

## Refugio Groundwater Conservation District

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**Directors:****President:**

Larry  
Aduddell

**Vice  
President:**

Dallas Ford

**Secretary:**

David  
Mason

**Members:**

Scott Carter

Dr. Gary  
Wright

February 26, 2009

**VIA CMRRR:**

Mr. J. Kevin Ward

Executive Administrator

Texas Water Development Board

P.O. Box 13231

Austin, Texas 78711-3231

RE: Refugio Groundwater Conservation District

Dear Mr. Ward:

Pursuant to Chapter 36, Water Code, please find enclosed for your review and approval the revised District Management Plan for the Refugio Groundwater Conservation District. Also enclosed please find certified copies of the Resolution of the Board of Directors and notice of the public hearing on the District Management Plan.

By copy of this letter, the above documents are also forwarded to the South Central Texas Regional Planning Group and applicable surface water management entities. If you have any questions please call me. Thank you for this consideration.

Sincerely,

Garrett Engelking

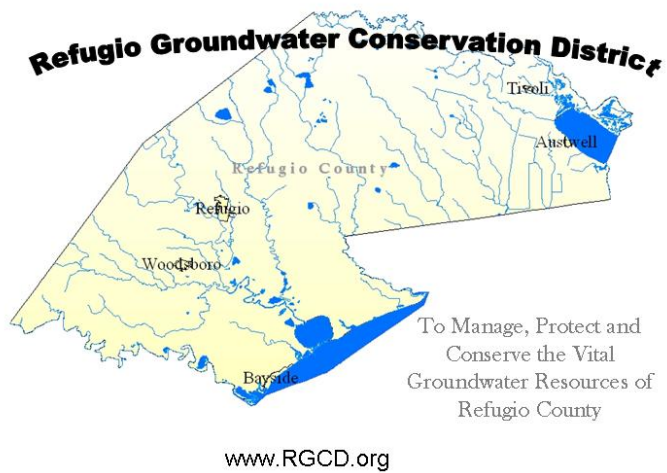
General Manager

Enclosures

# Refugio Groundwater Conservation District

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## Management Plan



Adopted by RGCD: February 23, 2009

Approved by TWDB: XXXXX xx, 2008

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## **I. District Mission and Goal**

The mission of the Refugio Groundwater Conservation District is to manage, protect, and conserve the groundwater resources of Refugio County, Texas, while protecting private property rights and promoting constructive and sustainable development in Refugio County.

The goal of the Refugio Groundwater Conservation District in pursuing its mission is the sustainability of the groundwater resources of Refugio County.

## **II. Purpose of the Management Plan**

Senate Bill 1 (SB 1), enacted in 1997, and Senate Bill 2 (SB 2), enacted in 2001, established a comprehensive statewide planning process, including for requirements for groundwater conservation districts under the Texas Water Code Chapter 36 to manage and conserve the groundwater resources of the State of Texas. This legislation requires that each groundwater conservation district develop a management plan that defines the District's water needs and supply within the District and to establish goals that the District will use to manage groundwater in order to meet those needs.

House Bill 1763, enacted in 2005, requires joint planning among districts within the same Groundwater Management Area (GMA). These districts must establish the Desired Future Conditions (DFCs) of the aquifers within their respective GMAs. Through this process, the Districts will submit the desired future conditions of the aquifer to the executive administrator of the Texas Water Development Board (TWDB). The TWDB will calculate the managed available groundwater in each district within the management area based upon the submitted desired future conditions of the aquifer within the GMA. Technical information, such as the desired future conditions of the aquifers within the District's jurisdiction and the amount of managed available groundwater from such aquifers is required by statute to be included in the District's management plan and will guide the District's regulatory and management policies.

## **III. District Information**

### **A. Creation**

The District was created by S.B. 1911, 76<sup>th</sup> Legislature and continued by H.B. 2046, 77<sup>th</sup> Legislature. The District was ratified by the citizens of Refugio County through a confirmation election on November 6, 2001. The boundaries of the District are coterminous with those of Refugio County, Texas. The economy of the County and the District is dominated by petroleum, agriculture, tourism, and light industrial activities. Agricultural income is derived primarily from beef cattle production, farming, hunting, and outdoor recreation.

### **B. Directors**

The Board of Directors consists of five members. One director is elected by the qualified voters of the entire district, and one director is elected from each County Commissioner's precinct by the qualified voters of that precinct. Directors serve four year terms with a two year staggered interval. Directors from Precinct 1, 2 and 3 serve the same term period while directors from Precinct 4, and at-large serve the same term.

### **C. Authority**

The District has all of the rights, powers, privileges, authority, functions, and duties provided by the general law of this state, including Chapter 36, Water Code, applicable to groundwater conservation districts created under Section 59, Article XVI, Texas Constitution. Therefore it has the duty to provide for the conservation, preservation, protection, recharging, and the prevention of waste of groundwater and to control subsidence. Under Chapter 36 it has the duty to create its management plan in order to adopt goals and performance standards to meet those duties.

Under Chapter 36 the District has the authority to adopt and enforce rules, including rules to limit groundwater production, and impose spacing requirements to minimize as far as practicable the drawdown of the water table or the reduction of artesian pressure, to control subsidence, to prevent the interference between wells, to prevent the degradation of water quality, or to prevent waste.

### **D. Location of the District**

The District is located on the coastal plain of Texas and includes the entire area of Refugio County. Refugio County has a land area of 770 square miles (Census, 2002) and is located in the northeast portion of the coastal bend region. It is surrounded by Victoria County in the North, Calhoun County along northeast, Goliad County in the west, Bee County in the southwest, San Patricio County in the South and Aransas County and the Gulf of Mexico along the east. It falls in the Tropical/Subtropical Steppe Ecosystem Division (Norwine, 1995). According to Trewertha (1968), the climate in this region is semi-arid and is characterized by hot and humid summers and mild winters.

In recent times, eco-tourism, recreational fishing and hunting are seen as major drivers of economy (RCDC, 2002). In addition to the saltwater fishing in the bays, fresh water fishing is also available at the Mission, Aransas, San Antonio, and Guadalupe Rivers in Refugio County, as well as at nearby lakes. Refugio County, is part of the Great Texas Coastal Birding Trail, and offers views of over 400 species of birds, including the rare Whooping Crane, which makes its winter home in the Aransas Wildlife Refuge, located near Austwell, Refugio County and adjoining Aransas County. It is estimated that 15,590,000 tourists visit annually within 50 miles radius of Refugio County and an average of 30 tour buses daily travel through the town of Refugio (RCDC, 2002). This recent trend towards tourism-oriented economy and the associated water demands must be accounted for in long-term water planning endeavors.

### **E. Topography and Drainage**

Refugio County is located on the Coastal Plain. The highest elevation in the County is about 86 feet above mean sea level along the north-northwestern corner. The eastern portion of the County, especially near the gulf coast is a low lying area with elevations very near (within 10 feet) to the mean sea level.

### **F. Groundwater Resources**

The Gulf Coast aquifer has been divided into four units, each of which can be generally correlated to different sedimentary formations (Baker, 1979) and has different hydraulic properties (Chowdhury and Mace, 2003; Chowdhury and others, 2004; Kasmarek and Robinson, 2004). The deepest of these is the Catahoula confining system, which includes the Frio

Formation, the Anahuac Formation, and the Catahoula Tuff or Sandstone. The Catahoula is overlain by the Jasper aquifer, which consists of the Oakville Sandstone and Fleming Formation. The upper part of the Fleming Formation forms the Burkeville confining system. This separates the Jasper aquifer from the Evangeline aquifer, which is made up of water within the Goliad Sand. The shallowest unit, the Chicot aquifer, is made up of the Willis Sand, the Bentley and Montgomery formations, the Beaumont Clay, and alluvial deposits at the surface (Baker, 1979). The total sand thickness in all four units ranges from 700 feet in the south to 1,300 feet in the north (Ashworth and Hopkins, 1995).<sup>1</sup>

System	Series	Stratigraphic Units	Hydrostratigraphy	
			Baker (1979)	
Quaternary	Holocene	Alluvium	Chicot aquifer	
	Pleistocene	Beaumont Clay		
		Lissie Formation		Montgomery Formation
				Bentley Formation
		Willis Sand		
Tertiary	Pliocene	Goliad Sand	Evangeline aquifer	
	Miocene	Fleming Formation/ Lagarto Clay	Burkeville Confining System	
		Oakville Sandstone	Jasper aquifer	
	Oligocene	Catahoula tuff or sandstone <sup>1</sup>	Upper part of Catahoula tuff <sup>2</sup>	Catahoula Confining System
			Anahuac Formation <sup>2</sup>	
			Frio Formation <sup>2</sup>	
Frio Clay <sup>1</sup>		Vicksburg Group equivalent <sup>2</sup>		

1 = outcrop  
2 = subsurface

<sup>1</sup> Davidson, S.C., and Mace, R.E., 2006 Aquifers of the Gulf Coast of Texas Report 365, 9 p.

<sup>2</sup> Davidson, S.C., and Mace, R.E., 2006 Aquifers of the Gulf Coast of Texas Report 365, 9 p.

<sup>3</sup> Source: TWDB Historic Water Use Survey Summary Database

Figure 1: Stratigraphic column showing sediment successions formed during the Oligocene to the Pleistocene periods. Hydrostratigraphic divisions for corresponding stratigraphic units are indicated (after Baker 1979).

The Gulf Coast Aquifer within the Refugio County can be considered to comprise of two principal aquifer subsystems – namely, the “Beaumont/Lissie Sand” subsystem (Chicot Aquifer) that extends to about 500 – 700 feet below the ground surface (bgs), and the “Goliad Sand” subsystem (Evangeline Aquifer) that begins at roughly 600 feet below the ground surface and extends to about 300 to 600 beyond. However, the water yields and water quality vary significantly with depth within the County.

#### **A. Groundwater Quality**

Water quality often determines whether or not water can be used for drinking, industry, irrigation, or other uses. The salinity—or amount of dissolved solids—of groundwater in the aquifer increases naturally in deep parts of the Gulf Coast aquifer, toward the coast. In addition, the eastern part of the aquifer contains significantly higher amounts of chloride, sulfate, and sodium than the western part.

Researchers are starting to find that groundwater can constitute a significant amount of freshwater flow to coastal areas and may have important impacts on coastal areas, including estuaries.<sup>2</sup>

#### **G. Surface Water Resources**

The major surface water features of the County and its vicinity include the San Antonio and Guadalupe Rivers along the north, Mission River and Copano Creek along the central part of the County and the Aransas River along the southern boundary of the County. Refugio County also contains shorelines on Copano, Mission, Hynes and San Antonio bays.

#### **H. Drought Contingency Plan**

A drought contingency plan to cope with the effects of water supply shortages due to climatic or other conditions may be developed by the District and will be adopted by the Board of Directors after notice and hearing. In developing the contingency plan, the District will consider the economic effect of conservation measures upon all water storage conditions, the unique hydrogeologic conditions of the aquifer and the appropriate conditions under which to implement the contingency plan.

### **IV. Statement of Guiding Principles**

The groundwater resources of Refugio County (“the County”) are of vital importance to all citizens, and as the economic activities of the County continue to increase, additional pressure will be placed on the groundwater resources of the County. The preservation of this vital resource can be managed in prudent and cost effective manner through education, cooperation

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<sup>2</sup> Davidson,S.C., and Mace, R.E., 2006 Aquifers of the Gulf Coast of Texas Report 365, 9 p.

and development of a comprehensive understanding of the aquifer system in the District. The Refugio Groundwater Conservation District (“the District”), managed and controlled locally, is the most practical means of preventing over-development of the natural resources of the County.

The District can achieve its mission and goals by increasing the quantity and quality of knowledge regarding the groundwater resources of the County, encouraging the most efficient use of groundwater, preserving and improving groundwater quality, and increasing public awareness and education of groundwater issues. Believing that local control of local resources is critical to the District’s mission and goal, the District will monitor the activities of the Texas Legislature and Texas Water Planning Groups, along with the rules and orders of state agencies which may affect the private ownership, use, and management of groundwater.

## **V. Criteria for Plan Approval**

### **A. Planning Horizon**

The planning period for this plan is ten (10) years from the date of approval by the TWDB. This plan will be reviewed within five (5) years as required by TWC 36.1072(e). The District will consider the necessity to amend the plan and re-adopt the plan with or without amendments as required by TWC 36.1072(e) every five (5) years. This management plan will remain in effect until replaced by a revised management plan approved by the TWDB.

### **B. Board of Directors Resolution**

*Certified copy of the Refugio Groundwater Conservation District Resolution adopting the management plan as required by, 31 TAC §356.6(a)(2).*

A certified copy of the Groundwater Conservation District Resolution adopting the plan is located in Appendix B - District Resolution.

### **C. Plan Adoption**

*Evidence that the plan was adopted following notice and hearing, as required by 31 TAC §356.6(a)(4).*

Public Notices documenting that the Plan was adopted following appropriate public meetings and hearings are located in Appendix C – Notice of Meetings.

### **D. Coordination with Surface Water Management Entities**



*Evidence that following notice and hearing the District coordinated with Surface Water Management Entities, as required by Texas Water Code § 36.1071 (a).*

Letters transmitting copies of this plan to the Guadalupe Blanco River Authority and the San Antonio River Authority and the Region L (South Central Texas Regional Planning Group) are located in Appendix D – Letters to Surface Water Management Entities/ Regional Water Planning Groups.

## **VI. Technical Information Required by Texas Water Code § 36.1071 and 31 TAC §356.5**

### **A. Managed Available Groundwater**

*Estimate of the Managed Available Groundwater in the District based upon the desired future condition of the aquifer, if available from TWDB, as required by TWC § 36.1071 (e)(3)(A) and 31 TAC §356.5 (a)(5)(A).*

Managed Available Groundwater is defined in TWC §36.001 as "the amount of water that may be permitted by a district for beneficial use in accordance with the Desired Future Condition of the aquifer." Under Texas Water Code § 36.108 (d), the Desired Future Condition of the aquifer may only be determined through joint planning with other Groundwater Conservation Districts (GCDs) in the same Groundwater Management Area (GMA) as required by the 79th Legislature with the passage of HB 1763 into law.

Estimates of the Managed Available Groundwater are obtained through the Groundwater Management Area (GMA) joint planning process. Refugio Groundwater Conservation District is part of the GMA 15 which is currently in the process of developing Desired Future Conditions that will lead to the quantitative estimates of Managed Available Groundwater (MAG) that will be developed by the Texas Water Development Board. As such, estimates for MAG for the District are currently unavailable. Previous modeling studies have indicated that groundwater availability could range between 20,000 – 42,000 ac-ft/yr depending upon the preferences of the stakeholders. Several technical stakeholder workshops have been carried out in the last years and based on the inputs generated, the major factors concerning the Desired Future Conditions of the aquifer include – 1) prevention of excessive drawdowns in the shallow wells; 2) deterioration of groundwater quality due to advancement of the (high salinity) poor water quality line along the coast; 3) maintaining ambient surface water-groundwater interactions at perennial streams such as the Mission River.

### **B. Annual Groundwater Use**

*Estimate of the amount groundwater being used within the District on an annual basis, as required by TWC §36.1071 (e)(3)(B) and 31 TAC §356.5 (a)(5)(B).*

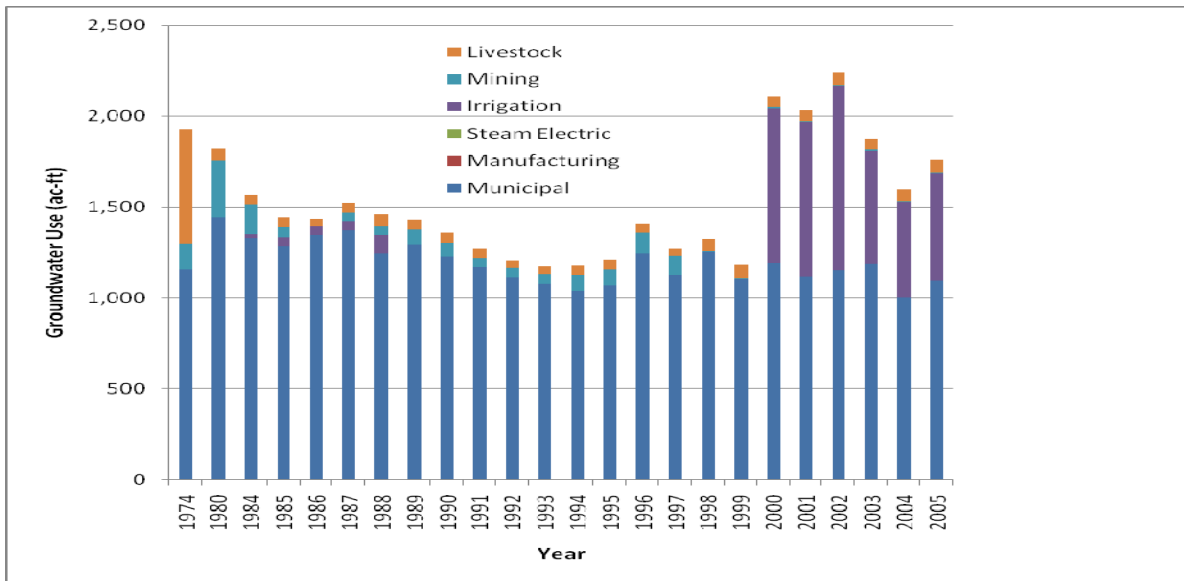


Figure 2: Historical Water Use in the Refugio Groundwater Conservation District (Data from Water Use Survey, Texas Water Development Board<sup>3</sup>) Source: <http://www.twdb.state.tx.us/wushistorical/>

As can be seen, the historical water use in the District has been fairly low and less than 3000 ac-ft/yr. Municipalities are the largest user of groundwater. According to the Texas Water Development Board rules, districts are required to present the water use data for the last five years. The data from 2000 – 2005 represent the last five years of available data and are summarized in Table 1. As can be seen, from Table 1 and Figure 1, there is a slight increase in the water use over this period, primarily due to increased irrigation activities.

Table 1: Groundwater Use for the Period of 2000 – 2005 (Last five years of available data from the Groundwater Use Survey of TWDB) Source: <http://www.twdb.state.tx.us/wushistorical/>

County	Year	Source	Municipal	Manufacturing	Steam Electric	Irrigation	Mining	Livestock	Total
Refugio	2000	GW	1,193	0	0	850	6	62	2,111
Refugio	2001	GW	1,120	0	0	850	6	55	2,031
Refugio	2002	GW	1,149	0	0	1,019	6	63	2,237
Refugio	2003	GW	1,188	0	0	621	6	60	1,875
Refugio	2004	GW	1,002	0	0	527	6	62	1,597
Refugio	2005	GW	1,096	0	0	588	6	74 <sup>4</sup>	1,764
<b>Average</b>			<b>1,125</b>	<b>0</b>	<b>0</b>	<b>743</b>	<b>6</b>	<b>63</b>	<b>1,936</b>

<sup>3</sup> Source: TWDB Historic Water Use Survey Summary Database (<http://www.twdb.state.tx.us/wushistorical/ReportViewer.aspx?ReportName=rptWaterUseSummaryByCountySource&ReportParameters=Num%3d196%26Year%3d+>)

<sup>4</sup> Source: 2005 TWDB Historic Water Use Survey Summary Estimates, this estimate assumes that 90% of livestock use is from Surface Water. Total estimated water use for Livestock is 742 ac-ft.

Groundwater is primarily used to meet the municipal demands, irrigation accounts for 39% of the groundwater use followed by livestock (3 %) and mining (0.3%).

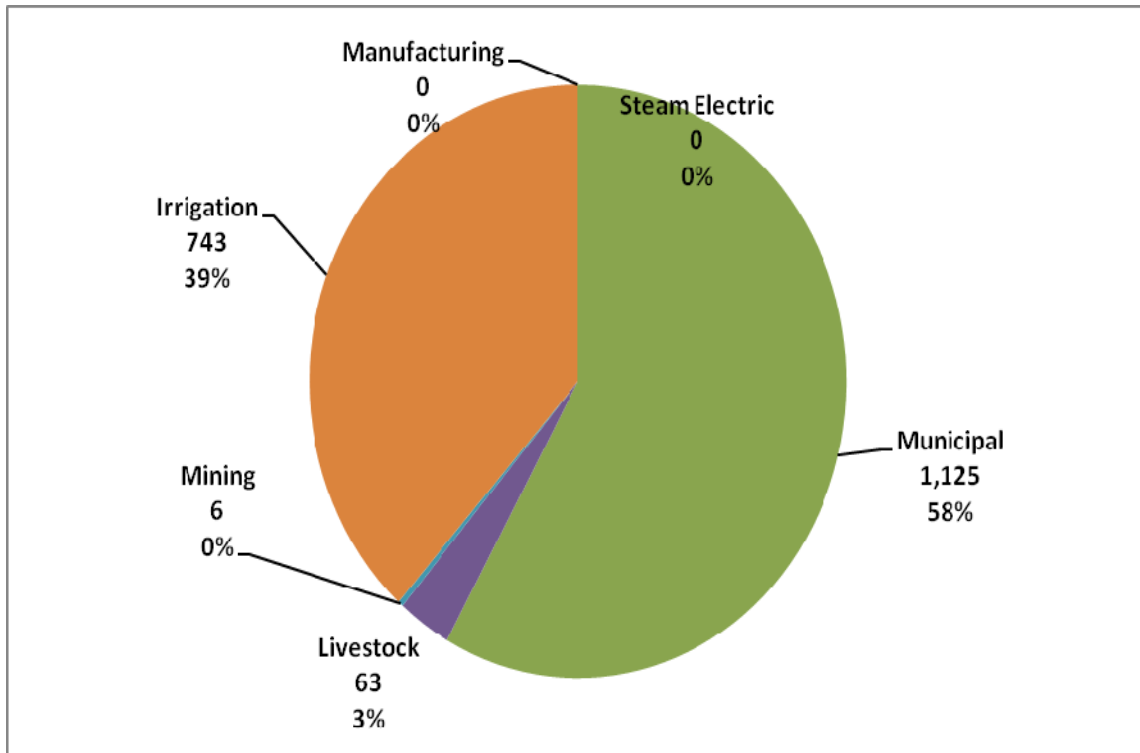


Figure 3: Average Groundwater Use across Water Use Categories (Water volumes in Ac-ft/yr)

### C. Annual Recharge from Precipitation

*Estimate of annual amount of recharge from precipitation to the groundwater resources within the District, as required by Texas Water Code §36.1071(e)(3)(C) and 31 TAC § 356.5 (a)(5)(C.)*

Recharge from precipitation contributes to groundwater in the shallow aquifer formations that are in direct contact with the land surface. In the Refugio Groundwater Conservation District, shallow formation of the Gulf Coast Aquifer is referred to as the Chicot Formation. The formation is nearly 300 ft thick along the western sections of the District and roughly 800 ft thick along the coast, with an average thickness of roughly 500 ft. The Evangeline Formation underlies the Chicot Aquifer Formation but does not outcrop within the District as such all of the recharge due to precipitation occurs to the Chicot Formation. **The average recharge from precipitation is 13,172 ac-ft/yr** based on water budgets carried out between the years 1981 – 1999 using the Central Gulf Coast Aquifer Groundwater Availability Model Report (GAM 08-39) developed by the Texas Water Development Board. This number is to be used in the management plan per State of Texas statutes.

Recharge exhibits considerable variability due to a variety of factors including erratic rainfall, soil moisture characteristics and modifications to land use.

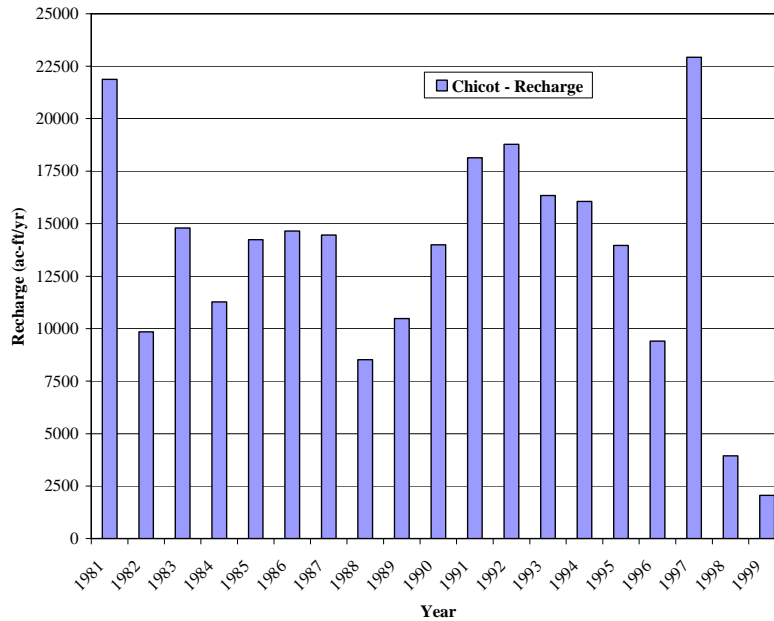


Figure 4: Estimates of Total Recharge from Precipitation developed using CGC-GAM for the Refugio Groundwater Conservation District

The period 1990 – 1999 represents the most recent conditions for which a calibrated Groundwater Availability Model exists. This period is characterized by periods of rainfall that are both higher and lower than the historical averages and as such can provide a reasonable representation of the project planning period of the management plan. Groundwater Budgets were therefore developed for the decades of 1980 – 1999 using the CGC-GAM and used to develop estimates of recharge. As can be seen from Figure 3, recharge exhibits considerable variability and can be less than 2,500 ac-ft/yr during dry years. It is also important to remember that the deeper aquifer formations, namely the Evangeline, Burkeville and Jasper are not directly recharged by precipitation within the Refugio Groundwater Conservation District.

**D. Annual Discharge to Surface Water Bodies**

*For each aquifer in the District, estimate the annual volume of water that discharges from the aquifer to springs and any surface water bodies, including lakes, streams, and rivers Texas Water Code § 36.1071(e)(3)(D) and 31 TAC § 356.5 (a)(D)(5). Not site-specific information was used in developing this information.*

The major surface water bodies within the Refugio Groundwater Conservation District include the Mission River, Copano Creek. In addition there are several ephemeral streams that flow during periods of high rainfall. Also, the District is bounded by several important bays including

the Mission Bay, Copano Bay and Hynes Bay. The regional groundwater gradient is along the north-west to south-east direction and as such, groundwater discharges to bays and estuaries are also of concern. Groundwater budgets were again utilized to estimate discharges to surface water bodies. Groundwater budgets were developed again for a period of 1990 – 1999 to estimate surface-water-Groundwater interactions.

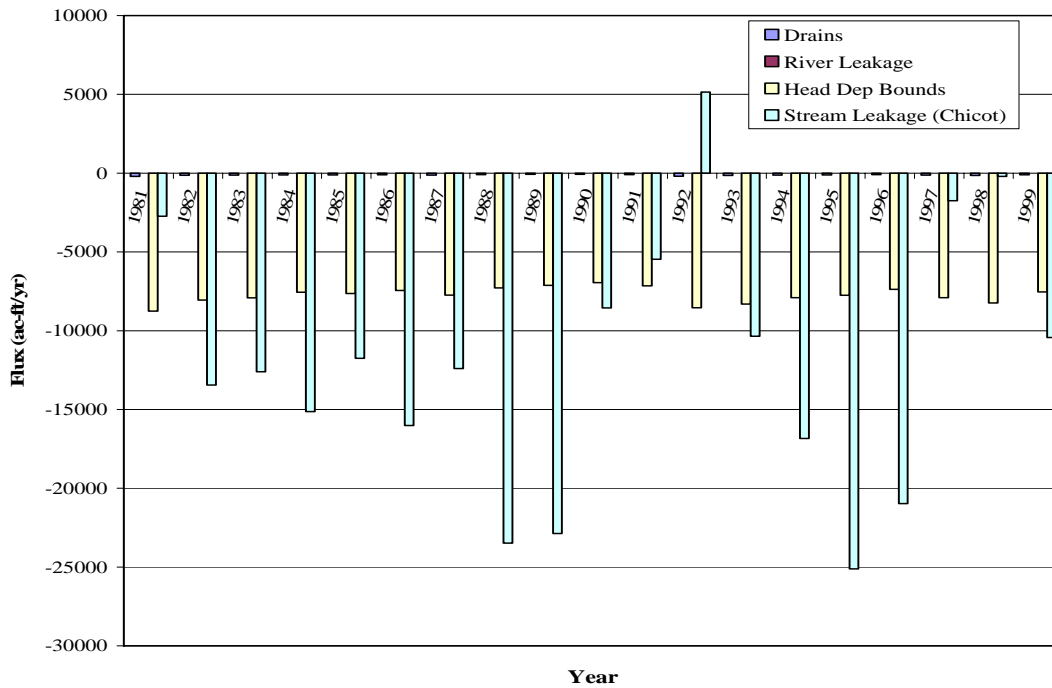


Figure 5: Interactions of Aquifers with Surface Water Bodies within the Refugio GCD during 1980-1999.

The interactions of the aquifer with various surface water bodies are schematically depicted in Figure 5. As can be seen the interactions with streams exhibit considerable variability with the aquifer losing water to streams for most part. The stream interactions occur with the Chicot formation which is the shallowest aquifer in the District. There is constant discharge of groundwater into the coastal bodies along the eastern sections of the District. The interactions with wetlands, ponds and reservoirs modeled using drains and river leakage in the GAM model is of little relative significance.

**Based on the GAM 08-39 modeling report performed by the Texas Water Development Board (TWDB), the estimated annual discharges to surface water bodies is 36,476 ac-ft/yr.** As can be seen from Figure 6, the losses to streams and to coastal water bodies are the most significant surface water-groundwater interactions within the District.

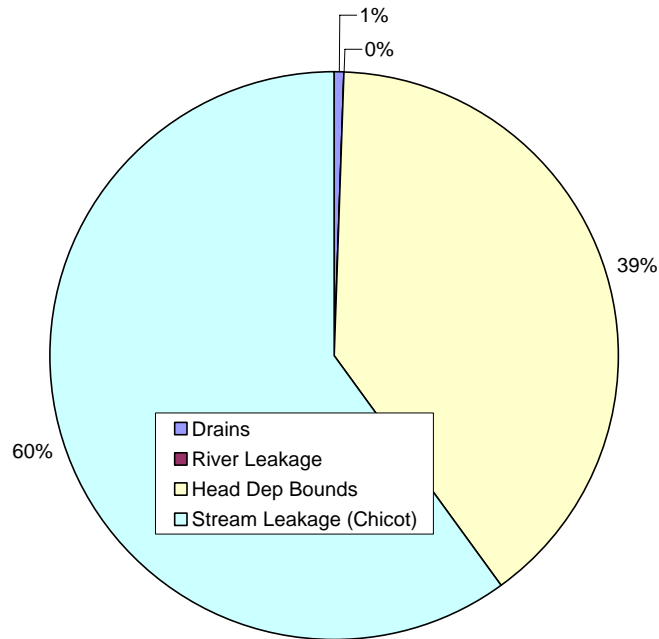


Figure 6: Average Stream Aquifer Interactions with Various Surface Water Features

**E. Groundwater Flow Into and Out of the District, and Between Aquifers within the District**

*Estimate of annual volume of flow into and out of the District within each aquifer and between aquifers, in the District, if a groundwater availability model is available, as required by Texas Water Code §36.1071 (e)(3)(E)*

Horizontal flows in and out of the District were again ascertained using the hydrologic budgets using the years 1980-1999 as representative years. The net horizontal exchanges are depicted in Figure 7. While there is both inflow to and outflow from the aquifer formations, there is a net inflow. This result is to be expected given the location of the District in the regional context of the aquifers. The gains and losses in the deeper Burkeville confining unit and the Jasper aquifer are minimal and well buffered as they don't interact with the land-surface within the District and are currently not being tapped for water use. On average there is a net inflow of nearly 5000 ac-ft/yr into the Chicot and 4600 ac-ft/yr into Evangeline aquifer formation.

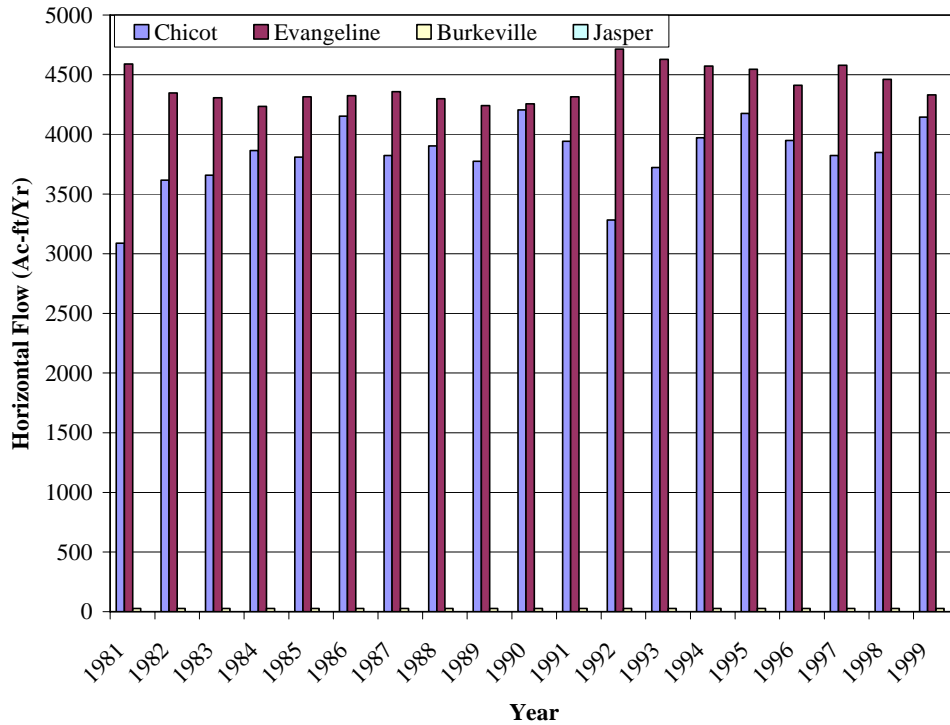


Figure 7: Net Horizontal Exchange from the Refugio Groundwater Conservation District

It is important to note that there are both inflows and outflows from each of the aquifer formation. Summary statistics for the inflows, the outflows for the Refugio GCD during the simulation periods is summarized in the Table below.

Table 2: Summary of Horizontal Inflows and Outflows into the Refugio GCD during the simulation period (1981 – 1999) (As per Texas Water Development Board, GAM Run 08-39)

Aquifer Formation	Inflow (ac-ft/yr)	Outflow (ac-ft/yr)
Chicot	13002	6997
Evangeline	6608	2055
Burkeville	32	5
Jasper	0	0

### Vertical Exchanges between the Aquifer Formations

As stated previously, the Gulf Coast aquifer within the Refugio GCD comprises of four formations, namely – Chicot, Evangeline, Burkeville and Jasper. Water budgets developed for the simulation time-period indicate that there is a net loss of water from Evangeline to Chicot.

Similarly, there is a very small net flow into Evangeline from Burkeville. The exchange between Burkeville and Jasper is negligible as well. The average vertical flows are summarized in Table 3 for the simulation period 1990 – 1999.

Table 3: Net Average Vertical Exchanges between Different Aquifer Formations as per the Texas Water Development Board GAM run 08-39

Aquifer Formation	Net Flow (ac-ft/yr)
Evangeline to Chicot	3895
Burkeville into Evangeline	31
Burkeville into Jasper	0

The exchange between the Evangeline formation and the upper Chicot formation are depicted in Figure 8. As can be seen, the losses from Chicot to Evangeline are minimal and occur along in upland areas which occur in the western sections of the District. For most part however, the exchange is from Evangeline into the Chicot formation. The exchange between Burkeville formation into Evangeline is negligible and is to be expected given the permeability of the formation.

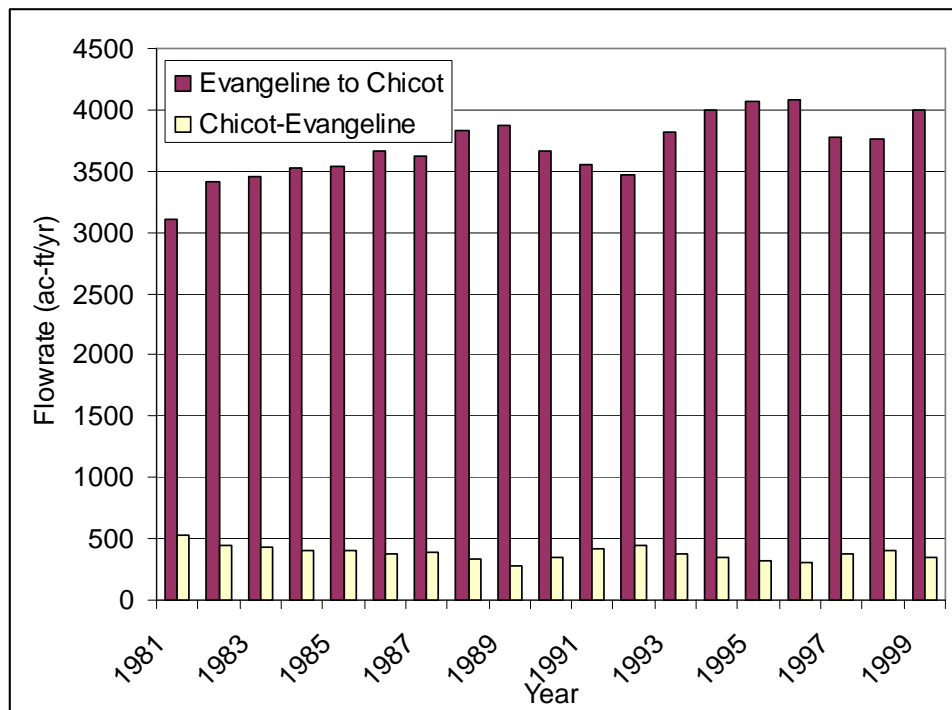


Figure 8: Vertical Exchanges between Chicot and Evangeline Formations during the Simulation Period (1981 – 1999).



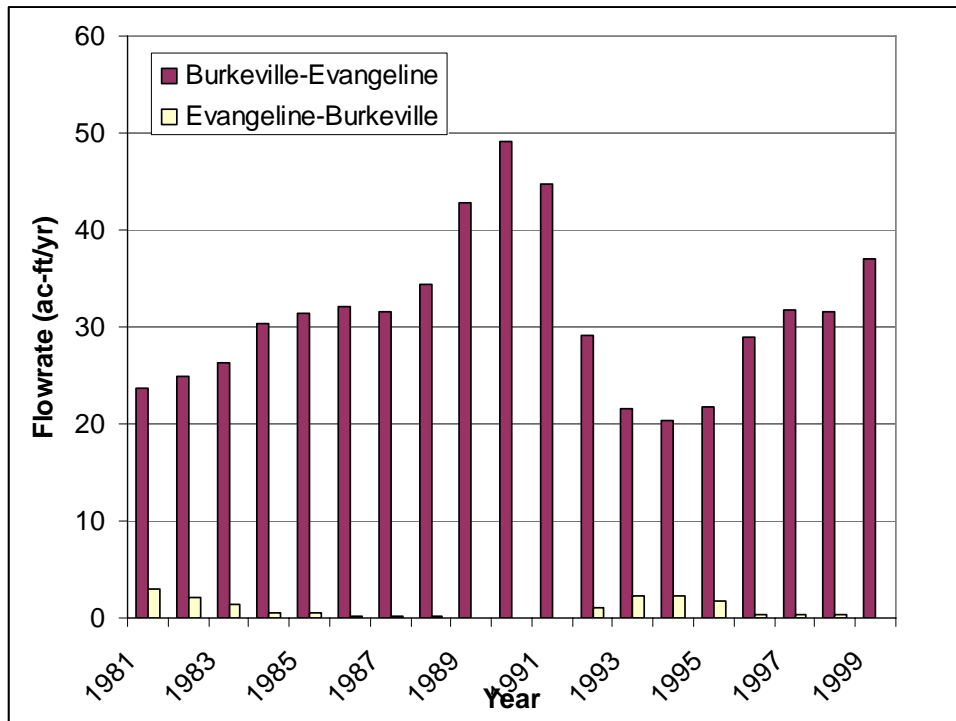


Figure 9: Vertical Exchanges between the Evangeline and Burkeville Formations during the Simulation Period (1981 – 1999).

**F. Projected Surface Water Supply**

*Estimate of the projected surface water supply within the District, according to the most recently adopted State Water Plan, as required by Texas Water Code §36.1071(e)(3)(F), and 31 TAC § 356.5 (a)(5)(F).*

The projected surface water supply information was obtained from the most recent state water plan from the Texas Water Development Board (TWBD) DB07 Database (<http://www.twdb.state.tx.us/data/db07/defaultReadOnly.asp>). These results are summarized in the following table.

Table 4: Project Surface Water Supply in the Refugio GCD as per the 2007 State of Texas Water Plan (Source: <http://www.twdb.state.tx.us/data/db07/defaultReadOnly.asp>) All values in Ac-ft/yr

RWPG	Water User Group	River Basin	Source Name	2000	2010	2020	2030	2040	2050	2060
L	Livestock	San Antonio	Livestock Local Supply	16	13	13	13	13	13	13
L	Livestock	San Antonio-Nueces	Livestock Local Supply	391	299	299	299	299	299	299

<b>Total Projected Surface Water Supplies (acre-feet per year) =</b>	<b>407</b>	<b>312</b>	<b>312</b>	<b>312</b>	<b>312</b>	<b>312</b>	<b>312</b>
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Source: Volume 3, 2007 State Water Planning Database  
 (http://www.twdb.state.tx.us/DATA/db07/defaultReadOnly.asp)

As can be seen, from Table 4, the surface water supply in the District is small (reflecting a lack of major surface water bodies) and as such groundwater resources are of significant importance to the District. The surface water supplies are projected to stay constant over the next 50 years.

**G. Projected Demand for Water**

*Estimated of the projected total water demand within the District according to the most recently adopted State Water Plan, as required by the Texas Water Code § 36.1071 (e)(3)(G) and 31 TAC 356.5 (a)(5)(G).*

The projected total water demand in the District according to the most recently adopted state water plan was also obtained from the Texas Water Development Board, DB07 database and is summarized in Table 5. As can be seen, the total water demand in the District is also projected to stay fairly constant over the next 50 years. In addition, the supplies in the District far exceed these demands and as such water deficits are not likely in the District.

Table 5: Projected total demand for water in the District as per the 2007 State of Texas Water Plan (Source: <http://www.twdb.state.tx.us/data/db07/defaultReadOnly.asp>)

RWPG	Water User Group	County	River Basin	2010	2020	2030	2040	2050	2060
L	Refugio	Refugio	San Antonio-Nueces	665	745	773	826	858	848
L	Woodsboro	Refugio	San Antonio-Nueces	291	306	311	321	326	324
L	County Other	Refugio	San Antonio	7	7	7	6	6	6
L	County Other	Refugio	San Antonio-Nueces	321	296	287	271	261	264
L	Mining	Refugio	San Antonio-Nueces	7	8	8	8	8	8
L	Livestock	Refugio	San Antonio	25	25	25	25	25	25
L	Livestock	Refugio	San Antonio-Nueces	598	598	598	598	598	598
L	Irrigation	Refugio	San Antonio-Nueces	69	69	69	69	69	69
<b>Total Projected Water Demands (acre-feet per year) =</b>				<b>1,983</b>	<b>2,054</b>	<b>2,078</b>	<b>2,124</b>	<b>2,151</b>	<b>2,142</b>

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

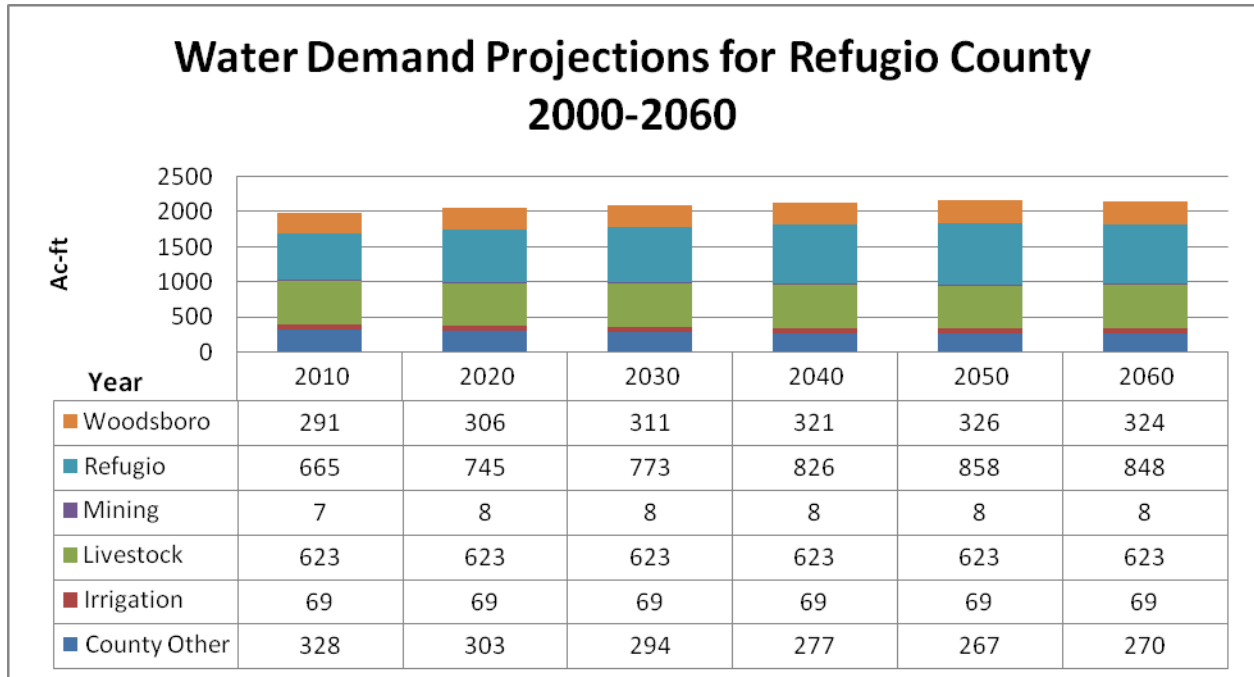


Figure 10: Projected total demand for water in the District as per the 2007 State of Texas Water Plan (Source: <http://www.twdb.state.tx.us/data/db07/defaultReadOnly.asp>)

## VII. Consideration of Adopted State Water Plan

*Consideration of water supply needs and water management strategies that are included in the adopted state water plan, as required by Texas Water Code §36.1071(e)(4) and 31 TAC §356.5 (a)(7).*

Table 6: Water Management Strategies identified for Refugio County as per the 2007 State of Texas Water Plan (Source: <http://www.twdb.state.tx.us/data/db07/defaultReadOnly.asp>)

WUG_Name	WUG_RWPG	WMS_Project_ID	Project_Name	WMS_Type_Name
REFUGIO	L	L1.1	MUNICIPAL WATER CONSERVATION	CONSERVATION
WOODSBORO	L	L1.1	MUNICIPAL WATER CONSERVATION	CONSERVATION

The District reviewed the 2007 State Water Plan, and found no water shortages within the District. The State Water Plan identifies a brackish groundwater desalination strategy from the Gulf Coast Aquifer in Refugio County; however this strategy does not identify an end-user for the potential water supply. The District recognizes that groundwater within the District has total dissolved solids exceeding the secondary safe drinking water standards of 1,000 ppm; however the District currently does not treat any such groundwater source differently than better quality groundwater. The groundwater within the County increases total dissolved solids as it migrates towards the coast.

Region N has identified a strategy to produce groundwater from the western portions of Refugio County to meet future needs when surface water levels are low. The Plan would produce the groundwater and transport the groundwater/surface water via the Texana Pipeline.

The District is concerned about the surface water impact to the river systems within the District boundaries. Significant withdrawal of groundwater could potentially decrease the flows within the Aransas and Mission Rivers. Any production of groundwater that has the potential to increase the salinity or total dissolved solids within the District would be evaluated carefully for its full impact upon the aquifer as well. Furthermore the District supports the research efforts to study the amount of groundwater that is contributed to the bays and estuaries, and realizes that these resources impact the economy and balance of nature. The District will continue to monitor the water management strategies in the regional water planning process and evaluate new proposals and projects as appropriate.

### **VIII. Management of Groundwater Supplies**

The District, in partnership with the landowners of the District, will manage the groundwater resources within the District in accordance with its mission and goal while seeking to maintain the economic viability of all resource user groups, public and private. With due consideration to the economic, cultural, historical, and environmental activities occurring within the District, the District will identify and engage in such activities and practices, which, if implemented, would result in the sustainability of the groundwater resources within the District, including reductions of groundwater use where necessary for that result.

A network of observation wells will be established and maintained in cooperation with private landowners in order to monitor changing storage conditions, and groundwater quality within the District. The District will undertake and cooperate with investigations of the groundwater resources within the District and will make the results of investigations available to the public. The District will cooperate with investigations of the groundwater resources of the District undertaken by other political subdivisions or agencies of the State of Texas.

In pursuit of the District's mission of managing, protecting, and conserving the resource, while protecting private property rights and promoting constructive and sustainable development in Refugio County, the District may be forced to require reductions of groundwater withdrawals from existing commercial or non-exempt wells. The District will not regulate domestic or livestock wells. To achieve this purpose, the District may, at the Board of Directors' discretion, amend or revoke any permit after notice and hearing. If necessary, the District will enforce the

terms and conditions of the permits and the District Rules by enjoining the permit holder in a court of competent jurisdiction as provided for in TWC 36.102.

## **IX. Actions, Procedures, Performance, and Avoidance for Plan Implementation**

*Detailed description of the actions, procedures, performance, and avoidance necessary to effectuate the management plan, including specifications, and proposed rules, as required by the Texas Water Code § 36.1071 (e)(2), 31 TAC § 356.5 (a)(4), and 31 TAC § 356.6 (a)(3)*

The District will implement the provisions of this Plan and will utilize the provision of this Plan as guidelines for determining the direction or priority for all District activities. All operations of the District, all agreements entered into by the District, and any additional planning efforts in which the District may participate will be consistent with the provisions of this Plan. This Plan will remain in effect for a period of 5 years or until a revised or amended Plan may be approved, whichever occurs first.

The District has adopted District Rules relating to the permitting of wells and the production of groundwater. The District Rules shall be as required by Chapter 36 of the Texas Water Code and the provisions of this Plan. All District Rules will be enforced. The promulgation and enforcement of the District Rules will be based on the best technical evidence available. The District Rules can be found at [http://rgcd.org/district\\_rules\\_amend.htm](http://rgcd.org/district_rules_amend.htm).

The District shall treat all citizens equally. Citizens and property owners may apply to the District for a waiver in the enforcement of one or more of the District Rules on grounds of adverse economic effects or unique local conditions. In granting or denying any waiver to any District Rule, the Board of Directors shall consider the potential for adverse effects on adjacent landowners. The exercise of discretion in the granting or denying of any waiver by the Board of Directors shall not be construed as limiting the power of the Board of Directors.

The District will seek the cooperation of all landowners in the implementation of this plan and the management of groundwater supplies within the District. All activities of the District will be undertaken with the cooperation and coordination with the appropriate state, regional or local water management entities.

### **A. Methodology for Tracking Progress in Achieving Management Goals**

The District Manager will prepare and present an annual report to the Board of Directors on District performance in regards to achieving management goals and objectives. The report will include the number of instances in which each of the activities specified in the District's management objectives was engaged in during the fiscal year. The report will be provided to the District Directors at the Board of Directors meeting at the first meeting of each New Year beginning January 1, 2004. The District will maintain the report on file for public inspection at the District office upon adoption. This methodology will apply to all management goals contained within this plan.

## X. Goals Management Objectives and Performance

*Identify the performance standards and management objectives for effecting the plan, as required by the Texas Water Code §36.1071 (a)(1) and 31 TAC §356.5 (a)(1)(A).*

### 1. Providing for the Most Efficient Use of Groundwater 31 TAC 356.5(a)(1)(A); §36.1071(a)(1)

- a. **Objective:** Each year the District will provide educational materials to the public (the District may provide speakers to address water topics, distribute water resource education packets for use in classrooms, articles on website, etc.)
  - (i) **Performance Standard:** Include summary of activities in annual report.
- b. **Objective:** Register and permit wells.
  - (i) **Performance Standard:** Track number of wells registered and permitted annually and include information in annual report
- c. **Objective:** Maintain groundwater database.
  - (i) **Performance Standard:** Report progress in annual report.
- d. **Objective:** Measure water levels annually.
  - (i) **Performance Standard:** Monitor thirty wells and report annually.
- e. **Objective:** Meter permitted wells.
  - (i) **Performance Standard:** Report volume used annually.

### 2. Controlling and preventing waste of groundwater 31 TAC 356.5(a)(1)(b); §36.1071(a)(2)

- a. **Objective:** Measure water quantity and quality on strategic wells annually.

- (i) **Performance Standard:** Measure depth to water on thirty wells annually and measure chemical analysis of five wells annually.
  - b. **Objective:** Identify polluted wells and pollution sources and take appropriate action.
    - (i) **Performance Standard:** Report to Board of Directors at next meeting on all complaints after complaint filed.
  - c. **Objective:** Investigate all identified wasteful practices within determined period of time after identification or complaint received.
    - (i) **Performance Standard:** Track wasteful practices identified and time frame taken to respond or investigate, plus actions taken to remedy.
  - d. **Objective:** Meter permitted wells.
    - (i) **Performance Standards:** Track metered wells.
  - e. **Objective:** Water use fee.
    - (i) **Performance Standard:** Track fee amounts and amount of water used for each permitted use to be included in Annual Report.
3. **Controlling and Preventing Subsidence 31 TAC 356.5(a)(1)(C); §36.1071(a)(3)**
- a. **Objective:** Measure water levels in thirty wells annually.
    - (ii) **Performance Standard:** Report the number of wells monitored each year and reporting water level changes to the Board of Directors Annually.
  - b. **Objective:** Meter permitted wells.
    - (ii) **Performance Standard:** Report to the Board of Directors the number of wells metered and volume used annually.

Through the measurement of water levels, large withdrawals of groundwater through permitted wells, and the enforcement of the District Rules, the District believes that it can prevent subsidence. The District believes that many other factors will come forth prior to any subsidence occurring.

4. **Addressing Conjunctive Surface Water Management Issues 31 TAC 356.5(a)(1)(D); §36.1071(a)(4)**

a. **Objective:** Meet with surface water entities such as GBRA, and SARA , attend Regional Water Planning Group Meetings.

(i) **Performance Standard:** The number of meetings attended annually will be included in the Annual Report.

b. **Objective:** Evaluate data, precipitation, etc.

(i) **Performance Standard:** Maintain Weather Station program, and report data collected quarterly to the Board of Directors, and final report in the Annual Report

5. **Addressing Natural Resource Issues that Impact the use and Availability of Groundwater and Which are Impacted by the use of Groundwater 31 TAC 356.5(a)(1)(E); §36.1071(a)(5)**

a. **Objective:** Monitor water quality within District.

(i) **Performance Standard:** Provide status report on number of wells tested and testing results in Annual Report.

6. **Addressing Drought Conditions 31 TAC 356.5(a)(1)(F); §36.1071(a)(6)**

a. **Objective:** Monitor Palmer Drought Severity Index.

(i) **Performance Standard:** A report of the Palmer Drought Severity Index will be presented to the Board of Directors on an annual basis.

b. **Objective:** Monitor rainfall.

(ii) **Performance Standard:** Maintain Weather stations, and report data collected quarterly to the Board of Directors, and final report in the Annual Report



7. **Addressing Conservation, Recharge Enhancement, Rainwater Harvesting, Precipitation Enhancement, Brush Control where Appropriate and Cost Effective 31 TAC 356.5(a)(1)(G); §36.1071(a)(7)**

a. **Objective:** Promote conservation through the District working with landowners and other local agencies such as the Copano Bay Soil and Water Conservation District. A summary of those joint activities will be included in the annual report.

(i) **Performance Standard:** Number of meetings attended by the District each year with landowners or the Copano Bay Soil and Water Conservation District.

b. **Objective:** Recharge enhancement.

This objective is not applicable to the District at the current time, it is cost prohibitive.

c. **Objective:** Promote rainwater harvesting.

(i) **Performance Standard:** Include a copy of promotional rainwater harvesting material in Annual Report.

d. **Objective:** Precipitation Enhancement.

This objective is not applicable to the District at the current time, it is cost prohibitive.

e. **Objective:** Promote brush control through the District working with landowners and the Copano Bay Soil and Water Conservation District. A summary of those joint activities will be included in the annual report.

(i) **Performance Standard:** Number of meetings attended by the District each year with landowners or the Copano Bay Soil and Water Conservation District

8. **Addressing in a Quantitative Manner the Desired Future Condition of the Groundwater Resources in the District (if available from the Districts in the Groundwater Management Area) 31 TAC 356.5(a)(1)(H); §36.1071(a)(8)**

The desired future conditions of the groundwater within the District have not yet been established in accordance with Chapter 36.108 of the Texas Water Code. The District is actively participating in Groundwater Management Area 15 planning process and the development of the desired future condition of the aquifer within the District. Therefore this goal is not applicable at this time.

## **Appendix A:**

### Technical Elements Required for Refugio Groundwater District Management Plan

Submitted to,

Refugio Groundwater Conservation District

Submitted by,

Venkatesh Uddameri, Ph.D.

Department of Environmental Engineering, MSC 213

Texas A&M University-Kingsville

Kingsville, TX 78363

**A. Introduction**

As per the recent Texas Water Code (Chapter 36) requirements, Groundwater conservation districts are required to include information pertaining to various hydrologic, hydrogeologic and water resources characteristics in their management plan. This information is intended to provide an overview of the water availability, supply and demand and help guide the aquifer management process. The information to be used in the management plan must be consistent with the state and regional water plans. The management plan must address the following issues as applicable:

- (1) aim to provide the most efficient use of groundwater;
- (2) help control and prevent waste of groundwater;
- (3) help control and prevent subsidence;
- (4) address conjunctive surface water management
- (5) address natural resource issues;
- (6) address drought conditions;
- (7) address conservation, recharge enhancement, rainwater harvesting, precipitation enhancement, or brush control, where appropriate and cost-effective; and
- (8) address in a quantitative manner the desired future conditions of the groundwater resources.

The management plan must include estimates of the following technical elements:

- (A) managed available groundwater in the district based on the desired future condition established under Section 36.108 of the Texas Water Code.
- (B) the amount of groundwater being used within the district on an annual basis;
- (C) the annual amount of recharge from precipitation, if any, to the groundwater resources within the district;
- (D) for each aquifer, the annual volume of water that discharges from the aquifer to springs and any surface water bodies, including lakes, streams, and rivers;
- (E) the annual volume of flow into and out of the district within each aquifer and between aquifers in the district, if a groundwater availability model is available;

- (F) the projected surface water supply in the district according to the most recently adopted state water plan; and
- (G) the projected total demand for water in the district according to the most recently adopted state water plan; and
- (H) consider the water supply needs and water management strategies included in the adopted state water plan.

This report summarizes the information pertaining to each of the technical elements presented above. Consistent with the statutes, the required information was obtained from either the recent state water plan of 2007. In addition, groundwater modeling runs using the Central Gulf Coast Aquifer Groundwater Availability Model (CGC-GAM) developed by the Texas Water Development Board (TWDB) to develop certain information. The details of the model runs are also discussed here in this report.

**B. Information on Technical Elements**

**C. Managed Available Groundwater**

Estimates of the managed available groundwater are obtained through the Groundwater Management Area (GMA) joint planning process. Refugio Groundwater Conservation District is part of the GMA 15 which is currently in the process of developing desired future conditions that will lead to the quantitative estimates of managed available groundwater (MAG) that will be developed by the Texas Water Development Board. As such, estimates for MAG for the district are currently unavailable. Previous modeling studies have indicated that groundwater availability could range between 20,000 – 42,000 Ac-ft/yr depending upon the preferences of the stakeholders. Several technical stakeholder workshops have been carried out in the last years and based on the inputs generated, the major factors concerning the desired future conditions of the aquifer include – 1) Prevention of excessive drawdowns in the shallow wells; 2) deterioration of groundwater quality due to advancement of the (high salinity) poor water quality line along the coast; 3) Maintaining ambient surface water-groundwater interactions at perennial streams such as the Mission River.

**D. Groundwater Usage on an Annual Basis**

The historical groundwater usage in the district was obtained from Texas Water Development Board Water Use Database. The historic water use data across various water use categories is summarized in Figure 1.

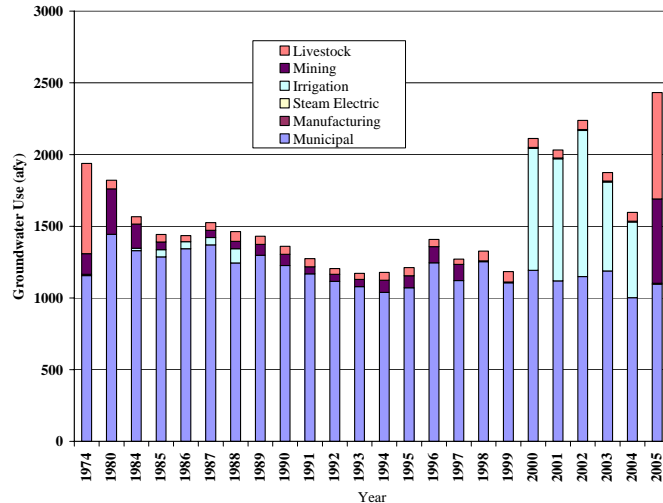


Figure 11: Historical Water Use in the Refugio Groundwater Conservation District (Data from Water Use Survey, Texas Water Development Board) Source :

<http://www.twdb.state.tx.us/wushistorical/>

As can be seen, the historical water use in the district has been fairly low and less than 3000 ac-ft/yr. Municipalities are the largest user of groundwater. According to the Texas Water Development Board rules, districts are required to present the water use data for the last five years. The data from 2000 – 2005 represent the last five years of available data and are summarized in Table 1. As can be seen, from Table 1 and Figure 1, there is a slight increase in the water use over this period, primarily due to increased irrigation activities.

Table 7: Groundwater Use for the Period of 2000 – 2005 (Last five years of available data from the Groundwater Use Survey of TWDB) Source :

<http://www.twdb.state.tx.us/wushistorical/>

County	Year	Source	Municipal	Manufacturing	Steam Electric	Irrigation	Mining	Livestock	Total
Refugio	2000	GW	1193	0	0	850	6	62	2111
Refugio	2001	GW	1120	0	0	850	6	55	2031
Refugio	2002	GW	1149	0	0	1019	6	63	2237
Refugio	2003	GW	1188	0	0	621	6	60	1875
Refugio	2004	GW	1002	0	0	527	6	62	1597
Refugio	2005	GW	1096	0	6	0	588	742	2432
<b>Average</b>			<b>1125</b>	<b>0</b>	<b>1</b>	<b>645</b>	<b>103</b>	<b>174</b>	<b>2047</b>

Groundwater is primarily used to meet the municipal demands, irrigation accounts for nearly 31% of the groundwater use followed by livestock (8%) and mining (5%).

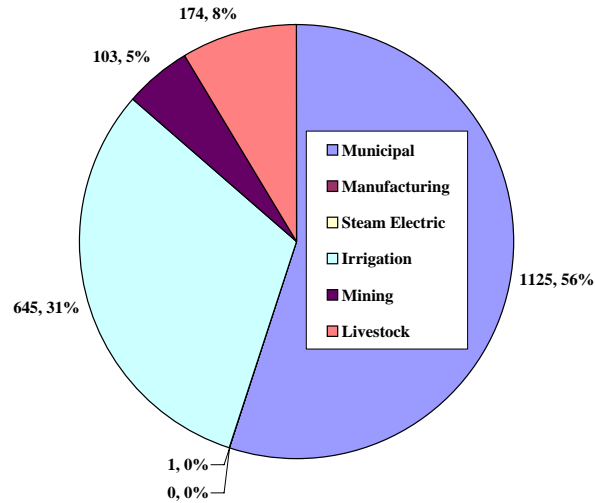


Figure 12: Average Groundwater Use across Water Use Categories (Water volumes in Ac-ft/yr)

**E. Annual Amount of Recharge from Precipitation**

Recharge from precipitation contributes to groundwater in the shallow aquifer formations that are in direct contact with the land surface. In Refugio Groundwater Conservation District, the shallow formation of the Gulf Coast aquifer is referred to as the Chicot formation. The formation is nearly 300 ft thick along the western sections of the district and roughly 800 ft thick along the coast, with an average thickness of roughly 500 ft. The Evangeline formation underlies the Chicot aquifer formation but does not outcrop in within the district as such all of the recharge due to precipitation occurs to the Chicot formation. **The average recharge from precipitation is 13,172 Ac-ft/yr** based on water budgets carried out between the years 1981 – 1999 using the Central Gulf Coast Aquifer GAM developed by the Texas Water Development Board. This number is to be used in the management plan per state of Texas statutes.

Recharge exhibits considerable variability due to a variety of factors including erratic rainfall, soil moisture characteristics and modifications to land use.

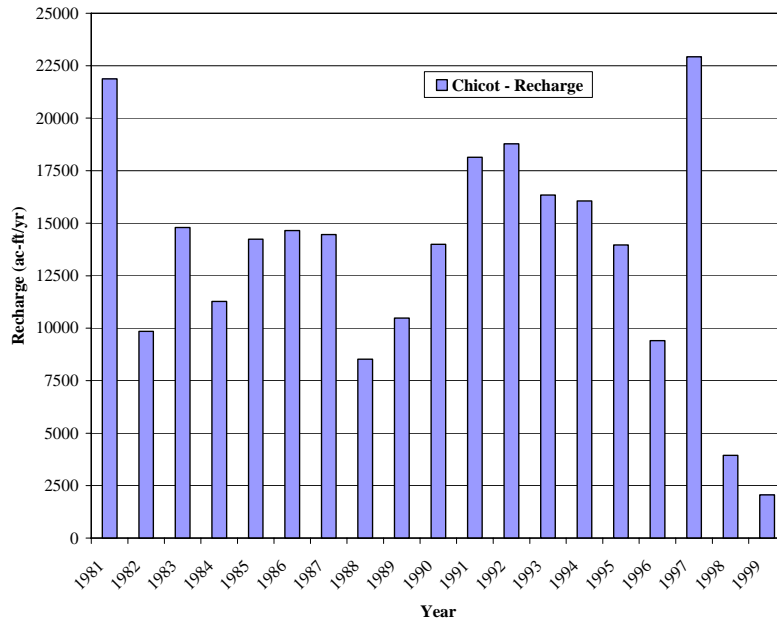


Figure 13: Estimates of Total Recharge from Precipitation developed using CGC-GAM for the Refugio Groundwater Conservation District

The period 1990 – 1999 represents the most recent conditions for which a calibrated Groundwater Availability Model exists. This period is characterized by periods of rainfall that are both higher and lower than the historical averages and as such can provide a reasonable representation of the project planning period of the management plan. Groundwater Budgets were therefore developed for the decade of 1981 – 1999 using the CGC-GAM and used to develop estimates of recharge. As can be seen from Figure 3, recharge exhibits considerable variability and can be less than 2,500 ac-ft/yr during dry years. It is also important to remember that the deeper aquifer formations, namely the Evangeline, Burkeville and Jasper are not directly recharged by precipitation within the Refugio Groundwater Conservation District.

**F. Discharge to Surface Water Bodies**

The major surface water bodies within the Refugio Groundwater Conservation District include the Mission River, Copano Creek. In addition there are several ephemeral streams that flow during periods of high rainfall. Also, the district is bounded by several important bays including the Mission Bay, Copano Bay and Hynes Bay. The regional groundwater gradient is along the north-west to south-east direction and as such, groundwater discharges to bays and estuaries are also of concern. Groundwater budgets were



again utilized to estimate discharges to surface water bodies. Groundwater budgets were developed again for a period of 1990 – 1999 to estimate surface-water-Groundwater interactions.

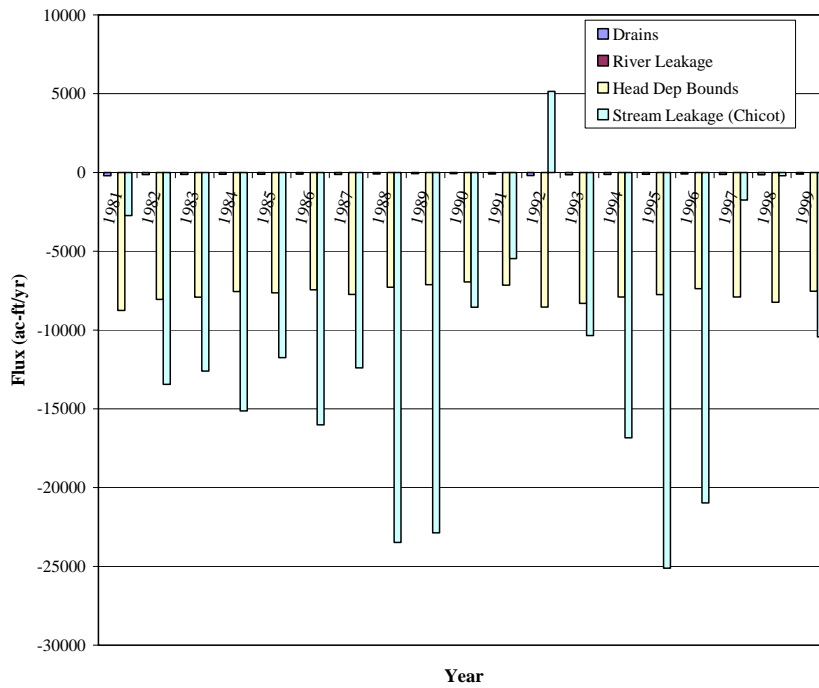


Figure 14: Interactions of Aquifers with Surface Water Bodies within the Refugio GCD during 1981-1999.

The interactions of the aquifer with various surface water bodies are schematically depicted in Figure 4. As can be seen the interactions with streams exhibit considerable variability with the aquifer losing water to streams for most part. The stream interactions occur with the Chicot formation which is the shallowest aquifer in the district. There is constant discharge of groundwater into the coastal bodies along the eastern sections of the district. The interactions with wetlands, ponds and reservoirs modeled using drains and river leakage in the GAM model is of little relative significance.

**Based on the GAM modeling performed by the Texas Water Development Board (TWDB), the estimated annual discharges to surface water bodies is 36,476 ac-ft/yr. As can be seen from Figure**

5, the losses to streams and to coastal water bodies are the most significant surface water-groundwater interactions within the district.

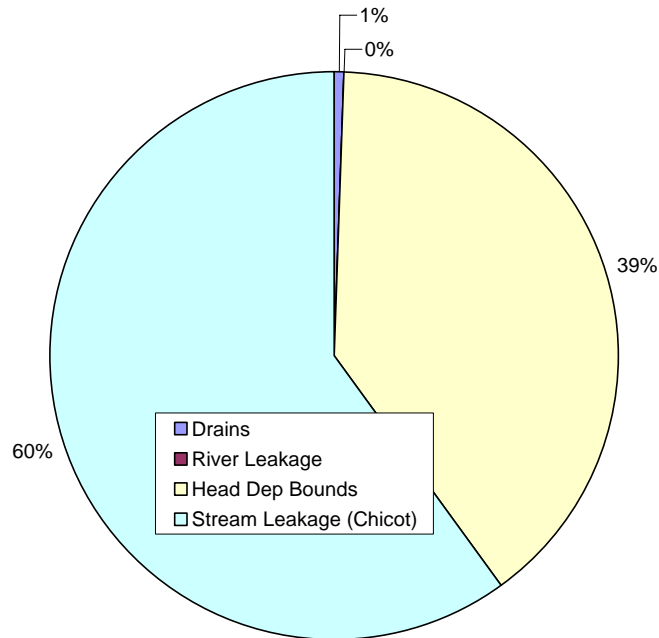


Figure 15: Average Stream Aquifer Interactions with Various Surface Water Features

**G. Flows In and Out of the District**

Horizontal flows in and out of the district were again ascertained using the hydrologic budgets using the years 1980-1999 as representative years. The net horizontal exchanges are depicted in Figure 6. While there is both inflow to and outflow from the aquifer formations, there is a net inflow. This result is to be expected given the location of the district in the regional context of the aquifers. The gains and losses in the deeper Burkeville confining unit and the Jasper aquifer are minimal and well buffered as they don't interact with the land-surface within the district and are currently not being tapped for water use. On average there is a net inflow of nearly 5000 ac-ft/yr into the Chicot and 4600 ac-ft/yr into Evangeline aquifer formation.

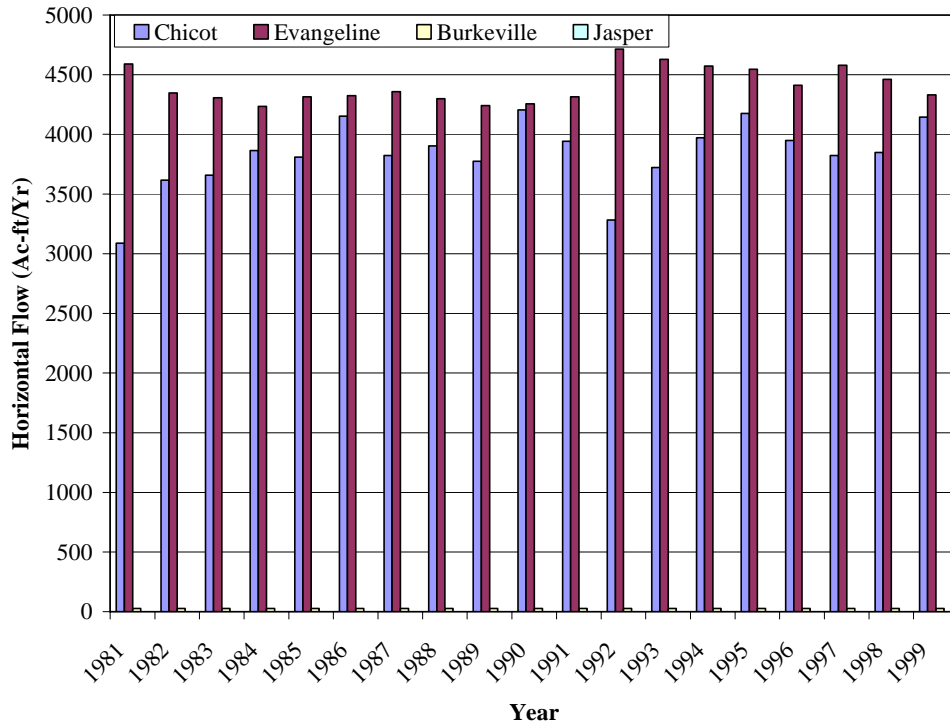


Figure 16: Net Horizontal Exchange from the Refugio Groundwater Conservation District

It is important to note that there are both inflows and outflows from each of the aquifer formation. Summary statistics for the inflows, the outflows and the net flows for the Refugio GCD during the simulation periods are summarized in the Tables below.

Table 8: Summary of Horizontal Inflows and Outflows into the Refugio GCD during the simulation period (1981 – 1999) (As per Texas Water Development Board, GAM Run 08-39)

Aquifer Formation	Inflow (ac-ft/yr)	Outflow (ac-ft/yr)
Chicot	13002	6997
Evangeline	6608	2055
Burkeville	32	5
Jasper	0	0

**H. Vertical Exchanges between the Aquifer Formations**

As stated previously, the Gulf Coast aquifer within the Refugio GCD comprises of four formations, namely – Chicot, Evangeline, Burkeville and Jasper. Water budgets developed for the simulation time-period indicate that there is a net loss of water from Evangeline to Chicot. Similarly, there is a very small net flow into Evangeline from Burkeville. The exchange between Burkeville and Jasper is negligible as well. The average vertical flows are summarized in Table 5 for the simulation period 1990 – 1999.

**Table 9: Net Average Vertical Exchanges between Different Aquifer Formations as per the Texas Water Development Board GAM run 08-39**

Aquifer Formation	Net Flow (ac-ft/yr)
Evangeline to Chicot	3895
Burkeville into Evangeline	31
Burkeville into Jasper	0

The exchange between the Evangeline formation and the upper Chicot formation are depicted in Figure 7. As can be seen, the losses from Chicot to Evangeline are minimal and occur along in upland areas which occur in the western sections of the district. For most part however, the exchange is from Evangeline into the Chicot formation. The exchange between Burkeville formation into Evangeline is negligible and is to be expected given the permeability of the formation.

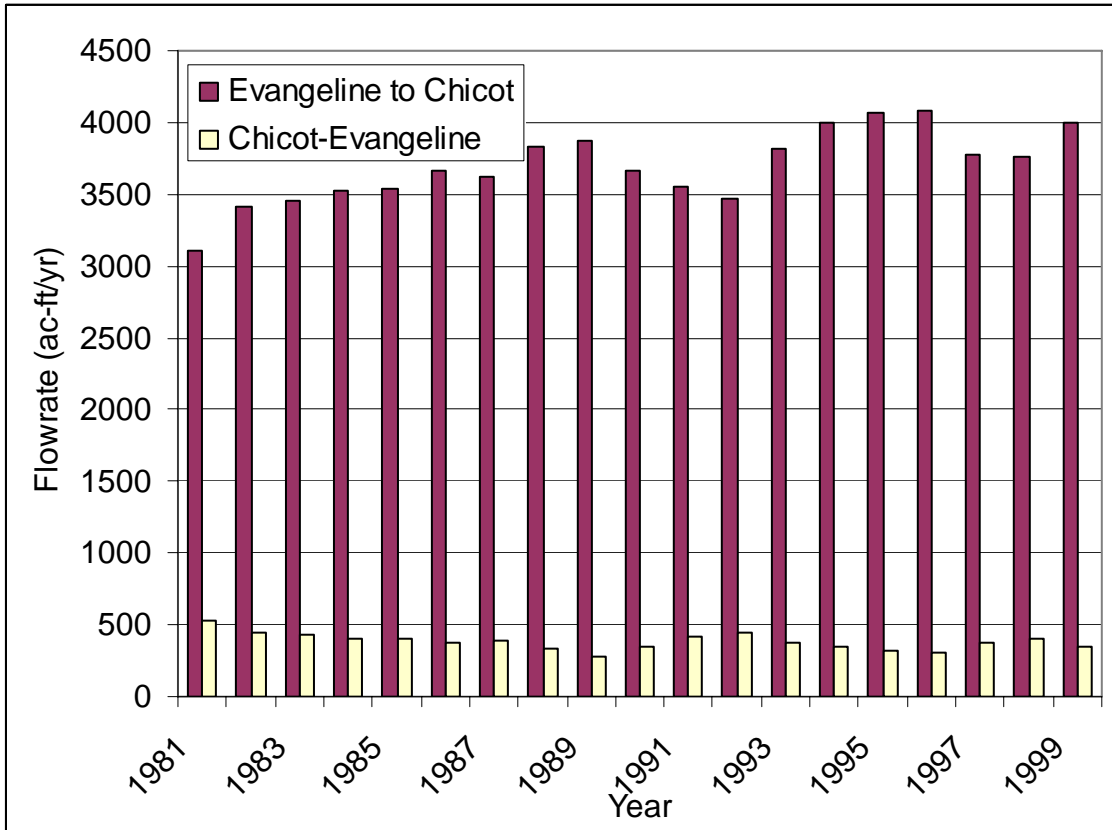
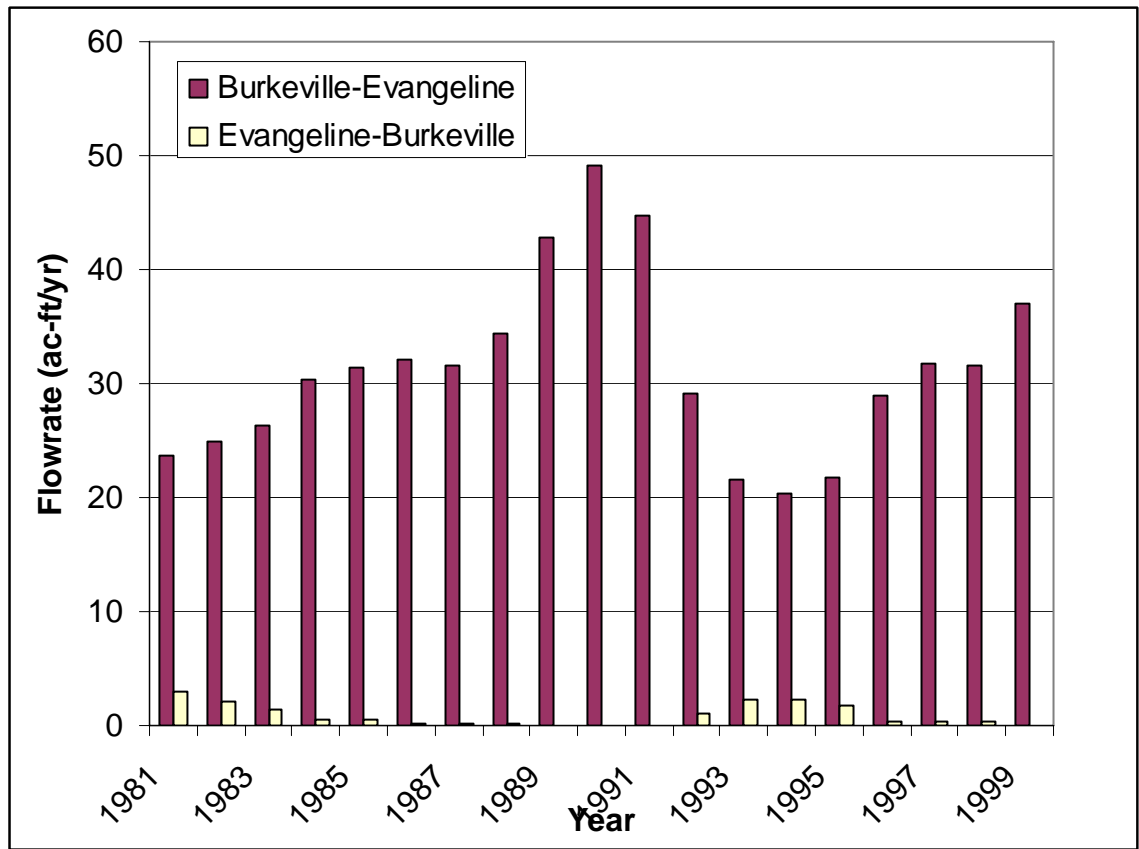


Figure 17: Vertical Exchanges between Chicot and Evangeline Formations during the Simulation Period (1981 – 1999).



I.

Figure 8: Vertical Exchanges between the Evangeline and Burkeville Formations during the Simulation Period (1981 – 1999).

**J. Projected Surface Water Supply**

The projected surface water supply information was obtained from the most recent state water plan from the Texas Water Development Board (TWBD) DB07 Database

(<http://www.twdb.state.tx.us/data/db07/defaultReadOnly.asp>). These results are summarized in the following table.

Table 10: Project Surface Water Supply in the Refugio GCD as per the 2007 State of Texas Water Plan (Source: <http://www.twdb.state.tx.us/data/db07/defaultReadOnly.asp>) All values in Ac-ft/yr

Year	WUG Region	County Name	Municipal	Manufacturing	Steam Electric	Irrigation	Mining	Livestock	Total
2010	L	REFUGIO	2675	0	0	69	7	623	3374
2020	L	REFUGIO	2675	0	0	69	8	623	3375
2030	L	REFUGIO	2675	0	0	69	8	623	3375
2040	L	REFUGIO	2675	0	0	69	8	623	3375
2050	L	REFUGIO	2675	0	0	69	8	623	3375
2060	L	REFUGIO	2675	0	0	69	8	623	3375

As can be seen, from Table 6, the surface water supply in the district is small (reflecting lack of major surface water bodies) and as such groundwater resources are of significant importance to the district. The surface water supplies are projected to stay constant over the next 50 years.

**K. Projected Total Water Demand**

The projected total water demand in the district according to the most recently adopted state water plan was also obtained from the Texas Water Development Board, DB07 database and is summarized in Table 7. As can be seen, the total water demand in the district is also projected to stay fairly constant over the next 50 years. In addition, the supplies in the district far exceed these demands and as such water deficits are not likely in the district.

Table 11: Projected total demand for water in the district according to the most recently adopted state water plan (Source: <http://www.twdb.state.tx.us/data/db07/defaultReadOnly.asp>)

WUG Name	WUG RWP G	WUG County Name	Population	Municipal	Manufacturing	Steam Electric	Irrigation	Mineral	Livestock	Total
TWD2010	L	REFUGIO	8217	1284	0	0	69	7	623	1983
TWD2020	L	REFUGIO	8505	1354	0	0	69	8	623	2054
TWD2030	L	REFUGIO	8609	1378	0	0	69	8	623	2078
TWD2040	L	REFUGIO	8799	1424	0	0	69	8	623	2124
TWD2050	L	REFUGIO	8915	1451	0	0	69	8	623	2151
TWD2060	L	REFUGIO	8877	1442	0	0	69	8	623	2142

**L. Summary and Conclusions**

The primary goal of this report was to summarize the technical elements required as part of the groundwater management plan. Data from the Texas Water Development Board’s DB07 database along with the simulations using the Central Gulf Coast Groundwater Availability Model (CGC-GAM) also developed by the Texas Water Development Board were used to generate the necessary information. The information generated is consistent with the statutory requirements of the Chapter 36 of the Texas Water Code.



## **Appendix B:**

Technical Elements Provided by the Texas Water Development Board  
GAM Report 08-39

# GAM Run 08-39

by Cynthia K. Ridgeway, P.G.

Texas Water Development Board  
Groundwater Availability Modeling Section  
(512) 936-2386  
May 30, 2008

## EXECUTIVE SUMMARY:

Texas State Water Code, Section 36.1071, Subsection (h), states that, in developing its groundwater management plan, groundwater conservation districts shall use groundwater availability modeling information provided by the Executive Administrator of the Texas Water Development Board in conjunction with any available site-specific information provided by the district for review and comment to the Executive Administrator. Information derived from groundwater availability models that shall be included in groundwater management plans include:

- (1) the annual amount of recharge from precipitation to the groundwater resources within the district, if any;
- (2) for each aquifer within the district, the annual volume of water that discharges from the aquifer to springs and any surface water bodies, including lakes, streams, and rivers; and
- (3) the annual volume of flow into and out of the district within each aquifer and between aquifers in the district.

The purpose of this model run is to provide information to the Refugio Groundwater Conservation District for its groundwater management plan. The groundwater management plan for the Refugio Groundwater Conservation District is due for approval by the executive administrator of the Texas Water Development Board before December 29, 2008.

This report discusses the method, assumptions, and results from model runs using the groundwater availability models for the central part of the Gulf Coast Aquifer. Table 1 summarizes the groundwater availability model data required by statute for the Refugio Groundwater Conservation Districts groundwater management plan.

## METHODS:

We ran the groundwater availability model for the central part of the Gulf Coast Aquifer and (1) extracted water budgets for each year of the 1980 through 1999 period and (2) averaged the annual water budget values for recharge, surface water outflow, inflow to the district, outflow from the district, net inter-aquifer flow (upper), and net inter-aquifer flow (lower) for the portions of the Gulf Coast Aquifer located within the district.

## **PARAMETERS AND ASSUMPTIONS:**

- We used Version 1.01 of the groundwater availability model for the central part of the Gulf Coast Aquifer. See Chowdhury and others (2004) and Waterstone and others (2003) for assumptions and limitations of the groundwater availability model for the central part of the Gulf Coast Aquifer.
- The model simulates groundwater flow through four hydrostratigraphic layers. From top to bottom, these layers are: the Chicot Aquifer, Evangeline Aquifer, Burkeville Confining System, and the Jasper Aquifer.
- The mean absolute error (a measure of the difference between simulated and actual water levels during model calibration) in the entire model for 1999 is 26 feet, which is 4.6 percent of the hydraulic head drop across the model area (Chowdhury and others, 2004).
- We used Groundwater Vistas Version 5 (Environmental Simulations, Inc. 2007) as the interface to process model output results.

## **RESULTS:**

A groundwater budget summarizes the water entering and leaving the aquifer according to the groundwater availability model. Selected components were extracted from the groundwater budget for the aquifers located within the district and averaged over the duration of the calibrated portion of the model run (1980 to 1999). The components of the modified budgets shown in Table 1 include:

- Precipitation recharge—This is the areally distributed recharge sourced from precipitation falling on the outcrop areas of the aquifers (where the aquifer is exposed at land surface) within the district.
- Surface water outflow—This is the total water exiting the aquifer (outflow) to surface water features such as streams, reservoirs, and drains (springs).
- Flow into and out of district—This component describes lateral flow within the aquifer between the district and adjacent counties.
- Flow between aquifers—This describes the vertical flow, or leakage, between aquifers or confining units. This flow is controlled by the relative water levels in each aquifer or confining unit and aquifer properties of each aquifer or confining unit that define the amount of leakage that occurs. “Inflow” to an aquifer from an overlying or underlying aquifer will always equal the “Outflow” from the other aquifer.

The information needed for the district’s management plan is summarized in Table 1. It is important to note that sub-regional water budgets are not exact. This is due to the size of the model cells and the approach used to extract data from the model. To avoid double

accounting, a model cell that straddles a political boundary, such as district or county boundaries, is assigned to one side of the boundary based on the location of the centroid of the model cell. For example, if a cell contains two counties, the cell is assigned to the county where the centroid of the cell is located.

#### REFERENCES:

Chowdhury, A.H., Wade, S.W., Mace, R.E., and Ridgeway, C., 2004, Groundwater availability model of the central Gulf Coast Aquifer system—Numerical simulations through 1999: Unpublished Texas Water Development Board report, 114 p.  
[http://www.twdb.state.tx.us/gam/glfc\\_c/glfc\\_c\\_TWDB\\_SummaryReport.pdf](http://www.twdb.state.tx.us/gam/glfc_c/glfc_c_TWDB_SummaryReport.pdf)

Environmental Simulations, Inc. 2007, Guide to Using Groundwater Vistas Version 5, 381 p.

Waterstone Environmental Hydrology and Engineering Inc. and Parsons, 2003, Groundwater availability of the Central Gulf Coast Aquifer: Numerical Simulations to 2050, Central Gulf Coast, Texas Contract report to the Texas Water Development Board, 157 p.



The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G., on May 30, 2008.

Table 1: Summarized information needed for the Refugio Groundwater Conservation District's groundwater management plan. All values are reported in acre-feet per year. All numbers are rounded to the nearest 1 acre-foot.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Chicot	13,172
	Evangeline	0
	Burkeville	0
	Jasper	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Chicot	36,476
	Evangeline	0
	Burkeville	0
	Jasper	0
Estimated annual volume of flow into the district within each aquifer in the district	Chicot	13,002
	Evangeline	6,608
	Burkeville	32
	Jasper	0
Estimated annual volume of flow out of the district within each aquifer in the district	Chicot	6,997
	Evangeline	2,055
	Burkeville	5
	Jasper	0
Estimated net annual volume of flow between each aquifer in the district	Evangeline into Chicot	3,895
	Burkeville into Evangeline	31
	Burkeville into Jasper	0

## **Appendix C:**

### Resolution Adopting the Refugio Groundwater Conservation District Management Plan

FROM :

FPX NO. : 3615261294

Feb. 12 2009 10:39AM P2

Refugio Groundwater Conservation District  
Board of Directors  
**NOTICE OF REGULARLY SCHEDULED MEETING**

NOTICE IS GIVEN IN ACCORDANCE WITH CHAPTER 551, GOVERNMENT CODE (V.T.C.A.) TEXAS OPEN MEETING ACT, that the Refugio Groundwater Conservation District Board of Directors will hold a Regularly Scheduled Meeting on Monday, February 23, 2009 at 6:00 p.m. at the Refugio County Court House, Commissioner's Court Room, 808 Commerce, Refugio, Texas. The following subjects will be considered for discussion and/or action at said meeting:

**AGENDA**

1. Call to Order
2. Approval of Minutes from the December 8, 2008 Regularly Scheduled meeting
3. Financials for the months of November, December and January
4. Public Comment
5. Offers to Purchase Tax Sale Property from Lindbarger Goggan Blair and Sampson, LLP
6. Public Hearing on the Re-Adoption of the Districts Management Plan
7. Adoption of Revised Management Plan
8. Coastal Impact Assistance Program Grant
9. Nominations for Environmental Flows Stakeholder Committee Member
10. 2007-2008 District Audit Report from Goldman, Hunt and Notz, LLP
11. District Rules
12. General Manager's Report
  - a. Region L
  - b. Weather Stations
13. Executive Session pursuant to Sec. 551.071 and Sec. 551.074, Government Code
14. Announce next meeting date
15. Adjourn

Certificate of Posting

The above Notice of Meeting was posted February 12, 2009, at a place convenient to the public on a bulletin board in the Refugio County Courthouse at Refugio, Texas.

WITNESS MY HAND AND SEAL of office on above date.

Ruby Garcia, Clerk County Court  
Refugio County, Texas

By Melanie Poy deputy



## RESOLUTION

Resolution Number: 022320092

### Resolution Adopting the Refugio Groundwater Conservation District Management Plan

WHEREAS on February 5, 2009 the Notice of Hearing was published in the Refugio County Press regarding a public hearing on the adoption of the Refugio Groundwater Conservation District's Management Plan; and

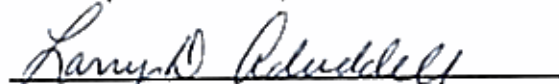
WHEREAS the Refugio Groundwater Conservation District posted its above Notice of Public Hearing to be held on February 23, 2009 at 6:00 pm at the Refugio County Courthouse in Refugio, Texas; and

WHEREAS on August 25, 2008 the Refugio Groundwater Conservation District Board of Directors, with a quorum present, conducted a public hearing regarding the adoption of the Refugio Groundwater Conservation District Management Plan; and

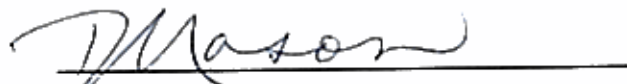
WHEREAS on September 24, 2008 the Refugio Groundwater Conservation District Board of Directors, with a quorum present, conducted a public hearing regarding the adoption of the Refugio Groundwater Conservation District Management Plan; and

NOW THEREFORE BE IT RESOLVED that the Refugio Groundwater Conservation District Management Plan is ADOPTED as described in the Refugio Groundwater Conservation District Management Plan attached hereto and made part hereof for all purposes and that said Management Plan be submitted to the Executive Administrator of the Texas Water Development Board for review and approval.

ADOPTED by a vote of 4 ayes and 0 nays on this  
23<sup>rd</sup> day of February, 2009.

  
Larry Aduddell, President

I, the undersigned, do hereby certify that the above Resolution was adopted by the Board of Directors of the Refugio Groundwater Conservation District on the 23<sup>rd</sup> day of February, 2009.

  
David Mason, Secretary



## RESOLUTION

Resolution Number: 022320091


### Resolution Rescinding the Refugio Groundwater Conservation District Management Plan

WHEREAS on December 8<sup>th</sup>, 2008 the Refugio Groundwater Conservation District adopted the Refugio Groundwater Conservation District Management Plan and said Management Plan was submitted to the Executive Administrator of the Texas Water Development Board for review and approval; and


WHEREAS on December 30<sup>th</sup>, 2008 the Refugio Groundwater Conservation District received notice by letter from the Texas Water Development Board that the District's adopted management plan contains certain discrepancies in the technical data.

NOW THEREFORE BE IT RESOLVED that the Refugio Groundwater Conservation District **RESCINDS** the Refugio Groundwater Conservation District Management Plan as previously adopted.

ADOPTED by a vote of 4 ayes and 0 nays on  
this 23<sup>rd</sup> day of February, 2009.

  
Larry Aduddell, President

I, the undersigned, do hereby certify that the above Resolution was adopted by the Board of Directors of the Refugio Groundwater Conservation District on the 23<sup>rd</sup> day of February, 2009.

  
David Mason, Secretary

## **Appendix D:**

Notice of Hearing on the Refugio Groundwater Conservation District  
Management Plan

### Notice of Public Hearing

Under Section 36.1071 of the Texas Water Code, the Refugio Groundwater Conservation District Board of Director's does hereby give notice of a public hearing to be held on Monday, February 23, 2009 at 6 pm at the Refugio County Courthouse Commissioner's Courtroom, 808 Commerce Street in Refugio, Texas. The purpose of this hearing is to hear public comment on the proposed Management Plan for the District.

Copies of the draft Management Plan may be obtained by written request to the Refugio Groundwater Conservation District at P.O. Box 116, Refugio, Texas 78377. Oral and written comments will be received at the public hearing.

#### Certificate of Posting

The above Notice of Meeting was posted February 2nd, 2009.  
at a place convenient to the public on a bulletin board in the Refugio County Courthouse at Refugio, Texas.

WITNESS MY HAND AND SEAL of office on above date.

Ruby Garcia, Clerk County Court  
Refugio County, Texas

Lucinda H. Cordova deputy

Lucinda H. Cordova

# Refugio County Press Classifieds

Thursday, Feb. 5, 2009

## Garage Sales 490

**REFUGIO-Friday-(2-6), 3-6; Saturday-(2-7), 8-7** 133 Twin Oak Road. Canceled if rain. MW&baby girl clothes, household items, Poker table w/stools, double bed frame, brush-guard, carseats. No earlybirds!

**REFUGIO-GARAGE SALE:** 9-3 p.m. Selling washer & dryer, furniture, baby items, toys, many other items. Come see: 507 E Plasuela.

**WOODSBORO-SEVERAL FAMILIES YARD SALE:** Woodsboro Washateria, Saturday, 8-5 (2/7). Floral arrangements, children's clothes, kitchenware, furniture & misc.

## Miscellaneous 495

**2002 WILDWOOD:** Travel trailer, sleeps 6, 5th wheel, 30', air/heat, self-contained. \$12,000. 361-362-9275

**3 PROM DRESSES:** Fully sequined pink, size XS; lime green w/beads and sequins, never worn, w/tags, size 4; and fully beaded baby blue, size S. (361)526-5130

**BEEVILLE-COLD FEET?** Too young to get married? Wedding dress, size 10, valued at \$3,110, sell for \$1,500 OBO. Never been used. 362-0591

**BEEVILLE-FOR SALE:** Kimball piano and padded bench seat. Great condition, make reasonable offer. Leave message at 832-595-4832.

**BEEVILLE-METAL BUNK BEDS:** Full futon mattress bottom, twin top, \$150. 462-561-561

## Miscellaneous 495

**WOODSBORO- FOR PROFESSIONAL:** Quality Tools. NV Tools is the right company. Walk-ins only, Saturday, 8-12 p.m. 817A Guadalupe St., 361-343-0865

**500 RENTALS**

## Apartments, Unfurnished 560

**1 AND 2 BEDROOM:** Units available. No smokers. No pets. \$375-450 per month, deposit required. 6-month lease. Call 526-2586 after 5:00 or leave message.

## Trailer Spaces 750

**SKIDMORE-TRAILER HOUSE:** No pets. \$500 month, \$200 deposit. (361)287-3430

**800 REAL ESTATE**

## Acreage For Sale 810

## Houses 830

**ATTN: HOMEOWNERS Planning To Sell Your Home? Call PAM CLIBURN THE LOCAL REALTOR YOU CAN TRUST TO HELP! Specializing In Selling Refugio County Real Estate 361-816-3486**



**OPEN RANGE, INC. RESIDENTIAL DIVISION**  
www.texasopenrange.com

**REFUGIO-164 ELLIOTT ROAD:** 2/2, 2300 sq. ft., 20 acres. Pond, workshop, storage building. Edith Clarkson, Realtor. Houses in San Antonio, 210-493-5262.

**REFUGIO-512 CROCKETT:** Country setting, 5/4-1/2, 4400 sq. ft. on 2 acres. Edith Clarkson, Realtor. Houses in San Antonio, 210-493-5262.

**REFUGIO-703 N. ALAMO,** 2 story, 2/1, on 1/2 acre lot. \$2,000 allowance. Edith Clarkson, Realtor. Houses in San Antonio, 210-493-5262.

**RATES:**  
26¢ per word  
**Deadline:**

## Legals 910

**NOTICE OF PUBLIC HEARING**  
Under Section 36.1071 of the Texas Water Code, the Refugio Groundwater Conservation District Board of Director's does hereby give notice of a public hearing to be held on Monday, Feb. 23, 2009, at 6 p.m. at the Refugio County Courthouse Commissioner's Courtroom, 808 Commerce Street in Refugio, Texas. The purpose of this hearing is to hear public comment on the proposed Management Plan for the District. Copies of the draft Management Plan may be obtained by written request to the Refugio Groundwater Conservation District at P.O. Box 116, Refugio, Texas 78377. Oral and written comments will be received at the public hearing.

TO2-5

## ORDER FOR ELECTION PROCEDURE FOR HOSPITAL DISTRICT DIRECTORS ELECTION THE STATE OF TEXAS COUNTY OF REFUGIO

On this the 28th day of January, 2009, the Board of Directors of Refugio County Memorial Hospital, a Hospital District, convened in Regular Session, open to the public, with the following members present, to wit:  
**Sandra Ermis, President**  
**Clifton Pfeil, Vice President**  
**Art Loya, Secretary**  
**Glen Naylor, Jerry Lockett, Ronald Boerner, Kenneth Wright** and the following absent: None, constituting a quorum, and among other proceedings had by said Board of Directors was the following:  
WHEREAS under the terms and provisions of the acts authorizing the crea-

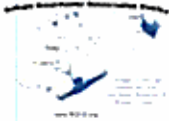
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**BIG**



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## **Appendix E:**

Letter to Surface Water Management Entities, and Relevant Regional  
Water Planning Group



## Refugio Groundwater Conservation District

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**Directors:****President:**

Larry  
Aduddell

**Vice  
President:**

Dallas Ford

**Secretary:**

David  
Mason

**Members:**

Scott Carter

Dr. Gary  
Wright

February 26, 2009

**VIA CMRRR:**

Mr. Bill West

General Manager

Guadalupe Blanco River Authority

933 E. Court St.

Seguin, TX 78155

RE: Refugio Groundwater Conservation District

Dear Mr. West:

Pursuant to Chapter 36.1071, Water Code, following notice and hearing, the District has enclosed for your review the revised District Management Plan for the Refugio Groundwater Conservation District. Also enclosed please find certified copies of the Resolution of the Board of Directors and notice of the public hearing on the District Management Plan.

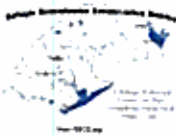
If you have any questions please call me. Thank you for this consideration.

Sincerely,

Carrett Engelking

General Manager

Enclosures



## Refugio Groundwater Conservation District

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**Directors:** February 26, 2009

**President:**

Larry  
Aduddell

**Vice  
President:**

Dallas Ford

**Secretary:**

David  
Mason

**Members:**

Scott Carter

Dr. Gary  
Wright

**VIA CMRRR:**

Ms. Suzanne B. Scott

General Manager

San Antonio River Authority

P.O. Box 839980

San Antonio, TX 78283-9980

RE: Refugio Groundwater Conservation District

Dear Ms. Scott:

Pursuant to Chapter 36.1071, Water Code, following notice and hearing, the District has enclosed for your review the revised District Management Plan for the Refugio Groundwater Conservation District. Also enclosed please find certified copies of the Resolution of the Board of Directors and notice of the public hearing on the District Management Plan.

If you have any questions please call me. Thank you for this consideration.

Sincerely,

Garrett Engelking

General Manager

Enclosures



## Refugio Groundwater Conservation District

---

**Directors:**

February 26, 2009

**President:**

Larry  
Aduddell

**Vice  
President:**

Dallas Ford

**Secretary:**

David  
Mason

**Members:**

Scott Carter  
Dr. Gary  
Wright

**VIA CMRRR:**

Mr. Con Mims, Chair

South Central Texas Regional Planning Group

P.O. Box 839980

San Antonio, TX 78283-9980

RE: Refugio Groundwater Conservation District

Dear Mr. Mims:

Pursuant to Chapter 36.1071, Water Code, following notice and hearing, the District has enclosed for your review the revised District Management Plan for the Refugio Groundwater Conservation District. Also enclosed please find certified copies of the Resolution of the Board of Directors and notice of the public hearing on the District Management Plan.

If you have any questions please call me. Thank you for this consideration.

Sincerely,

Garrett Engelking

General Manager

Enclosures