must approve the Project as a Regional Water Provider.

This strategy assumes the designation of a specific water-supply entity other than EPWU and depends on the consummation of an agreement between the designated water-supply entity, EPCWID#1, the Bureau of Reclamation, and others. If no agreement is reached, this strategy may be impossible to fully implement.

**INTERBASIN TRANSFER:**

No interbasin transfer is required.

**SOCIAL AND ECONOMIC IMPACTS:**

There are some social and economic impacts associated with the Sustainable Water Project. These impacts are discussed in the DEIS for the Sustainable Water Project. The reader is referred to this document for a detailed analysis of these impacts.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

In 1998, a Conversion Contract was signed between EPCWID#1 and the Bureau of Reclamation outlining the framework and commitment to convert additional Rio Grande surface water to M&I use. This can be accomplished by such methods as conservation, wastewater reclamation and reuse and municipal purchase of available and/or unused water directly from EPCWID#1 and individual landowners through forbearance and other means. EPWU, EPCWID#1 and the Bureau of Reclamation are currently negotiating one or more Implementing Agreements to carry forward the additional municipal conversions in a legal and socially and financially responsible manner that is agreeable to all parties.

IMPACT ON NAVIGATION: None

**STRATEGY # 71-27**

**WATER USER NAME:**
**County:** El Paso
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**
Distribution system maintenance

**STRATEGY DESCRIPTION:**
Identify and repair water-supply transmission leaks.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Leaks repaired as identified
Long Term (from the year 2030 to the year 2050): Leaks repaired as identified

**QUANTITY OF WATER:**
This strategy does not generate new water but rather extends existing supply by eliminating water losses.

**RELIABILITY OF WATER:**
Water saved by the repair of transmission leaks was previously being produced and is therefore guaranteed as being an available addition supply.

**COST OF WATER:**
Expected cost of identifying and repairing transmission leaks is highly variable and is primarily dependent on size and length of the required pipeline replacement. Potential for pipeline leaks increases with age of the existing pipeline. The capital costs for this strategy are $0. The annual cost associated with this strategy is $192,000. The cost per acre-foot/year is $662. The cost to treat 1,000 gallons is $2.03.

**ENVIRONMENTAL ISSUES:**
Limited environmental effects may be expected as a result of required excavation.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**
The water savings achieved will offset the total quantity of water previously required to be withdrawn. No effect is anticipated on other water resources.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**
None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**
None

**OTHER FACTORS:**

None

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

An efficient water system with limited to no water loss conserves the water supply source and may lower the overall cost of delivered water to the end user.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-28**

**WATER USER NAME:**

**County:** El Paso
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**

Ground water transfer

**STRATEGY DESCRIPTION:**

Ground water will be produced and transported through a pipeline from basins primarily in Hudspeth, Culberson, Jeff Davis, and Presidio Counties and delivered to rural communities. Primary aquifers include the Bone Spring-Victorio Peak, and Wild Horse and Ryan Flats. The rights to use water from current landowners in eastern county basins will be negotiated, well fields will be developed, and water from the well fields will be delivered through a pipeline to El Paso County. Rural citizens will need to be represented by a political entity that can apply for permits and loans. The feasibility of a pipeline is under investigation by Hunt and EPWU (see Strategy 71-6).

**TIME INTENDED TO IMPLEMENT:**

Short Term (prior to the year 2030): Immediate implementation is desired.
Long Term (from the year 2030 to the year 2050): Only repair and replacement needed.

**QUANTITY OF WATER:**

Approximately 220 acre-feet per year are needed.

**RELIABILITY OF WATER:**

The availability of sufficient quantities of ground water will be dependent on the specific locations selected and the existing use of water resources in that area. The quantity of water required for this strategy is available from these aquifers, however quality issues may exist depending on the specific well field site selected. The successful implementation of City of El Paso strategies will enhance the reliability of available supply.

**COST OF WATER:**

Cost of Water Transfer will be directly related to the Cost of Water Transfer discussed under Strategy #71-6A since the same pipeline would provide the transferred water to the rural communities. The capital costs for this strategy are $356,138,169. The annual cost associated with this strategy is $172,040. The cost per acre-foot/year is $782. The cost to treat 1,000 gallons is $2.40.

**ENVIRONMENTAL ISSUES:**

Water levels in the vicinity of proposed well fields may decline and windmill wells in the near vicinity could go dry. If this were to occur, wildlife dependent on these livestock watering facilities could be impacted.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

Possible water-level declines may affect wells owned by adjacent landowners. However, the data available is insufficient to state this with any degree of certainty. Additional data from new studies of the local aquifers is needed.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

Impact to existing agricultural activities is possible if well fields are located in the near proximity to active irrigation farming.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

Ground water produced from wells and transported out of the area must comply with rules of local Groundwater Conservation Districts and must have the support of the EPWU as the Regional Water Planner.

Additional hydrological studies of the aquifers in the county, including modeling where appropriate, are necessary to assess the impact of this strategy. If the hydrology does not verify the impacts and assumptions of this strategy, it should be reconsidered. Development of a plan to prevent the depletion of the aquifer is necessary prior to the full implementation of this strategy. Additionally, this strategy is dependent on more thorough cost analysis.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Existing water supply sources will soon be unavailable as they currently exist. The inability to implement new water-supply strategies will have a severe negative social and economic impact on citizens in the rural part of the County. The area from which the water is derived could experience social and economic impacts if water-level declines occur on surrounding properties as a result of this strategy.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

Purchase of land or rights to use water must be negotiated with local landowners.

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-29**

**WATER USER NAME:**

**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Manufacturing

**STRATEGY NAME:**

Purchase water from City of El Paso

**STRATEGY DESCRIPTION:**

Desired quantity of treated water derived from the Upper Rio Grande and the Hueco Bolson would be purchased and delivered to businesses and industries.

**TIME INTENDED TO IMPLEMENT:**

Short Term (prior to the year 2030): The purchase and delivery of water would continue indefinitely.

Long Term (from the year 2030 to the year 2050): Delivery of water would continue indefinitely.

**QUANTITY OF WATER:**

Up to 17,904 acre-feet per year would be purchased annually through 2030. Additional 2,428 acre-feet per year (total of 20,332 acre-feet/year) would be purchased annually through 2050.

**RELIABILITY OF WATER:**

Rio Grande water is unavailable during drought-of-record conditions and the reliability of fresh ground water from the Hueco Bolson becomes doubtful during drought-of-record conditions approximately after the year 2020. The successful implementation of City of El Paso strategies will enhance the reliability of available supply. Purchase of water from the City of El Paso must be approved by EPWU and must comply with all of the policies, provisions and guidelines of El Paso's Annexation Policy, Comprehensive Plan, and Drought Contingency Plan, as well as EPWU's Rules and Regulations and Growth Management Plan.

**COST OF WATER:**

The estimated cost of water purchased from the City of El Paso will depend on the established water rates established by the EPWU at time of purchase. The capital costs for this strategy are $0. The annual cost associated with this strategy is $25,841,972. The cost per acre-foot/year is $1,271. The cost to treat 1,000 gallons is $3.90.

**ENVIRONMENTAL ISSUES:**

Based on findings from El Paso-Las Cruces Regional Sustainable Water (SWP) Project Draft Environmental Impact Statement (DEIS), there would be some permanent and temporary adverse impacts on wildlife resources, including birds, mammal, and herptiles (amphibians and reptiles), as well as some benefits to the environment from the project. These impacts are discussed more fully in the DEIS for the SWP. The reader is referred to this document if a more detailed analysis of these impacts is desired. The record-of-decision for the draft EIS for this project is pending. However, it is important to recognize that the water supply source for this strategy (Upper Rio Grande) is considered to be unavailable during drought-of-record conditions, as flows would be insufficient for diversions to occur.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

None

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

Unless the implementation of El Paso's strategies is successful, this strategy will not be viable.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Local self-supplied water may not be adequate in the future due to both quantity and quality problems. The future livelihood of businesses and industries in the County may rely on the ability to purchase water supplies.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

Impacts are the same as those for the City of El Paso strategies.

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-30**

**WATER USER NAME:**
**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Steam Electric Power

**STRATEGY NAME:**
Purchase water from City of El Paso

**STRATEGY DESCRIPTION:**
Desired quantity of treated effluent water originally derived from the Upper Rio Grande and the Hueco Bolson would be purchased and delivered to the Power Company.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): The purchase and delivery of water would continue indefinitely.
Long Term (from the year 2030 to the year 2050): Delivery of water would continue indefinitely.

**QUANTITY OF WATER:**
Up to 6,000 acre-feet would be purchased annually through 2030. No additional water would be needed through 2050.

**RELIABILITY OF WATER:**
Rio Grande water is unavailable during drought-of-record conditions and the reliability of fresh ground water from the Hueco Bolson becomes doubtful during drought-of-record conditions approximately after the year 2020. The successful implementation of City of El Paso strategies will enhance the reliability of available supply. Purchase of water from the City of El Paso must be approved by EPWU and must comply with all of the policies, provisions and guidelines of El Paso's Annexation Policy, Comprehensive Plan, and Drought Contingency Plan, as well as EPWU's Rules and Regulations and Growth Management Plan.

**COST OF WATER:**
The estimated cost of water purchased from the City of El Paso will depend on the established water rates established by the EPWU at time of purchase. The capital costs for this strategy are $0. The annual cost associated with this strategy is $7,626,000. The cost per acre-foot/year is $1,271. The cost to treat 1,000 gallons is $3.90.

**ENVIRONMENTAL ISSUES:**
Based on findings from El Paso-Las Cruces Regional Sustainable Water (SWP) Project Draft Environmental Impact Statement (DEIS), there would be some permanent and temporary adverse impacts on wildlife resources, including birds, mammal, and herptiles (amphibians and reptiles), as well as some benefits to the environment from the project. These impacts are

discussed more fully in the DEIS for the SWP. The reader is referred to this document if a more detailed analysis of these impacts is desired. The record-of-decision for the draft EIS for this project is pending. However, it is important to recognize that the water supply source for this strategy (Upper Rio Grande) is considered to be unavailable during drought-of-record conditions, as flows would be insufficient for diversions to occur.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

None

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

Unless the implementation of El Paso's strategies is successful, this strategy will not be viable.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Local self-supplied water may not be adequate in the future due to both quantity and quality problems. The community's future livelihood may rely on the ability to purchase water supplies.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-31**

**WATER USER NAME:**
**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Steam Electric Power

**STRATEGY NAME:**
System improvement

**STRATEGY DESCRIPTION:**
Identify and implement system repairs and procedures that will generate more efficient use of water.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): System improvements implemented in the near future and continued as technology develops.
Long Term (from the year 2030 to the year 2050): System improvements continued to be made as technology develops.

**QUANTITY OF WATER:**
This strategy does not generate new water but rather extends existing supply by eliminating less efficient water use.

**RELIABILITY OF WATER:**
Water saved by system improvements was previously being produced and is therefore guaranteed as being an available addition supply.

**COST OF WATER:**
It is not possible to estimate the related cost of water under this strategy. A more detailed analysis of the system repairs, procedures and improvements is needed in order to identify specific needs and thus related costs. However, costs could range from $500,000 to $5 million per year over a five to 10 year period depending on the age and condition of the equipment in operation.

**ENVIRONMENTAL ISSUES:**
None

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**
The water savings achieved will offset the total quantity of water previously required. No effect is anticipated on other water resources.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**
None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**
None

**OTHER FACTORS:**
A cost analysis may result in this strategy not being viable.

**INTERBASIN TRANSFER:**
No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**
Impact is not determinable at this time.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**
None

**IMPACT ON NAVIGATION:**
None

**STRATEGY # 71-32**

**WATER USER NAME:**
**County**: El Paso
**River Basin:** Rio Grande
**User Name:** Steam Electric Power

**STRATEGY NAME:**
Additional wells

**STRATEGY DESCRIPTION:**
This strategy considers the possible expansion of electric power generating facilities into Hudspeth County and the need for ground water from 10 wells in the Hueco Bolson or Bone Spring-Victorio Peak aquifers for the steam generating process. The rights to use ground water from current landowners will be negotiated and a well field will be developed.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): May be implemented prior to the year 2030.
Long Term (from the year 2030 to the year 2050): Maintenance only.

**QUANTITY OF WATER:**
Approximately 4,000 acre-feet per year will be needed.

**RELIABILITY OF WATER:**
Sufficient ground water from the Hueco Bolson or Bone Spring-Victorio Peak aquifers to meet increased needs may be limited. Chemical quality of the water is marginal and is the limiting factor. Sufficient ground water may require developing a well field away from the plant facility. A ground-water mining condition might occur if significant withdrawals are concentrated within a relatively small area.

**COST OF WATER:**
The capital costs for this strategy are $600,000. The annual cost associated with this strategy is $3,492,000. The cost per acre-foot/year is $873.

**ENVIRONMENTAL ISSUES:**
Water levels in the vicinity of the proposed well field may decline and windmill wells in the near vicinity could go dry. If this were to occur, wildlife dependent on these livestock watering facilities could be impacted.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**
No effects on other water resources are anticipated. However, the data available is insufficient to state this with any degree of certainty. Additional data from new studies of the local aquifers is needed.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**
None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**
None

**OTHER FACTORS:**
Sufficient reliable ground-water resources will have to be identified before this strategy will be viable.

**INTERBASIN TRANSFER:**
No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**
Impact is not determinable at this time.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**
None

**IMPACT ON NAVIGATION:**
None

**STRATEGY # 71-33**

**WATER USER NAME:**

**River Bas in:** Rio Grande
**County:** El Paso
**User Name:** Mining

**STRATEGY NAME:**

Purchase water from City of El Paso

**STRATEGY DESCRIPTION:**

Desired quantity of treated effluent originally derived from the Upper Rio Grande and the Hueco Bolson water would be purchased from the City of El Paso.

**TIME INTENDED TO IMPLEMENT:**

Short Term (prior to the year 2030): The purchase and delivery of water would continue indefinitely.

Long Term (from the year 2030 to the year 2050): The purchase and delivery of water would continue indefinitely.

**QUANTITY OF WATER:**

Up to 28 acre-feet would be purchased annually through 2030. Lesser amounts will be needed through 2050.

**RELIABILITY OF WATER:**

Rio Grande water is unavailable during drought-of-record conditions and the reliability of fresh ground water from the Hueco Bolson becomes doubtful during drought-of-record conditions approximately after the year 2020. The successful implementation of City of El Paso strategies will enhance the reliability of available supply. Purchase of water from the City of El Paso must be approved by EPWU and must comply with all of the policies, provisions and guidelines of El Paso's Annexation Policy, Comprehensive Plan, and Drought Contingency Plan, as well as EPWU's Rules and Regulations and Growth Management Plan.

**COST OF WATER:**

The estimated cost of water purchased from the City of El Paso will depend on the established water rates by the EPWU at time of purchase. The capital costs for this strategy are $0. The annual cost associated with this strategy is $35,588. The cost per acre-foot/year is $1,271. The cost to treat 1,000 gallons is $3.90.

**ENVIRONMENTAL ISSUES:**

Based on findings from El Paso-Las Cruces Regional Sustainable Water (SWP) Project Draft Environmental Impact Statement (DEIS), there would be some permanent and temporary adverse impacts on wildlife resources, including birds, mammal, and herptiles (amphibians and reptiles), as well as some benefits to the environment from the project. These impacts are

discussed more fully in the DEIS for the SWP. The reader is referred to this document if a more detailed analysis of these impacts is desired. The record-of-decision for the draft EIS for this project is pending. However, it is important to recognize that the water supply source for this strategy (Upper Rio Grande) is considered to be unavailable during drought-of-record conditions, as flows would be insufficient for diversions to occur.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

None

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

Unless the implementation of El Paso's strategies is successful, this strategy will not be viable.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

The cost and availability of water may impact the profitability of the industry.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-34**

**WATER USER NAME:**
**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Irrigation

**STRATEGY NAME:**
Additional wells

**STRATEGY DESCRIPTION:**

There are approximately 500 irrigation wells in various stages of use in El Paso County. One hundred additional wells will be installed if expanded use of existing wells in the Rio Grande Alluvium is insufficient to meet anticipated needs. These wells may be used to provide supplemental water to carry perennial crops such as alfalfa, irrigated pasture, nursery crops, and pecans through a growing season. New wells will be considered acceptable if they have electrical conductivities up to 4 dS/m (TDS or 2,180 mg/L). Additionally, 100 more wells will be installed to meet needs resulting from loss of reuse water in 2030.

**TIME INTENDED TO IMPLEMENT:**

Short Term (prior to the year 2030): New wells should be installed immediately if no existing wells are located on a given property. At the least, installation should be targeted so that producers can have systems operational following notification of an impending water shortage.

Long Term (from 2030 to 2050): Additional wells will be needed to compensate for the predicted loss of reuse water in 2030.

**QUANTITY OF WATER:**

To meet the needs for carrying perennial crops through the growing season, 100 new wells will be developed. Only wells capable of pumping at greater than 500 gpm with electrical conductivities less than 4 dS/m will be acceptable. Pecans, alfalfa, and perennial irrigated pasture will need 73,940 ac-ft water per year. Reuse water provides 49,203 ac-ft/yr in 2000, 59,628 ac-ft/yr in 2010, and 72,800 ac-ft/yr in 2020. The 100 wells are designed to produce 24,800 ac-ft/yr in 2000, 14,400 ac-ft/yr in 2010, and 1,200 ac-ft/yr in 2020.

Following 2020, two scenarios can be set out. If reuse water is available for the 2030 through 2050 years, additional wells will not be required beyond the 2020 numbers. If reuse water is not available, then pecan producers would maintain their level of irrigation, and alfalfa and irrigated perennial pasture producers would scale their irrigations back to 30% use. The amount of water needed from wells would be 49,300 ac-ft/yr, which would require an additional 100 wells with greater than 500 gpm capacity and electrical conductivities less than 4 dS/m.

**RELIABILITY OF WATER:**

Sufficient ground water is available from the Rio Grande Alluvium; however, water with electrical conductivities less than 4 dS/m (TDS=2,180 mg/L) should be selected. Some draw down will occur based on the rate of pumping. This could also result in a change in water quality at a given well. During a prolonged severe drought, shallow ground water may diminish very quickly, and water quality may deteriorate further.

**COST OF WATER:**

Well depths in the Rio Grande Alluvium range from 20 to greater than 200 ft. An average well depth of 120 ft is chosen for these calculations. Cost of drilling a well, installing 10 inch casing with gravel pack and cement, galvanized production pipe, and a 500 gpm stainless steel submersible pump and wiring is $20,000.

Estimated cost per well is $20,000.

Estimated cost for 100 wells (current) is $2,000,000.

Estimated cost for second group of 100 wells (2030) is $2,000,000.

**ENVIRONMENTAL ISSUES:**

Use of the highly saline water associated with the Rio Grande Alluvium creates a significant alkalinity hazard, and should only be considered a short-term emergency solution. That is why only perennial crops were selected for irrigation. In the time following drought relief, a leaching program will have to be initiated to aid in reducing the soil salt buildup from use of the Alluvium water.

**IMPACT ON OTHER WATER RESOURCES:**

None

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

The strategy is designed only to prevent loss of high value perennial crops.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

Only that associated with soil salinity buildup.

**OTHER FACTORS:**

Well permits are required within the El Paso City Limits. Given the probable environmental impacts, this strategy is of limited value unless cost-effective leaching techniques are developed.

**INTERBASIN TRANSFER:**

No interbasin transfer is required.

**SOCIAL AND ECONOMIC IMPACTS:**

Use of this strategy will save pecan producers the potential loss of their orchards, and will also keep alfalfa and perennial irrigated pasture producers from having to replant their crops.

**IMPACT ON WATER RITGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:** None

**STRATEGY # 71-35**

**WATER USER NAME:**

**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Irrigation

**STRATEGY NAME:**

Expanded use of existing wells

**STRATEGY DESCRIPTION:**

Approximately 500 existing wells in the Rio Grande Alluvium in various stages of use are used for supplemental irrigation and for livestock watering. Of the 154 wells (water quality data from 1970 on) in the TWDB water quality database, 100 have electrical conductivities less than 4 dS/m. These wells may be used to provide supplemental water to carry perennial crops such as alfalfa, irrigated pasture, nursery crops, and pecans through a growing season.

**TIME INTENDED TO IMPLEMENT:**

Short Term (prior to the year 2030): Existing wells should be evaluated immediately so that producers (particularly those with pecans) can have systems operational following notification of an impending water shortage.

Long Term (from 2030 to 2050): Phased in as needed, maintenance on wells and equipment will be necessary.

**QUANTITY OF WATER:**

To meet the needs for carrying perennial crops through the growing season, existing wells can be evaluated and prepared for expanded use. Pecans, alfalfa, and perennial irrigated pasture will need 73,940 ac-ft water per year. Reuse water provides 49,203 ac-ft/yr in 2000, 59,628 ac-ft/yr in 2010, and 72,800 ac-ft/yr in 2020. The 100 existing wells with electrical conductivities less than 4 dS/m can be scaled up to produce: 24,800 ac-ft/yr in 2000, 14,400 ac-ft/yr in 2010, and 1,200 ac-ft/yr in 2020.

Following 2020, two scenarios can be set out. If reuse water is available for the 2030 through 2050 years, increased pumping will not be required beyond the 2020 level. If reuse water is not available, then pecan producers would maintain their level of irrigation, and alfalfa and irrigated perennial pasture producers would scale their irrigations back to 30% use. The amount of water needed from the existing wells would be 49,300 ac-ft/yr, which would require additional wells.

**RELIABILITY OF WATER:**

Sufficient ground water is available from the Rio Grande Alluvium; however, water with electrical conductivities less than 4 dS/m (TDS=2,180 mg/L) should be selected. Some draw down will occur based on the rate of pumping. This could also result in a change in water quality at a given well.

**COST OF WATER:**

Expanding the use of existing wells should incur no additional cost except that for increased energy use. To meet projected needs, it is likely that a number of wells will need to be reworked and many will need larger capacity pumping systems installed. For calculation purposes, it is assumed that 75% of the wells will need to be reworked and have larger pumping units installed. Average well depth of the 100 wells is 120 ft. Estimated cost for reworking a well and installing higher capacity pump with engine is $10,000. This cost may vary considerably from well to well, and in some cases may entail abandoning the original well and drilling a new well.

Estimated cost for the entire strategy is $750,000.

**ENVIRONMENTAL ISSUES:**

Use of the highly saline water associated with the Rio Grande Alluvium creates a significant alkalinity hazard, and should only be considered a short-term emergency solution. That is why only perennial crops were selected for irrigation. In the time following drought relief, a leaching program will have to be initiated to aid in reducing the soil salt buildup from use of the Alluvium water.

**IMPACT ON OTHER WATER RESOURCES:**

None

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

The strategy is designed only to prevent loss of high value perennial crops.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

Only that associated with soil salinity buildup.

**OTHER FACTORS:**

Given the probable environmental impacts, this strategy is of limited value unless cost-effective leaching techniques are developed.

**INTERBASIN TRANSFER:**

No interbasin transfer is required.

**SOCIAL AND ECONOMIC IMPACTS:**

Use of this strategy will save pecan producers the potential loss of their orchards, and will also keep alfalfa and perennial irrigated pasture producers from having to replant their crops.

**IMPACT ON WATER RITGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-36**

**WATER USER NAME:**

**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Irrigation

**STRATEGY NAME:**

Conservation and technology

**STRATEGY DESCRIPTION:**

Use of aggressive water conservation technologies, improved water efficient crops, and reduction in the Federal farm program subsidies serve to reduce the amount of water used on agricultural crops.

Irrigation demand data provided by TWDB incorporated a scenario whereby demand over time was affected by changes in crop prices, crop yields, and production costs. Federal farm payments were held constant over the planning period. Water conserving irrigation technology is incorporated as it becomes economically feasible.

The TWDB provided additional scenario data that reflected an aggressive implementation of water-conservation technology. Their scenario also incorporated a 50% reduction in farm subsidies, which may represent the major cause for decreased water-use.

**TIME INTENDED TO IMPLEMENT:**

Short term (prior to the year 2030): Phased in as technologies become available.
Long term (from 2030 to 2050): Phased in as technologies become available.

**QUANTITY OF WATER:**

This strategy does not generate new water, but reduces demand by using aggressive conservation and technology improvements. Over the planning period, TWDB estimates water savings to be: 2009 ac-ft/yr in 2000, 3910 ac-ft/yr in 2010, 5706 ac-ft/yr in 2020, 7404 ac-ft/yr in 2030, 9006 ac-ft/yr in 2040, and 10,517 ac-ft/yr in 2050.

**RELIABILITY OF WATER:**

Water saved through this strategy can be used within the system where technology improvements are not feasible.

**COST OF WATER:**

Costs associated with this strategy are impossible to quantify. The costs are expected to be supported by agricultural producers through increased yield potential and decreased costs associated with irrigation.

**ENVIRONMENTAL ISSUES:**

A reduction in the use of water for irrigation would result in less return flow. In some portions of the Rio Grande agricultural return flows are about all that keeps the river wet.

**IMPACT ON OTHER WATER RESOURCES:**

None

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

This strategy generally has a positive impact on agriculture.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

If new techniques are not developed that make this strategy more cost effective, this strategy is not viable.

**INTERBASIN TRANSFER:**

No interbasin transfer is required.

**SOCIAL AND ECONOMIC IMPACTS:**

Efficient water use technology may allow certain farm operations to continue during periods of minimal water availability.

**IMPACT ON WATER RITGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-37**

**WATER USER NAME:**

**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Livestock

**STRATEGY NAME:**

Expanded use of existing wells.

**STRATEGY DESCRIPTION:**

Typically wells used exclusively for range livestock watering have low yields and are pumped for minimal periods of time. Wells supplying the needs of cow/calf, stocker, and dairy operations in or near irrigated areas require larger capacity wells for watering a greater density of livestock. Sufficient water is often available to meet increased supply needs for existing livestock by increasing the pumping time of existing wells. In addition, increasing the extent of the water distribution system will allow for better utilization of the range resource. Of course, many wells used by ranchers are equipped with windmills, and these are already used to their maximum capacity.

**TIME INTENDED TO IMPLEMENT:**

Short Term (prior to the year 2030): Phased is as needed.
Long Term (from the year 2030 to 2050): No additional supply needed.

**QUANTITY OF WATER:**

In rangeland areas, an additional one hour of pumping time for each of an estimated 15 existing wells at an average of 5 gpm (windmill or small submersible pump) will generate 5 ac-ft/yr. For dairies, irrigated cow/calf, and stocker operations, an additional 2.5 hours of pumping time of each of an estimated 30 existing wells at an average pumping rate of 15 gpm will generate 75 ac-ft/yr.

**RELIABILITY OF WATER:**

Sufficient groundwater is available from the Hueco, Mesilla, and Rio Grande Alluvium aquifers while causing minimal increase in water-level declines. Temporary water shortages may occur during drought periods, which may require lowering of pumps or deepening of wells.

**COST OF WATER:**

Additional annual energy cost of approximately $1,000 represent the only additional cost for supplying the water.

Installation of a water distribution system associated with the 15 rangeland wells would increase the efficient use of the water supply and the range resource. A single well can serve a larger area by adding a pipeline and a trough. So that a single well could service up to 8,000 acres, 2 miles of 1¼ in. pvc (200 psi) pipe can be installed at an average (normal or rocky) cost of $0.78 per ft. or $8,236 (prices based on NRCS guidelines and the possibility exists for some federal cost sharing). Estimated cost for 15 new pipelines is $124,000.

**ENVIRONMENTAL ISSUES:**

In addition to livestock, local and migratory wildlife often depend on livestock watering facilities. Maintaining water and access at these facilities is a crucial aspect of wildlife habitat. Additional ground-water withdrawals could potentially decrease flow in local springs and streams, which could have a negative impact on water-dependent species.

**IMPACT ON OTHER WATER RESOURCES:**

No effects on other water resources are anticipated. However, the data available is insufficient to state this with any degree of certainty. Additional data from new studies of the Igneous and other local aquifers is needed.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

No effects on agricultural activities are anticipated except insofar as local springs may be affected, in which cases some ranchers could be severely impacted. If the water level declines, some ranches may not be able to deepen their wells given the increased cost of producing the wells, together with the capital required. At this point ranching may cease to be viable in some areas of the county.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

Additional hydrological studies of the aquifers in the county, including modeling where appropriate, are necessary to assess the impact of this strategy. If the hydrology does not verify the impacts and assumptions of this strategy, it should be reconsidered.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Local increased water-level declines may occur which potentially may affect water levels in wells on surrounding properties.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-38**

**WATER USER NAME:**
**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Livestock

**STRATEGY NAME:**
Herd reduction.

**STRATEGY DESCRIPTION:**
Livestock numbers would be reduced to be proportionate to available water and forage resources. If insufficient drinking water or range forage is available across rangeland or drinking water and produced irrigated forage and feed are insufficient for dairy and stocker cattle, a planned herd reduction should take place. For range and dairy production, this may entail selling off older animals or poor producers, selling offspring earlier than normal or delaying replacement animal development. For stocker cattle, this may mean selling stockers earlier than normal (after any travel restrictions removed) or by minimizing purchases of new stockers.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Herd reduced as necessary.
Long Term (from the year 2030 to 2050): Herd reduction as necessary.

**QUANTITY OF WATER:**
Additional water is not needed for this strategy.

**RELIABILITY OF WATER:**
Additional water is not needed for this strategy.

**COST OF WATER:**
There is no water cost for this strategy.

**ENVIRONMENTAL ISSUES:**
Herd reduction will lessen the impact on remaining water supplies and natural forage resources, resulting in a positive environmental impact. Ranchers should factor in wildlife species and numbers when determining stocking rate on their rangeland.

**IMPACT ON OTHER WATER RESOURCES:**
Herd reduction will lessen the impact on all water sources.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**
Herd reduction creates a loss in potential revenue.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

Although in general controlled grazing promotes bio-diversity, in times of drought all natural resources are stressed, and herd reduction, which will occur automatically by the ranchers' decisions, will minimize adverse impacts on natural resources.

**OTHER FACTORS:**

None

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Although loss of short-term revenue is expected, from a financial and biological standpoint herd reduction has generally been a rancher's best drought management strategy.

**IMPACT ON WATER RITGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-39**

**WATER USER NAME:**
**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Livestock

**STRATEGY NAME:**
Rainfall harvesting.

**STRATEGY DESCRIPTION:**
Rainfall harvesting is the process of collecting and storing precipitation for beneficial uses from land that is susceptible to runoff. Rainfall harvesting structures (catchment basins or rain traps) are also doubly effective in reducing soil erosion losses by slowing the flow of water in drainage channels.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Phased is as needed.
Long Term (from the year 2030 to 2050): No additional supply needed.

**QUANTITY OF WATER:**
The Texas Water Development Board's "Texas Guide to Rainwater Harvesting" gives the methodology to calculate rainfall harvest amounts using average precipitation for the time period 1940 through 1990 at selected rain stations across Texas. However, this Regional Water Plan must be based on water supply amounts that could be yielded during drought-of-record. Therefore, average water yield amounts produced by the methodology using average precipitation amounts should be adjusted. The TWDB publication gives minimum precipitation, maximum precipitation and 10th percentile, 25th percentile, and 50th percentile (median) amounts as well as the average precipitation amounts. Investigation of National Climatic Data Center precipitation data for West Texas stations shows that the drought-of-record in 1956 closely approximates the 25$^{th}$ percentile precipitation amounts. Therefore, if one substitutes the 25$^{th}$ percentile precipitation amounts for the average precipitation amounts within the methodology, the quantity of water on an annual basis from a 1,500 square-foot residences in El Paso County is 5,193 gallons, or only 0.016 acre-foot of water per year.

**RELIABILITY OF WATER:**
This strategy is only as reliable as frequency and quantity of precipitation events.

**COST OF WATER:**
Care must be taken in locating catchment basins so they will hold as much water as possible and to prevent them from being washed-out following a significant rainfall event. Usually an earthen dam is constructed across a drainage way (arroyo) that is cutting through relatively deep soils that will act as a natural seal to prevent deep percolation losses. Most of the earthen dams are less than 2,000 cubic yards in size. Normal cost for construction is about $1.00

per cubic yard of earth moved. For purposes of this analysis assume a cost of $2,000 per structure.

A major part of the benefit of these structures is soil erosion control, and the possibility exists that a part of the construction costs can be associated with erosion control.

**ENVIRONMENTAL ISSUES:**

In addition to livestock, local and migratory wildlife often depends on livestock watering facilities. Catchment basins can serve to reduce soil erosion losses, and in some cases reduce sediment loading in ephemeral waterways.

**IMPACT ON OTHER WATER RESOURCES:**

None

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

None

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Economic impact to local ranchers is expected to be positive, because of better utilization of the range resource.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-40**

**WATER USER NAME:**

**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Livestock

**STRATEGY NAME:**

Additional wells

**STRATEGY DESCRIPTION:**

Twenty additional wells will be drilled if expanded use of existing wells is insufficient to meet anticipated needs. Most of the wells will be associated with dairies, which represent the greatest use by livestock. Some wells will be associated with stocker operations within the Rio Grande flood plain.

**TIME INTENDED TO IMPLEMENT:**

Short Term (prior to the year 2030): Twenty additional wells would be needed immediately to meet current expected deficits.

Long Term (from 2030 to 2050): No additional wells needed to meet water supply needs, but well and pump maintenance may be necessary.

**QUANTITY OF WATER:**

Twenty new wells pumping at an average rate of 20 gpm for 3 hours each day will produce 80 ac-ft of water per year.

**RELIABILITY OF WATER:**

Sufficient groundwater is available from the Rio Grande Alluvium and likely from the Hueco and Mesilla Bolsons without excessive water level declines. Care will need to be taken in identifying sites, since water with TDS levels less than 3,000 mg/L would be most desirable for dairies, while stocker operations could use water with TDS levels up to 5,000 mg/L.

**COST OF WATER:**

Water well depths in the Rio Grande Alluvium range from 20 to about 200 ft in depth. An average well depth of 140 ft was selected, which may be deeper than needed, but generally the deeper the well the higher the water quality. Water well depths in the Mesilla and Hueco Bolsons range from 200 to greater than 1,500 ft. An average of 650 ft. was selected for this analysis.

Cost for well drilling is taken as $15 per ft. Cost for casing, installation, and development is $6 per ft. A suitable submersible pump is priced at $1,000. Average cost for a well in the Rio Grande Alluvium is taken to be $3,940. Average cost for wells in the Hueco and Mesilla Bolsons is taken at $14,650.

Cost for 15 wells in the Rio Grande Alluvium – $59,100.

Cost for 5 wells in the Hueco and/or Mesilla Bolsons - $73,250.

**ENVIRONMENTAL ISSUES:**

Additional watering locations may have a beneficial effect on wildlife needs.

**IMPACT ON OTHER WATER RESOURCES:**

None

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

In some cases, irrigation wells drilled into the Rio Grande Alluvium could serve double duty for livestock water.

**INTERBASIN TRANSFER:**

No interbasin transfer is required.

**SOCIAL AND ECONOMIC IMPACTS:**

If amount of water available for livestock becomes a significant issue during a drought of record, then the impact on local livestock owners and operators would be positive.

**IMPACT ON WATER RITGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-41**

**WATER USER NAME:**
**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Livestock

**STRATEGY NAME:**
Water Conservation by Dairies

**STRATEGY DESCRIPTION:**

Traditional dairies use water resources for: drinking by dairy cattle, cleaning cows prior to milking, cleaning equipment, evaporative cooling, and flushing manure. Reduction in quantity of water in any area can effect a saving in water use.

Traditional dairies use about 150 to 200 gallons of water per cow per day. By eliminating evaporative cooling and flushing manure, and modifying the methods for washing cows prior to milking, El Paso dairies have reduced water use to slightly under 100 gallons of water per cow per day.

**TIME INTENDED TO IMPLEMENT:**

Short Term (prior to the year 2030): Dairies in El Paso County are already leading in water conservation practices.

Long Term (from 2030 to 2050): Conservation practices and maintenance of facilities to continue.

**QUANTITY OF WATER:**

This strategy does not generate new water, but reduces demand through conservation practices.

**RELIABILITY OF WATER:**
NA

**COST OF WATER:**

There is no water cost for this strategy, nor are benefits to be accrued because the strategy has been implemented.

**ENVIRONMENTAL ISSUES:**

Elimination of excess within the dairy management system serves to reduce the amount of wastewater generated by dairies. The dairies still must remove manure solids from their location. Offsite transport of manure solids is an easier task than transport of wastewater.

**IMPACT ON OTHER WATER RESOURCES:**
None

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

Maximum conservation is currently being practiced. New conservation technology will be required to make this strategy viable.

**INTERBASIN TRANSFER:**

No interbasin transfer is required.

**SOCIAL AND ECONOMIC IMPACTS:**

None

**IMPACT ON WATER RITGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-42**

**WATER USER NAME:**
**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Livestock

**STRATEGY NAME:**
Wastewater reuse by Dairies

**STRATEGY DESCRIPTION:**
Traditional dairies use water resources for drinking by dairy cattle, cleaning cows prior to milking, cleaning equipment, evaporative cooling, and flushing manure. All but drinking water and a part of the evaporative cooling generate wastewater. In addition, runoff from rainfall events can generate significant wastewater.

Conservation savings of water have dramatically reduced the amount of wastewater generated by dairies in El Paso County. That coupled with a scarcity of rainfall minimizes the amount of wastewater generated by dairies.

Wastewater and biosolids from dairies and other confined animal feeding operations (CAFO's) are regulated by EPA and the TNRCC under the Clean Water Act. Wastewater that is generated is stored in lagoons, and generally evaporated or in some cases applied to beneficial-use sites. The amount of wastewater and biosolids that can be applied to a beneficial-use site is governed by the nitrogen level in the material. Soil phosphorus levels determine which fields can receive applications. With the current regulations it is beneficial for the dairies to move as much of the material off-site as possible, and distribute it over a large area.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Dairies in El Paso County generate very little wastewater, and what is generated is highly regulated.

Long Term (from 2030 to 2050): The use of wastewater by dairies is likely to continue to be regulated.

**QUANTITY OF WATER:**
This strategy does not generate new water.

**RELIABILITY OF WATER:**
This strategy does not generate new water.

**COST OF WATER:**
There is no water cost for this strategy.

**ENVIRONMENTAL ISSUES:**
EPA and TNRCC under the Clean Water Act regulate wastewater and biosolids from CAFO's in El Paso County.

**IMPACT ON OTHER WATER RESOURCES:**

None

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

Current regulations regarding the use of dairy-generated wastewater reuse would have to be modified to allow this strategy to be viable.

**INTERBASIN TRANSFER:**

No interbasin transfer is required.

**SOCIAL AND ECONOMIC IMPACTS:**

None

**IMPACT ON WATER RITGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 71-43**

**WATER USER NAME:**
**County:** El Paso
**River Basin:** Rio Grande
**User Name:** Livestock (Dairies)

**STRATEGY NAME:**
Purchase water from El Paso

**STRATEGY DESCRIPTION:**
Contracts for the purchase of raw water from the City of El Paso derived from the Upper Rio Grande and the Mesilla Bolson may be developed in the unlikely event that additional wells are insufficient to meet anticipated needs by the dairies. Although dairies represent close to 90% of water use by livestock, they would likely resort to water purchases only in times of emergency and for only a relatively small quantity of water. Longer duration requirements would likely prove unprofitable.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): On an as-need basis only.
Long Term (from 2030 to 2050): On an as-need basis only.

**QUANTITY OF WATER:**
Since dairies represent about 90% of the livestock water use in El Paso County, to meet the projected shortfall will require 70 ac-ft/yr. Depending on water-use efficiencies by dairies, this represents the quantity of water needed to support 625 to 780 dairy cattle.

**RELIABILITY OF WATER:**
Rio Grande water is unavailable during drought-of-record conditions and the reliability of fresh ground water from the Hueco and Mesilla Bolsons becomes doubtful during drought-of-record conditions approximately after the year 2020. Purchase of water from the City of El Paso must be approved by EPWU and must comply with all of the policies, provisions and guidelines of El Paso's Annexation Policy, Comprehensive Plan, and Drought Contingency Plan, as well as EPWU's Rules and Regulations and Growth Management Plan.

**COST OF WATER:**
The capital costs for this strategy are $0. The annual cost associated with this strategy is $88,970. The cost per acre-foot/year is $1,271. The cost to treat 1,000 gallons is $3.90.

**ENVIRONMENTAL ISSUES:**
None

**IMPACT ON OTHER WATER RESOURCES:**
None

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

Unless the implementation of El Paso's strategies is successful, this strategy will not be viable.

**INTERBASIN TRANSFER:**

No interbasin transfer is required.

**SOCIAL AND ECONOMIC IMPACTS:**

None

**IMPACT ON WATER RITGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 115-1**

**WATER USER NAME:**
**County**: Hudspeth
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**
Additional wells

**STRATEGY DESCRIPTION:**
All public supply and rural domestic water supplies in the county are derived from ground-water sources primarily in the Hueco Bolson aquifer. Drilling of new wells will provide additional water that is needed in excess of water that can be obtained from the maximum practical withdrawals from existing wells (strategy 115-3). Individual, low volume wells will be drilled to serve each new rural home, and moderate volume new public-supply wells will serve increased demands primarily along the river corridor in the southern part of the county.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Approximately 20 new individual domestic wells and two new public-supply wells would be needed.
Long Term (from the year 2030 to the year 2050): Only maintenance and replacement wells needed.

**QUANTITY OF WATER:**
2PS wells x 100gpm x 60min x 12 hours x 365 days ÷ 325,851 = 160 ac-ft/yr
20 domestic wells x 3gpm x 60min x 5 hours x 365 days ÷ 325,851 = 20 ac-ft/yr
Total volume = 180 ac-ft/yr

**RELIABILITY OF WATER:**
Sufficient ground water from the Hueco Bolson to meet increased needs may be limited. Many dry holes have been drilled in the past in the County and more should be anticipated. Proper well spacing and pump sizing should be considered to prevent interference between wells and to keep wells operating at acceptable capacity. Chemical quality of the water is marginal and is the limiting factor. Water quality should be monitored routinely to guard against the encroachment of poorer quality water.

**COST OF WATER:**
The average depth of public water-supply wells in the Ft. Hancock area is expected to approximately 200 ft. If the well is fitted with 6-in ID casing, the cost of the borehole should be approximately $14,000. The pump, motor, drop pipe, cable, and control panel should be as much as $8,250. The total cost of two wells is $44,500.
The average depth of new domestic wells in the Ft. Hancock area is expected to be approximately 100 ft. The cost to drill the borehole and set surface casing should be

approximately $1,500. The cost of the pump, motor, drop pipe, cable and control box should be an additional $2,000. Cost for 20 domestic wells is $40,000. Total strategy cost is $84,500.

**ENVIRONMENTAL ISSUES:**

Additional ground-water withdrawals could potentially decrease flow in local springs and streams, which could have a negative impact on water-dependent species.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

No effects on other water resources are anticipated. However, the data available is insufficient to state this with any degree of certainty. Additional data from new studies of the Igneous and other local aquifers is needed.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

No effects on agricultural activities are anticipated except insofar as local springs may be affected, in which cases some ranchers could be severely impacted.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

The drilling of public-supply wells must be in compliance with state regulations.

Additional hydrological studies of the aquifers in the county, including modeling where appropriate, are necessary to assess the impact of this strategy. If the hydrology does not verify the impacts and assumptions of this strategy, it should be reconsidered.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

The quality of existing ground-water supplies is marginal, and often does not meet safe drinking water standards. Continued use of this supply source may result in health related problems.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 115-2**

**WATER USER NAME:**
**County:** Hudspeth
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**
Distribution system maintenance

**STRATEGY DESCRIPTION:**
Identify and repair water-supply transmission leaks.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Leaks repaired as identified
Long Term (from the year 2030 to the year 2050): Leaks repaired as identified

**QUANTITY OF WATER:**
This strategy does not generate new water but rather extends existing supply by eliminating water losses.

**RELIABILITY OF WATER:**
Water saved by the repair of transmission leaks was previously being produced and is therefore guaranteed as being an available addition supply.

**COST OF WATER:**
Expected cost of identifying and repairing transmission leaks is highly variable and is primarily dependent on size and length of the required pipeline replacement. Potential for pipeline leaks increases with age of the existing pipeline. Assuming a replacement of 1,000 feet of 12-inch pipeline with appurtenances plus 20% markup for urban repairs (1,000 x $32 x 1.2), annual cost would be approximately $38,400.

**ENVIRONMENTAL ISSUES:**
Limited environmental effects may be expected as a result of required excavation.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**
The water savings achieved will offset the total quantity of water previously required to be withdrawn. No effect is anticipated on other water resources.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**
None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**
None

**OTHER FACTORS:**

None

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

An efficient water system with limited to no water loss conserves the water supply source and may lower the overall cost of delivered water to the end user.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 115-3**

**WATER USER NAME:**

**County:** Hudspeth
**River Basin:** Rio Grande
**User Name:** County other

**STRATEGY NAME:**

Expanded use of existing wells

**STRATEGY DESCRIPTION:**

All of the "County Other" water shortage is with water-supply entities and individual rural domestic homes that are supplied from ground-water sources primarily from the Hueco Bolson aquifer. The existing public-supply wells may be capable of being pumped for a longer period of time each day to meet increased needs. Increased demand from new rural domestic homes will be met by strategy 115-1.

**TIME INTENDED TO IMPLEMENT:**

Short Term (prior to the year 2030): Additional pumping time will occur as needed.

Long Term (from the year 2030 to the year 2050): Additional pumping time will occur as needed.

**QUANTITY OF WATER:**

Assuming that the water-supply entities operate four moderate-capacity wells at an average 50 gpm, increasing the pumping time of each well by two hours will generate 27 ac-ft/yr.

**RELIABILITY OF WATER:**

Sufficient ground water is available from local aquifers; however, local water-level declines may increase. Water quality is of concern (above safe-drinking-water standards) in some wells completed in the Hueco Bolson aquifer.

**COST OF WATER:**

Additional annual energy cost of approximately $3,000 is anticipated from this strategy.

**ENVIRONMENTAL ISSUES:**

Additional ground-water withdrawals could potentially decrease flow in local springs and streams, which could have a negative impact on water-dependent species.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

No effects on other water resources are anticipated. However, the data available is insufficient to state this with any degree of certainty. Additional data from new studies of the Igneous and other local aquifers is needed.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

No effects on agricultural activities are anticipated except insofar as local springs may be affected, in which cases some ranchers could be severely impacted. If the water level declines, some ranches may not be able to deepen their wells given the increased cost of producing the wells, together with the capital required. At this point ranching may cease to be viable in some areas of the county.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

Additional hydrological studies of the aquifers in the county, including modeling where appropriate, are necessary to assess the impact of this strategy. If the hydrology does not verify the impacts and assumptions of this strategy, it should be reconsidered.

**INTERBASIN TRANSFER:**

No interbasin transfer is required.

**SOCIAL AND ECONOMIC IMPACTS:**

Local increased water-level declines may occur which potentially may affect water levels in wells on surrounding properties.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 115-4**

**WATER USER NAME:**
**County:** Hudspeth
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**
Surface water conversion and treatment

**STRATEGY DESCRIPTION:**
This strategy includes the conversion of rights to use up to 3,000 acre-feet of Rio Grande Project water to be stored in an HCCRD#1 reservoir. This strategy also includes the construction of a treatment plant located near the reservoir and a 12-mile, 20-inch distribution pipeline from the treatment plant to the Fort Hancock area. This new supply is intended to replace the existing ground-water supplies currently being provided by the Fort Hancock WCID and the Esperanza FWSD#1 that are no longer compliant with state drinking water standards.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Supply is needed in the very near future.
Long Term (from the year 2030 to the year 2050):

**QUANTITY OF WATER:**
A quantity of 3,000 acre-feet converts to 2.7 MGD; a peaking factor of 1.5 brings this to a 4.05 MGD design capacity.

**RELIABILITY OF WATER:**
Single year supply problems expected 1 out of 15 years and multiple-year supply problems expected 3 out of 30 years. Ground water will be used during times of surface water shortage. Source water from the Upper Rio Grande is considered to be insufficient for diversions during drought-of-record conditions.

**COST OF WATER:**
The cost of the water treatment plant, based on a design capacity of 4.05 MGD, is estimated to be $9,855,000. The cost of a 20.29 hp water intake / pump station is estimated to be $125,800. A 12-mile, 20-inch pipeline from the treatment plant to the Fort Hancock area is estimated to cost $3,041,280. Total infrastructure cost is estimated to be $13,022,080. The estimated cost for ground storage facilities, if required, based on the number of Fort Hancock and Esperanza water connections required by TNRCC for public water systems is approximately $63,900. Total cost including ground storage is $13,085,980.

**ENVIRONMENTAL ISSUES:**
None

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

None

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

Existing storage reservoirs conserve an estimated 20,000 acre-feet of Rio Grande Project Water annually. All water expected to be obtained from water salvage projects.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

This strategy depends on the consummation of an agreement between EPCWID#1, the Bureau of Reclamation and others. If no agreement is reached, this strategy may be impossible to fully implement.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Existing water supply sources will soon be unavailable as they currently exist. The inability to implement new water-supply strategies will have a severe negative social and economic impact on citizens and businesses currently being served by the Fort Hancock WCID and the Esperanza FWSD#1.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

The existing March 19, 1998 Conversion Contract between the USA and EPCWID#1 provides the legal framework for conversion of Rio Grande Project Water from irrigation to municipal use. The Conversion Contract of 1998 which allows conversion of agricultural water for municipal purposes limits the conversion to providers of municipal and industrial water, does not include Hudspeth at this time. In addition, the Conversion Contract requires a Third Party Contract with the recipient of the water, and Hudspeth County is not a party to an existing Third Party Contract with EPCWID#1 and the Bureau.

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 115-5**

**WATER USER NAME:**
**County**: Hudspeth
**River Basin**: Rio Grande
**User Name:** County Other

**STRATEGY NAME:**
Desalination

**STRATEGY DESCRIPTION:**
Desalination refers to any activity that reduces the salinity of a water source to below 1000-ppm TDS. This strategy includes the construction of a reverse-osmosis desalination facility near the current ground-water supply for Fort Hancock. This new supply is intended to replace the existing ground-water supplies currently being provided by the Ft. Hancock WCID and a portion of the supply from the Esperanza FWSD#1. These ground-water supplies are no longer compliant with state drinking water standards. This strategy considers the desalination of brackish groundwater (not currently being developed to any significant extent in the southern part of the county).

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Immediate implementation is desirable.
Long Term (from the year 2030 to the year 2050): Only maintenance needed.

**QUANTITY OF WATER:**
This strategy considers the desalination by treatment of up to 216 acre-feet of water to meet all of Hudspeth "County Other" projected demands.

**RELIABILITY OF WATER:**
Sufficient reserves of brackish water exist in the Hueco Bolson and Rio Grande Alluvium aquifers~~.~~

**COST OF WATER:**
The design capacity is lower than what economies of scale will produce in the reverse osmosis desalination plant. If instead, a 1-MGD plant is designed, then the annualized cost is approximately $1.10 per 1,000 gallons of water or $354 per acre-foot. Over a 30-year life, this is a $1,593,000 capital cost. Assuming 5,000 feet of pipe and a pipe diameter of 8 inches, the estimated cost for the water transmission system is approximately $120,000. The estimated cost for ground storage facilities, if required, based on the number of Fort Hancock and Esperanza water connections required by TNRCC for public water systems is approximately $63,900. Total estimated cost is $1,776,900.

**ENVIRONMENTAL ISSUES:**

The major environmental issue related to the use of desalination is the disposal of the process by-product. Alternatives for disposal of the reject brine include deep well injection and the use of evaporation beds. Drying beds require the use of large land areas to accommodate the daily production of brine. Disposal using deep well injection is not very prevalent and there are numerous uncertainties relative to the practical disposal of large volumes by this method. Preliminary planning indicates viable disposal options exist that have environmentally benign impacts including disposal in existing salt flat environments or in lined pits.

**IMPACT ON OTHER WATER RESOURCES:**

Mining of brackish water aquifers is required under this strategy. There is no impact to other water resources in the area.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

No impacts to natural resources with well engineered brine disposal.

**OTHER FACTORS:**

A method must be found to dispose of the by-product. Cost and environmental issues may result in this strategy being difficult to implement.

**INTERBASIN TRANSFER:**

No interbasin transfer is required.

**SOCIAL AND ECONOMIC IMPACTS:**

Existing water supply sources will soon be unavailable as they currently exist. The inability to implement new water-supply strategies will have a severe negative social and economic impact on citizens and businesses currently being served by the Ft. Hancock WCID and the Esperanza FWSD#1.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 115-6A**

**WATER USER NAME:**
**County:** Hudspeth
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**
Ground water transfer

**STRATEGY DESCRIPTION:**
Ground water from the Wild Horse Flat aquifer would be purchased from the City of Van Horn and delivered through an existing pipeline to Sierra Blanca and onward through a new pipeline to southern Hudspeth County. The water would be delivered to communities served by the Fort Hancock WCID and the Esperanza FWSD#1.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Immediate implementation is desired.
Long Term (from the year 2030 to the year 2050): Only repair and replacement needed.

**QUANTITY OF WATER:**
Approximately 220 acre-feet per year will be delivered.

**RELIABILITY OF WATER:**
Ground water is available in the vicinity of the Van Horn well field in the Wild Horse Flat aquifer; however, Van Horn will likely need to expand its ability to produce water by drilling additional wells. Depending on the amount of water-level decline, water quality may be adversely affected as the water remaining becomes increasingly brackish.

**COST OF WATER:**
The cost of a 34-mile, 8-inch pipeline from Sierra Blanca to Fort Hancock along IH-10 is approximately $4,286,600. A booster station needed to lift the water over elevation difference in the Quitman Mountains is estimated to cost approximately $620,000. A 1-MGD ground storage tank associated with the booster station is also needed at a cost of $275,000. Estimated cost for a Fort Hancock / Esperanza ground storage facilities is approximately $63,900. Total facility cost is approximately $5,245,500.

**ENVIRONMENTAL ISSUES:**
Temporary land surface disturbance can be expected with the construction of wells and pipelines. No long-term negative environmental impact is anticipated in the vicinity of the Van Horn well field.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

Additional ground-water pumpage from the Van Horn well field will likely increase water-level declines in the area. The overall effect on water levels in the Wild Horse Flat aquifer is also dependent on other users of the aquifer.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

**A**reas adjacent to the proposed well field may experience an undetermined amount of water-level decline in the aquifer being pumped.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

Ground water produced from wells and transported out of the area must comply with rules of the Culberson County Groundwater Conservation District.

Additional hydrological studies of the aquifers in the county, including modeling where appropriate, are necessary to assess the impact of this strategy. If the hydrology does not verify the impacts and assumptions of this strategy, it should be reconsidered. Development of a plan to prevent the depletion of the aquifer is necessary prior to the full implementation of this strategy. Additionally, this strategy is dependent on more thorough cost analysis.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Existing water-supply sources will soon be unavailable as they currently exist. The inability to implement new water-supply strategies will have a severe negative social and economic impact on citizens and businesses currently being served by the Fort Hancock WCID and the Esperanza FWSD#1. Depending on the extent of decline, some ranches may no longer be economically viable.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 115-6B**

**WATER USER NAME:**
**County:** Hudspeth
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**
Ground water transfer

**STRATEGY DESCRIPTION:**
Ground water would be produced from wellfields to be developed in the Red Light Draw or Green River basin aquifers and transported through a pipeline to communities in southern Hudspeth County served by the Fort Hancock WCID and the Esperanza FWSD#1. The rights to use water from current landowners in the Red Light Draw or Green River basins would be negotiated.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Immediate implementation is desired.
Long Term (from the year 2030 to the year 2050): Only repair and replacement needed.

**QUANTITY OF WATER:**
Approximately 220 acre-feet per year are needed.

**RELIABILITY OF WATER:**
Sufficient ground water exists in the Red Light Draw and Green River basin aquifers; however, the data available is insufficient to state this with any degree of certainty. Because of the relatively low transmissivity of the aquifers, proper well spacing will be necessary to prevent interference between wells. A ground-water mining condition can be expected if significant withdrawals are concentrated within a relatively small area. Depending on the amount of water-level decline, water quality may be adversely affected as the water remaining becomes increasingly brackish.

**COST OF WATER:**
The estimated cost of installing a 900-ft deep public water-supply well with 8-in ID casing is $87,000. The pump, motor, drop pipe, cable, and control panel will cost an additional $17,000. The total cost is $104,000. For three wells, the total cost is $312,000.

The cost of a 57-mile, 8-inch pipeline from Red Light Draw to Sierra Blanca and then to Fort Hancock along IH-10 is approximately $7,263,400. A booster station needed to lift the water over elevation difference in the Quitman Mountains is estimated to cost approximately $620,000. A 1-MGD ground storage tank associated with the booster station is also needed at a cost of $275,000. Estimated cost for a Fort Hancock / Esperanza ground storage facilities is approximately $63,900. Total facility cost is approximately $ 8,534,300.

**ENVIRONMENTAL ISSUES:**

Water levels in the vicinity of the proposed well field may decline and windmill wells in the near vicinity could go dry. If this were to occur, wildlife dependent on these livestock watering facilities could be impacted.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

No effects on other water resources are anticipated. However, the data available is insufficient to state this with any degree of certainty. Additional data from new studies of the local aquifers is needed.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

**A**reas adjacent to the proposed well field may experience an undetermined amount of water-level decline in the aquifer being pumped.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

The drilling of new public-supply wells must be in compliance with State regulations and rules of local Ground Water Conservation Districts.

Additional hydrological studies of the aquifers in the county, including modeling where appropriate, are necessary to assess the impact of this strategy. If the hydrology does not verify the impacts and assumptions of this strategy, it should be reconsidered. Development of a plan to prevent the depletion of the aquifer is necessary prior to the full implementation of this strategy. Additionally, this strategy is dependent on more thorough cost analysis.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Existing water supply sources will soon be unavailable as they currently exist. The inability to implement new water-supply strategies will have a severe negative social and economic impact on citizens and businesses currently being served by the Fort Hancock WCID and the Esperanza FWSD#1. Depending on the extent of decline, some ranches may no longer be economically viable.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

Purchase of land or rights to use water must be negotiated with local landowners.

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 115-8**

**WATER USER NAME:**
**County:** Hudspeth
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**
Rainfall Harvesting

**STRATEGY DESCRIPTION:**
Rainfall harvesting involves capturing rainfall from roofs or in small surface impoundments, providing water that is usually lost to the rural homeowner.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): This strategy could be implemented relatively easily, inexpensively and quickly for immediate to short-term benefit.

Long Term (from the year 2030 to the year 2050): The strategy would continue in place as long as the homeowner desired and/or the home remained intact.

**QUANTITY OF WATER:**
The Texas Water Development Board's "Texas Guide to Rainwater Harvesting" gives the methodology to calculate rainfall harvest amounts using average precipitation for the time period 1940 through 1990 at selected rain stations across Texas. However, this Regional Water Plan must be based on water supply amounts that could be yielded during drought-of-record. Therefore, average water yield amounts produced by the methodology using average precipitation amounts should be adjusted. The TWDB publication gives minimum precipitation, maximum precipitation and 10th percentile, 25th percentile, and 50th percentile (median) amounts as well as the average precipitation amounts. Investigation of National Climatic Data Center precipitation data for West Texas stations shows that the drought-of-record in 1956 closely approximates the 25$^{th}$ percentile precipitation amounts. Therefore, if one substitutes the 25$^{th}$ percentile precipitation amounts for the average precipitation amounts within the methodology, the quantity of water on an annual basis for a 1,500 square-foot residence near Alpine is 5,193 gallons, or only 0.016 acre-foot of water per year.

**RELIABILITY OF WATER:**
The quantity given above is on an annual basis; an efficiency of 100% is assumed. Also, the methodology is simplified from a monthly water balance. Both the efficiency and characteristic monthly water balance are site-specific and dependent on the individual homeowner's skill in designing and implementing his particular system.

**COST OF WATER:**
The ongoing cost of water is negligible, as operation and maintenance would involve nothing more than regular application of chlorine, iodide or other sanitizing chemicals or

methods, regular inspection of the system for leaks or deterioration, and costs for operating a small pump. A residential system in Far West Texas, using metal roofing and above-ground polyethylene cisterns costs approximately $4,000.

**ENVIRONMENTAL ISSUES:**

None

**IMPACT ON OTHER WATER RESOURCES:**

Minimal loss of water to aquifer recharge and an associated decrease in surface water flows may result, as the water reaches the homeowner rather than the region in general.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

None

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

This could be an extremely beneficial water management strategy in terms of reviving a local economy and/or encouraging people to settle in a very water-scarce area.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 115-9**

**WATER USER NAME:**
**County:** Hudspeth
**River Basin:** Rio Grande
**User Name:** Irrigation

**STRATEGY NAME:**
Conservation and technology (Lower Valley)

**STRATEGY DESCRIPTION:**
Use of aggressive water conservation technologies, improved water efficient crops, and reduction in the Federal farm program subsidies serve to reduce the amount of water used on agricultural crops.

Irrigation demand data provided by TWDB incorporated a scenario whereby demand over time was affected by changing crop prices, crop yields, and production costs. Federal farm payments were held constant over the planning period. Water conserving irrigation technology is incorporated as it becomes economically feasible.

The TWDB provided additional scenario data that reflected an aggressive implementation of water-conservation technology. Their scenario also incorporated a 50% reduction in farm subsidies, which may represent the major cause for decreased water-use.

**TIME INTENDED TO IMPLEMENT:**
Short term (prior to the year 2030): Phased in as technologies become available.
Long term (from 2030 to 2050): Phased in as technologies become available.

**QUANTITY OF WATER:**
This strategy does not generate new water, but reduces demand by using aggressive conservation and technology improvements. On a county wide basis, over the planning period, TWDB estimates water savings to be: 1,571 ac-ft/yr in 2000, 3,057 ac-ft/yr in 2010, 4,463 ac-ft/yr in 2020, 5,791 ac-ft/yr in 2030, 7,044 ac-ft/yr in 2040, and 8,226 ac-ft/yr in 2050.

The lower valley in Hudspeth County represents approximately 43% of the demand for irrigation water in Hudspeth County. As such, water savings in the lower valley are estimated to be: 675 ac-ft/yr in 2000, 1,314 ac-ft/yr in 2010, 1,919 ac-ft/yr in 2020, 2,490 ac-ft/yr in 2030, 3,029 ac-ft/yr in 2040, and 3,537 ac-ft/yr in 2050.

**RELIABILITY OF WATER:**
Water saved through this strategy can be used within the system where technology improvements are not feasible.

**COST OF WATER:**
Costs associated with this strategy are impossible to quantify. The costs are expected to be supported by agricultural producers through increased yield potential and decreased costs associated with irrigation.

**ENVIRONMENTAL ISSUES:**

A reduction in the use of water for irrigation would result in less return flow. In some portions of the Rio Grande agricultural return flows are about all that keeps the river wet. Some over-irrigation to minimize the impact of salinity will have to be factored in to this strategy.

**IMPACT ON OTHER WATER RESOURCES:**

None

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

This strategy generally has a positive impact on agriculture.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

Currently the cost of water to agricultural producers is relatively low. New techniques developed for this strategy must be cost effective or this strategy will not be viable.

**INTERBASIN TRANSFER:**

No interbasin transfer is required.

**SOCIAL AND ECONOMIC IMPACTS:**

Efficient water use technology may allow certain farm operations to continue during periods of minimal water availability.

**IMPACT ON WATER RITGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 115-10**

**WATER USER NAME:**

**County:** Hudspeth
**River Basin:** Rio Grande
**User Name:** Irrigation

**STRATEGY NAME:**

Expanded use of existing wells (Lower Valley)

**STRATEGY DESCRIPTION:**

A number of wells in the Rio Grande Alluvium in various stages of use are used for supplemental irrigation and for livestock watering in Hudspeth County. Of the 39 wells (water quality data from 1970 on) in the TWDB water quality database, 7 have electrical conductivities less than 4 dS/m. These wells may be used to provide supplemental water to carry perennial crops such as alfalfa and irrigated pasture through a growing season.

**TIME INTENDED TO IMPLEMENT:**

Short term (prior to the year 2030): Existing wells should be evaluated periodically so that producers can have systems operational following notification of an impending water shortage.

Long term (from 2030 to 2050): Phased in as needed, maintenance on wells and equipment will be necessary.

**QUANTITY OF WATER:**

To meet the needs for carrying perennial crops through the growing season, existing wells can be evaluated and prepared for expanded use. Alfalfa and perennial irrigated pasture will need 8,700 ac-ft/yr under full irrigation, or 2,610 ac-ft/yr at 30% use. The 7 existing wells with electrical conductivities less than 4 dS/m can be scaled up (500 gpm) to meet the 2,610 ac-ft/yr water needs through the time period of the plan.

**RELIABILITY OF WATER:**

Sufficient ground water is available from the Rio Grande Alluvium; however, water with electrical conductivities less than 4 dS/m (TDS=2,180 mg/L) should be selected. Some draw down will occur based on the rate of pumping. This could also result in a change in water quality at a given well.

**COST OF WATER:**

Although expanding the use of existing wells should incur no additional cost except that for increased energy use. To meet projected needs, It is likely that a number of wells will need to be reworked and many will need larger capacity pumping systems installed. For calculation purposes, it is assumed that five out of the seven wells will need to be reworked and have larger pumping units installed. Average well depth of wells is 120 ft. Estimated cost for reworking a well and installing higher capacity pump and motor is $10,000. This cost may vary considerably from well to well, and in some cases may entail abandoning the original well and drilling a new well.

Estimated cost for the entire strategy is $50,000.

**ENVIRONMENTAL ISSUES:**

Use of the highly saline water associated with the Rio Grande Alluvium creates a significant alkalinity hazard, and should only be considered an short-term emergency solution. That is why only perennial crops were selected for irrigation. In the time following drought relief, a leaching program will have to be initiated to aid in reducing the soil salt buildup from use of the Alluvium water.

**IMPACT ON OTHER WATER RESOURCES:**

None

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

The strategy is designed only to prevent loss of high value perennial crops.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

Only that associated with soil salinity buildup.

**OTHER FACTORS:**

It is likely that the TWDB database underestimated the number of wells available for irrigation. If additional wells can be brought on-line, then additional irrigation should be applied. Given the probable environmental impacts, this strategy is of limited value unless cost-effective leaching techniques are developed.

**INTERBASIN TRANSFER:**

No interbasin transfer is required.

**SOCIAL AND ECONOMIC IMPACTS:**

Use of this strategy will save pecan producers the potential loss of their orchards, and will also keep alfalfa and perennial irrigated pasture producers from having to replant their crops.

**IMPACT ON WATER RITGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 115-11**

**WATER USER NAME:**
**County:** Hudspeth
**River Basin:** Rio Grande
**User Name:** Irrigation

**STRATEGY NAME:**
Additional wells (Lower Valley)

**STRATEGY DESCRIPTION:**
There are a number of irrigation wells in various stages of use in the lower valley of Hudspeth County. Forty additional wells will be installed if expanded use of existing wells in the Rio Grande Alluvium is insufficient to meet anticipated needs. These wells may be used to provide supplemental water to carry perennial crops such as alfalfa and irrigated pasture through a growing season. New wells will be considered acceptable if they have electrical conductivities up to 4 dS/m (TDS or 2,180 mg/L).

**TIME INTENDED TO IMPLEMENT:**
Short term (prior to the year 2030): New wells should be installed immediately if no existing wells are located on a given property. At the least, installation should be targeted so that producers can have systems operational following notification of an impending water shortage.
Long term (from 2030 to 2050): Phased in as needed, maintenance will be needed.

**QUANTITY OF WATER:**
To meet the needs for carrying perennial crops through the growing season, 40 new wells will be developed. Only wells capable of pumping at greater than 500 gpm with electrical conductivities less than 4 dS/m will be acceptable. For full irrigation, alfalfa and perennial irrigated pasture will need 8,700 ac-ft/yr water.

**RELIABILITY OF WATER:**
Sufficient ground water is available from the Rio Grande Alluvium; however, water with electrical conductivities less than 4 dS/m (TDS=2,180 mg/L) should be selected. Some draw down will occur based on the rate of pumping. This could also result in a change in water quality at a given well. During a prolonged severe drought, shallow ground water may diminish very quickly, and water quality may deteriorate further.

**COST OF WATER:**
Water well depths in the Rio Grande Alluvium range from 20 to greater than 200 ft in depth. An average well depth of 120 ft is chosen for these calculations. Cost of drilling a well, installing 10 inch casing with gravel pack and cement, galvanized production pipe, and a 500 gpm stainless steel submersible pump and wiring is $20,000.
Estimated cost per well is $20,000.
Estimated cost for 40 wells (current) is $800,000.

**ENVIRONMENTAL ISSUES:**

Use of the highly saline water associated with the Rio Grande Alluvium creates a significant alkalinity hazard, and should only be considered a short-term emergency solution. That is why only perennial crops were selected for irrigation. In the time following drought relief, a leaching program will have to be initiated to aid in reducing the soil salt buildup from use of the Alluvium water.

**IMPACT ON OTHER WATER RESOURCES:**

None

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

The strategy is designed only to prevent loss of high value perennial crops.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

Only that associated with soil salinity buildup.

**OTHER FACTORS:**

Well permits are required within Hudspeth County. Given the probable environmental impacts, this strategy is of limited value unless cost-effective leaching techniques are developed.

**INTERBASIN TRANSFER:**

No interbasin transfer is required.

**SOCIAL AND ECONOMIC IMPACTS:**

Use of this strategy will help keep alfalfa and perennial irrigated pasture producers from having to replant their crops.

**IMPACT ON WATER RITGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 115-12**

**WATER USER NAME:**

**County:** Hudspeth
**River Basin:** Rio Grande
**User Name:** Irrigation

**STRATEGY NAME:**

Expansion of Regulating Reservoir Storage (Rio Grande Valley)

**STRATEGY DESCRIPTION:**

Expansion and renovation of the regulating reservoir system currently in use by Hudspeth County Reclamation District No. 1

**TIME INTENDED TO IMPLEMENT**

Short Term (prior to 2030): Renovations on Reservoirs No. 1 and 2.
Long Term (from the year 2030 to the year 2050): Construction of Reservoir No. 4.

**QUANTITY OF WATER**

Quantities vary from year to year, but a rough estimate is that for every acre-foot of additional storage in regulating reservoirs, 4 to 7 acre-feet of water can be salvaged during years with a full or excess Rio Grande Project diversion allocation. The expansion and renovation of the regulating reservoir system currently in use by Hudspeth County Reclamation District No. 1 could salvage between 300 and 8,500 acre-feet of water per year. Reservoir No. 1 could be expanded to provide an additional 500 acre-feet of storage. Reservoir No. 2 could be renovated to provide an additional 300 acre-feet of storage. Reservoir No. 4 could be constructed to provide for an additional 3,000 to 5,000 acre-feet of floodwater storage.

**RELIABILITY OF WATER**

The reliability of available water from the Rio Grande for this strategy is fair to poor. Water availability is "run of the river" and unpredictable. Approximately one out every six to eight years excess water in river due to flood conditions at Elephant Butte Reservoir. During normal diversion allocation years expansion of reservoirs would allow capture of a small percentage of local storm flows (perhaps less than 2% of the total flood hydrograph). Occurrence and duration of flood hydrographs is unpredictable. During drought years expanded storage would have little or no use since existing storage is adequate to capture available water.

**COST OF WATER**

Over the 40-year life cycle of the reservoirs, the additional capacity is expected to have a \$5.00 per acre-foot operational cost and a \$14.00 to \$25.00 per acre-foot capital cost. A prolonged period of drought could increase the cost of any water salvaged in normal or excess diversion allocation years to \$28.00 to \$50.00.

## ENVIRONMENTAL ISSUES

Capture of flood, sewage effluent and operational spill water will reduce the quantities of water flowing past Fort Quitman. The time when most of such water will be captured will be during years when the Rio Grande Project has a full or excess diversion allocation or flood conditions. The quantity of flow captured by the expanded capacity of the reservoirs is expected to be less than 2 percent of the flow downstream of Fort Quitman and such water will be captured partially by trimming the peak of flood hydrographs. Approximately 25% of the water salvaged by the expanded reservoirs will be returned to the Rio Grande. The return flow from water salvaged during flood events potential would increase flows downstream of Fort Quitman during time or reduce flow in the river. No significant change in the flow regimes is expected downstream of Fort Quitman during normal and flood conditions, and no change in the flow regime is expected during drought conditions.

## IMPACT ON OTHER WATER RESOURCES

None

## IMPACT OF STRAGEGY TO THREATS TO AGRICULTURE

This strategy has a positive impact on agriculture.

## IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES

Minimal or none.

## OTHER FACTORS

None

## INTERBASIN TRANSFER

No interbasin transfer of water is required.

## SOCIAL AND ECONOMIC IMPACTS

Benefit of salvaged water has direct impact on local and regional economy. Agriculture is the primary source of income for the region and any ability to maintain or expand production will directly improve the local economy and social conditions. Some of the water developed from this strategy may be used in supplementing and conserving M&I groundwater supplies.

## IMPACT ON WATER RIGHTS, CONTRACT, AND OPTION AGREEMENTS

None

## IMPACT ON NAVIGATION

None

**STRATEGY # 122-1**

**WATER USER NAME:**
**County:** Jeff Davis
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**
Additional wells

**STRATEGY DESCRIPTION:**

All public supply and rural domestic water supplies in the county are derived from ground-water sources. Drilling of new wells will provide additional water that is needed in excess of water that can be obtained from the maximum practical withdrawals from existing wells (strategy 122-3). Approximately 60 individual, low volume new wells wills be needed to serve a projected rural population increase of 175 by the year 2050. One additional moderate-volume, new public-supply well is needed to provide water to the High Frontier area of the Davis Mountains.

**TIME INTENDED TO IMPLEMENT:**

Short Term (prior to the year 2030): Approximately 50 new individual domestic wells and one public-supply well to provide for the High Frontier service area.

Long Term (from the year 2030 to the year 2050): An additional 10 domestic wells will be needed by the year 2050. Maintenance and replacement wells will also be needed.

**QUANTITY OF WATER:**

1PS well x 50gpm x 60min x 12 hours x 365 days ÷ 325,851 = 40 ac-ft/yr
60 domestic wells x 3gpm x 60min x 5 hours x 365 days ÷ 325,851 = 60 ac-ft/yr
Total volume = 100 ac-ft/yr

**RELIABILITY OF WATER:**

Sufficient ground water is primarily available from the Igneous aquifer in most parts of the County; however, many dry holes have been drilled in the past in the County and more should be anticipated since the Igneous aquifer does not underlie all parts of the County. However, proper well spacing and pump sizing should be considered to prevent interference between wells and to keep wells operating at acceptable capacity. Water levels in the vicinity of higher capacity commercial pumping centers should be monitored for possible long-term declines. Temporary water shortages may occur during drought periods, which may require the lowering of pumps or deepening of wells. Chemical quality of the water is good.

**COST OF WATER:**

An additional public water-supply well for Jeff Davis County is expected to be 400 ft deep and to be equipped with 6-in ID steel casing and screen. The cost of drilling the hole and setting the casing and screen is expected to be $28,100. The pump, motor, drop pipe, cable, and control panel are expected to cost an additional $8,250. The total cost is $35,350.

Cost to drill and complete private domestic wells will be incurred by the well owners. The depth of the average domestic well is expected to be approximately 300 ft. The cost to drill and set surface casing for a well of this depth should be $4,500. The cost of the pump, motor, drop pipe, cable, control panel, and pressure tank should be an additional $2,000. Cost of 60 domestic wells is $120,000. Total strategy cost is $155,350.

**ENVIRONMENTAL ISSUES:**

Additional ground-water withdrawals could potentially decrease flow in local springs and streams, which could have a negative impact on water-dependent species.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

Additional ground-water withdrawals could potentially decrease flow in local springs and streams. However, the data available is insufficient to state this with any degree of certainty. Additional data from new studies of the Igneous and other local aquifers is needed.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

No effects on agricultural activities are anticipated except insofar as local springs may be affected, in which cases some ranchers could be severely impacted.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

The number of new wells currently being permitted in the County suggests that there will be significantly more wells drilled than is anticipated in this strategy. The drilling of new domestic and public-supply wells must be in compliance with State and Jeff Davis County Underground Water Conservation District rules.

Additional hydrological studies of the aquifers in the county, including modeling where appropriate, are necessary to assess the impact of this strategy. If the hydrology does not verify the impacts and assumptions of this strategy, it should be reconsidered.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Local water-level declines may occur which potentially may affect water levels in wells on surrounding properties.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 122-2**

**WATER USER NAME:**
**County:** Jeff Davis
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**
Distribution system maintenance

**STRATEGY DESCRIPTION:**
Identify and repair water-supply transmission leaks.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Leaks repaired as identified
Long Term (from the year 2030 to the year 2050): Leaks repaired as identified

**QUANTITY OF WATER:**
This strategy does not generate new water but rather extends existing supply by eliminating water losses.

**RELIABILITY OF WATER:**
Water saved by the repair of transmission leaks was previously being produced and is therefore guaranteed as being an available addition supply.

**COST OF WATER:**
Expected cost of identifying and repairing transmission leaks is highly variable and is primarily dependent on size and length of the required pipeline replacement. Potential for pipeline leaks increases with age of the existing pipeline. Assuming a replacement of 1,000 feet of 6-inch pipeline with appurtenances plus 20% markup for urban repairs (1,000 x $20 x 1.2), annual cost would be approximately $24,000.

**ENVIRONMENTAL ISSUES:**
Temporary environmental effects may be expected as a result of required excavation.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**
The water savings achieved will offset the total quantity of water previously required to be withdrawn. No effect is anticipated on other water resources.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**
None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**
None

**OTHER FACTORS:**

None

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

An efficient water system with limited to no water loss conserves the water supply source and may lower the overall cost of delivered water to the end user.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 122-3**

**WATER USER NAME:**
**County:** Jeff Davis
**River Basin:** Rio Grande
**User Name:** County other

**STRATEGY NAME:**
Expanded use of existing wells

**STRATEGY DESCRIPTION:**
All of the "County Other" water shortage is with water-supply entities and individual rural domestic homes that are supplied from ground-water sources. The existing public-supply wells may be capable of being pumped for a longer period of time each day to meet increased needs. Increased demand from new rural domestic homes will be met by strategy 122-1.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Additional pumping time will occur as needed.
Long Term (from the year 2030 to the year 2050): Additional pumping time will occur as needed.

**QUANTITY OF WATER:**
Assuming that water-supply entities operate three moderate-capacity wells at an average 50 gpm, increasing the pumping time of each well by two hours will generate 20 ac-ft/yr.

**RELIABILITY OF WATER:**
Sufficient ground water is available from the Igneous aquifer, however, local water-level declines may increase. Temporary water shortages may occur during drought periods, which may require the lowering of pumps or deepening of wells.

**COST OF WATER:**
The primary cost involved with this strategy involves the additional required energy. Additional cost may occur if pumps are required to be lowered or wells deepened. The well owner will incur these costs. Additional annual energy cost of approximately $2,500 is anticipated.

**ENVIRONMENTAL ISSUES:**
Additional ground-water withdrawals could potentially decrease flow in local springs and streams, which could have a negative impact on water-dependent species.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

Additional ground-water withdrawals could potentially decrease flow in local springs and streams. However, the data available is insufficient to state this with any degree of certainty. Additional data from new studies of the Igneous and other local aquifers is needed.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

No effects on agricultural activities are anticipated except insofar as local springs may be affected, in which cases some ranchers could be severely impacted. If the water level declines, some ranches may not be able to deepen their wells given the increased cost of producing the wells, together with the capital required. At this point ranching may cease to be viable in some areas of the county.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

Additional hydrological studies of the aquifers in the county, including modeling where appropriate, are necessary to assess the impact of this strategy. If the hydrology does not verify the impacts and assumptions of this strategy, it should be reconsidered.

**INTERBASIN TRANSFER:**

No interbasin transfer is required.

**SOCIAL AND ECONOMIC IMPACTS:**

Local water-level declines may occur which potentially may affect water levels in wells on surrounding properties.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 122-4**

**WATER USER NAME:**
**County:** Jeff Davis
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**
Water production management

**STRATEGY DESCRIPTION:**
The Jeff Davis County Underground Water Conservation District will establish rules to regulate the production of ground water from the Igneous and other local aquifers to insure adequate water for the future.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Rules are currently in force.
Long Term (from the year 2030 to the year 2050): Rules will continue to be enforced.

**QUANTITY OF WATER:**
This strategy does not generate additional water but rather conserves existing supplies.

**RELIABILITY OF WATER:**
This strategy does not generate additional water but rather conserves existing supplies

**COST OF WATER:**
The cost to enforce the rules is incurred by the District.

**ENVIRONMENTAL ISSUES:**
The conservation of ground water has a positive effect on local and regional water-level declines and, thus, may have a positive effect on habitats that benefit from springflows.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**
Water production management will result in the conservation of all ground-water sources over which the rules have been established.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**
This strategy generally does not impact low yielding livestock wells but could impact higher yielding irrigation wells.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**
None

**OTHER FACTORS:**

The implementation of management rules is subject to district board approval and may be reversed at the discretion of the district board.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Although production management rules may impact specific water users, the overall intent is to ensure adequate, long-term water availability to benefit the social and economic needs of the region.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 122-5**

**WATER USER NAME:**

**County:** Jeff Davis
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**

Purchase water from the Fort Davis Water Supply Company (WSC)

**STRATEGY DESCRIPTION:**

The Fort Davis WSC will expand its services to the Fort Davis Estates subdivision and the County Park. The existing subdivision well is sufficient for the existing 15 homes, but the subdivision is growing and will require additional water. The Fort Davis WSC would complete one additional well into the Igneous aquifer and construct additional storage facilities.

**TIME INTENDED TO IMPLEMENT:**

Short Term (prior to the year 2030): Immediate implementation is probable.

Long Term (from the year 2030 to the year 2050): Only operations and maintenance costs required.

**QUANTITY OF WATER:**

The quantity of water on an annual basis for up to 30 homes in Fort Davis Estates is 30 acre-foot of water per year.

**RELIABILITY OF WATER:**

With the addition of a well and storage facility, sufficient ground water from the Igneous aquifer is expected to be available for the expansion. Shortages may occur during prolonged drought periods due to lack of recharge to the local aquifer.

**COST OF WATER:**

A well drilled to 300 feet, fitted with a 200 gpm pump and a 500,000 gallon ground storage tank may be expected to cost $310,000. (Well=$60,000; tank=$250,000)

**ENVIRONMENTAL ISSUES:**

Construction will temporarily disturb the existing land surface; no long-term impacts are anticipated.

**IMPACT ON OTHER WATER RESOURCES:**

None

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

The drilling of a new public-supply well must be in compliance with State and Jeff Davis County Underground Water Conservation District rules.

**INTERBASIN TRANSFER:**

No interbasin transfer is required.

**SOCIAL AND ECONOMIC IMPACTS:**

The increased availability of water will benefit the neighborhood and the community. However, increased ground-water withdrawals may increase local water-level declines that potentially may affect water levels in wells on surrounding properties.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 122-6**

**WATER USER NAME:**
**County:** Jeff Davis
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**
Rainfall Harvesting

**STRATEGY DESCRIPTION:**
Rainfall harvesting involves capturing rainfall from roofs or in small surface impoundments, providing water that is usually lost to the rural homeowner.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): This strategy could be implemented relatively easily, inexpensively and quickly for immediate to short-term benefit.

Long Term (from the year 2030 to the year 2050): The strategy would continue in place as long as the homeowner desired and/or the home remained intact.

**QUANTITY OF WATER:**
The Texas Water Development Board's "Texas Guide to Rainwater Harvesting" gives the methodology to calculate rainfall harvest amounts using average precipitation for the time period 1940 through 1990 at selected rain stations across Texas. However, this Regional Water Plan must be based on water supply amounts that could be yielded during drought-of-record. Therefore, average water yield amounts produced by the methodology using average precipitation amounts should be adjusted. The TWDB publication gives minimum precipitation, maximum precipitation and 10th percentile, 25th percentile, and 50th percentile (median) amounts as well as the average precipitation amounts. Investigation of National Climatic Data Center precipitation data for West Texas stations shows that the drought-of-record in 1956 closely approximates the 25$^{th}$ percentile precipitation amounts. Therefore, if one substitutes the 25$^{th}$ percentile precipitation amounts for the average precipitation amounts within the methodology, the quantity of water on an annual basis for a 1,500 square-foot residence near Alpine is 5,193 gallons, or only 0.016 acre-foot of water per year.

**RELIABILITY OF WATER:**
The quantity given above is on an annual basis; an efficiency of 100% is assumed. Also, the methodology is simplified from a monthly water balance. Both the efficiency and characteristic monthly water balance are site-specific and dependent on the individual homeowner's skill in designing and implementing his particular system.

**COST OF WATER:**
The ongoing cost of water is negligible, as operation and maintenance would involve nothing more than regular application of chlorine, iodide or other sanitizing chemicals or

methods, regular inspection of the system for leaks or deterioration, and costs for operating a small pump. A residential system in Far West Texas, using metal roofing and above-ground polyethylene cisterns costs approximately $4,000.

**ENVIRONMENTAL ISSUES:**

None

**IMPACT ON OTHER WATER RESOURCES:**

Minimal loss of water to aquifer recharge and an associated decrease in surface water flows may result, as the water reaches the homeowner rather than the region in general.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

None

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

This could be an extremely beneficial water management strategy in terms of reviving a local economy and/or encouraging people to settle in a very water-scarce area.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 122-7**

**WATER USER NAME:**
**County:** Jeff Davis
**River Basin:** Rio Grande
**User Name:** Livestock

**STRATEGY NAME:**
Expanded use of existing wells.

**STRATEGY DESCRIPTION:**
Wells used exclusively for livestock typically have low yields and are pumped for only the amount of time needed to supply livestock and storage capacity needs. Extending the period of time these wells are pumped would produce additional water.

**TIME INTENDED TO IMPLEMENT:**
Short term (prior to the year 2030): Phased is as needed.
Long term (from the year 2030 to 2050): No additional supply needed.

**QUANTITY OF WATER:**
An additional 2.5 hours of pumping time for each of an estimated 30 existing wells at an average of 5 gpm (windmill or small submersible pump) will generate 25 ac-ft/yr.

**RELIABILITY OF WATER:**
Sufficient groundwater is available from the Igneous Aquifers, West Texas Bolson – Ryan Flat and Lobo Flat, Edwards-Trinity (Plateau), and other local aquifers without excessive water level declines. However, in some parts of the County wells typically go dry during droughts. Temporary water shortages may occur during severe drought periods, which may require the lowering of pumps or deepening of wells.

**COST OF WATER:**
Energy costs represent the only additional cost for supplying the water. Installation of a water distribution system would increase the efficient use of the water supply and the range resource. A single well can serve a larger area by adding a pipeline and a trough. So that a single well could service up to 8,000 acres, 2 miles of 1¼ in. pvc (200 psi) pipe can be installed at an average (normal or rocky) cost of $0.78 per ft. or $8,236 (prices based on NRCS guidelines and the possibility exists for some federal cost sharing).
Estimated cost for 30 new pipelines is $247,000.

**ENVIRONMENTAL ISSUES:**
In addition to livestock, local and migratory wildlife often depend on livestock watering facilities. Maintaining water and access at these facilities is a crucial aspect of wildlife habitat. Additional ground-water withdrawals could potentially decrease flow in local springs and streams, which could have a negative impact on water-dependent species.

**IMPACT ON OTHER WATER RESOURCES:**

No effects on other water resources are anticipated. However, the data available is insufficient to state this with any degree of certainty. Additional data from new studies of the Igneous and other local aquifers is needed.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

No effects on agricultural activities are anticipated except insofar as local springs may be affected, in which cases some ranchers could be severely impacted. If the water level declines, some ranches may not be able to deepen their wells given the increased cost of producing the wells, together with the capital required. At this point ranching may cease to be viable in some areas of the county. Increasing the extent of the water distribution system will allow for better utilization of the range resource.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

Additional hydrological studies of the aquifers in the county, including modeling where appropriate, are necessary to assess the impact of this strategy. If the hydrology does not verify the impacts and assumptions of this strategy, it should be reconsidered.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Local increased water-level declines may occur which potentially may affect water levels in wells on surrounding properties. A positive economic impact is expected, because of better utilization of the available range resource.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 122-8**

**WATER USER NAME:**
**County:** Jeff Davis
**River Basin:** Rio Grande
**User Name:** Livestock

**STRATEGY NAME:**
Additional wells

**STRATEGY DESCRIPTION:**
Eighteen additional wells will be drilled if expanded use of existing wells is insufficient to meet anticipated needs.

**TIME INTENDED TO IMPLEMENT:**
Short term (prior to the year 2030): Eighteen additional wells would be needed immediately to meet current expected deficits.

Long term (from the year 2030 to 2050): No additional wells needed to meet water supply needs, but maintenance may be necessary.

**QUANTITY OF WATER:**
Eighteen new wells pumping at an average rate of 5 gpm for four hours each day will generate 24 ac-ft of water per year.

**RELIABILITY OF WATER:**
Sufficient groundwater is available from the Igneous Aquifers, West Texas Bolson – Ryan Flat and Lobo Flat, Edwards-Trinity (Plateau), and Other Aquifers for minimal expanded pumpage without excessive water level declines.

**COST OF WATER:**
Water well depths in Jeff Davis County range from 20 ft. to 1,200 ft. Costs for well drilling – 6 in. service casing, 4.5 in. PVC casing, and installation of a submersible pump (10-15 gpm) are $21 per ft. Based on $21 per ft., well cost in Jeff Davis County will range from $1,680 to $21,000, with an average cost of $11,340.

Based on NRCS specifications a fiberglass storage tank (12 ft. by 15 ft.) on a sand and gravel base is located at each well at a cost of $5,400.

To properly distribute water over an area, so that a single well could service up to 8,000 acres, 2 miles of 1¼ in. pvc (200 psi) pipe can be installed at an average (normal and rocky installation) cost of $0.78 per ft. or $8,236.

Estimated cost for a new well, storage tank, and 2-mile pipeline is $25,000.

Estimated cost for 18 new wells, storage tanks, and pipelines is $450,000.

**ENVIRONMENTAL ISSUES:**

Since many livestock ranching operations generate 10% to 20%, and in some instances much higher, of their revenue from wildlife, ranchers are typically careful to provide watering facilities that can be used equally well for livestock and wildlife. As such, additional watering locations with appropriate access will have a positive environmental impact.

**IMPACT ON OTHER WATER RESOURCES:**

None

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

The drilling of new wells must be in compliance with the Jeff Davis County Underground Water Conservation District rules.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Economic impact to local ranchers is expected to be positive, because of better utilization of the range resource.

**IMPACT ON WATER RITGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 122-9**

**WATER USER NAME:**

**County:** Jeff Davis
**River Basin:** Rio Grande
**User Name:** Livestock

**STRATEGY NAME:**

Herd reduction.

**STRATEGY DESCRIPTION:**

Livestock numbers are reduced to be proportionate to available water and forage resources. If insufficient forage is available across a range resource area, a planned herd reduction should take place. This may entail selling off older animals or poor producers, selling offspring earlier than normal or delaying replacement animal development. Remaining livestock should be evenly distributed across rangeland to best utilize available forage resources. If a feeding program is initiated, livestock should be confined to dry-lots or small pastures.

**TIME INTENDED TO IMPLEMENT:**

Short term (prior to the year 2030): Herd reduced as necessary using a fall forage resource inventory as a guideline.

Long term (from the year 2030 to 2050): Herd reduction as necessary.

**QUANTITY OF WATER:**

Additional water is not needed for this strategy.

**RELIABILITY OF WATER:**

Additional water is not needed for this strategy.

**COST OF WATER:**

There is no water cost for this strategy.

**ENVIRONMENTAL ISSUES:**

Herd reduction will lessen the impact on remaining water supplies. Ranchers should factor in wildlife species and numbers when determining stocking rate for a given year on their rangeland.

**IMPACT ON OTHER WATER RESOURCES:**

Herd reduction will lessen the impact on all water sources.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

Herd reduction creates a loss in potential revenue.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

Although in general controlled grazing promotes bio-diversity, in times of drought all natural resources are stressed, and herd reduction, which will occur automatically by the ranchers' decisions, will minimize adverse impacts on natural resources.

**OTHER FACTORS:**

None

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Although loss of short-term revenue is expected, from a financial and biological standpoint herd reduction has generally been a rancher's best drought management strategy.

**IMPACT ON WATER RITGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 189-1**

**WATER USER NAME:**
**County:** Presidio
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**
Additional wells

**STRATEGY DESCRIPTION:**
Additional public and private domestic wells will be drilled to supply water to new rural homes.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Two public-supply wells and 40 domestic wells are needed to meet current shortages. An additional 107 domestic wells will be required to meet the 2030 demand.

Long Term (from the year 2030 to the year 2050): Additional domestic wells will be required to meet the 2050 demand.

**QUANTITY OF WATER:**
2 PS wells x 50 gpm x 12 hours x 365 days ÷ 325,851 = 80 ac-ft/yr
147 domestic wells x 5 gpm x 4 hours x 365 days ÷ 325,851 = 198 ac-ft/yr
Total volume = 278 ac-ft/yr

**RELIABILITY OF WATER:**
Sufficient ground water is available from Presidio-Redford Bolson, Igneous, and local alluvial aquifers in most parts of the County; however, local water-level declines may increase. Many dry holes have been drilled in the past in the County and more should be anticipated. Water quality may be problematic in some locations. Temporary water shortages may occur during drought periods, which may require the lowering of pumps or deepening of wells.

**COST OF WATER:**
Most private wells are expected to be drilled in the Presidio Bolson, where the average depth should be approximately 200 ft. The cost to drill the borehole and to set surface casing is estimated to be $3,000. The cost of the pump, motor, drop pipe, cable, control panel, pressure tank, and associated labor should be an additional $2,000 for a total of $5,000. Cost for 147 domestic wells is $735,000. Two public supply wells will cost approximately $120,000. Total strategy cost is $855,000.

**ENVIRONMENTAL ISSUES:**
Additional ground-water withdrawals could potentially decrease flow in local springs and streams, which could have a negative impact on water-dependent species.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

No impacts on other water resources are anticipated. However, the data available is insufficient to state this with any degree of certainty. Additional data from new studies of the Igneous and other local aquifers is needed.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

No impact on agriculture activities is anticipated except insofar as local springs may be affected, in which cases some ranchers could be severely impacted.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

The drilling of new wells must be in compliance with state and Presidio County Underground Water Conservation District rules. Additional hydrological studies of the aquifers in the county, including modeling where appropriate, are necessary to assess the impact of this strategy. If the hydrology does not verify the impacts and assumptions of this strategy, it should be reconsidered.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Local water-level declines may occur which potentially may affect water levels in wells on surrounding properties.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 189-2**

**WATER USER NAME:**
**County:** Presidio
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**
Distribution system maintenance

**STRATEGY DESCRIPTION:**
Identify and repair water-supply transmission leaks.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Leaks repaired as identified
Long Term (from the year 2030 to the year 2050): Leaks repaired as identified

**QUANTITY OF WATER:**
This strategy does not generate new water but rather extends existing supply by eliminating water losses.

**RELIABILITY OF WATER:**
Water saved by the repair of transmission leaks was previously being produced and is therefore guaranteed as being an available addition supply.

**COST OF WATER:**
Expected cost of identifying and repairing transmission leaks is highly variable and is primarily dependent on size and length of the required pipeline replacement. Potential for pipeline leaks increases with age of the existing pipeline. Assuming a replacement of 1,000 feet of 12-inch pipeline with appurtenances plus 20% markup for urban repairs (1,000 x $32 x 1.2), annual cost would be approximately $38,400.

**ENVIRONMENTAL ISSUES:**
Limited environmental effects may be expected as a result of required excavation.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**
The water savings achieved will offset the total quantity of water previously required to be withdrawn. No effect is anticipated on other water resources.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**
None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**
None

**OTHER FACTORS:**

None

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

An efficient water system with limited to no water loss conserves the water supply source and may lower the overall cost of delivered water to the end user.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 189-3**

**WATER USER NAME:**

**County:** Presidio
**River Basin:** Rio Grande
**User Name:** County other

**STRATEGY NAME:**

Expanded use of existing wells

**STRATEGY DESCRIPTION:**

All of the "County Other" water shortage is with water-supply entities and individual rural domestic homes that are supplied from ground-water sources. The existing public-supply wells may be capable of being pumped for a longer period of time each day to meet increased needs. Increased demand from new rural domestic homes will be met by other strategies.

**TIME INTENDED TO IMPLEMENT:**

Short Term (prior to the year 2030): Additional pumping time will occur as needed.

Long Term (from the year 2030 to the year 2050): Additional pumping time will occur as needed.

**QUANTITY OF WATER:**

Assuming that the public water-supply entities operate two small-to-moderate capacity wells operating at an average of 25 gpm, increasing the pumping time of each well by two hours will generate 7 ac-ft/yr.

**RELIABILITY OF WATER:**

Sufficient ground water is available from Presidio-Redford Bolson, Igneous, and local alluvial aquifers; however, local water-level declines may increase. Water quality may be problematic in some locations. Temporary water shortages may occur during drought periods, which may require the lowering of pumps or deepening of wells.

**COST OF WATER:**

Additional annual energy cost of approximately $1,400 is anticipated from this strategy.

**ENVIRONMENTAL ISSUES:**

Additional ground-water withdrawals could potentially decrease flow in local springs and streams, which could have a negative impact on water-dependent species.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**

No effects on other water resources are anticipated. However, the data available is insufficient to state this with any degree of certainty. Additional data from new studies of the Igneous and other local aquifers is needed.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

No effects on agricultural activities are anticipated except insofar as local springs may be affected, in which cases some ranchers could be severely impacted. If the water level declines, some ranches may not be able to deepen their wells given the increased cost of producing the wells, together with the capital required. At this point ranching may cease to be viable in some areas of the county.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

Additional hydrological studies of the aquifers in the county, including modeling where appropriate, are necessary to assess the impact of this strategy. If the hydrology does not verify the impacts and assumptions of this strategy, it should be reconsidered.

**INTERBASIN TRANSFER:**

No interbasin transfer is required.

**SOCIAL AND ECONOMIC IMPACTS:**

Local water-level declines may occur which potentially may affect water levels in wells on surrounding properties.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 189-4**

**WATER USER NAME:**
**County:** Presidio
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**
Rainfall Harvesting

**STRATEGY DESCRIPTION:**
Rainfall harvesting involves capturing rainfall from roofs or in small surface impoundments, providing water that is usually lost to the rural homeowner.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): This strategy could be implemented relatively easily, inexpensively and quickly for immediate to short-term benefit.

Long Term (from the year 2030 to the year 2050): The strategy would continue in place as long as the homeowner desired and/or the home remained intact.

**QUANTITY OF WATER:**
The Texas Water Development Board's "Texas Guide to Rainwater Harvesting" gives the methodology to calculate rainfall harvest amounts using average precipitation for the time period 1940 through 1990 at selected rain stations across Texas. However, this Regional Water Plan must be based on water supply amounts that could be yielded during drought-of-record. Therefore, average water yield amounts produced by the methodology using average precipitation amounts should be adjusted. The TWDB publication gives minimum precipitation, maximum precipitation and 10th percentile, 25th percentile, and 50th percentile (median) amounts as well as the average precipitation amounts. Investigation of National Climatic Data Center precipitation data for West Texas stations shows that the drought-of-record in 1956 closely approximates the 25$^{th}$ percentile precipitation amounts. Therefore, if one substitutes the 25$^{th}$ percentile precipitation amounts for the average precipitation amounts within the methodology, the quantity of water on an annual basis for a 1,500 square-foot residence near Alpine is 5,193 gallons, or only 0.016 acre-foot of water per year.

**RELIABILITY OF WATER:**
The quantity given above is on an annual basis; an efficiency of 100% is assumed. Also, the methodology is simplified from a monthly water balance. Both the efficiency and characteristic monthly water balance are site-specific and dependent on the individual homeowner's skill in designing and implementing his particular system.

**COST OF WATER:**

The ongoing cost of water is negligible, as operation and maintenance would involve nothing more than regular application of chlorine, iodide or other sanitizing chemicals or methods, regular inspection of the system for leaks or deterioration, and costs for operating a small pump. A residential system in Far West Texas, using metal roofing and above-ground polyethylene cisterns costs approximately $4,000.

**ENVIRONMENTAL ISSUES:**

None

**IMPACT ON OTHER WATER RESOURCES:**

Minimal loss of water to aquifer recharge and an associated decrease in surface water flows may result, as the water reaches the homeowner rather than the region in general.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

None

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

This could be an extremely beneficial water management strategy in terms of reviving a local economy and/or encouraging people to settle in a very water-scarce area.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 189-5**

**WATER USER NAME:**
**County:** Presidio
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**
Water production management

**STRATEGY DESCRIPTION:**
The Presidio County Underground Water Conservation District will establish rules to regulate the production of ground water from the Igneous aquifer, Presidio and Ryan Flat Bolson aquifers, and other local aquifers to insure adequate water for the future.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Rules are currently in force.
Long Term (from the year 2030 to the year 2050): Rules will continue to be enforced.

**QUANTITY OF WATER:**
This strategy does not generate additional water but rather insures efficient and prudent use of existing supplies.

**RELIABILITY OF WATER:**
Prudent management and use of ground-water resources will improve the long-term reliability of this supply.

**COST OF WATER:**
The cost to enforce the rules is incurred by the District and indirectly by the property owners from fees or property taxes levied by the Groundwater District.

**ENVIRONMENTAL ISSUES:**
The prudent management of ground water has a positive effect on local and regional water-level declines and, thus, may have a positive effect on habitats that benefit from springflows.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**
Water production management will result in the conservation of all ground-water sources over which the rules have been established.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**
This strategy generally does not impact low yielding livestock wells but could impact higher yielding irrigation wells.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

The implementation of management rules is subject to district board approval and may be reversed at the discretion of the district board. Groundwater District Rules must be consistent with the State and Federal Constitution and with State ground-water laws and regulations.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Although production management rules may impact specific water users, the overall intent is to ensure adequate, long-term water availability to benefit the social and economic needs of the region.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 222-1**

**WATER USER NAME:**
**County:** Terrell
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**
Additional private wells

**STRATEGY DESCRIPTION:**
Additional private domestic wells will be drilled to supply water to new rural homes.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Sixteen domestic wells are required to meet current shortages. No additional wells will be needed beyond current demand.
Long Term (from the year 2030 to the year 2050): No additional wells will be needed beyond current demand.

**QUANTITY OF WATER:**
16 domestic wells x 5 gpm x 4 hours x 365 days = 21 ac-ft/yr

**RELIABILITY OF WATER:**
Sufficient ground water is available from the Edwards-Trinity (Plateau) aquifer in most parts of the County; however, many dry holes have been drilled in the past in the County and more should be anticipated. Temporary water shortages may occur during drought periods, which may require the lowering of pumps or deepening of wells. Chemical quality of the water should remain acceptable providing wells are properly constructed.

**COST OF WATER:**
The average depth of new private wells in Terrell County is expected to be approximately 600 ft. The cost to drill a borehole to this depth and to set surface casing is expected to be as much as $9,000. The cost of the pump, motor, drop pipe, cable, control panel, and pressure tank is approximately an additional $2,250 for a total of $11,250. For 16 wells, the total cost is $180,000.

**ENVIRONMENTAL ISSUES:**
Additional ground-water withdrawals could potentially decrease flow in local springs and streams, which could have a negative impact on water-dependent species.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**
No impacts on other water resources are anticipated. However, the data available is insufficient to state this with any degree of certainty. Additional data from new studies of the Igneous and other local aquifers is needed.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

No negative impact to agriculture is anticipated except insofar as local springs may be affected, in which cases some ranchers could be severely impacted.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

Additional hydrological studies of the aquifers in the county, including modeling where appropriate, are necessary to assess the impact of this strategy. If the hydrology does not verify the impacts and assumptions of this strategy, it should be reconsidered.

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

Local water-level declines may occur which potentially may affect water levels in wells on surrounding properties.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 222-2**

**WATER USER NAME:**
**County:** Terrell
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**
Distribution system maintenance

**STRATEGY DESCRIPTION:**
Identify and repair water-supply transmission leaks.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Leaks repaired as identified
Long Term (from the year 2030 to the year 2050): Leaks repaired as identified

**QUANTITY OF WATER:**
This strategy does not generate new water but rather extends existing supply by eliminating water losses.

**RELIABILITY OF WATER:**
Water saved by the repair of transmission leaks was previously being produced and is therefore guaranteed as being an available addition supply.

**COST OF WATER:**
Expected cost of identifying and repairing transmission leaks is highly variable and is primarily dependent on size and length of the required pipeline replacement. Potential for pipeline leaks increases with age of the existing pipeline. Assuming a replacement of 1,000 feet of 12-inch pipeline with appurtenances plus 20% markup for urban repairs (1,000 x $32 x 1.2), annual cost would be approximately $38,400.

**ENVIRONMENTAL ISSUES:**
Limited environmental effects may be expected as a result of required excavation.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**
The water savings achieved will offset the total quantity of water previously required to be withdrawn. No effect is anticipated on other water resources.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**
None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**
None

**OTHER FACTORS:**

None

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

An efficient water system with limited to no water loss conserves the water supply source and may lower the overall cost of delivered water to the end user.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 222-3**

**WATER USER NAME:**
**County:** Terrell
**River Basin:** Rio Grande
**User Name:** County other

**STRATEGY NAME:**
Expanded use of existing wells

**STRATEGY DESCRIPTION:**
All of the "County Other" water shortage is with water-supply entities and individual rural domestic homes that are supplied from ground-water sources. The existing public-supply wells may be capable of being pumped for a longer period of time each day to meet increased needs. Increased demand from new rural domestic homes will be met by other strategies.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): Additional pumping time will occur as needed.
Long Term (from the year 2030 to the year 2050): Additional pumping time will occur as needed.

**QUANTITY OF WATER:**
Assuming that the public water-supply entities operate four moderate capacity wells operating at an average of 50 gpm, increasing the pumping time of each well by two hours will generate 27 ac-ft/yr.

**RELIABILITY OF WATER:**
Sufficient ground water is available from the Edwards-Trinity (Plateau) aquifer; however, local water-level declines may increase. Temporary water shortages may occur during drought periods, which may require the lowering of pumps or deepening of wells.

**COST OF WATER:**
Additional annual energy cost of approximately $2,800 is anticipated from this strategy.

**ENVIRONMENTAL ISSUES:**
Additional ground-water withdrawals could potentially decrease flow in local springs and streams, which could have a negative impact on water-dependent species.

**IMPACT OF STRATEGY ON OTHER WATER RESOURCES:**
No effects on other water resources are anticipated. However, the data available is insufficient to state this with any degree of certainty. Additional data from new studies of the Igneous and other local aquifers is needed.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

No effects on agricultural activities are anticipated except insofar as local springs may be affected, in which cases some ranchers could be severely impacted. If the water level declines, some ranches may not be able to deepen their wells given the increased cost of producing the wells, together with the capital required. At this point ranching may cease to be viable in some areas of the county.

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

Additional hydrological studies of the aquifers in the county, including modeling where appropriate, are necessary to assess the impact of this strategy. If the hydrology does not verify the impacts and assumptions of this strategy, it should be reconsidered.

**INTERBASIN TRANSFER:**

No interbasin transfer is required.

**SOCIAL AND ECONOMIC IMPACTS:**

Local water-level declines may occur which potentially may affect water levels in wells on surrounding properties.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

**STRATEGY # 222-4**

**WATER USER NAME:**
**County:** Terrell
**River Basin:** Rio Grande
**User Name:** County Other

**STRATEGY NAME:**
Rainfall Harvesting

**STRATEGY DESCRIPTION:**
Rainfall harvesting involves capturing rainfall from roofs or in small surface impoundments, providing water that is usually lost to the rural homeowner.

**TIME INTENDED TO IMPLEMENT:**
Short Term (prior to the year 2030): This strategy could be implemented relatively easily, inexpensively and quickly for immediate to short-term benefit.

Long Term (from the year 2030 to the year 2050): The strategy would continue in place as long as the homeowner desired and/or the home remained intact.

**QUANTITY OF WATER:**
The Texas Water Development Board's "Texas Guide to Rainwater Harvesting" gives the methodology to calculate rainfall harvest amounts using average precipitation for the time period 1940 through 1990 at selected rain stations across Texas. However, this Regional Water Plan must be based on water supply amounts that could be yielded during drought-of-record. Therefore, average water yield amounts produced by the methodology using average precipitation amounts should be adjusted. The TWDB publication gives minimum precipitation, maximum precipitation and 10th percentile, 25th percentile, and 50th percentile (median) amounts as well as the average precipitation amounts. Investigation of National Climatic Data Center precipitation data for West Texas stations shows that the drought-of-record in 1956 closely approximates the 25$^{th}$ percentile precipitation amounts. Therefore, if one substitutes the 25$^{th}$ percentile precipitation amounts for the average precipitation amounts within the methodology, the quantity of water on an annual basis for a 1,500 square-foot residence near Alpine is 5,193 gallons, or only 0.016 acre-foot of water per year.

**RELIABILITY OF WATER:**
The quantity given above is on an annual basis; an efficiency of 100% is assumed. Also, the methodology is simplified from a monthly water balance. Both the efficiency and characteristic monthly water balance are site-specific and dependent on the individual homeowner's skill in designing and implementing his particular system.

**COST OF WATER:**
The ongoing cost of water is negligible, as operation and maintenance would involve nothing more than regular application of chlorine, iodide or other sanitizing chemicals or

methods, regular inspection of the system for leaks or deterioration, and costs for operating a small pump. A residential system in Far West Texas, using metal roofing and above-ground polyethylene cisterns costs approximately $4,000.

**ENVIRONMENTAL ISSUES:**

None

**IMPACT ON OTHER WATER RESOURCES:**

Minimal loss of water to aquifer recharge and an associated decrease in surface water flows may result, as the water reaches the homeowner rather than the region in general.

**IMPACT OF STRATEGY TO THREATS TO AGRICULTURE:**

None

**IMPACT OF STRATEGY TO THREATS TO NATURAL RESOURCES:**

None

**OTHER FACTORS:**

None

**INTERBASIN TRANSFER:**

No interbasin transfer required.

**SOCIAL AND ECONOMIC IMPACTS:**

This could be an extremely beneficial water management strategy in terms of reviving a local economy and/or encouraging people to settle in a very water-scarce area.

**IMPACT ON WATER RIGHTS, CONTRACTS, AND OPTION AGREEMENTS:**

None

**IMPACT ON NAVIGATION:**

None

# CHAPTER 6

# ADDITIONAL RECOMMENDATIONS

## 6.1 INTRODUCTION

An important aspect of Senate Bill 1 (SB-1) is the opportunity to provide recommendations for the improvement of future water management planning in Texas. This chapter contains specific suggestions and decisions made by the Far West Texas Regional Planning Group. The recommendations, which are derived from careful consideration of many issues covered during the course of the planning exercise, are divided into three areas: (1) regulatory, administrative and legislative; (2) ecologically unique river and stream segments; and (3) unique sites for the construction of reservoirs. The recommendations in the following sections are designed to present new and/or modified approaches to key technical, administrative, institutional, and policy matters that will help to streamline the planning process, and to offer guidance to future planners with regard to specific issues of concern within the region.

Water planning - as required by SB-1 - is a process that is new to most residents of the State of Texas. Because of the complex nature of an undertaking such as SB-1, many ideas and approaches to the problems of water-resource management are either refined or changed significantly as all participants in the planning process learn more about the region and about what is required to produce a plan that will benefit all segments of the economy of Far West Texas.

The Far West Texas Water Planning Group approves of the legislative intent of SB-1 and supports the continuance of water planning at the regional level. However, the Far West Texas Water Planning Group suggests that the Legislature and TWDB consider the following changes to the SB-1 planning process.

## 6.2 REGULATORY, ADMINISTRATIVE AND LEGISLATIVE RECOMMENDATIONS

The following recommendations are intended to address regulatory, administrative and legislative issues related to water supply management planning. Some of the recommendations listed below may at first appear to be redundant, but each of them emphasizes a slightly different point. Several related points in the interest of specificity were intentionally refrained from being combined. The items that would involve a legislative change are marked with an asterisk.

- <u>Provide for reimbursement of reasonable expenses incurred by planning group members</u>. In other appointed state jobs the appointee's actual expenses are reimbursed, but although the planning group members were initially appointed by the TWDB by a mandate of the Legislature, their expenses are not reimbursed. Many of these members serve in a purely voluntary capacity, so that the donation of their time away from their businesses or jobs is a huge contribution to the process. To expect them to also cover their out of pocket expenses to travel sometimes over 400 miles and frequently over 200 miles, is so unreasonable that it limits those who can afford to participate in the process and negatively affects the attitude of all participants. A per diem amount could be payable to each regional member in lieu of actual reimbursement.
- <u>*Ability to contract</u>. The planning groups should have the ability to contract with those persons or entities with which they determine they should contract to further the purposes of the Plan. Presently they can contract only with their administrative entity. This will involve the Planning Group more directly in the process.
- <u>*Eliminate the unfunded mandate</u>. The current regulations of the TWDB require local entities to pay for 100 percent of the administrative costs of developing the plans. This is difficult to sell when a local government has to tell its constituents that they have to do with one less full-time deputy, a lower level of funding for the library, and no new fire truck – but that they can afford to pay for a water plan. Trying to force local "buy-in" by requiring local funding causes resentment of the process and antagonism toward the plan. In a time of record surpluses, the State should pay for what the State thinks is important. The current 100/100 Plan is an improvement over the original concept (pursuant to which the State was to pay for 75 percent of everything, including administration), but it is still an unfunded mandate, and is still a bad idea – no matter how good the idea being funded.

- Regional planning member training. The TWDB should have special training sessions for all planning group members before they become engaged in the water planning process, and these sessions should continue as the process proceeds. The complexity of water resource issues makes it unreasonable to expect members to draft a plan without appropriate preparatory training. Representatives must be appropriately trained in water planning and in the regional situation before they carry out their duties. There should be one or two education sessions during the planning process.
- Need to allow for more local planning initiatives. The planning process seems to focus too heavily on meeting the technical requirements of Senate Bill 1 and the TAC rules, to the detriment of allowing for local planning initiatives. Providing for more local influence of the process and reducing the numerous, standardized checklists of the requirements of the Plan would help.
- *Flexibility. The planning process and the ultimate Plan must be flexible because of the unique characteristics of the border region. The Regional Planning Group cannot control the planning or water use of Mexico or New Mexico, with which it shares both its surface and groundwater resources. Despite this, it must recognize that the Hueco Bolson portion of El Paso County is a Priority Groundwater Management Area. The Plan should also recognize the legal, political and financial constraints of an area governed by three states and two nations. It should also recognize that El Paso has been designated the water and wastewater planner through Senate Bill 450 ($74^{th}$ Legislative Session) for the El Paso County region. Regional Planning under Senate Bill 450 includes participation in water and wastewater planning with the adjacent Texas counties and the border states of New Mexico and Chihuahua, Mexico to address transboundary water quality issues. Senate Bill 450 is not applicable to El Paso County Water Development District No.1. The Planning Group should have the legal ability to consider all water resources available to the region, regardless of whether or not they are located within Texas.

- *Excessive emphasis on drought of record. Although it is important to address what may happen in the drought of record, the Plan should not be just a drought contingency plan. This is particularly true since a drought in New Mexico and Colorado can have a much more serious impact on those portions of the region bordering the Rio Grande than a drought of record in Far West Texas. The Plan needs to be a realistic plan for the region, with the drought contingency being a key chapter, but not the entire focus of the Plan. It is also important to evaluate long term water needs outside of the drought of record context. The Regional Plan seems to focus too much on the drought of record, which in our area is approximately once every 50 years, compared to the constant need for long term planning to compensate for the smaller droughts that occur much more frequently. A cluster of moderate droughts could put the region into a substantially worse position than a serious drought of short duration bounded by wet years. These smaller droughts tend to occur every 10 to 20 years and their impacts can be lessened through ongoing resource management plans.
- Arid regions necessitate different drought analyses. There should be an acknowledgment of the differences between areas that receive significant rainfall (over 20 inches a year) and those in an arid climate. Compared to the non-arid areas of Texas, the arid areas are always in a drought. These differences have a critical impact on numerous issues, but especially on the 50-year drought of record calculations and analysis.
- Drought of record conditions. The length of drought-of-record conditions during the planning period should be better defined. Does the drought-of-record condition exist continuously for the entire 50-year period, or only during the decade year represented in the tables? Supply estimates over the entire time period are significantly affected by the length of dry and wet periods. It seems reasonable to assume that average conditions prevail throughout most of the 50-year period and are interrupted by droughts at the key decade evaluation year.

This becomes a critical factor in estimating ground-water availability based on the volume and recurrence of recharge.

- Different drought approach needed in conjunctive use areas. In arid areas that conjunctively use ground water and surface water, the drought of record has very little immediate effect on groundwater availability. Further, a drought of record is caused by upstream factors, which in El Paso means a reduction in snowmelt in Colorado. The required tables seem to assume that the drought will be caused by a localized absence of rainfall in Texas. Drought cycles in Texas exhibit different frequencies than snowmelt cycles in Colorado and the resulting runoff.
- Required tables 4, 5 and 6. The required tables 4, 5 and 6 should be clarified to more clearly depict assumptions about a) how often the drought of record will occur (is it every 10 years, or is it only once in the 50 year planning cycle?); b) how long the drought will last (most droughts last longer than one year, but the table only looks at a one year snap shot); and c) whether it should be assumed that there will be periodic droughts of lesser extent between the 10 years snap shots of the drought of record. All of these assumptions have a major effect on the numbers in the 10-year windows. Perhaps the intent of TWDB was for each region to define its own drought assumptions, however; this was not made clear to the Far West Texas Planning Group.
- Ground-water supply and quality evaluation methodology. The ground-water supply and quality evaluation methodology should be standardized statewide in areas such as the analysis for total water by quality range in the aquifer, recoverability of the water, and estimate of recharge. With such data, each region can better evaluate safe-yield and mining strategies. The different methodologies that have been employed by the 16 regions do not allow the TWDB to develop a comprehensive accounting of available ground water in the state.
- Modification of demand numbers. Modification of demand numbers should be allowed further into the planning process. Demand errors may not be discovered until the supply-demand analysis (Task 4) is performed. Demand scenarios.

Demand tables should also show different numbers based on different growth and population scenarios.

- Irrigation and livestock demand numbers. The manner in which the irrigation and livestock demand numbers increase during drought scenarios is inappropriate because other factors influence the demand. For example, during a drought in Far West Texas, livestock are sold, thus reducing the overall demand on groundwater. There needs to be a better understanding of the process of how livestock, drought and water demand interact, and this understanding needs to be reflected in the demand numbers.
- Format of data. Although TWDB data was very helpful in the development of the regional plan, it would be useful and less time consuming for the data to be better formatted and easier to locate.
- Use of codes in tables. Having the required TWDB tables uniformly developed by all regions is recognizably important in establishing a statewide database that will be used in the development of the full state plan. However, the format of multiple columns containing codes is of little interest to the regions and is quite time consuming for the consultants. The TWDB should establish a single code for each water-user that will automatically cross-reference to the necessary codes in the TWDB database. This would allow the consultants to develop a single table that will serve the purpose for both the printed regional plan and the required TWDB table.
- Clarification of existing plans. Senate Bill 1 should clarify how existing plans and funding interrelate.
- Cost analysis. The cost analysis requirement must acknowledge that most cost estimating, especially for those projects in the initial planning phase, will be extremely rough. The price of water component of the cost analysis could be especially problematic because the numbers used are very preliminary in some cases and could influence sensitive price negotiations with third parties. Frequently the cost of future raw surface water and groundwater is out of the

control of the entity using the water. Because of this, the Plan should be able to show a range in costs or contain an acknowledgment that the cost estimate is preliminary and could change significantly before the strategy is implemented.

- *Needed funding for data collection in rural areas. Rural areas need to be able to access state funding to gather the information needed to draft a substantive regional plan. This funding is needed for test wells, monitoring equipment, observation wells, modeling, and to obtain more data on the West Texas aquifers. Specific data-need recommendations for the rural areas are included in the regional data needs listed under recommendation 29. The Planning Group should be allowed to request funding for the data needs and contract for the studies.
- *Amendments to the regional water plans. We have already identified several areas where we will require additional time and resources. These areas include the consideration of the USGS final report on the modeling for the Hueco Bolson, the designation of ecologically unique stream segments, and the modeling for the West Texas aquifers. Our region must have the ability to modify the Plan as needed. Presently the statutes seem to expect only 5-year revisions to the plans, but amendments to the plans must be allowed whenever the Planning Group determines them to be necessary.
- Make an Open Records exception for private water data. The regional water planning process is predicated on the planning group's gathering thorough and complete data about water supplies within the planning area in order to inventory and evaluate the water resources. The problem with that predicate is that, given current law, most landowners are not going to give the Planning Groups or Groundwater Conservation Districts any information about their water. Under current law, if landowners give data about their water to the water planning groups, they are also giving it to anybody that wants it. The landowner's position will be that "My wells, my springs, and my tanks - where they are located, how deep they are, what their capacity is, the quality of the water - are my business. They are not the State's business, and they are not the public's business." This is

counter-productive to the data collection that is necessary to effective water planning. The solution is an amendment to the Open Records Act that (1) excepts or exempts any water data from private lands without the landowner's prior written consent and (2) prohibits the TWDB and the TNRCC and all other state agencies from sharing any water data with any other person or agency without the landowner's prior written consent and (3) requires the TWDB and the TNRCC to treat all water data as confidential. The second and third need to have some teeth, such as criminal sanctions and/or personal liability for knowing or intentional violations without the need to prove damages. If we do not make this change, we are not going to get the data we need to plan effectively.

- Open Meetings Application. Verify that all committees, subcommittees, and subgroups of the planning groups are covered by the Open Meetings Act. Although the regulations say they are, the legislation itself should clarify the applicability as well as specify who has authority to investigate and prosecute alleged violations.
- Interbasin transfers. The possibility of the transfer of water from other river basins should be considered and studied during the next planning cycle because of the need for coordination with other regions.
- Difficulty of cost estimates. The problems associated with costing alternative strategies should be studied for the next planning cycle. It should be clear that cost estimates are highly preliminary and inexact, and should not be binding on future projects.
- Plan Implementation. Implementation of the plan's recommendations must be the responsibility of the local governments, entities, and individuals within the region. The Planning Group is not intended to assume a supervisory or command-and-control role. The Planning Group's function will be to monitor implementation and assist the local governments, entities, and individuals within the region as requested.

- Unique Stream Segments. The guidelines for nominating a stream or segment of a stream as unique should be clarified, and the results of any designation should be similarly clarified and limited.
- Translation Services. The Texas Water Development Board should provide funding for translation services where necessary.
- Water Quality. The next planning cycle should provide more emphasis on water quality, and specifically for this region, the growing need to manage total dissolved solids (TDS).
- Data Needs.
    - Irrigators in the region, specifically in Culberson County, believe the historical irrigation pumpage reported by the TWDB to be significantly low. The TWDB should continue its irrigation surveys and attempt to improve the estimates.
    - A study should be conducted to evaluate the potential contamination of the Rio Grande Alluvium aquifer below the confluence of the Aciequia Madre with the Rio Grande.
    - A gain-loss study of the segment of the Pecos River between Girvin and Langtry is needed to quantify and identify the source of channel gains.
    - A study should be performed to evaluate the feasibility and potential benefits of rechanneling a segment of the Rio Grande below Fort Quitman.
    - A ground-water flow model of the Ryan Flat, Wild Horse Flat and Michigan Flat aquifers should be constructed to simulate potential pumping effects on the surrounding region.
    - A regional ground-water availability evaluation of the Igneous aquifer in Brewster, Jeff Davis and Presidio counties should be conducted. Current reports identify only three separate portions of the aquifer. The aquifer's entire extent should be identified and characterized.
    - A regional ground-water availability evaluation of the aquifer underlying the Diablo Plateau in Hudspeth County should be conducted. Presently,

only water availability information in the Dell City area has been documented by the TWDB. Previous studies by the Bureau of Economic Geology indicated that there exists the potential for significant volumes of water underlying this area.

- Other aquifers within the region that have limited knowledge of quantity of water in storage and recharge potential include the Edwards-Trinity (Plateau), Capitan Reef, Marathon, and Rustler. Additional study is needed to quantify water availability in these aquifers.
- A ground-water flow model of the southern portion of the Mesilla Bolson should be constructed to simulate pumping effects on the surrounding region.

## 6.3 CONSIDERATION OF ECOLOGICALLY UNIQUE RIVER AND STREAM SEGMENTS

Water needed to maintain ecological habitats was an important consideration in the preparation of this regional water management plan. The uniqueness and diversity of West Texas wildlife reflect directly on this region's strong eco-tourism industry. In the preparation of this plan, numerous ecological databases or reports prepared by universities and government agencies were reviewed. Unique ecological stream segments identified by the Texas Parks and Wildlife Department were also reviewed. Significant consideration was also given to the impact that each water-supply strategy might have on local environmental water needs.

A portion of the wildlife is acknowledged to occur in streams and rivers that may contain water-dependent habitats. SB-1 allows for the recommendation of "ecologically unique river and stream segments" in a regional water plan. Based on these recommendations, the Texas Legislature can designate a river or stream segment as "unique". However, in review of the provisions of SB-1, the effects of designating a stream segment on future uses are not clear. The bill does not outline potential restrictions of uses or development along designated watercourses, and, therefore, the activities that will be allowed or disallowed under an "ecologically unique stream segment" designation are unclear. Following thorough evaluation, the Regional Planning

Group determined that streams within the region are already protected under existing federal law, and therefore existing state and federal regulatory protection of surface water is adequate until the state Legislature clarifies the actions associated with the designation.

## 6.4 CONSIDERATION OF UNIQUE SITES FOR RESERVOIR CONSTRUCTION

Senate Bill 1 gives each of the Regional Water Planning Groups the opportunity to recommend stream locations for designation as "unique sites for reservoir construction." The Senate Bill 1 legislation and rules list many criteria to determine if a site is qualified for such designation. Since the Far West Texas Region is not modeled by a TNRCC Water Availability Model and USGS gages are few and far between on watercourses other than the Rio Grande, methodologies to determine water availability for potential reservoir construction sites are very limited.

The availability of water is one of the most important criteria in the selection of a reservoir site - if not the most important criterion. The low rainfall totals and the spotty nature of precipitation in Far West Texas limit the potential for sufficient runoff to maintain desired water levels in reservoirs.

Many canyons in the mountainous areas of Far West Texas might not retain large volumes of water because of the fractured and often highly-permeable bedrock that forms the walls and floors of these topographic features. Any attempt to develop a reservoir in Far West Texas will require extensive and costly geological, geotechnical, and hydrological investigations to determine whether a site is suitable. The program of work would also require detailed state and federal environmental impact assessments.

With regard to the Rio Grande, the 1944 international treaty between the United States and Mexico specifies that a reservoir project considered by one country have the other country's permission. Furthermore, the treaty stipulates that international reservoirs are to be operated by both countries.

On watercourses other than the Rio Grande, the water use reported to the TNRCC by surface water right holders gives some clues as to which watercourses are the most reliably used and therefore could be investigated for potential reservoir sites. Reported water use data, provided by the Rio Grande Watermaster and by TNRCC's Austin office, have been examined to identify holders of surface water rights who are able to divert water in amounts greater than 1,000 acre-feet per year. The analysis indicates that Musquiz and Maravillas Creeks in Brewster County are probably the most reliable surface water sources.

On Alamito Creek in Presidio County, there is an existing recreational reservoir, authorized to impound 18,700 acre-feet, but diversions are not authorized and therefore no use amounts are reported. Whether this reservoir stays reliably full is unknown, and the reliability of Alamito Creek in general is unknown.

A feasibility study for a recreational lake site near Alpine was previously conducted and consideration was given to its municipal water supply potential. The project was abandoned because of its high cost-to-yield potential.

Additional off-channel reservoir sites, as well as flood protection dam sites on major arroyos have been studied by the Hudspeth County Conservation and Reclamation District #1, El Paso-Hudspeth County Soil Conservation District, and the Hudspeth County Commissioners Court. None of these sites have been selected for construction. Additional flood retention dams have been considered for the El Paso area. These retention dams would have the added benefit of increasing recharge of the local aquifer by increasing infiltration of the retained water into the bolson deposits.

The firm yield for any reservoirs constructed on even the most reliable Far West Texas watercourses is not likely to exceed 2,000 acre-feet per year. For this reason, the Far West Texas Regional Water Plan does not currently recommend any watercourse for designation as a "unique site for reservoir construction."

# CHAPTER 7

# PLAN ADOPTION

## 7.1 INTRODUCTION

The Far West Texas Regional Water Planning Group (RWPG) members recognized from the beginning the importance of involving the public in the planning process. Chapter 7, the final chapter of the plan, contains an overview of the Regional Planning Group representation, the group's commitment to public involvement, and specific activities that insured that the public was informed and involved in the planning process and the implementation of the plan.

## 7.2 REGIONAL WATER PLANNING GROUP

The TWDB appointed an initial coordinating body for Far West Texas, based on names submitted by the public for consideration. The RWPG then expanded its membership based on familiarity with persons who could appropriately represent a water user group. Senate Bill 1 provisions mandate that one or more representatives of the following water user groups be seated on each RWPG: agriculture, counties, electric generating utilities, environment, industries, municipalities, river authorities, public, small business, water districts, and water utilities. Because there is no river authority in Far West Texas, this sector is not represented. The members of the RWPG have not been compensated for their participation in the planning process. Members of the group have voluntarily devoted considerable amounts of their time to develop the regional water plan.

Committee members and their alternates are listed in the table below:

| Water-use Category | Committee Member | County | Alternate Member | County |
|---|---|---|---|---|
| Agriculture | Tom Beard | Brewster | William Gearhart | Jeff Davis |
| Counties | Teresa Todd ** | Presidio | Kerr Mitchell | Presidio |
| Counties | Lloyd Goldwire | Terrell | Cliff McSparran | Terrell |
| Counties | Dolores Briones | El Paso | Jim Manley | El Paso |
| Counties | Jake Brisbin * | Presidio | | |
| Counties | Chuck Maddox | El Paso | | |
| Environment | Tom Brady** | El Paso | Carl Lieb | El Paso |
| Environment | Chip Groat* | El Paso | | |
| Municipalities | Becky Brewster | Culberson | Okey Lucas | Culberson |
| Municipalities | Richard Castro | El Paso | Ed Archuleta | El Paso |
| Municipalities | Carlos Ramirez | El Paso | Edward Drusina | El Paso |
| Public | Elza Cushing | El Paso | Dave Hall | El Paso |
| Public | Teodora Truillo | El Paso | Maureen Jerkoivski | El Paso |
| Public | Jesus Terrazas | El Paso | Patricia D. Adauto | El Paso |
| Public | Pete Gallego | Brewster | C.M. Kahl | Presidio |
| Public | Eliot Shapleigh | El Paso | Ramon Bracamontes | El Paso |
| Industries | Howard Goldberg** | El Paso | | |
| Industries | Tom Martin * | El Paso | | |
| Small Business | Ralph Meriwether | Brewster | Michael Davidson | Brewster |
| Electric Utilities | Victoria Perea | El Paso | Richard Grenier | El Paso |
| Water Districts | Jim Ed Miller | Hudspeth | W.D. Skov | El Paso |
| Water Districts | Johnny Stubbs | El Paso | Ed Fifer | El Paso |
| Water Utilities | Janet Adams | Jeff Davis | Albert Miller | Jeff Davis |

* Former members of the Far West Texas Regional Water Planning Group.

** New members that replaced former members.

In addition to the committee members, 13 non-voting members were appointed. Their function is to provide advice and guidance, based on their respective areas of expertise or geographic areas. Two non-voting liaisons were assigned from regions adjacent to Far West Texas (Region F and Region J). The non-voting members and their alternates are listed in the following table:

| Non-Voting Member | Agency | Alternate Member | Agency |
|---|---|---|---|
| Deborah Reyes | TWDB | Rima Petrosian | TWDB |
| Mike Hobson | TPWD | Bobby Farquhar | |
| Jeff Frank | GLO | | |
| Jack Stallings | TDA | | |
| Caroline Moore | Region F | | |
| Otila Gonzalez | Region J | | |
| Jim Stefanov | IBWC | James Robinson | IBWC |
| Filiberto Cortez | USBR | Mike Landis | USBR |
| Alfred Gonzalez | TAES | | |
| Mary Follingstad | NMISC | | |
| Alberto Torres | Juarez | | |
| Adriana Resendez | CILA Mexico | Aldo Garcia | CILA Mexico |
| Ari Michelsen | TAMU Ag. Exp. St. | | |

## 7.3 PROJECT MANAGEMENT

Work on the Far West Texas Regional Water Plan was divided along two parallel tracks; (1) an urban track representing the metropolitan portion of El Paso County, and (2) a rural track representing the other six rural counties and the eastern portion of El Paso County. The Regional Planning Group members were appointed evenly to each track team such that each track team was composed of members residing in both areas. Each track team was responsible for the development of the plan with oversight of tasks and concerns specific to its area. Work developed along the two-track approach was integrated at appropriate intervals to ensure a unified, coherent regional plan.

Because of its large population and water demand, as well as the breadth of its previous water planning efforts, the urban track team focused on tasks pertinent to the El Paso County metropolitan area. Key to this track team's planning effort was El Paso's role as the designated regional water supply planner for El Paso County. The rural track focused on issues relevant to the predominantly rural nature of the remaining counties that characteristically contain small communities located far apart. In El Paso County, water-supply issues could often be addressed with regional strategies; whereas, the distance between cities in the six rural counties made regional solutions between the cities generally infeasible.

The planning decisions and recommendations made in the regional plan will have far-reaching and long-lasting social, economic, and political repercussions on each community involved in this planning effort and on individuals throughout the region. Therefore, involvement of the public was projected to be a key factor for the success and acceptance of the plan. Open discussion and citizen input was encouraged throughout the planning process and helped planners develop a plan that reflects community values and concerns. Some members of the public participated almost as non-voting members. To insure public involvement, notice of all regional planning group and track meetings was posted in advance and all meetings were held in publicly accessible locations with sites rotating among rural and urban locations throughout all counties in the region. Special public meetings were held to convey information on project progress and to gather input on the development of the plan. Prior to submittal of the initially prepared plan to the TWDB, a copy of the regional water plan was provided for inspection in the county clerk's office and in at least one library in each county. Following public inspection of the initially prepared plan, a public meeting was conducted to present results of the planning process and gather public input and comments. To provide a public access point, an internet web site (**http://24.28.171.253/rio/fwtwpgsplash.htm**) was developed that contains timely information that includes names of planning group members, bylaws, meeting schedules, agendas, minutes, and important documents.

## 7.4 PRE-PLANNING SURVEY

Prior to the development of a scope of work, a public survey was conducted to identify a common long-range vision for the development of a regional water plan. The survey was designed to gauge opinions about issues related to the development and management of water-resources in the region. The survey was distributed to members of the RWPG and to representatives of cities and industries in the seven-county region. Thirty-six responses were received. The questions and summaries of the responses are provided in appendix 7A.

## 7.5 PUBLIC PRESENTATIONS

Several presentations were provided specifically for the public. The presentations listed below were intended to increase the awareness of the planning process and to engage public input where possible.

- Public hearing – Van Horn, 7/15/98
- Public meeting – El Paso, 12/8/99
- Public meeting – Alpine, 12/9/99
- Public hearing – El Paso, 9/28/00
- Public hearing – Alpine, 9/29/00

## 7.6 PLANNING GROUP MEETINGS AND PUBLIC HEARINGS

All meetings of the RWPG, including committee meetings, were open to the public where visitors were encouraged to express their opinions and concerns, or to make suggestions regarding the planning process. The locations of the meetings were originally rotated between all seven counties so that all citizens within the region would have an equal opportunity to attend. However, because of increased public attendance, the meetings eventually were held only in Alpine and El Paso, where adequate facilities could be arranged.

In accordance with the Federal Open Meetings Act, meeting notices were posted in the following newspapers and were reported by the following television and radio stations:

- El Paso Times
- El Paso Inc.
- West Texas County Courier
- Hudspeth County Herald
- Van Horn Advocate
- Alpine Observer
- Alpine Avalanche
- Jeff Davis County News/Mountain Dispatch
- Presidio International
- Big Bend Sentinel
- Terrell County News Leacder
- KVIA (Channel 7, El Paso)
- KTSM (Channel 9, El Paso)
- KINT (Channel 26, El Paso & Ciudad Juarez)
- KALD FM (Alpine)

The first regional public hearing was held in Van Horn on July 15, 1998. The intent of the hearing was to explain the planning process, introduce the planning group members, and receive comments and recommendations regarding the proposed Scope of Work.

Two final public hearings were held to receive comments on the initially prepared plan, one in El Paso on September 28, 2000, and the other in Alpine on September 29, 2000.

Copies of the plan were available by August 24, 2000 at the following locations:

- County Clerk's Office:
  - Brewster County
  - Culberson County
  - El Paso County
  - Hudspeth County
  - Jeff Davis County
  - Presidio County
  - Terrell County
- Public libraries:
  - Alpine Public Library, 203 N. 7th St., Alpine
  - Van Horn City-County Library, 410 Crockett St., Van Horn
  - El Paso Public Library, 501 N. Oregon, El Paso
  - El Paso Public Library, Lower Valley Branch, 7915 San Jose, El Paso
  - Grace/Grebing Public School, 110 N. Main, Dell City
  - Ft. Hancock/Hudspeth County Public Library, 100 School Drive, Ft. Hancock
  - Jeff Davis County Library, 3 Woodward, Ft. Davis
  - Marfa Public Library, 115 E. Oak, Marfa
  - City of Presidio Library, O'Reilly St., Presidio
  - Terrell County Public Library, Courthouse Square, Sanderson
  - U.S. Post Office, Terlingua

## 7.7 COORDINATION WITH OTHER REGIONS

The Far West Texas RWPG held one coordination meeting with the Rio Grande Water Planning Region (Region M). At a joint meeting held in El Paso on October 6, 1999, representatives of both groups agreed that the two regions would:

- Coordinate the planning efforts of the two regions in areas of common interest and inform each other of issues that may affect both groups.

- Appoint a liaison member for the other group. The liaison member would convey items of interest or of common concern to the chairman of his respective planning group.
- Send to each other, through the liaison members, a copy of the drafts of each chapter and task as they are forwarded to the TWDB.
- Identified the following areas of common interest:
  a. How to approach the designation of ecologically unique segments of the Rio Grande;
  b. Re-channelization of the Rio Grande from Fort Quitman to Presidio;
  c. Evaluate how Mexico affects and is affected by the regional water planning process;
  d. The conversion of agricultural water rights to municipal use.
- Meet informally whenever necessary.

In addition to the coordination efforts arranged with the Rio Grande Water Planning Region, liaisons were exchanged with Region F and the Plateau Region (Region J). The responsibility of the liaisons was to report on any issues of common interest between adjoining regions.

**7.8 PLAN IMPLEMENTATION**

Following final adoption of the Far West Texas Regional Water Plan, copies of the plan will be provided to each municipality and county commissioner's court in the region. Early in the next planning cycle, visits will be made to each city to review the plan and to obtain recommendations for needed improvements. Each community will be asked to consider their specific short-range and long-range goals with those presented in the regional plan. Based on the results of these meetings, the RWPG members may consider plan revisions prior to the conclusion of the next 5-year planning period.

Of specific concern is the lack of confidence in future projected population growth trends and their impact on projected water demands as shown in this current regional water plan. Rural county trends in particular may not be as predictable as the urban trends. An effort will be initiated immediately to begin a process to develop appropriate revisions. Finally, an educational outreach program task will be established in the next planning cycle with the goal of reaching and involving a larger percentage of the public in the planning process.