CCGCD
Colorado County Groundwater Conservation District

James E. Brasher, General Manager
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November 30, 2009

Kevin Ward, Executive Administrator
Texas Water Development Board
P.O. Box 13231
Austin, TX 78711-3231

Dear Mr. Ward:

Please find enclosed a hard copy and a digital copy (on CD) of the adopted District Management Plan for the Colorado County Groundwater Conservation District. This plan was adopted by the District's Board on November 23 and is being submitted for TWDB approval.

The management plan has undergone preliminary reviews by TWDB staff prior to this submittal. As per their direction and according to the rules of the Texas Administrative Code, the following is being included in this official submittal: a signed resolution by the District Board adopting this management plan (Appendix I); evidence of notice and hearing (Appendix J); and, evidence of coordination with all surface water management entities subsequent to the Board adopting the plan (Appendix H).

Because the Colorado County Groundwater Conservation District is a relatively new district, final rules and regulations have not yet been adopted. However, formulation of the rules is underway and the progress can be tracked on the district's website: www.ccgcd.net.

If you have any questions, please feel free to call.

Regards,

James E. Brasher

James E. Brasher
General Manager

CCGCD

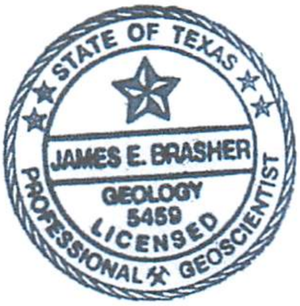
Colorado County Groundwater Conservation District

MANAGEMENT PLAN

Adopted by CCGCD: November 23, 2009

Approved by TWDB:

Prepared by:



James E. Brasher 11/23/09

James E. Brasher, P.G.
Colorado County Groundwater Conservation District

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SECTION 1.1 – District Mission Statement

The mission of the Colorado County Groundwater Conservation District (CCGCD) is to evaluate, preserve and protect the groundwater of Colorado County and to prevent waste and ensure an adequate supply for current and future residents, industry and agriculture.

SECTION 1.2 – Guiding Principals

The CCGCD was formed with the belief that the ownership and pumpage of groundwater is a private property right. It is understood however, that through the confirmation election of the District, the landowners relinquish some of their control over that right for the collective benefit of the community which the District serves. The CCGCD will monitor groundwater quality and quantity in order to better understand the aquifer systems over which it has jurisdiction. This monitoring program will allow the District to take preventive action to avoid drastic changes in water level or water quality that could severely impact local municipalities, businesses, farmers and ranchers. Should it become necessary, the District can regulate the spacing of wells and the amount that large users can pump. Also, it has authority to limit the amount of groundwater that outside interests export from Colorado County should there be insufficient water available to meet desired future conditions.

The rules of the CCGCD will be written with the intent to give all landowners a fair and equal opportunity to use the groundwater resource underlying their property for beneficial purposes. It will be the policy of the District to educate constituents of their responsibility for groundwater conservation and to employ regulation only as a last resort.

This document is intended to be used as a tool to provide continuity in the management of the District. It will be used by CCGCD staff as a guide to insure that all aspects of the goals of the District are carried out. The management plan will also be referenced by the Board for future planning for the District. The Board may modify this document and re-submit it to the Texas Water Development Board (TWDB), should conditions warrant it.

The goals, objectives and performance standards put forth in this planning document have been set at a reasonable level in consideration of existing and future fiscal and technical resources. Conditions may change which could cause a change in the management objectives defined to reach the stated goals. The following guidelines will be used to insure that the management objectives are set at a sufficient level to be realistic and effective:

- The constituency of Colorado County will appraise the District's overall performance in the process of electing or re-electing Board members;
- The interests and needs of the District's constituency shall control the direction of the management of the CCGCD;
- The CCGCD will endeavor to maintain local control of the privately owned resources over which the District has jurisdictional authority;
- The General Manger of the CCGCD will have day-to-day authority over the District's operations and will be wholly accountable to the Board of Directors;
- The Board will evaluate District activities on a fiscal year basis (January 1 through December 31). Any reference to the terms annual, annually or yearly will refer to the fiscal year of the District.

SECTION 1.3 – CCGCD Management Plan Implementation

Section 36.1071.a of the Texas Water Code states that the District shall develop a comprehensive management plan which addresses the following goals: (1) providing the most efficient use of groundwater; (2) controlling and preventing waste of groundwater; (3) controlling and preventing subsidence; (4) addressing conjunctive surface water management issues; (5) addressing natural resource issues; (6) addressing drought conditions; (7) addressing

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The CCGCD Management Plan becomes effective upon approval by the TWDB and remains in effect until a revised plan is approved or ten years from the date of approval as administratively complete. This plan may be revised at anytime; however, the governing board of the CCGCD must, at least once every five years, review the Management Plan to insure that it is consistent with the applicable regional and state water plans. The Board may re-adopt this plan with or without change.

CHAPTER 2 – ABOUT THE CCGCD

SECTION 2.1 – Location and Extent

Subsection 2.1.1 – Colorado County Geography and Topography

Colorado County lies in the Gulf Coast Plain about sixty miles from the coastline and approximately seventy miles west of Houston (Figure 1). The county comprises about 936 mi^2 of land and is roughly rectangular shaped except for a small panhandle on the southwestern part of the county. The county is bounded by Fayette County to the northwest, Lavaca County to the southwest, Jackson County at the end of the panhandle, Wharton County to the southeast and Austin County to the northeast. According to 2000 census, the population of Colorado County was 20,390. The projected 2006 population was about 20,824.

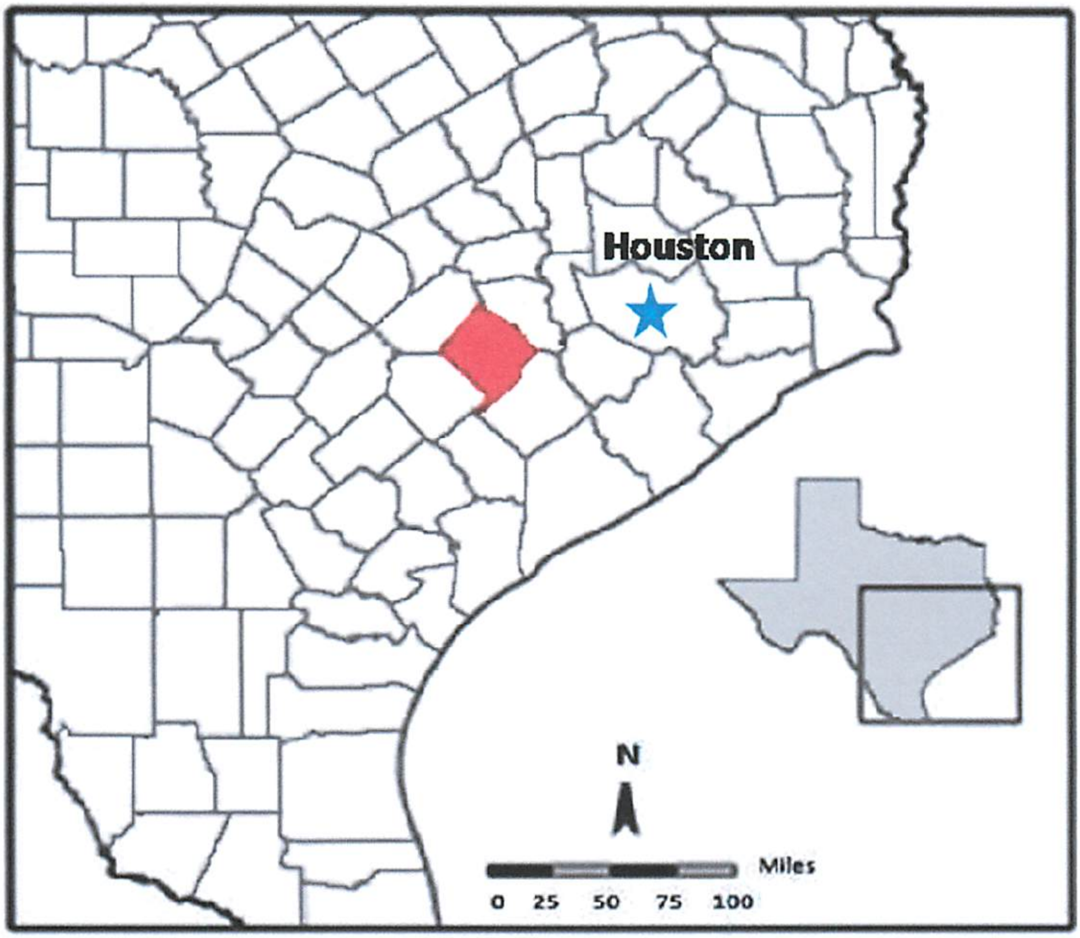

Figure 1: Colorado County shown in red.

The county seat, Columbus, is located roughly in the center of the county. The two other incorporated towns in the county are Eagle Lake to the southeast and Weimar to the west. The county is bisected by the Colorado River which runs northwest-southeast (Figure 2). Elevation ranges from about 150 feet above sea level in the southeastern parts of the county to about 425 feet above sea level in the northwestern parts of the county. The eastern and southern parts of the county comprise relatively flat grasslands. The western and northern parts of the county have a more rolling topography and are more heavily wooded.

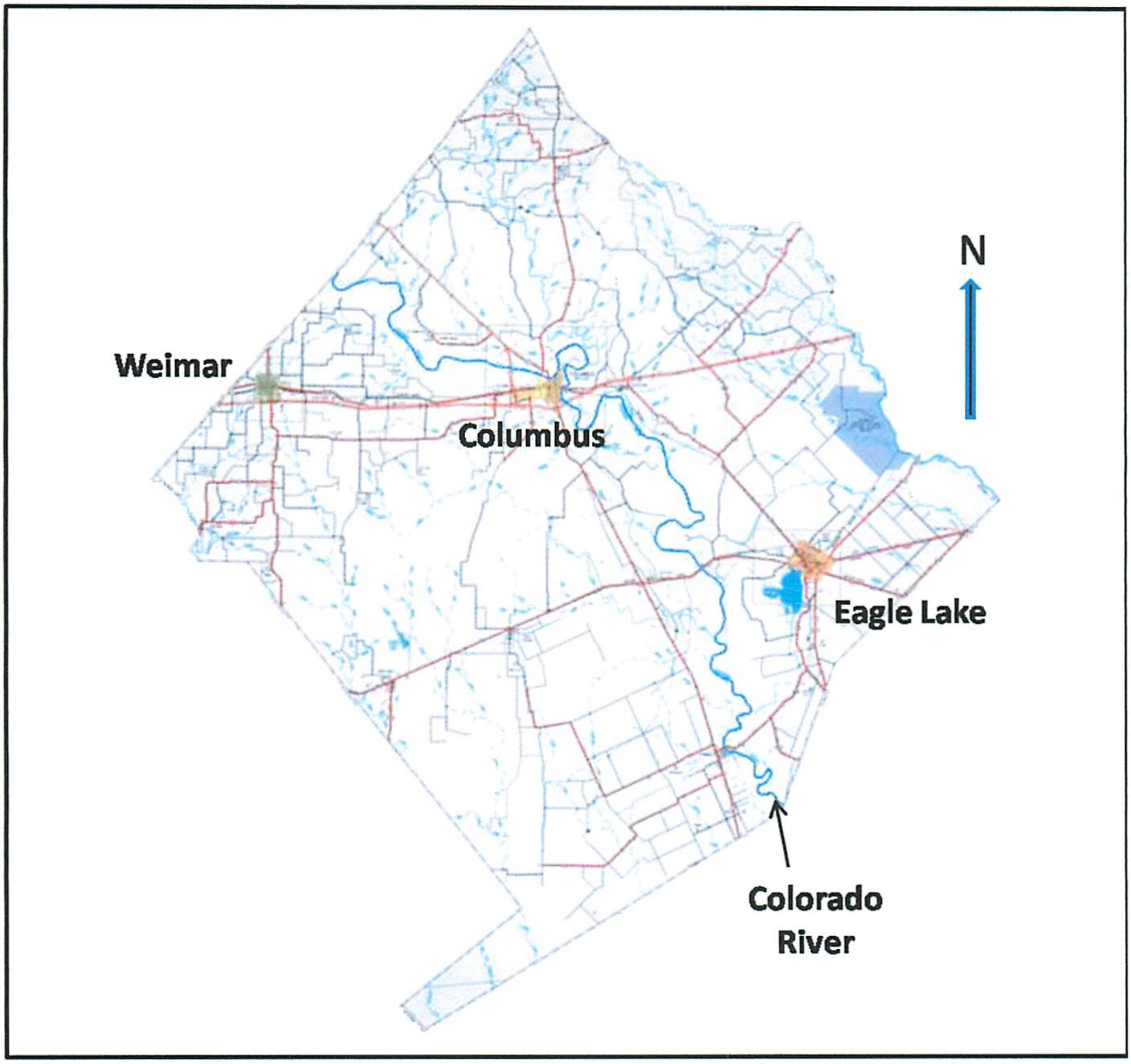

Figure 2: Map of Colorado County showing major towns. Colorado River is in blue and bisects the county in a northwest-southeast orientation.

Since the 1930's, Colorado County has been one of the leading producers of gravel in the state, but since the early twenty-first century, agribusiness, oil-field services and oil-field equipment manufacturing were key elements of the area's economy. As of 2002, there were 1770 farms and ranches in Colorado County covering about 538,000 acres. Of that, forty-nine percent are devoted to pasture and thirty-nine percent to crops. Rice, cattle, corn, nursery plants, poultry, hay and sorghum are the county's chief agricultural products (Odintz, 2008).

Subsection 2.1.2 – Area of Jurisdiction for the CCGCD

With one exception, the boundaries of the CCGCD are congruent with the boundaries of Colorado County, Texas. The noted exception is an approximately 800-acre parcel of land located in the southeastern portion of the county.

The landowner of this acreage elected to join the Coastal Bend Groundwater Conservation District prior to the formation of the CCGCD. According to TWDB calculations, the CCGCD represents about 99.86% of the total area of Colorado County. This figure was used to calculate apportioned District values from Colorado County data.

SECTION 2.2 – General Description of the District

Subsection 2.2.1 – CCGCD Roles and Responsibilities

The Texas Legislature has given groundwater conservation districts the responsibility to manage, conserve, preserve and protect groundwater resources within their jurisdiction. Since no state agency has these responsibilities, it was deemed that these responsibilities were best accomplished on a local basis. Therefore, it will be the responsibility of the CCGCD to develop, promote and implement management strategies that provide for the conservation, preservation, protection, recharging and prevention of waste of the groundwater resources, over which it has jurisdictional authority, for the benefit of the residents of Colorado County. Specifically, the CCGCD will exercise its rights, powers and duties in a manner that will effectively and expeditiously accomplish the purposes of the Act creating the District, Chapter 36 of the Texas Water Code, and Section 59, Article XVI of the Texas Constitution.

Groundwater conservation districts are required by law to develop and submit a groundwater management plan for state approval. A groundwater management plan is a ten-year plan that describes a district's groundwater management goals. These goals include providing for the most efficient use of groundwater, controlling and preventing waste of groundwater and the control and prevention of subsidence. Additionally, the management plan should address conjunctive surface water management issues, natural resource issues, drought conditions and conservation. Each district must also perform the following: adopt rules needed to implement the plan; keep records on water wells and the production and use of groundwater; permit and register certain wells; and, adopt and follow administrative and financial procedures (Rules 356.5 and 356.6, Texas Administrative Code, relating to management plan and plan submittal, respectively). The CCGCD is required to submit its management plan to the TWDB for approval.

Subsection 2.2.2 – History of the CCGCD

The Colorado County Groundwater Conservation District was created under authority of Section 59, Article XVI of the Texas Constitution and in accordance with Chapter 36 of the Texas Water Code by the 80^{th} Texas Legislature with the Act of May 23, 2007, House Bill 4032, ("An act relating to the creation"), as a governmental agency and a body politic and corporate. The CCGCD was later confirmed by the voters of Colorado County in November 2007, in accordance with the Underground Water Conservation Districts Act passed by the Texas Legislature in 1949 (currently codified as Chapters 35 and 36 of the Water Code, Vernon's Texas Codes Annotated).

In January, 2007, a Colorado County citizen's group was organized to present and promote the case for forming a groundwater conservation district. This group gave numerous presentations to local organizations and also brought in speakers with expertise in groundwater conservation. In April 2007, the group received enabling legislation through the Colorado County Commissioner's Court and in July of that year, documentation from the State of Texas was received and seven directors were appointed to the Board of the proposed Colorado County Groundwater Conservation District.

In November of 2007, the proposal for the CCGCD was once again placed on the ballot for voter approval. Also at that time, elections were held for the Board of Directors for the CCGCD. The voters of Colorado County approved the creation of the District and the elected Board members were sworn in shortly after the election.

Subsection 2.2.3 –Governing Board

The governing Board of Directors for the CCGCD consists of seven members and is elected under the general laws of Texas. Of the seven members, four are elected by each of the county's four precincts. The remaining three members are at-large positions that represent the towns of Columbus, Eagle Lake and Weimar.

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Table 1 shows the first elected Board of Directors for the newly formed CCGCD. Originally, Bill Briscoe was elected for Place 2 (Precinct 2), but resigned shortly after the election. Thomas Hudec was appointed (per Water Code, Section 36.051.c) to replace him until the 2008 elections. The subsequent election for that position was for an unexpired term that will end in 2010.

Position	Name	Place	End of Term
President	Tom Kelley	4 / Precinct 4	November, 2010
Vice-President	Mike Wostarek	3 / Precinct 3	November, 2008
Secretary	Marian Schonenberg	5 / Columbus (At-Large)	November, 2008
Treasurer	Jim Wiese	6 / Eagle Lake (At-Large)	November, 2010
Director	Betty Schiurring	1 / Precinct 1	November, 2008
Director	Thomas Hudec*	2 / Precinct 2	November, 2010
Director	Scott Brasher	7 / Weimar (At-Large)	November, 2008

Table 1: Results of the 2007 election. Board of Directors representing precincts were elected under the general election laws of Texas. (*) Thomas Hudec was appointed to replace Bill Briscoe.

Elections for Directors of CCGCD were held November 4, 2008. Places 1, 3, 5 and 7 were up for full four-year term elections. Place 2 was up for the unexpired term until 2010. Results of the elections are shown in Table 2.

Position	Name	Place	End of Term
President	Tom Kelley	4 / Precinct 4	November, 2010
Vice-President	Scott Brasher	7 / Weimar (At-Large)	November, 2012
Secretary	Marian Schonenberg	5 / Columbus (At-Large)	November, 2012
Treasurer	Jim Wiese	6 / Eagle Lake (At-Large)	November, 2010
Director	Betty Schiurring	1 / Precinct 1	November, 2008
Director	Thomas Hudec*	2 / Precinct 2	November, 2010
Director	Whyman Psencik	3 / Precinct 3	November, 2012

Table 2: Results of the 2008 election. Board of Directors representing precincts were elected under the general election laws of Texas. (*) Thomas Hudec was elected to unexpired term.

Subsection 2.2.4 –Daily Operations

The person employed by the Board as General Manager shall be the chief administrative office of the District and shall have full authority to manage and operate the affairs of the District, subject to Board approval (Texas Water Code, Section 36.056). The General Manager is responsible for recommending employment of all persons necessary for the proper handling of the business and operation of the District and for recommending their compensation for Board approval. The General Manager is furthermore empowered to obtain official or legal status in matters of concern or interest to the District in public hearing processes, or other proceedings when Board action to establish an official Board of Director position cannot be obtained in a timely manner. Such matters will be brought to the Board for action at the earliest possible convenience (Colorado County Groundwater Conservation District Bylaws, February, 2008).

The General Manager may delegate his or her administrative duties as may be necessary to effectively and expeditiously accomplish his or her duties, provided, however, that no such delegation shall ever relieve him of responsibilities under the Texas Water Code, the act creating the District, the CCGCD Rules and Bylaws, or Board orders (Colorado County Groundwater Conservation District Bylaws, February, 2008).

All documents, reports, taped recordings, and minutes of the District shall be available for public inspection in accordance with the Texas Open Records Act. Upon application of any person, the District, when appropriate, will furnish copies, certified or otherwise, of any of its proceedings or other official acts of record or of any paper, map, or document files in the District office. Certified copies shall be made under the hand of the office secretary or General Manger and affixed with the seal of the District.

Persons who are furnished any such copies may be assessed a charge for the documents pursuant to policies established by the General Manager based on the reasonable cost of furnishing such copies (Colorado County Groundwater Conservation District Bylaws, February, 2008).

The CCGCD has established its office at 425 Spring St., Columbus, TX 78934. The District's mailing address is P.O. Box 667, Columbus, TX 78934. These addresses are subject to change pending a Board resolution. Regular office hours of the District shall be 8:00 am to 5:00 pm, Monday through Friday, except for District holidays or as may be set from time to time by the General Manager (Colorado County Groundwater Conservation District Bylaws, February, 2008). The Board of Directors hired James E. Brasher to the role of General Manager effective October 13, 2008.

Subsection 2.2.5 – Rules and Regulations

Under the provisions of the Texas Water Code, Section 36.1071.f, the District shall adopt rules necessary to implement the management plan. The rules and regulations for the CCGCD are contained in a separate document entitled "Colorado County Groundwater Conservation District Rules and Regulations."

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CHAPTER 3 – THE GULF COAST AQUIFER AND THE ASSOCIATED REGIONAL SUBSURFACE STRATIGRAPHY

SECTION 3.1 – Introduction

The Gulf Coast Aquifer forms a wide belt along the Gulf of Mexico running from Florida up to the northern Gulf, back along the Texas coast and into Mexico. In Texas, the aquifer provides water to all or parts of 54 counties and extends from the Rio Grande northeastward to the Louisiana-Texas border (Figure 3). The aquifer consists of complex interbedded clays, silts, sands and gravels of Cenozoic age, which are hydrologically connected to form a large, leaky artesian aquifer system. This system consists of four major components, each of which can be correlated to different sedimentary formations (Ashworth and Hopkins, 1995).

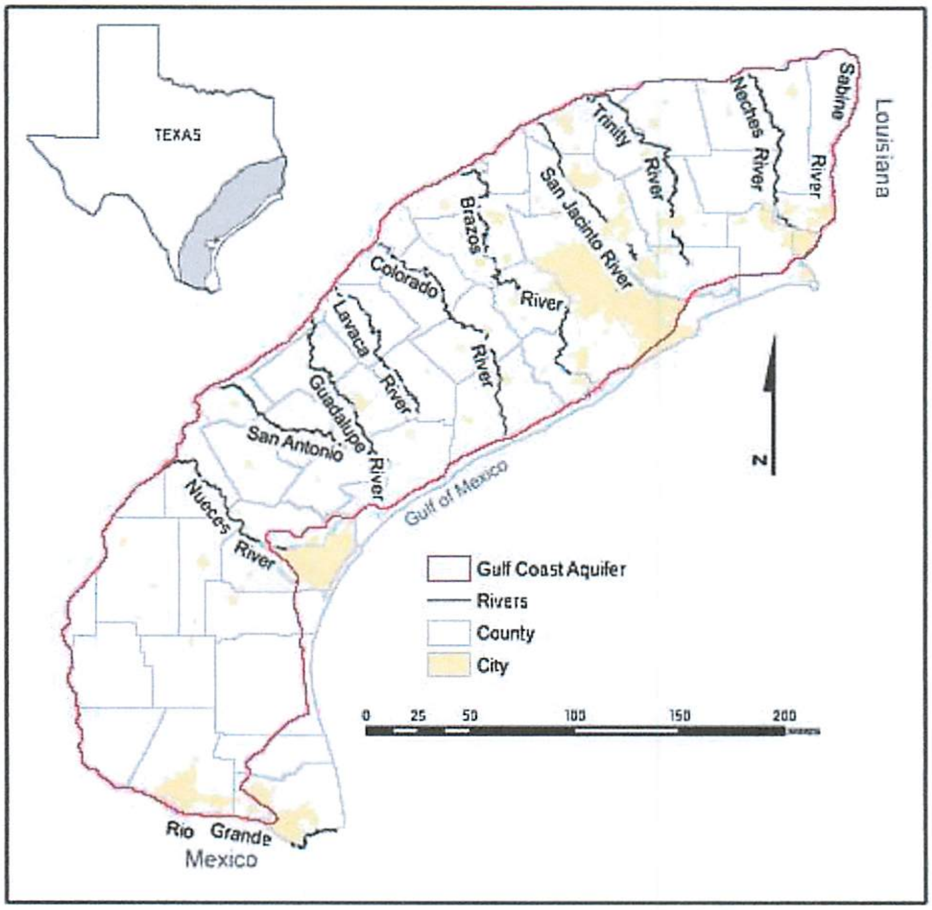


Figure 3: Regional extent of the Gulf Coast Aquifer. Modified from Chowdhury and Turco, 2006.

SECTION 3.2 – Depositional and Structural Setting

More than 200 million years ago, the Earth's land masses were generally clumped together and bore no real semblance to the continent's modern day configuration. It was during the early Mesozoic that large land masses began to move away from one another forming large basins. One of these basins was the precursor to the modern day Gulf of Mexico and became the site of massive deposition of sediments over the course of many millions of years. The sections below will use the geological system and series names depicted in Figure 4 as a reference for when certain structural elements occurred and when key geological formations were deposited.

Millions of Yrs Ago	Era	System
0 – 2	Cenozoic	Quaternary
2 – 65		Tertiary
65 – 136	Mesozoic	Cretaceous
136 – 190		Jurassic
190 – 225		Triassic

Millions of Yrs Ago	Era	System	Series
0 – 0.1	Cenozoic	Quaternary	Holocene
0.1 – 2			Pleistocene
2 – 7		Tertiary	Pliocene
7 – 26			Miocene
26 – 37			Oligocene
37 – 53			Eocene
53 – 65			Paleocene

Figure 4: Geological time scale. Left: Mesozoic and Cenozoic Eras. Right: Series of the Cenozoic and their associated ages.

During the early phases of the development of the Gulf of Mexico, the basin was relatively small and did not have good circulation with the open ocean. As a result, over many millions of years, evaporation exceeded water influx. Specifically, during the Jurassic, salt deposition abounded, especially south and east of the Balcones Escarpment. Areas of especially thick salt accumulations occurred in the Rio Grande and Houston Embayment (Figure 5). Basinward sliding of this salt layer may have had localized effects on the late Eocene deposition and post-deposition structure (Knox et al., 2007).

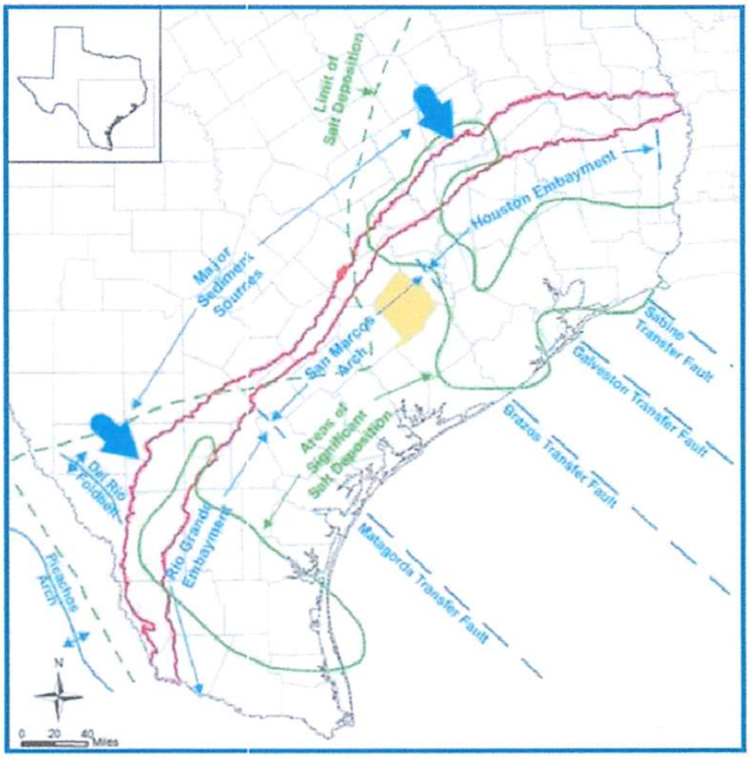


Figure 5: Structural setting of the region of interest during Eocene-Oligocene time (from Knox et al.., 2007). Colorado County designated in yellow.

Another impact on late-Eocene structuring was NW-trending transfer faults that initiated during the opening of the Gulf of Mexico (Figure 5). These transfer faults appear to have influenced salt tectonics in the Gulf of Mexico (Huh et al., 1996) and may have had minor lateral movement throughout the Tertiary (Knox et al, 2007). Note that the San Marcos Arch is roughly bounded to the northeast and southwest by the Brazos and Matagorda Transfer Fault Systems respectively.

The geologic formations of the mid- to late-Eocene dip toward the modern coastline and are part of the progressive filling of the Gulf of Mexico Basin by sand, silt and clay carried from the Rocky Mountains and the mountains of northern Mexico, as well as from other areas of Texas and the western part of the North American continental interior. These sediments, deposited in rivers and deltas, and even farther offshore, created a gradual down warping (subsidence) of the Earth's crust along the edges of the basin. Thus, the mid- to late-Eocene sediments dip more steeply toward the gulf than the current land surface (Knox et al., 2007). Additionally, because sediment deposition has outpaced the slow subsidence, the current shoreline has built farther toward the center of the Gulf of Mexico than the shoreline that existed during the late Eocene. Deposition during that time was focused in the Houston and Rio Grande Embayments (Figure 5), where down warping of the crust by tectonic forces was greatest. The northwest-southeast trending San Marcos Arch represents a long-standing tectonically uplifted area of Central Texas and acts to separate the two major embayments (Knox et al., 2007). Colorado County is located on the eastern portion of the San Marcos Arch closer to the Houston Embayment (Figure 5).

The Oligocene and Miocene were marked by a series of major and minor regressive and transgressive events attributable largely to sea-level fluctuations. With successive regressions, deltas were larger and prograded progressively further basinward until the next transgressive event (Morton et al., 1985). Subsidence of rapidly deposited sediments caused the formation of a thick zone of deposition and the formation of associated growth faults. With the deposition came the associated movement of underlying salts which formed diapirs, commonly along faults (Culotta et al., 1992). Though salt deposition did occur over Colorado County, it was most prevalent in the Houston Embayment and therefore the impact of salt diapirism is minimal in the county.

Progradation of the coastline and shelf edge continued through the lower Miocene, starting with lagoonal mudstone and shore-zone sand and followed by fluvial-delta plain sand and mudstone. Growth faulting at the lower Miocene shelf edge produced an enormously thick slope section offshore (Culotta et al., 1992).

Unconformably overlying the lower Miocene sequence is the middle-upper Miocene sequence (Morton et al., 1988). These sediments consist of mostly non-marine fluvial plain deposits.

The main drainage of the continental interior shifted from the western Gulf (i.e. Texas and Mexico) to the ancestral Mississippi River during the Miocene. As a result, the Pliocene-Pleistocene section in Texas is relatively thin. Although the Willis Formation of the early Pleistocene does outcrop, it cannot be readily distinguished in the seismic data from the underlying upper Miocene deposits (Culotta et al., 1992).

SECTION 3.3 – Overview of the Gulf Coast Aquifer

Figure 6 shows stratigraphic and hydrologic units that make up the Gulf Coast Aquifer. Though technically these sub-aquifers comprise the larger Gulf Coast Aquifer, for the sake of simplicity, they will henceforth be referred to simply as aquifers in ensuing sections. The deepest of the four units is the Catahoula which is sometimes referred to as an aquifer and sometimes as a confining layer. Three geologic formations comprise the Catahoula Aquifer: the Frio; the Anahuac; and, the Upper Catahoula Sand. Note that west of Colorado County, the Catahoula Sandstone is commonly referred to as the Catahoula Tuff Formation.

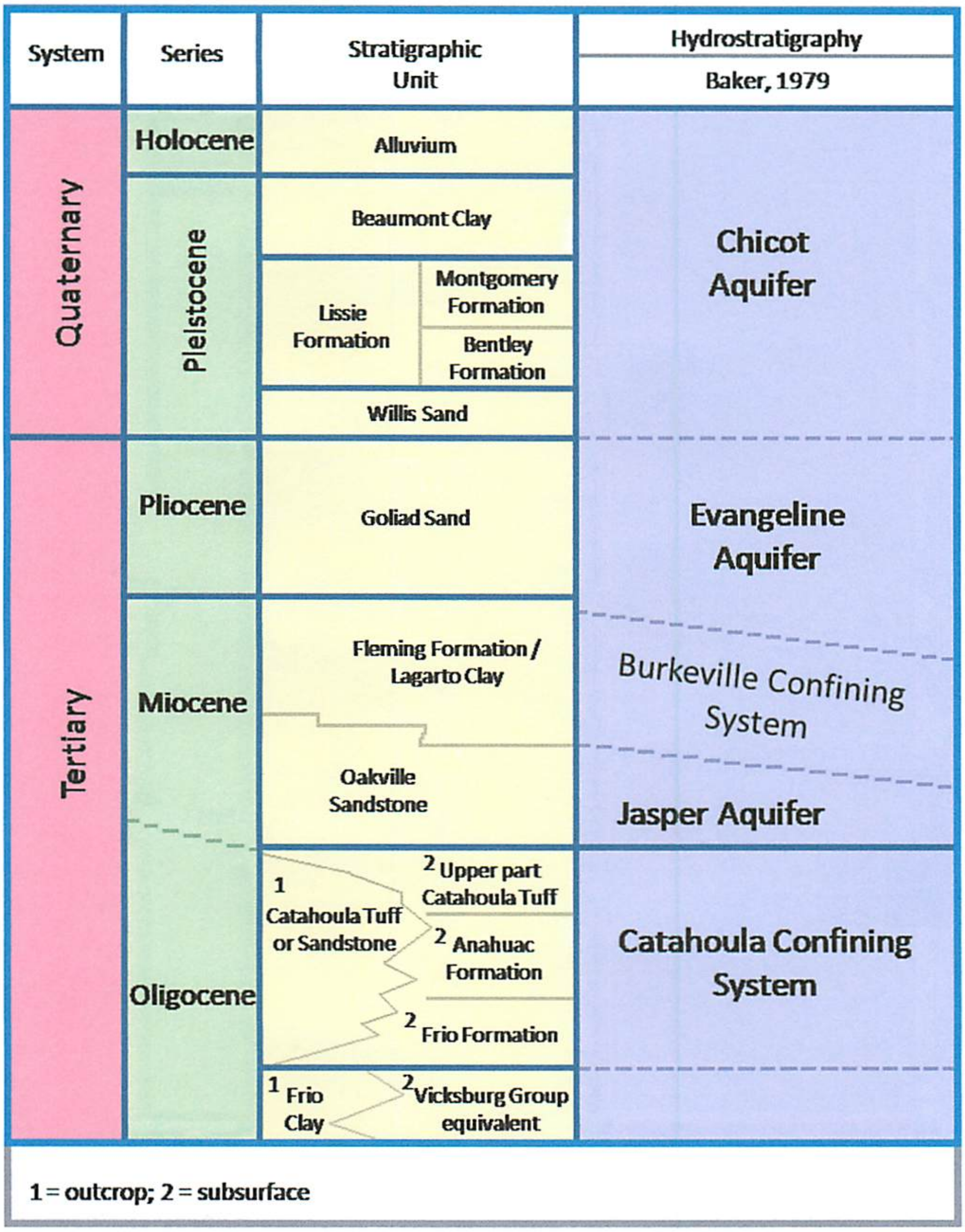


Figure 6: Hydrostratigraphy and the associated stratigraphic units that comprise the Gulf Coast Aquifer (from Baker, 1979).

Overlying the Catahoula is the Jasper Aquifer which is primarily contained within the Oakville Sandstone Formation. The Burkeville Confining Layer consists of the Fleming Formation and separates the Jasper Aquifer from the overlying aquifers (Figure 6).

Above the Burkeville Confining Layer are the two shallowest aquifers of the Texas Gulf Coast Aquifer. The Evangeline Aquifer is immediately above the Burkeville and is made up entirely of the Goliad Sand. Overlying the Evangeline is the shallowest of the aquifers, the Chicot (Figure 6). The Chicot Aquifer consists of the Willis Sand, the Lissie Formation (sometimes subdivided as the Bentley and Montgomery Formations) and the Beaumont Clay (Baker, 1979). Relatively recent alluvial deposits, largely from the Colorado River, comprise the uppermost surface sediments. Regionally, 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).

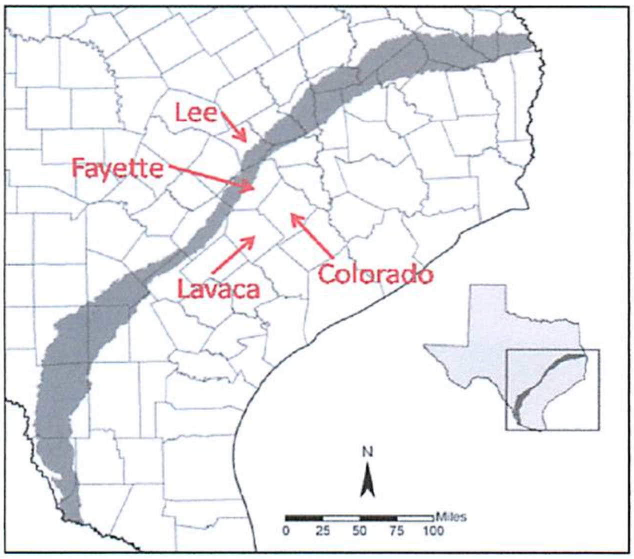
Water quality is generally good in the shallower portion of the Gulf Coast Aquifer. Groundwater containing less than 500 mg/l total dissolved solids (TDS) is usually encountered to a maximum depth of 3,200 feet in the aquifer from the San Antonio River Basin northeastward to Louisiana, inclusive of Colorado County (Ashworth and Hopkins, 1995).

Underlying the Gulf Coast Aquifer is the Yegua-Jackson Aquifer which, in 2002, was upgraded by the TWDB from the status of "other aquifer" to a classification of "minor aquifer" (Knox et al., 2007). This aquifer consists of the formations that comprise the Jackson and Upper Claiborne Groups and lies just north of the extensive Gulf Coast Aquifer roughly paralleling the present-day coastline.

SECTION 3.4 – Eocene Stratigraphy and the Yegua-Jackson Aquifer

Subsection 3.4.1 – Jackson Group and Yegua Formation

The Middle Eocene is composed of Claiborne Group formations, most notably the Yegua Formation. The Yegua along with formations of the Jackson Group comprise the Yegua-Jackson Aquifer which parallels the present-day coastline of the Gulf of Mexico (Figure 7). The Eocene/Oligocene Jackson Group (Figure 8) consists of the Whitsett, Manning, Wellborn and Caddell Formations (Knox et al., 2007) and is dominated by thick fluvial sands and gravels. It outcrops in Fayette and Lee Counties in a band approximately three to eight miles in width and along a northeasterly trend. The older formations of the Jackson Group are present in the subsurface (Loskot et al., 1982), but are not further differentiated in this report. The Whitsett Formation, the uppermost of the Jackson Group, outcrops in the extreme northwestern portion of Lavaca County. In the subsurface, the Jackson Group is overlain by the Vicksburg Formation (Coleman, 1990), but in the outcrop area, it is overlain by the Catahoula which is a combination of the Vicksburg and Frio Formations (Galloway, 1990).



Series			Group	Formation
Tertiary	Oligocene			Catahoula
	Eocene-Oligocene		Jackson	Whitsett
	Eocene	Upper		Manning
				Wellborn
				Caddell
		Middle	Upper Claiborne	Yegua
				Cook Mountain

Figure 7 (left): Regional extent of the Yegua-Jackson Aquifer. Figure 8 (right): The stratigraphic units that comprise the Yegua-Jackson Aquifer (from Preston, 2006).

Knox et al. (2007) divided the Yegua-Jackson Aquifer four major chronostratigraphic units. From deepest to shallowest, they are: the Lower Yegua; the Upper Yegua, the Lower Jackson; and, the Upper Jackson. Each of the four units is bounded above and below by time synchronous maximum flooding surfaces dominated by fine-grained (clay-rich) deposits. These units tend to impede vertical fluid flow. Maximum flooding surfaces also bound laterally contiguous sand-rich sediments which form high-flow units within the aquifer.

Overall, the stratigraphy of the Yegua-Jackson interval consists of interbedded sands, silts and clays deposited in settings ranging from fluvial to marginal marine (deltaic and barrier/strand plain) to shallow marine shelf

(Galloway, et al, 1979). Deltas from the middle of the Texas coast northeastward have greater fluvial influence and thus have large sand bodies more often aligned perpendicular to the coast. Depositional maps for the key Yegua-Jackson layers were constructed by Knox et al (2007).

Subsection 3.4.2 – Yegua-Jackson Aquifer

In 2002, the TWDB elevated the status of the Yegua-Jackson interval from the status of "other aquifer" to "minor aquifer". This was the result of the large number of wells and the concomitant large use of water reported in the TWDB database (Knox et al., 2007). The Yegua-Jackson Aquifer exists predominantly in the outcrop or near-outcrop areas of the Yegua Formation and Jackson Group. The outcrop area extends northeast-southwest covering roughly the northwestern portion of Fayette County (Figure 7). Thickness of the total Yegua-Jackson interval ranges from less than 1,800 feet over the San Marcos Arch to more than 3,000 feet in the adjacent Houston and Rio Grande Embayments of East and South Texas respectively. Structural dips vary from about 20 to 360 feet/mile (Preston, 2006), with the greater dips occurring in the down dip regions and across the San Marcos Arch.

The fluvial and deltaic sands typically provide moderate amounts of fresh to slightly saline water in some areas of the outcrop, or slightly down dip (Preston, 2006). The water quality overall is marginal for municipal and domestic purposes due to constituent levels exceeding recommended maximum limits for TDS, chloride, sulfate and calcium carbonate. Samples from 31 wells had an average TDS concentration of 1557 mg/l.

The Yegua-Jackson Group is a source for significant source of groundwater for Fayette County, but does not act as a water source for Colorado County. It is possible, that should the need arise in the future, the extreme northwestern portions of the county might access the Yegua-Jackson Aquifer.

SECTION 3.5 – Oligocene Stratigraphy and the Catahoula Sandstone Aquifer

Although there are some differences in the literature, for the purposes of this report, the Oligocene-aged sediments constitute the base of the Gulf Coast Aquifer in Texas (Chowdhury and Turco, 2006) (Figure 8). The contact between the Oligocene-aged sediments and the underlying Eocene-aged sediments is mostly indistinguishable based solely on lithology. Paleontological analyses are more commonly used to identify differences between the two units. Most of the marine deposits in the lower part of the Oligocene belong to the Vicksburg Group or equivalent strata (Hosman, 1996) (Figure 6). The Vicksburg Group is a regional confining unit that consists primarily of marine clays and thin-bedded sandstones.

The Catahoula Aquifer consists almost entirely of the Catahoula Sandstone Formation. Note that west of Colorado County, the Catahoula Sandstone is most often identified as the Catahoula Tuff. Also, in down dip areas, the Catahoula Sandstone Aquifer is instead considered to be a confining unit.

Subsection 3.5.1 – Frio Clay / Vicksburg Group

There is uncertainty as to the exact subsurface equivalent of the Oligocene-aged Frio Clay formation or whether it should even be a distinct stratigraphic unit from the Catahoula. Baker (1979) considers the Frio to lie at the base of the Oligocene sequence and is a time-equivalent of the subsurface Vicksburg Group - a marine unit of Oligocene age (Figure 6). According to Hosman (1996), most of the marine deposits in the lower part of the Oligocene belong to the Vicksburg Group or equivalent strata; however, Baker (1979) does suggest that the Vicksburg equivalent east of Karnes County (inclusive of Colorado County) may be at least a partial time-equivalent of the Whitsett Formation.

The Frio Clay consists of an assemblage of sediments that are almost entirely composed of dark, greenish-gray colored clays above the sands below (Sellards et al., 1932). The clays may contain some gypsum and can be laminated and interbedded with sandy clays, sands and sandstone. In the subsurface, the formation ranges from 250 to 600 feet in thickness.

Subsection 3.5.2 – Catahoula Sandstone Formation

The Catahoula Sandstone can be divided in the subsurface into three distinct formations (Figure 6). The Frio Formation (distinct from the Frio Clay), the Anahuac and the Upper Catahoula Sand (sometimes classified as Miocene-aged). The Catahoula outcrops in the extreme northwestern part of Lavaca County. Near the outcrop, the Catahoula is sandy, but becomes tuffaceous downdip. Thus, the unit's name was modified from Catahoula Tuff to Catahoula Sandstone east of Lavaca county where the formation becomes sandier (Darton et al., 1937). In Colorado County, the Catahoula consists of alternating beds of clay, tuff and sandstone (Loskot et al., 1982).

The Catahoula Formation is bounded unconformably by the Frio Clay below and the Oakville Formation above (Baker, 1979). The basal contact of the Catahoula Formation is delineated by the presence of coarse-grained sand and conglomerate. The Catahoula is a pyroclastic unit that has been independently mapped on the outcrop by various geologists with minimal modification. It is composed of interbedded and inter-lensing sand and clay. The thickness of the Catahoula increases down dip at a large rate. Downdip, the Catahoula Formation rapidly thickens and at about 2,800 feet below sea level, a gulfward thickening accretionary wedge of fossiliferous marine clay appears in the upper section. This clay, called the Anahuac Formation, is one of the most discernible formations in the subsurface (Baker, 1979 and 1986). It is overlain by the upper part of the Catahoula Formation.

Subsection 3.5.3 – Catahoula Sandstone Aquifer/Confining Unit

The sandy units of the Catahoula may well be in hydraulic continuity with the overlying sands of the Jasper Aquifer (Loskot et al., 1982). However, the water quality is generally poorer than the overlying Jasper Aquifer. Further downdip, the Catahoula contains a greater percentage of fine-grained material. In these areas, it acts as a confining unit and is often designated as the Catahoula Confining Unit (Loskot et al., 1982; Davidson and Mace, 2006).

The Frio Clay/Vicksburg Group acts as a regional confining unit and consists primarily of marine clays and thin-bedded sandstones.

SECTION 3.6 – Miocene Stratigraphy and the Jasper Aquifer

The Oakville Sandstone largely comprises the Jasper Aquifer though the uppermost Catahoula may also contribute to the aquifer (Figure 6).

Subsection 3.6.1 – Oakville Sandstone Formation

The Oakville Sandstone unconformably overlies the Catahoula Sandstone and is almost entirely composed of laterally discontinuous terrigenous clastic sediments (Loskot et al., 1982). Surface samples show that the sand is composed of 40% quartz, 25% chert and significant amounts of feldspar and calcite cement. Silicified wood and reworked Cretaceous fossils are also reported (Solis, 1981). The lower boundary between the fluvial-delta plain facies and the underlying unit is evident on seismic where highly reflective strata onlap a less reflective unit, then overstep the lower sequence boundary (Culotta et al., 1992). Lagoonal mudstone and shore-zone sand and gravel typify the Oakville progradational sequence. Massive cross-bedded sandstone beds at the base grade upward into more thinly bedded sandy shale and clay near the top.

The Oakville formation is a rock-stratigraphic unit that is distinguished and delineated on the basis of lithologic characteristics. It is only west of the Brazos River (in Washington County) where the Oakville Sandstone can be delineated with some confidence as a separate formation and where it's predominantly sandy character distinguishes it from the overlying and slightly less sandy Fleming Formation (Baker, 1986). In the central part of the coastal plain where the Oakville is most prominent, the formation is predominantly sand and is not only readily distinguishable from the underlying Catahoula, but also the overlying Fleming Formation which is dominantly composed of clay and subordinate amounts of sand. The thickness of the Oakville can range from 0 to 950 feet. A simplified version of the Seguin Sheet provided in Figure 9 is depicted in Figure 10 and will be referenced further in ensuing sections. The outcrop band of the Oakville ranges from about five to ten miles in width and trends northeasterly through Fayette County (Figure 10).

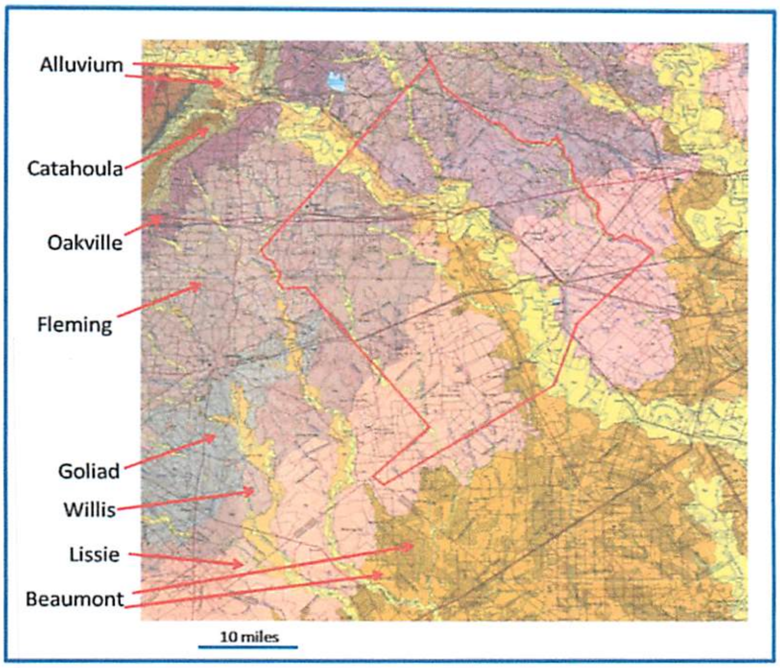


Figure 9: Outcrop map of Quaternary and Tertiary age formations in Colorado County. Colorado County outlined in red. Source: Geologic Atlas of Texas, Seguin Sheet, 1979, Bureau of Economic Geology (Barnes, 1974).

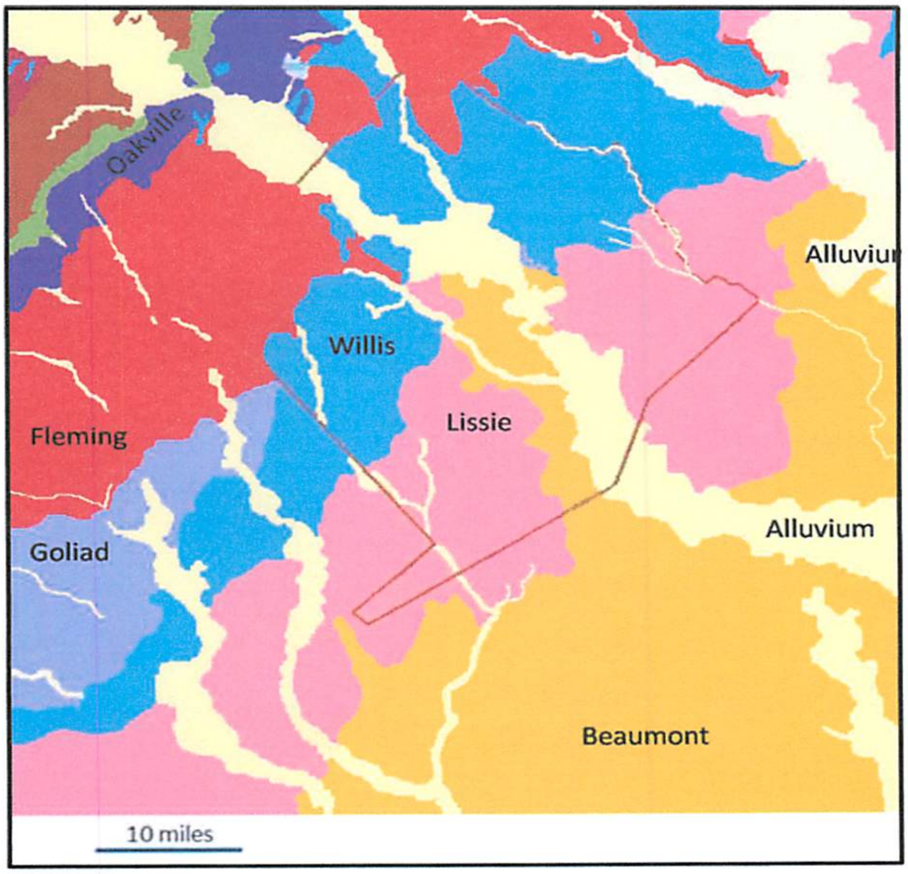


Figure 10: Simplified depiction of outcrops. Colorado County outlined in red. Modified from Figure 9.

Subsection 3.6.2 – Jasper Aquifer

The Jasper Aquifer was not delineated west of Washington, Austin and Fort Bend Counties until Baker (1979) made more detailed delineations of the Jasper and other related hydrologic units. Hydrologic boundaries were defined from observable lithologic features rather than from inferred geologic time lines (Baker, 1986). The position of the base and top of the Jasper Aquifer in southeast Texas transgresses stratigraphic boundaries along strike and downdip. The base of the aquifer typically coincides with the stratigraphic lower boundary of the Oakville sandstone though in some places it lies within the uppermost portion of the Catahoula Sandstone. The top of the Jasper Aquifer most often coincides with the top of the Oakville Sandstone.

The Jasper Aquifer ranges in thickness from about 200 feet near the outcrop, to about 2,500 feet in Wharton County. The average range in thickness within the zones of fresh to slightly saline water is about 200 to 800 feet (Loskot et al., 1982). The maximum thickness occurs in the region where the aquifer contains moderately saline water to brine. An average thickness of the aquifer within the zone of water having concentrations of less than 3,000 mg/l of TDS is from about 1,000 to 1,500 feet (Baker, 1986).

In the northern parts of Lavaca and Colorado Counties, the Jasper Aquifer contains fresh water, though the water quality varies widely. Very hard water can be found in most of the wells less than 300 feet deep to soft in water from two wells about 1,000 feet deep (Loskot et al., 1982). Sodium calcium bicarbonate or calcium bicarbonate type water is produced from the shallow wells. The TDS concentration ranged from 366 mg/l to 1,179 mg/l in wells with corresponding depths of 288 feet to 980 feet. Electric logs would suggest that the salinity of the water in the Jasper Aquifer increases downdip (Loskot et al., 1982).

SECTION 3.7 – Pliocene/Miocene Stratigraphy and the Evangeline Aquifer

Figure 11 shows a northwest-southeast cross-section through Colorado, Wharton and Matagorda Counties. The Beaumont, Lissie and Willis Formations make up the Chicot Aquifer and the Upper and Lower Goliad Layers represent the Evangeline Aquifer. Note that the formations dip toward the southeast (coastline) and that the degree of dip is progressively greater with depth and hence older in age.

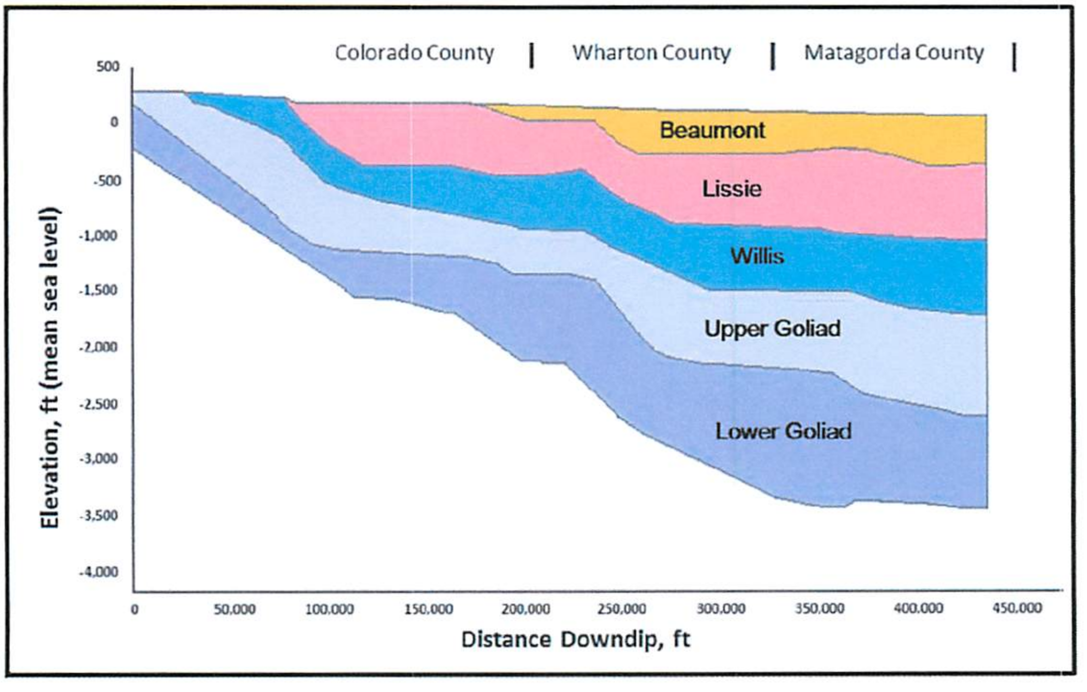


Figure 11: Cross-section through Colorado County showing the stratigraphy of the Evangeline and Chicot Aquifers (modified from Young et al., 2006).

During the Pliocene, the Goliad Sand was deposited and is the largest component of the Evangeline Aquifer. The uppermost portion of the Fleming Formation is also designated as part of the Evangeline, but most of it corresponds to the Burkeville Confining Layer (Figure 6).

Subsection 3.7.1 – Miocene Fleming Formation

The Fleming Formation is a minor component of the Evangeline Aquifer, but is the dominant component of the Burkeville Confining Layer. Though the Lagarto Clay and the Fleming are often used synonymously, the latter is currently considered to be the conventional designation (Solis, 1981). Plummer (1932) described the Lagarto (Fleming) as consisting of 75% marl or clay, 15% sand and 10% silt, with the clay beds being thicker and more massive and the sand beds being thinner and less massive than those of the Oakville. Surface samples of the Fleming consist of ocher to yellowish, green and gray calcareous shales and clays containing minor amounts of feldspar crystals, chert, and reworked Cretaceous fossil fragments. The intercalations of light-brown, gray and yellowish calcareous sands are composed of medium-grained sand (Solis, 1981). As the uppermost Miocene-aged unit in the coastal plain, the Fleming Formation has been mapped extensively on the surface in Texas outcropping along the northwestern part of Colorado County and the southeastern portion of Fayette County (Figure 10). The band of outcrop averages about 15 miles through Colorado County.

Because of complex facies changes in the subsurface however, the Fleming can often be lithologically indistinct from the underlying Oakville Sandstone. Massive clays interbedded with calcareous sand and shale (Rogers, 1967) is indicative of long-term shoreline stability punctuated by small-scale progradational events (Culotta et al., 1992; Zeng et al., 1996). Generally, west of the Brazos River, the clay-rich Fleming can be more easily separated from the sandier Oakville. Deep wells near the coastline penetrate marine facies of the Fleming which carry a diagnostic fauna (Baker, 1979).

Subsection 3.7.2 – Pliocene Goliad Sand

Unconformably overlying the lower Miocene Fleming sequence is the Goliad. Morton et al (1988) consider the Goliad Formation to be middle to upper Miocene. However, for this report, the Goliad will be considered Pliocene in age. The Goliad consists of mostly non-marine fluvial plain deposits (Culotta et al., 1992) and is the dominant component of the Evangeline Aquifer. The upper Goliad Formation is commonly ten percent lower in sand-class material than the overlying Willis and Lissie Formations (Young et al., 2007). Sand-class values for the lower Goliad Formation are about seven percent lower than those for the upper Goliad, with a series of distinctly sandier areas trending northwest to southeast across the area. Young et al. (2007) also noted that the boundary between the upper and lower Goliad appears to be mildly erosional over much of the subsurface area and coincides with an abrupt increase in sand content above the boundary. Sand content in the upper Goliad is greater in Colorado County than in areas further south, but there is not a specific area of sandiness in the Lower Goliad (Figure 12). The sandiest areas in the Goliad Formation may be narrow, on the order of ten miles wide and strongly northwest-southeast trending reflecting a series of sedimentary depositional settings from fluvial to bay fill (Young et al., 2006).

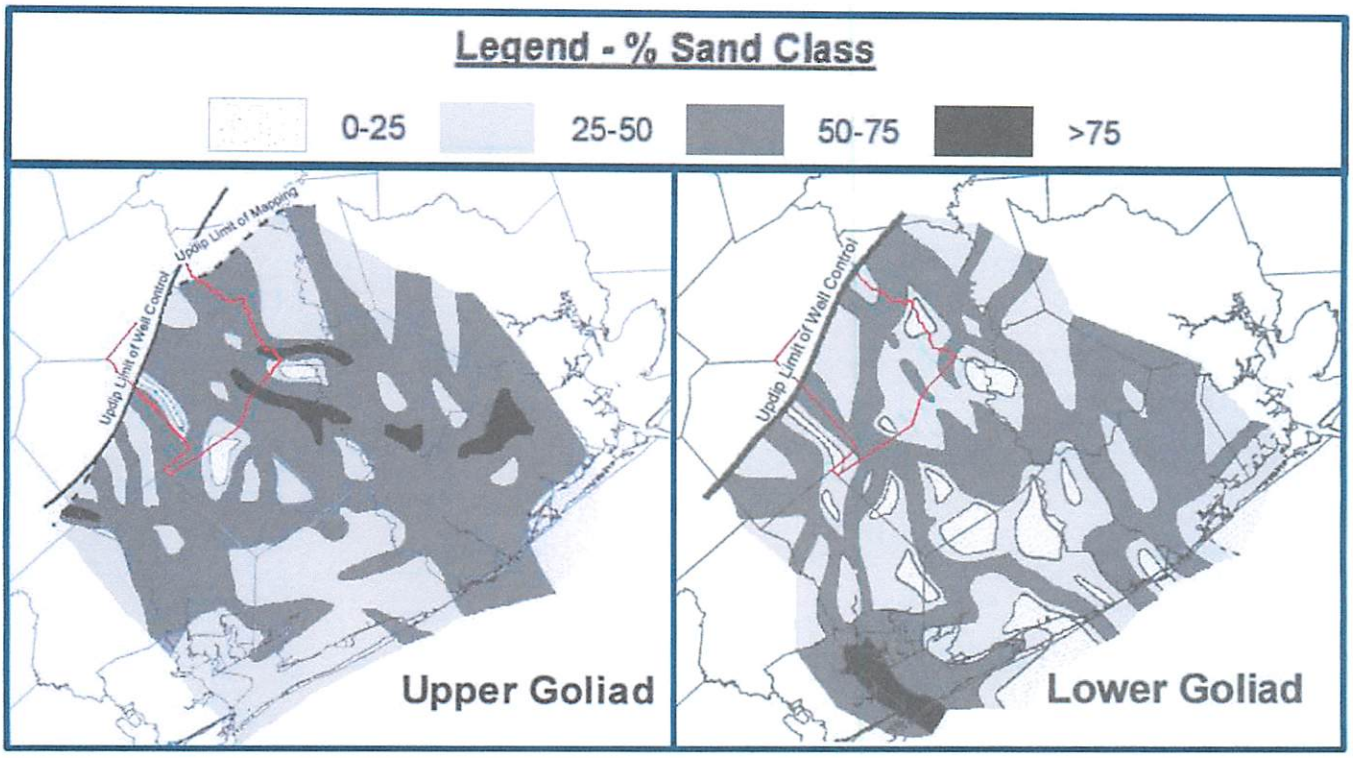


Figure 12: Sand-class distribution maps for the Upper (left) and Lower (right) Goliad formations (from Young et al., 2006). Colorado County is outlined in red.

Surface samples of Goliad sediments have been described as light-gray, medium- to course-grained unconsolidated sands that are locally well bedded and cross bedded (Solis, 1981). It includes pinkish or greenish calcareous clays, marls, clayey sands and cherty conglomerates at the base (Plummer, 1932). Thicknesses of individual sand beds in the Goliad range from a few feet to about 100 feet in the sequences that contain fresh and slightly saline water. The aggregate thickness of the sand units is as much as 470 feet. Unlike most of the other units, Carr et al. (1985) states that the Goliad Sand is overlapped by younger formations and is not exposed at the surface in the coastal area. The Goliad outcrops in a band between five and ten miles across Lavaca County; however, in Colorado County, it is overlain by younger sediments and only outcrops in small areas just east of the Colorado River (Figure 10). Likewise, Loskot, et al (1982) note that the Evangeline (hence the Goliad Sand) outcrops in central Lavaca County and subcrops in central and northern Colorado County. They further note that the Goliad is absent in northwestern Lavaca County in the outcrop area of the Burkeville Confining Layer (presumably the Fleming Formation).

Subsection 3.7.3 – Evangeline Aquifer and the Burkeville Confining Layer

The Evangeline Aquifer consists of mostly discontinuous layers of sand and clay of roughly equal thickness. The aquifer consists of the Goliad Sandstone Formation and of the uppermost section of the Fleming Formation. The aquifer can range from near surface in Lavaca County to more than 2,300 feet below mean sea level in Wharton County. The maximum thickness of the fresh-water section in the Evangeline is about 1,380 feet in southeastern Wharton County.

Because the Evangeline and overlying Chicot aquifers are geologically similar, the basis for separating them is primarily a difference in hydraulic conductivity. The up-dip portion of the Evangeline Aquifer exists under water-table conditions whereas down dip, it is confined (Carr et al., 1985).

Fresh water occurs in the Evangeline Aquifer throughout most of Colorado County and can occur as deep as 2,000 feet in east-central Wharton County (Loskot et al., 1982). Wells drilled into the deeper sands (1,600 ft) yield sodium bicarbonate type water whereas shallower sands (230 ft) tended to contain calcium bicarbonate type water. About half of the water samples collected in the Evangeline Aquifer were analyzed for dissolved solids and about one-half of these samples contained 500 mg/l or more.

The hydraulic characteristics of the Evangeline Aquifer in Colorado and Lavaca Counties were determined from aquifer-test data. The transmissivities ranged from 480 to 3,400 ft^2/d. Hydraulic conductivities ranged from 5.5 ft/d to about 24 ft/d and averaged about 12 ft/d in wells screened only in the Evangeline (Loskot et al., 1982).

The clays of the Fleming Formation typically dominate the Burkeville Confining Layer which underlies the Evangeline Aquifer. In the subsurface, the Burkeville Confining Layer can commonly be identified by electric logs as a series of clay layers that act as a regional impediment to vertical water flow. Exceptions to this are in areas where salt has pierced the surface and in areas where there is an unusually high percentage of sand (Carr et al., 1985). Indeed, parts of the unit in the outcrop area and in the shallow subsurface do contain sufficient amounts of saturated sand to supply small quantities of fresh to slightly saline water to rural-domestic and livestock wells (Loskot, et al, 1982). Thickness of the Burkeville Confining Layer typically ranges from 300 to 500 ft.

SECTION 3.8 – Quaternary Stratigraphy and the Chicot Aquifer

Delineation of the Pleistocene units - Willis Sand, Bentley Formation, Montgomery Formation and the Beaumont Clay - is exceedingly difficult due to the lithologic similarity of the sediments and lack of paleontological control (Baker, 1979). Nevertheless, the zones were differentiated as far as practical through the use, in part, of electric logs. Figure 11 shows the relationship of the geologic formations associated with the Chicot Aquifer in a northwest-southeast trending cross-section. The Beaumont Clay, Lissie and Willis Formations comprise the Chicot Aquifer. The cross-section does not depict the recently deposited alluvium associated with the Colorado River. Although technically a separate unit, it is not currently modeled as such by the TWDB and will be lumped into the Chicot Aquifer for this report. As with the Evangeline stratigraphic units, the formations that comprise the Chicot also dip toward the coastline in a southeasterly direction. Some of the shallowest layers that comprise the Chicot Aquifer are absent in the northern portions of Colorado County. An area of increased dip occurs along a zone in central Colorado County and is sub-parallel to the coast (Figure 10). Northwest of this zone, both the Lissie and Willis Formations thin abruptly as they come to the surface, each exhibiting mild erosional truncations of the respectively underlying formation. At outcrop, these two formations exist over large areas (Figure 10), most likely as a thin veneer of gravel as little as ten feet thick (Young et al., 2006).

Subsection 3.8.1 – Pliocene/Pleistocene Willis Sand Formation

The Willis has been mapped as outcropping through the center of Colorado County in a northeastern-southwestern direction (Figure 10). For the purposes of this report, this orientation of the outcrop will be considered valid. However, in his field work of Colorado County, Pickens (2009) is of the opinion that what is often mapped as Willis outcrop is actually part of a sandy surface layer that does not extend into the subsurface. This sand layer may be a high terrace associated with gravel or erosion from the Goliad Formation. Nevertheless, the Willis will be considered the lowermost and hence oldest of the Quaternary sediments, unconformably lying on the Pliocene Goliad Sand.

Plummer (1932) described the Willis as consisting of reddish, coarse and gravelly sands and subordinate clays attaining a maximum surficial thickness of about 350 ft. The Willis Formation, along with the Lissie, average about 65 percent sand and contain the highest sand-class percent material of any zone that comprises the Chicot. The highest percentages of sand tend to be toward the northeast (Young et al., 2006).

Because of the frequent difficulty in delineating the base of the Willis Sand, even with electric logs, the Chicot Aquifer can be difficult to define. At the surface, the base of the Chicot has been picked at the most landward edge of the oldest undissected coastwise terrace of Quaternary age. In the subsurface, the Chicot has been delineated by the presence of a higher sand-clay ratio than in the underlying Evangeline. In some places, a prominent clay layer was used as the boundary (Baker, 1979).

The Willis and Lissie Formations that comprise the upper and lower Chicot Aquifer are distinctly sandier than the Upper Goliad that comprises the upper Evangeline Aquifer. Sand content of the Chicot Aquifer is greatest in the up-dip half of the study area. The sandiest areas in both aquifers may be narrow, on the order of ten miles wide and strongly northeast-southwest trending. This trend reflects a series of sedimentary depositional settings from fluvial in the up-dip (northwest) area to bay fill in the mid-dip, and a mix of coastal, incised valley, and shelf in the downdip (southeast) area.

Subsection 3.8.2 – Pleistocene Lissie Formation

The overlying Lissie Formation (Figure 6) is sometimes subdivided into two formations; the Bentley Formation and the overlying Montgomery Formation. Lissie sediments consist of reddish, orange, and gray fine-to-coarse grained and cross bedded sands that contain intercalations of clays and sandy clays. They include abraded fossils and lentils of gravel of varied composition (Solis, 1981). The upper part of the Lissie, locally, is calcareous and includes calcareous concretions and iron-manganese nodules. Sediments were deposited as meanderbelt, level, crevasse splay, and floodbasin facies (Barnes, 1974).

Electric log profiles of the Willis and Lissie Formations were interpreted as reflecting a regional depositional transition from fluvial channel and intervening floodplain facies updip (northwestward) to a mixture of bay fill, coastal, incised valley and shelf facies downdip (toward the current shoreline). Fluvial channel facies vary from broad, sand-dominated regions, such as in the northwest are of the Lissie Formation, to a series of narrow northwest-southeast trending areas, such as in the northwest part of the Willis Formation (Young et al., 2006). Downdip of the fluvial facies are broad sandy areas that contain some upward-coarsening log profiles that represent bay head deltas such as across the Lissie and Willis Formations. Bay fill facies include river-fed deltas that filled bays with sandy sediments as wells as more clay-dominated quiet-water bay settings. Down dip narrow sandy areas that are parallel to and just landward of the current coastline often contain blocky or slightly upward-coarsening log profiles and are interpreted as a mix of coastal facies including barrier island, shoreline and delta front settings. Large regions of clay-dominated sediment in downdip areas that are crossed by northwest-southeast-trending sandy regions are interpreted as shelf settings during periods when sea level is high and as a broad area of dry land across which entrenched rivers (incised valleys) flow southeastward to the coast when sea level is low (a cycle that repeats every several hundred thousand years).

Subsection 3.8.3 – Pleistocene Beaumont Clay Formation

The Beaumont Clay Formation is the shallowest of the regionally deposited formations that comprise the Chicot Aquifer. Except in areas along the present-day Colorado River (Figure 10), the formation pinches out southeast of Colorado County in Wharton County. Shoreline transgressions and regressions during alternating glacial and interglacial periods likely impacted the distribution of Pleistocene sediments (LeBlanc and Hodgson, 1959), including the Beaumont Clay. The formation consists of clay, silt and sand, but also includes concretions of calcium carbonate, iron oxide and iron-manganese oxides common in zones of weathering. The surface of the Beaumont is almost featureless with poorly defined meander belts and levee ridges (Barnes, 1974; Proctor et al., 1974). It can weather into rich, dark soils crossed by meandering, low sand ridges (Solis, 1981).

Subsection 3.8.4 – Holocene Alluvium

The youngest of the zones of consideration for the Chicot Aquifer is the Holocene (Recent) alluvium section. In the case of the Chicot Aquifer, the alluvium would mostly be associated with the floodplain of the Colorado River, which bisects the county, and its major tributaries. Also included would be low terrace deposits three to eight feet above the floodplain. The Holocene alluvial deposits occur as broad bands one half to five miles wide, along the Colorado River (Figure 10) and in thicknesses that are estimated not to exceed 60 feet. The alluvial deposits consists of the following: dark gray to dark brown clay and silt, often calcareous; sand with a high component of quartz; cherty gravel; and, high amounts of limestone, igneous and metamorphic rock fragments, probably reworked from terrace deposits. Fluvial morphology is well preserved with point bars, oxbows and abandoned channel segments clearly visible (Barnes, 1974; Proctor et al., 1974).

Wells in the alluvium are shallow and provide water in only small quantities for livestock and rural domestic purposes.

Subsection 3.8.5 – Chicot Aquifer

The Chicot Aquifer is the main source of ground water in Colorado County. This aquifer overlies the Evangeline and is composed of water-bearing units of the Willis Sand, Lissie and Beaumont Clay Formations as well as Quaternary alluvium. The Chicot is defined as including all water deposits from the land surface to the top of the Evangeline Aquifer.

The base of the Chicot ranges from zero near the outcrop in Colorado County, to 1,100 feet below mean sea level in southern Wharton County. In much of the coastal area, the Chicot Aquifer consists of discontinuous layers of sand and clay of about equal total thickness. If laterally continuous layers cannot be confidently identified and correlated, then the aquifer is said to be undifferentiated. In some parts of the coastal area however (mainly within the Houston area), the aquifer can be separated into an upper and lower unit (Jorgensen, 1975). Young et al., (2006) have set out to differentiate the Chicot and Evangeline aquifers. They divide the Chicot into an upper unit corresponding to the Lissie Formation and a lower unit corresponding to the Willis Sand Formation. To accomplish this, they use formation boundaries and geologic timelines established by outcrop geology and micropaleontologic evidence from the subsurface. They also employed over 600 electric logs for correlation purposes.

More recently, Young et al. (2007) generated a new model that broke the Chicot Aquifer into four layers. Besides the previous designation of the Willis Sand and Lissie Formations, the group also generated layers for the Beaumont Clay and the Quaternary alluvium. As observed on Figure 10 the Beaumont Clay pinches out up dip. The alluvium layer however is represented as a thin widespread layer across the entire region. As mentioned previously, the Colorado River alluvium has not been differentiated from underlying layers. Unlike the Colorado, the alluvium of the Brazos River has not only been differentiated, but is considered a "minor aquifer" by the TWDB. Furthermore, the Brazos Alluvium Aquifer has been modeled for the potential of recharge enhancement (O'Rourke, 2006). It is possible that at some point in the future, the Colorado River alluvium might be broken out as a separate aquifer form the Chicot.

The Chicot and Evangeline Aquifers generally are in hydraulic continuity and can be difficult to differentiate. In the subsurface, the Chicot is differentiated from the Evangeline by its greater percentage of sand and correspondingly a greater hydraulic conductivity (Baker, 1979; Jorgensen, 1975; Carr et al., 1985). Transmissivity values range from 2,000 ft^2/d to more than 46,000 ft^2/d. Hydraulic conductivities range from 29 ft/d to more than 200 ft/d and average about 80 ft/d. The aquifer is under water-table conditions in its up dip part, becoming confined down dip.

Fresh water is present county-wide where the Chicot is present. Water in this reservoir is, for the most part, a calcium bicarbonate type; but water from about 20% of the samples analyzed was a sodium bicarbonate type. The Chicot Aquifer contains hard to very hard water, but the concentrations of TDS vary greatly (Loskot et al., 1982). Water quality from the alluvial deposits is generally adequate for most uses in Colorado County although quantity is limited. These shallow wells use the alluvial deposits as a sand filter to provide some measure of water treatment.

CHAPTER 4 – WATER BUDGET

SECTION 4.1 – Overview

The water budget can be described as the manner and amount of water that flows through a groundwater system as well as the amount of groundwater that is stored at any one time. A conceptual model of the water budget helps in the understanding of the groundwater flow system by describing how recharge, discharge, groundwater-surface interactions, and cross-formational flow take place through the aquifers (Chowdhury et al., 2004). The aquifer is impacted by the movements of water into, through and out of a particular study area. Prior to development (i.e. before pumping commenced), there was a steady-state system where the water that entered the aquifer, primary from recharge, was balanced by water that exited the aquifer (Figure 13). Once pumping commences, the system enters into a transient state where, for some period of time, more water is leaving the system than is entering it. With time, water is released from storage and another steady-state system may develop (Figure 13).

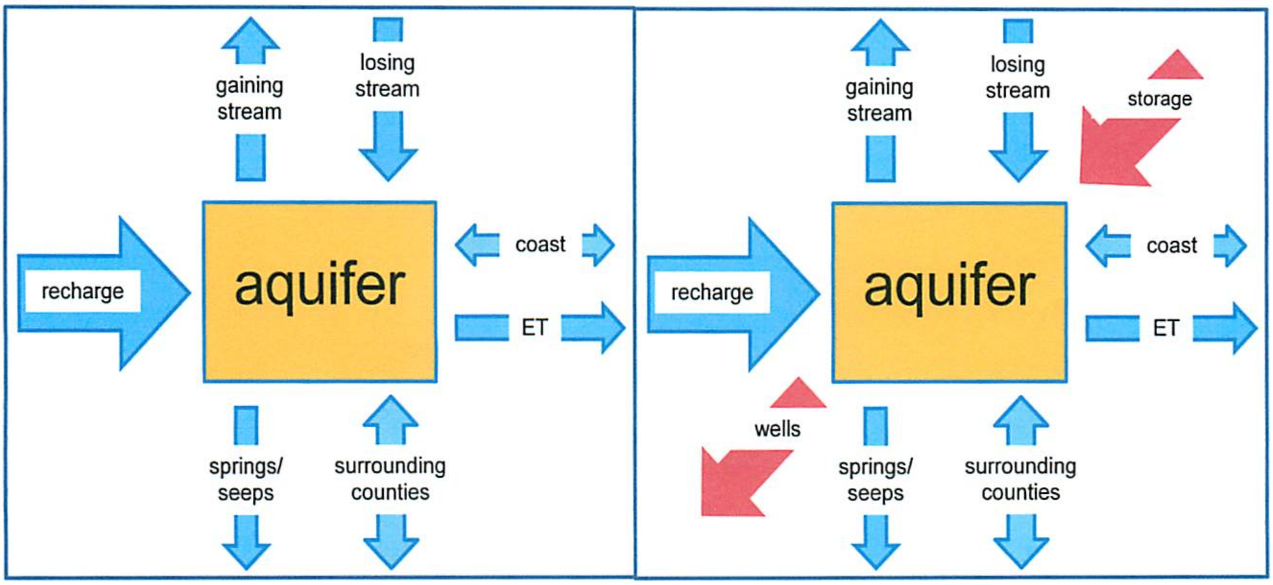


Figure 13: Left, aquifer in pre-development. Right, aquifer during transient period. Groundwater is pumped from wells and released from storage. ET equals Evapotranspiration.

Chowdhury et al., 2004, in their work on the Central Gulf Coast simulation model, estimated that in their steady-state model, about 620,000 acre-feet of water flows through the aquifer system annually. They further suggest that 30% of the total flow sources from rainfall that falls directly on the land surface in the outcrop areas of the model, 69% seeps into the aquifers from the numerous streams and the remaining small portions from the reservoir. Their estimates of cross-formational flow between the different aquifers and confining units are (1) about 20,000 ac-ft/yr from the Evangeline to the overlying Chicot Aquifer, (2) about 6,000 ac-ft/yr from the Burkeville Confining System to the overlying Evangeline Aquifer, and (3) about 1,400 ac-ft/yr from the Jasper Aquifer to the Burkeville Confining System. Of the total annual flow of 620,000 ac-ft, about 84% discharges into the streams, and 16% discharges through the general head boundary into the Gulf of Mexico. Baseflow discharges to the rivers are higher than inflow making most of the streams gaining in the area.

For the purposes of this report, the study area of the Gulf Coast Aquifer will be in an area that generally encompasses Colorado County. GAM Run 09-009 (Oliver, 2009) was performed by the TWDB at the request of the CCGCD in order to provide required information on recharge by precipitation, discharge from the aquifer to springs and surface water bodies, and the annual flows into and out of the district. Trends that hold true for the Central Gulf Coast Model as a whole don't necessarily hold true for the localized area around Colorado County. A summary of results of GAM Run 09-009 is provided in Appendix B. Other GAM Run results are summarized in Appendix C.

CHAPTER 4 – WATER BUDGET

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The water budget can be described as the manner and amount of water that flows through a groundwater system as well as the amount of groundwater that is stored at any one time. A conceptual model of the water budget helps in the understanding of the groundwater flow system by describing how recharge, discharge, groundwater-surface interactions, and cross-formational flow take place through the aquifers (Chowdhury et al., 2004). The aquifer is impacted by the movements of water into, through and out of a particular study area. Prior to development (i.e. before pumping commenced), there was a steady-state system where the water that entered the aquifer, primary from recharge, was balanced by water that exited the aquifer (Figure 15). Once pumping commences, the system enters into a transient state where, for some period of time, more water is leaving the system than is entering it. With time, water is released from storage and another steady-state system may develop (Figure 15).

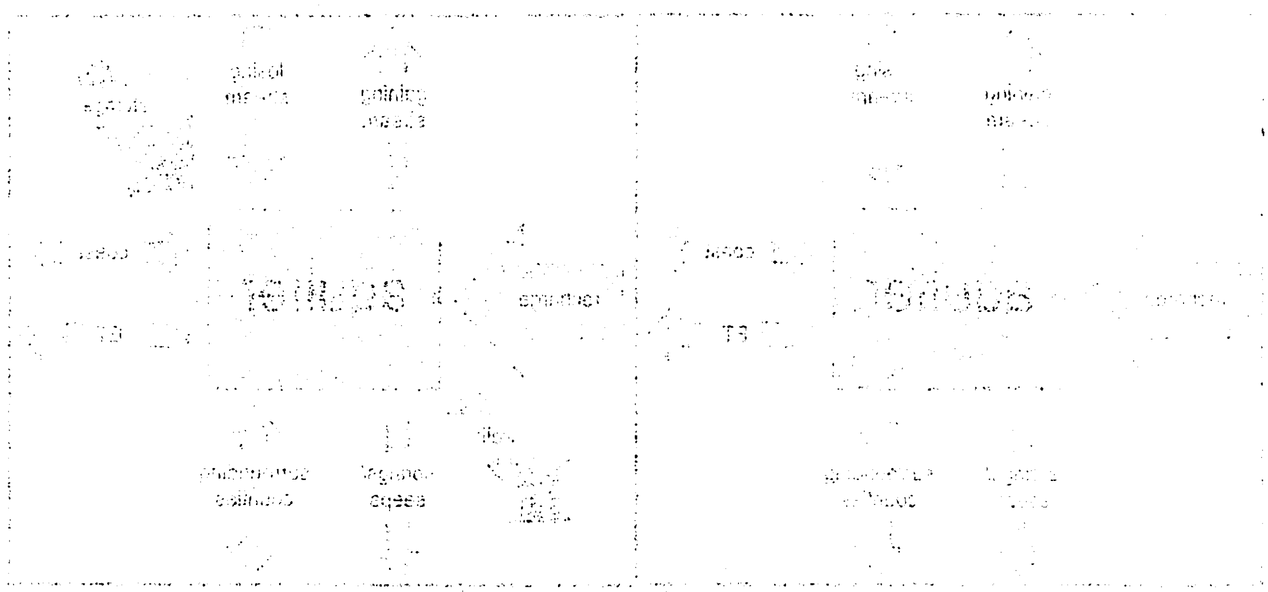

Figure 15. Left, aquifer in pre-development. Right, aquifer during transient period. Groundwater is pumped from wells and released from storage. ET equals Evapotranspiration.

Chowdhury et al. (2004), in their work on the Central Gulf Coast simulation model, estimated that in their steady-state model, about [illegible] acre-feet of water flows through the aquifer system annually. They further suggest that [illegible] of the total flow comes from rainfall that falls directly on the land surface in the outcrop areas of the model, [illegible] seeps into the aquifers from the numerous streams and the remaining small portions from the reservoirs. Their estimates of cross-formational flow between the different aquifers and confining units are (1) about 20,000 ac-ft/yr from the Beaumont to the overlying Chicot Aquifer, (2) about 6,000 ac-ft/yr from the Burkeville Confining System to the overlying Evangeline Aquifer, and (3) about 1,500 ac-ft/yr from the Jasper Aquifer to the Burkeville Confining System. Of the total annual flow of 600,000 ac-ft, about 84% discharges into the streams, and 16% discharges through the general head boundary into the Gulf of Mexico. Baseflow discharges to the rivers are higher than inflows making most of the streams gaining in the area.

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SECTION 4.2 – Water In

Subsection 4.2.1 – Precipitation

Though much of the rain that falls on the outcrop area runs off to rivers or is lost through Evapotranspiration, there is about one percent that reaches the saturated groundwater zone of the Gulf Coast Aquifer (Chowdhury et al., 2004; Kasmarek and Robinson, 2004). In dipping aquifers, like the Chicot and Evangeline, the principal source of recharge occurs through the infiltration of rainfall in the outcrops where the aquifers are unconfined. The Chicot Aquifer is recharged within an area of about 1,100 mi^2 in northern Wharton County, eastern and southern Lavaca County and a large portion of Colorado County (Figure 10). Dutton and Richter (1990) noted that the highest recharge occurs in the outcrops in Colorado County with very little to no recharge down-dip in Wharton and Matagorda Counties. This would suggest that rainfall in Colorado County will certainly be one of the key factors to recharge in the Chicot. In Colorado County, annual rainfall totals are nearly 40 inches (Figure 14).

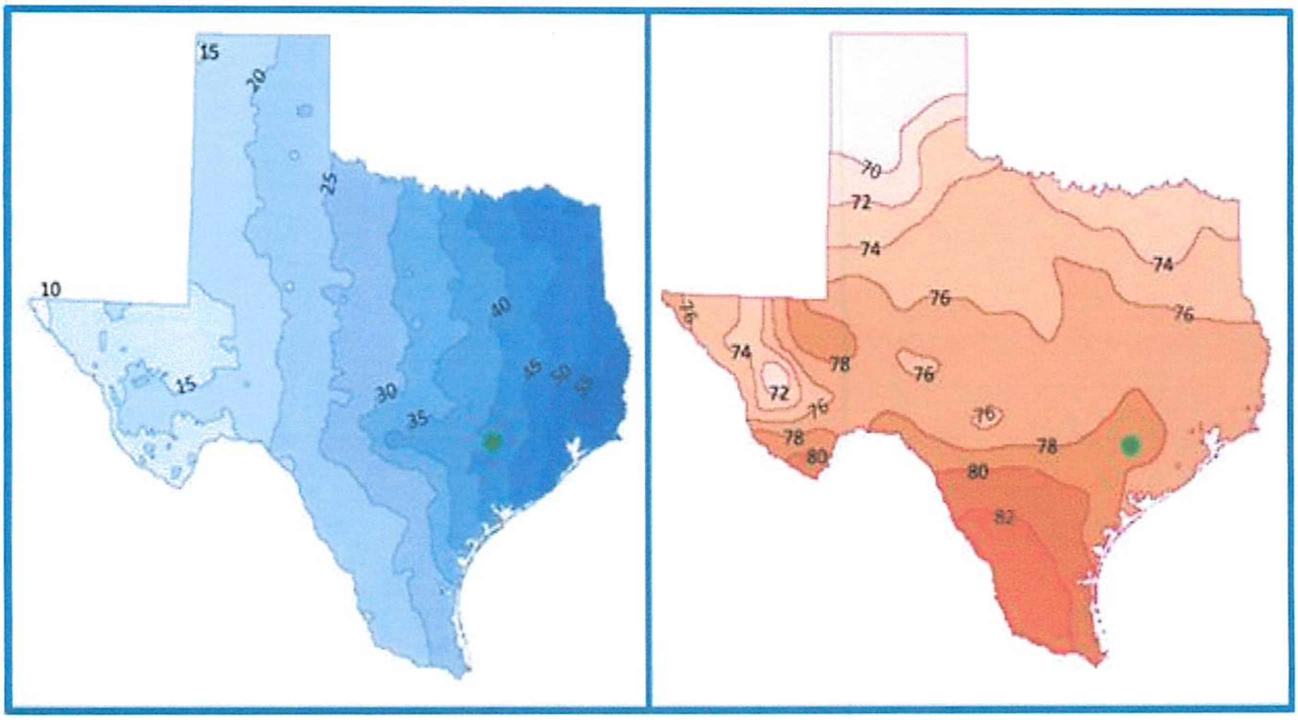

Figure 14: Left, average annual precipitation in inches from 1973 through 2000. Right, maximum temperature in degrees Fahrenheit from 1973 through 2000. Green dots indicate location of Colorado County. Slightly altered from 2007 State Water Plan. Data from SCAS, 2004.

Recharge though the unconfined, permeable sandy portions of the Gulf Coast Aquifer may be relatively fast while recharge to the confined portions of the aquifer may take considerably longer. Water not evaporated, consumed by plants through transpiration, or drained by streams from surface runoff infiltrates into the subsurface and eventually reaches the water table.

Recharge estimates can vary due to hydraulic conductivity, rainfall distribution and evapotranspiration among others. Nevertheless, several investigators have estimated recharge rates for the Gulf Coast Aquifer (Chowdhury and Mace, 2006). Dutton and Richter (1990) estimated a recharge rate of 0.1 to 0.4 in/yr for simulating the Chicot and Evangeline in Matagorda, Wharton and Colorado Counties. In "The Texas Water Atlas", the U.S. Geological Survey of 2004 shows estimated annual recharge rates of between 0.5 to 1.0 inches (Esterville and Earl, 2008).

According to Losket et al. (1982), the quantity of water that is available in the Colorado-Lavaca-Wharton tri-county area as natural recharge to the Chicot and Evangeline Aquifers has been approximated to be about 78,000 and

38,000 ac-ft per year respectively. The combined tri-county value of 78,000 acre-feet per year is consistent with GAM runs by the TWDB. However, the recharge in the Evangeline assumed in the GAM runs is only about 8,600 acre-feet per year. Despite the numerous parameters that may impact recharge, GAM runs put forth by the TWDB show very little variation in assumed recharge for both the Chicot and Evangeline (Appendix C).

Based on GAM Run 09-009 provided by the TWDB specifically for the CCGCD (Oliver, 2009), the total annual recharge from precipitation for Colorado County is 32,376 acre-feet for the Chicot and 2,311 acre-feet for the Evangeline (Appendix B). There is no recharge from precipitation to the district impacting the Burkeville Confining Unit or the Jasper Aquifer.

Subsection 4.2.2 – Losing Streams

Numerous streams cross the Central Gulf Coast and given the small variation in the topography of the model area, there is considerable interaction occurring between the streams and groundwater. A stream level that is higher than the water table defines a losing stream. Conversely, a stream level that is lower than the water table defines a gaining stream. As a whole, the Central Gulf Coast GAM has gaining streams (Chowdhury et al., 2004). However, major pumping centers that form large cones of depression (low pressure) may also capture recharged water that was naturally discharging to local streams, thereby increasing downdip recharge (Ryder and Ardis, 2002; Kasmarek and Robinson, 2004). The Colorado River, which bisects Colorado County and is its main water system, is noted to be a losing stream (Chowdhury et al., 2004). This is reflected in the TWDB GAM runs which generally assume the aquifers have a net gain of water from streams and rivers (Appendix C).

Unlike the recharge numbers from precipitation, TWDB GAM runs for surface waters show a bit more variability. GAM runs 07-12, 07-14, 07-43 and 08-56 have values of 28,347; 33,916; 28,408 and 32,511 acre-feet per year respectively (Donnelly, 2007a, 2007b, 2008a; Anaya, 2009). The same GAM runs for the Evangeline show 3,928; 5,238; 4,585 and 5,115 respectively. No gain or loss is reported in Colorado County for the Jasper Aquifer (Appendix C).

SECTION 4.3 – Groundwater Movement

Subsection 4.3.1 – Lateral Movement

Groundwater moves from areas of recharge to areas of discharge or more accurately, from points of higher hydraulic head to points of lower hydraulic head. In Colorado County, movement of groundwater is usually in the direction of the aquifer's regional dip which is to the southeast toward the coast. When recharge to the water table discharges relatively quickly in the surficial groundwater system, there is not a significant impact on the deeper, confined aquifer system. Therefore, recharge can be conceptually divided into two different types: 1) "shallow" recharge, which discharges quickly to streams and rivers through baseflow, and; 2) "deep" recharge, which moves into the confined system and exits, under predevelopment conditions, through cross-formational flow (Deeds et al., 2006).

In the outcrop, the groundwater system can act as a topographically-driven recharge/discharge system. Water levels generally follow topography with higher water levels occurring at higher elevations and lower water levels at lower elevations. Where there is an absence of regional slope, local flow systems are dominant (Toth, 1963). Most of the groundwater in the shallow system moves over short distances to nearby rivers and streams. However, when there is slope to the topography, a regional flow system develops. Regional flow components travel over long distances through deeper sections of the basin eventually discharging at lower elevations of coastal areas (Chowdhury et al., 2004). This regional flow system would account for much of the movement of groundwater out of the CCGCD.

It is not prudent to model a county in isolation since groundwater is constantly flowing in and out of the county boundaries. The Gulf Coast Aquifer in Colorado County is thin and is at a relatively high elevation. Considering this, it is not surprising that there is a net flow out of the county rather than in for the Chicot and Evangeline Aquifers. Previous GAM calculations for lateral groundwater movement in and out of Colorado County are [illegible] ac-ft per year respectively. The combined tri-county value of 78,000 acre-feet per year is consistent with GAM runs by the TWDB. However, the recharge in the Evangeline assumed in the GAM runs is only about 8,000 acre-feet per year. Despite the numerous parameters that may impact recharge, GAM runs put forth by the TWDB show very little variation in assumed recharge for both the Chicot and Evangeline (Appendix C).

Based on GAM Run results provided by the TWDB specifically for the CCGCD (Oliver, 2005), the total annual recharge from precipitation for Colorado County is 22,970 acre-feet for the Chicot and [illegible] acre-feet for the Evangeline (Appendix B). There is no recharge from precipitation to the district impacting the Burkeville Confining Unit or the Jasper Aquifer.

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Unlike the recharge numbers from precipitation, TWDB GAM runs for surface waters show a bit more variability. GAM runs [illegible] and 06-30 have values of 28,347; 35,016; 28,408 and 32,511 acre-feet per year respectively (Donnelly, 2005a, 2005b, 2006a; Anaya, 2006). The same GAM runs for the Evangeline show [illegible] respectively. No gain or loss is reported in Colorado County for the Jasper Aquifer (Appendix C).

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It is not prudent to model a county in isolation since groundwater is constantly flowing in and out of the county boundaries. The Gulf Coast Aquifer in Colorado County is thin and is at a relatively high elevation. Considering this, it is not surprising that there is a net flow out of the county rather than in for the Chicot and Evangeline Aquifers. Previous GAM calculations for lateral groundwater movement in and out of Colorado County are provided in Appendix C. GAM Run 09-009 (Oliver, 2009) shows that flow out of the county is greater than into the county (Appendix B). For the Chicot Aquifer, 9,050 acre-feet flow into the district whereas 19,429 flow out of the district resulting in a net loss of 10,379 acre-feet annually. The Evangeline likewise has flow into the District of 8,509 acre-feet annually and a flow of 17,273 acre-feet annually out of the District for a net loss of 8,764 acre-feet annually. With the recharge areas being mostly outside the county for the Burkeville Confining Unit and the Jasper Aquifer (Figure 10), there is a net inflow of groundwater into the thicker sediments of Colorado County. The inflow and outflow for the Burkeville is 42 and 49 acre-feet annually and for the Jasper is 533 and 293 acre-feet annually.

Subsection 4.3.2 – Vertical Movement

Groundwater can move vertically as well as laterally. Water can slowly creep through confining clay beds or by indirect movement through interconnected sand lenses. In the TWDB GAM, calibrated vertical leakance values increase from the east to the west following the depositional pattern expected in a prograding delta-deposition of coarser sediments in the up-dip areas and finer sediments in the down-dip areas. Differences in the distribution of vertical leakance values across the model area are caused by variations in lithology (Chowdhury et al., 2004).

Vertical movement of groundwater can also be associated with artificial discharge. For both artesian and water-table conditions, local anomalies are developed in areas of pumping and some water moves toward the point of artificial discharge. Under natural conditions, water in the deeper sands of the Gulf Coast aquifer are under greater hydrostatic pressure than the shallower sands and consequently, the deeper waters tend to move upward through any opening (such as boreholes) in the confining layers. However, development in heavily pumped zones has lowered its hydrostatic pressure, reversing the natural pressure gradient and causing water in shallower sands to move downward into the heavily pumped zone through wells screening both shallow and deep sands (Hammond, 1969). This has been demonstrated in Jackson County (Baker, 1965).

In Colorado County, the most recent GAM runs would suggest that there is dramatically more leakage from the Chicot to the Evangeline than vice versa (Appendix C). GAM Run 09-009, provided specifically at CCGCD request, confirms this. The net flow from the Chicot Aquifer to the Evangeline Aquifer is 23,110 acre-feet annually (Appendix B). There is minor net vertical leakage from the Burkeville to the Evangeline (502 acre-feet annually) and from the Jasper to the Burkeville (67 acre-feet annually).

SECTION 4.4 – Water Out (Discharge)

Subsection 4.4.1 – Springs, Seeps and Discharge to the Coast

Springs may develop where the water table is above the surface. Over twenty springs have been documented in Colorado County (Pickens, 2009). In areas where pumpage has been significant, the water table can drop to the point where springs disappear. Despite the relatively high number of springs in the county, there is little impact of springs on the water budget. Previous GAM runs show that just five to six acre-feet per year are lost to springs and seeps (Appendix C).

As groundwater flow reaches the saltwater-fresh water boundary near the coast, the density difference between the two, causes regional groundwater flow to shift direction and move vertically upward toward coastal areas at lower elevations. Whereas the coastal districts have a great concern of saltwater infiltration into their groundwater source, Colorado County is far enough inland that there is no direct impact.

Subsection 4.4.2 – Evapotranspiration

Evapotranspiration (ET) is the loss of water to the atmosphere through the process of evaporation from the soil or transpiration through plants. Two methods of calculation of ET are highlighted on contour maps in "The Texas Water Atlas" (Esterville and Earl, 2008). The Priestly Taylor Method measures potential evapotranspiration using soil heat flux and radiation. The method is an evaluation of how much water is needed to replace the amount that plants are using in the area. Colorado County is between the 67 and 71 inch contour. The Penman Method uses the same calculation as the Priestly Taylor Method, but also includes the impact of wind speed through an energy balance equation. In this calculation, Colorado County is just above the 79 inch contour line (Dugas and Ainsworth, 1983). Appendix C provides the simulated impact of ET.

Subsection 4.4.3 – Gaining Rivers and Streams

As presented in Section 4.2.2, the Central Gulf Coast GAM generally assumes gaining streams with Colorado County being the general exception. This study will consider the Colorado River as a losing stream. Nevertheless, there is ample evidence to suggest that this is not the case. During dry periods, tributary inflows to the lower Colorado River were insignificant compared to main channel stream flow rates. Withdrawals from the river were minimal, discharges to the river were nearly constant and ET rates were an order of magnitude less than total gain-loss values. With all other factors accounted for, the differences in flow between mainstream gauging stations (adjusted gain-loss values) were attributed to groundwater contribution (Saunders, 2006). Gauging stations in La Grange, Columbus and Wharton indicate that this nearly 110-mile length of the Colorado River, which spans all of Colorado County, is gaining at a rate of 91 ft^3/sec (Table 3). Thus, the consensus from many of the recent studies is that the lower Colorado River is a gaining stream that receives groundwater contribution from major and minor aquifers.

Description of River Reach	River Miles	Water-Bearing Units	Larger Aquifer	Median Adjusted Gain / Loss (ft^3/sec)
Austin - Bastrop	53.5	Simsboro	Carrizo-Wilcox	-9
Bastrop - Smithville	24.8	Calvert Bluff, Carrizo, Queen City, Sparta	Carrizo-Wilcox, Queen City, Sparta	+59
Smithville – La Grange	36	Yegua-Jackson	Yegua-Jackson	-22
La Grange - Columbus	40.9	Catahoula, Oakville, Goliad	Gulf Coast	+81
Columbus - Wharton	68.5	Goliad, Willis, Lissie	Gulf Coast	+10
Wharton – Bay City	34.1	Lissie, Beaumont	Gulf Coast	+98
			Total Gain	+217

Table 3: Stream flow gains and/or losses on the lower Colorado River. Shaded rows represent portions of the river that flow through Colorado County. From Saunders, 2006.

Based on GAM Run 09-009 provided by the TWDB specifically for the CCGCD (Oliver, 2009), the total estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers is 9,060 acre-feet for the Chicot and 2,363 for the Evangeline (Appendix B). There is no discharge associated with the Burkeville Confining Unit or the Jasper Aquifer.

Long-term severe drought conditions, under which groundwater aquifers may be stressed or slightly depleted, may produce somewhat less groundwater contribution to the Colorado River. However, such effects have lag times in years beyond the drought period, and therefore may not be a factor during times of low flow (Saunders, 2006).

A new model was created by consultants on behalf of LCRA and SAWS in order to evaluate the viability of a potential water project. The assumption in this model was that the Colorado was a gaining stream. This obviously had a large impact on projected water levels. This project and model are further discussed in Chapter 5.

Subsection 4.4.4 – Well Pumpage

In a predevelopment scenario, all types of discharge, as discussed above, are natural. However, artificial discharge can take place from flowing and pumped water wells, drainage ditches, gravel pits and other excavations that intersect the water table. Well pumping has been the overwhelmingly dominant artificial discharge mechanism.

Most of the pumping in the Gulf Coast Aquifer in Colorado County takes place in the Chicot and Evangeline Aquifers. Pumping in the Burkeville Confining System and the Jasper Aquifer occurs near outcrop areas only because water quality quickly deteriorates with increasing depth in the confined parts of the aquifer (Chowdhury et

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Lower Colorado River Reach	Reach Miles	Water-bearing Units	Tapped Aquifer	Median Adjusted Stream Flow Gain/Loss (ft³/sec)
Austin - Bastrop	52.5	Simsboro	Carrizo-Wilcox	-9
Bastrop - Smithville	24.8	Calvert Bluff, Carrizo, Queen City, Sparta	Carrizo-Wilcox, Queen City, Sparta	+59
Smithville - La Grange	36	Yegua-Jackson	Yegua-Jackson	-22
La Grange - Columbus	[illegible]	Catahoula, Oakville, Goliad	Gulf Coast	+80
Columbus - Wharton	68	Goliad, Willis, Lissie	Gulf Coast	[illegible]
Wharton - Bay City	34.1	Lissie, Beaumont	Gulf Coast	+90
			Total Gain	+247

Table 5. Stream flow gains and/or losses on the lower Colorado River. Shaded rows represent portions of the river that flow through Colorado County. From Saunders, 2006.

Based on GAM Run [illegible] provided by the TWDB specifically for the CCGCD (Oliver, 2007), the total estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers is 9,060 acre-feet for the Chicot and 2,569 for the Evangeline (Appendix B). There is no discharge associated with the Burkeville Confining Unit or the Jasper Aquifer.

Long-term severe drought conditions, under which groundwater aquifers may be stressed or slightly depleted, may produce somewhat less groundwater contribution to the Colorado River. However, such effects have lag times in years beyond the drought period, and therefore may not be a factor during times of low flow (Saunders, 2006).

A new model was created by consultants on behalf of LCRA and SAWS in order to evaluate the viability of a potential water project. The assumption in this model was that the Colorado was a gaining stream. This obviously had a large impact on projected water levels. This project and model are further discussed in Chapter 5.

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Most of the pumping in the Gulf Coast Aquifer in Colorado County takes place in the Chicot and Evangeline Aquifers. Pumping in the Burkeville Confining System and the Jasper Aquifer occurs near outcrop areas only because water quality quickly deteriorates with increasing depth in the confined parts of the aquifer (Chowdhury et al., 2004). No pumping in the Burkeville and only minimal pumping from the Jasper is present in Colorado County. Appendix C shows the modeled pumpage numbers.

The addition of pumping changes the dynamics of the aquifer system by turning a steady-state system into a transient system (Figure 13). Depending on the rate and amount of pumping, there could be a considerable impact on the aquifer. Extensive groundwater pumping over decades in Wharton, Victoria and Kleberg Counties altered the natural flow system. In these areas, a decline in the potentiometric (or water-level) surface and an increase in the hydraulic gradient have induced greater flow into the deeper parts of the aquifer than would have otherwise occurred (Chowdhury et al., 2004). The impacts of pumpage will be shown more clearly in Chapter 5 of this report.

SECTION 4.5 – Storage

Previous sections have discussed the groundwater flow system, tracking water movement in, out and within the aquifer. In this context, the groundwater flow system functions as a conduit that transports water from areas of recharge to discharge. However, the fact is, flowing groundwater in the system represents a large volume of water in storage (Alley et al, 1999).

In a steady state system where water in equals water out, there is no long-term component of storage influence (Figure 13). However, there are constant changes both seasonally and from year-to-year that do affect storage. Water levels in many wells exhibit an approximate annual cycle, usually highest during months of highest recharge, commonly the spring of the year, and lowest during months of lowest recharge, commonly the summer and early fall. Additionally, during periods of drought, water is withdrawn from storage without being replaced and the imbalance results in a water level decline. When rainfall resumes, the aquifer is recharged and water levels rise (McLaurin, 1988).

When sustained pumping is introduced to the groundwater system, an imbalance is created resulting in a transient system. At this point, more water is being extracted from the aquifer than is being introduced. The additional water is taken from storage (Figure 13). Over time, the effects of the withdrawal are propagated through the system as heads decrease at greater distance from the point of withdrawal. Ultimately, the effect of the withdrawal reaches a boundary (such as a stream) where there is either increased recharge to the groundwater system or decreased discharge from the system (Alley et al, 2002). A steady-state system could return however, even after pumping has commenced. Storage figures for Colorado County are shown in Appendix C.

Compared to changes in unstressed groundwater systems, the impact of ongoing pumping can be observed in declines in heads of hundreds of feet and corresponding reductions in storage. In Wharton County, the drawdown started with a severe drought in the 1950's. Continuous pumping caused the water levels to drop even further in the 1960's (Figure 15).

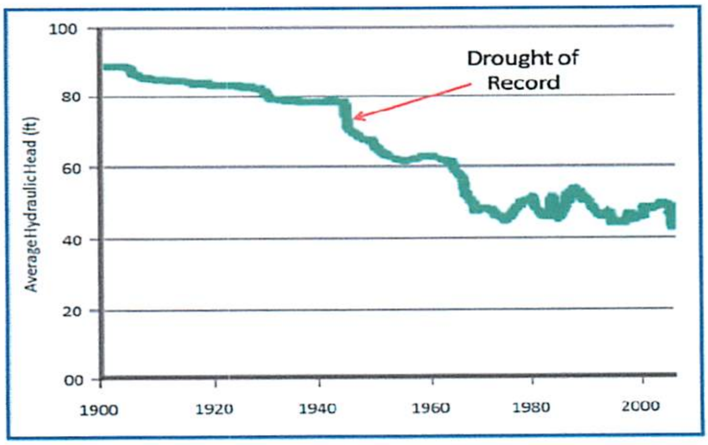

Figure 15: Record of drawdown in Wharton County from 1900 forward.

Widespread pumping that is sufficient to cause regional declines in heads can have some negative impacts. These impacts in clued: (1) large decreases in aquifer storage, particularly in unconfined aquifers; (2) dry wells where the lower water levels are below the open intervals of the well; (3) an increase in pumping costs because the groundwater must be lifted from a lower level to the surface; (4) because there is an increased rate of movement of contaminated water in the system, there is a higher probability that an adjacent well could intercept the contaminated water; and, (5) the possibility of land subsidence or intrusion of saline groundwater (Alley et al, 1999).

CHAPTER 5 – AVAILABILITY AND DEMAND

According to Section 36.1071 of the Texas Water Code, the district management plan shall include estimates of the following: the managed available groundwater (MAG); the amount of annual groundwater being used in the district; the projected surface supply; and, the total demand for water in the district. The CCGCD is wholly within the Lower Colorado Regional Planning Group (Region K) (Figure 16). Most of the information in this section was taken from the 2007 State Water Plan which relied heavily on data from the Region K Water Plan.

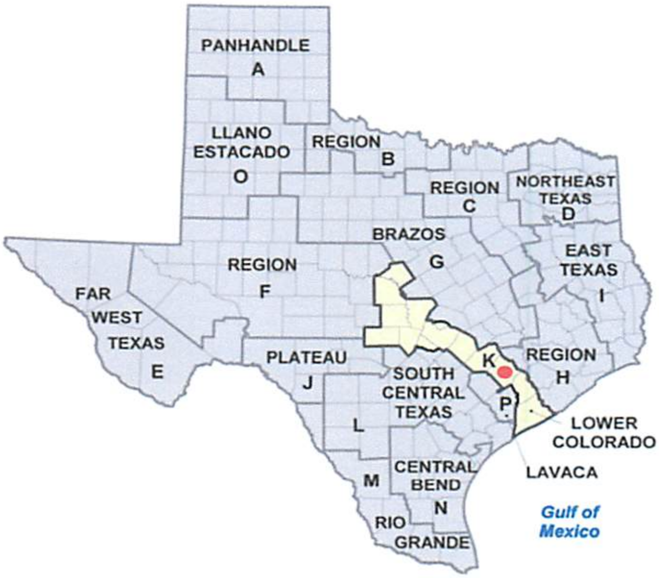

Figure 16: Location of Colorado County (red dot) within Region K.

SECTION 5.1 – Annual Groundwater Use

The Texas Water Development Board is required to provide annual estimates of the State's water use. The accuracy and dependability of these estimates rely on obtaining accurate and timely information from the annual water use survey. Response to the survey is mandatory. Table 4 shows the estimated 2007 combined ground and surface water use for six water-user groups in Colorado County and the adjacent counties of Wharton and Fayette. Colorado and Wharton Counties had estimated water usage from irrigation of 84.5% and 94.3% respectively. While the southern half of Colorado County is similar to Wharton County in usage, the northern half of the county is more similar to Fayette County. However, steam electric power generation, which is absent in Colorado County, is responsible for 78.0% of Fayette County's total water usage.

County	Irrigation (ac-ft/yr)	Municipal (ac-ft/yr)	Mining (ac-ft/yr)	Manufacturing (ac-ft/yr)	Livestock (ac-ft/yr)	Steam Electric (ac-ft/yr)	Total (ac-ft/yr)
Fayette	550	3,028	2	233	2,422	22,078	28,313
Colorado	117,117	2,669	16,947	188	1,693	0	138,614
Wharton	151,903	5,511	0	160	3,458	0	161,032

Table 4: Estimates by county for combined surface and groundwater use by water-user group. Information from the TWDB Water Use Summary Estimate for 2007 (taken 9/18/09). Note: Values may have been subsequently updated by the TWDB.

Most of the total water use represented in Table 4 is from access to the Colorado River. Nevertheless, there is a significant amount of county-wide usage from the Gulf Coast Aquifer which supplies all of the groundwater resources for southern Fayette, Colorado, Wharton and Matagorda Counties. As Table 4 shows, there is no water used for steam electric power generation in the county and minimal overall usage of water for manufacturing. By far, the most dominant groundwater usage in the District has been for irrigation of rice (Figure 17). Municipal and mining are the next largest user groups, but are dwarfed by the irrigation usage. In 2000, Colorado County alone accounted for over 20% of total water usage in Region K (TWDB, 2007). Appendix D provides an historical water use summary for the various water-user groups since the mid 1980s in the CCGCD area of jurisdiction. Groundwater and surface water are di□erentiated.

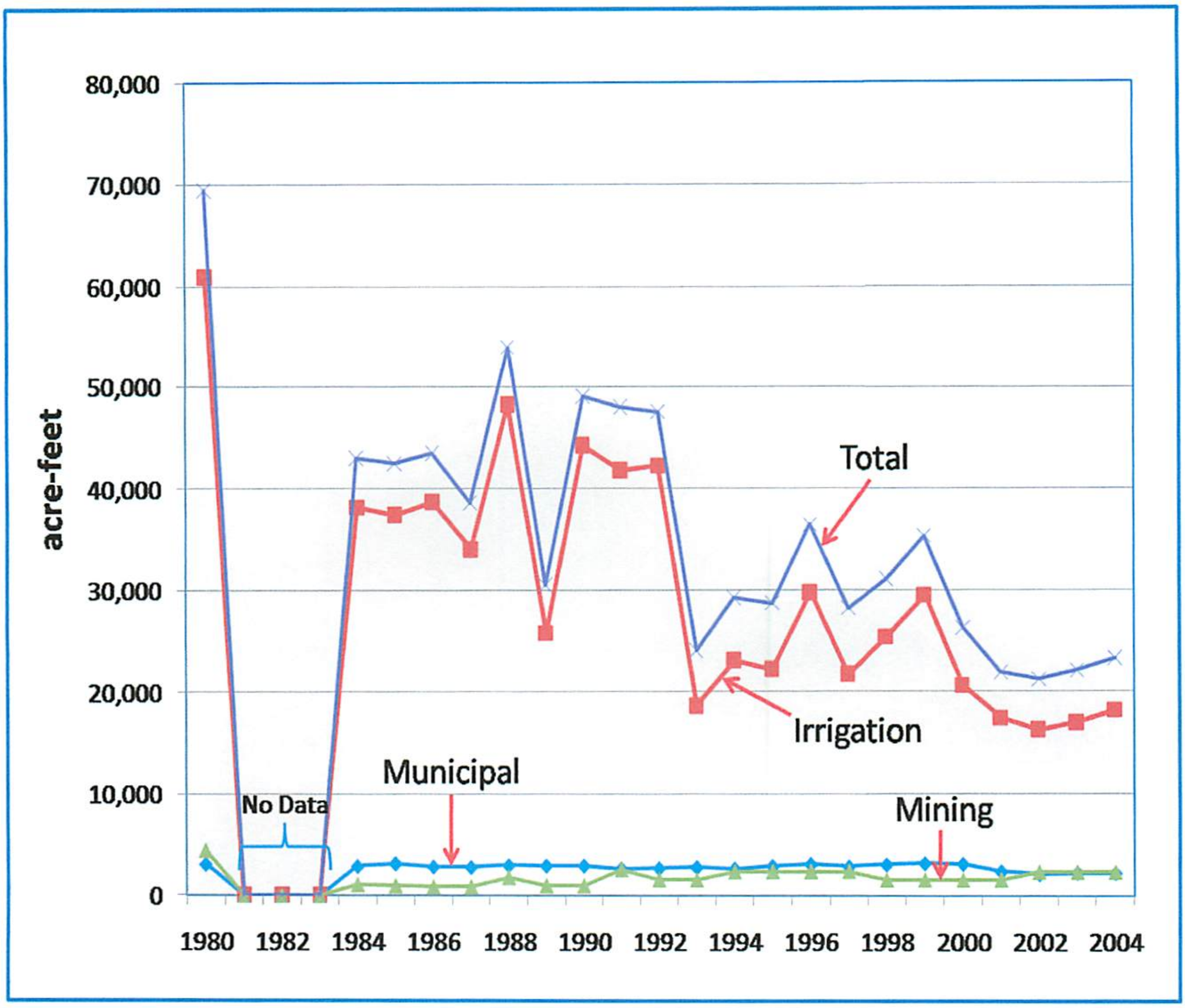

Figure 17: Groundwater usage by key users in Colorado County. Source: TWDB, Historical Water Use Information Data Web Interface. http://www.twdb.state.tx.us/wushistorical/ReportViewer.aspx?ReportName=rptWaterUseSummaryByCountySource&ReportParmeters=Mum%3d45%26year%3d+/

Subsection 5.1.1 – Irrigation Usage

The water demand distribution between the 14 counties in Region K shows that demand has consistently been greatest during the period from 1980 to 2000 in Matagorda, Wharton and Colorado Counties where rice irrigation is extensive. The three counties account for a large portion of the state's water usage for irrigation in southeast Texas (Figure 18).

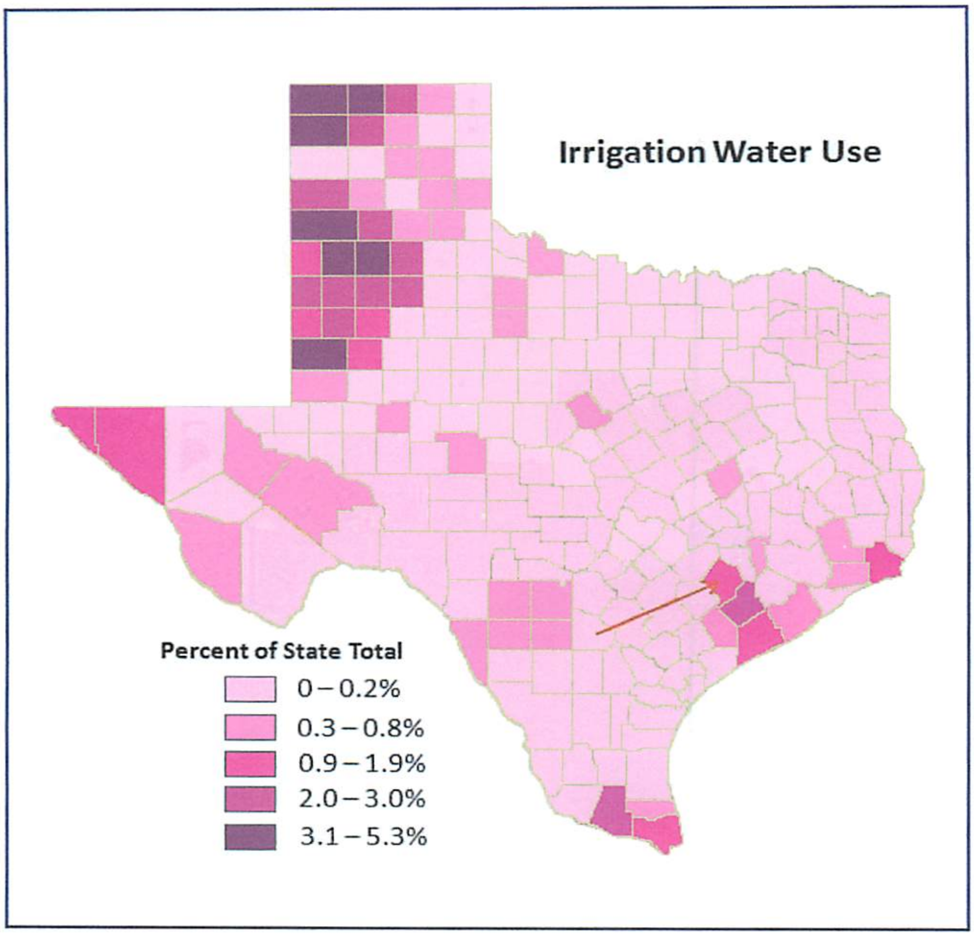

Figure 18: Summary estimate of irrigation use for counties as a percentage of state total. Red arrow indicates location of Colorado County. Information from the TWDB Water Use Summary Estimate for 2003.

Since 1997, the number of acres of rice planted has steadily decreased from about 40,000 acres to about 28,000 acres (Figure 19). This decrease in the number of acres of rice planted was driven in part by improvements in irrigation efficiency as well as market conditions. Precision-leveled fields require significantly less applied water than traditional contour levee fields by removing depressions in the field that hinder water movement. This ultimately results in a reduction in the minimum depth of water required to cover the entire field ("Texas Rice", Texas A&M University System, 2007). Effective land leveling reduces the work in crop establishment and management and increases the yield and quality. Level land improves water coverage that: improves crop establishment; reduces weed problems; improves uniformity of crop maturity; decreases the time to complete tasks; and, reduces the amount of water required for land preparation. Installation of underground pipelines to transport water into the fields can save water by preventing canal seepage and losing water to evaporation (Smith, 2002). Also, new varieties of rice are being developed. One goal is to develop a variety of rice that has a longer growing period and a higher yield. This higher yield would reduce the need for a second harvest and thereby reducing water needs.

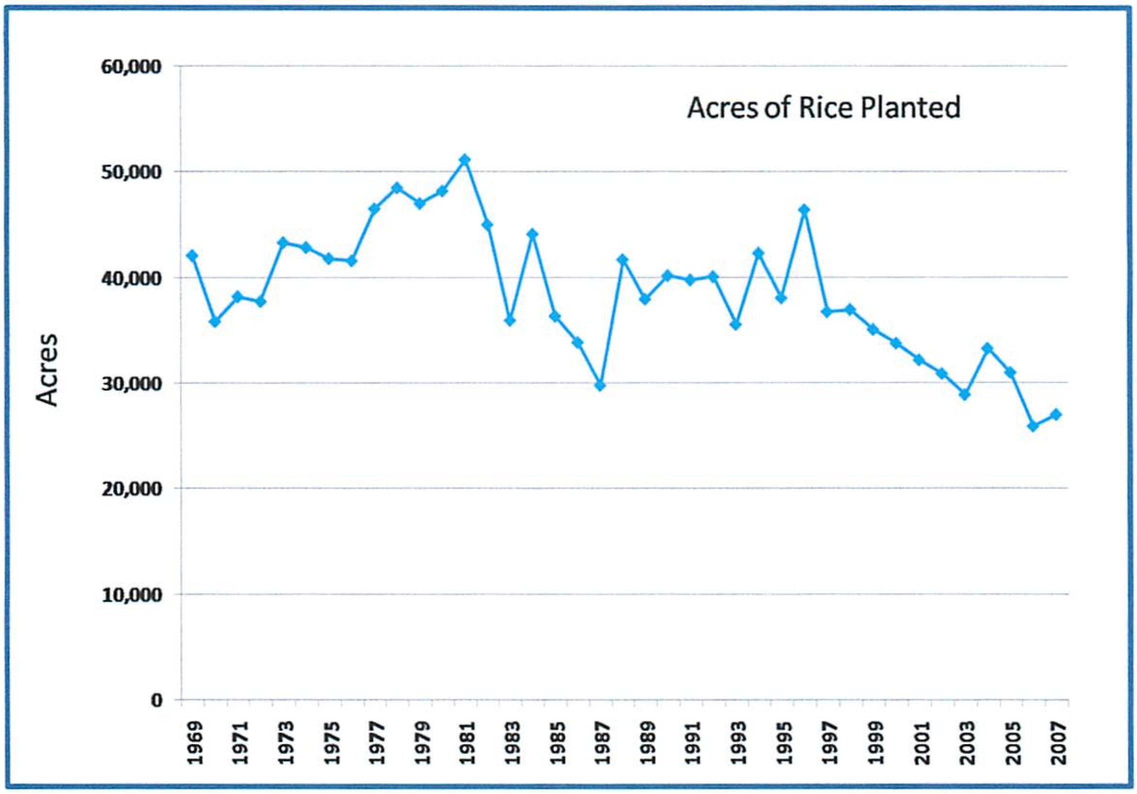

Figure 19: Total acres of rice planted in Colorado County. Source, U.S. Dept. of Agriculture.

From 1958 through 1989, groundwater from the Gulf Coast Aquifer has supplied between 18 and 28% of the water used for irrigation (Table 5). By 2000, there had been a marked decrease in the proportion of groundwater being used. Despite this, the number of wells increased appreciably from 1984 until 2000. These data would indicate that more wells are running below potential capacity.

Year	All Irrigation (ac-ft)	Surface Water Supplied Irrigation (ac-ft) / (%)	Groundwater Supplied Irrigation (ac-ft) / (%)	Combined Supplied Irrigation (ac/ft) / (%)	Irrigation Wells (number)
1958	111,422	84,877 / (76.2)	24,445 / (21.9)	2,100 / (1.9)	60
1964	147,647	111,8000 / (75.7)	26,936 / (18.2)	8,911 / (6.1)	86
1969	175,740	125,456 / (71.4)	49,046 / (27.9)	1,238 / (0.7)	115
1974	178,127	114,720 / (64.4)	45,619 / (25.6)	17,788 / (10.0)	95
1979	154,254	97,111 / (63.0)	41,926 / (27.1)	15,217 / (9.9)	105
1984	134,010	95,048 / (70.9)	35,115 / (26.2)	3,847 / (2.9)	105
1989	111,625	84,628 / (75.8)	23,127 / (20.7)	3,870 / (3.5)	110
1994	118,653	94,410 / (79.6)	20,098 / (16.9)	4,145 / (3.5)	110
2000	138,505	115,979 / (83.7)	16,605 / (12.0)	5,921 / (4.3)	160

Table 5: Sources of water for irrigation from five to six year intervals form 1958 through 2000 for Colorado County. Highlights show percentage of groundwater supplied to irrigation. Source is TWDB Report #347.

Subsection 5.1.2 – Mining Usage

In Colorado County, mining water usage is attributable to gravel extraction. Colorado County has the largest percentage of total water use attributable to mining in the state (Figure 20). Nevertheless, though Colorado County shows a large portion of water usage in mining operations from a state perspective, total mining groundwater use in the county still pales by comparison to irrigation usage (Figure 17).

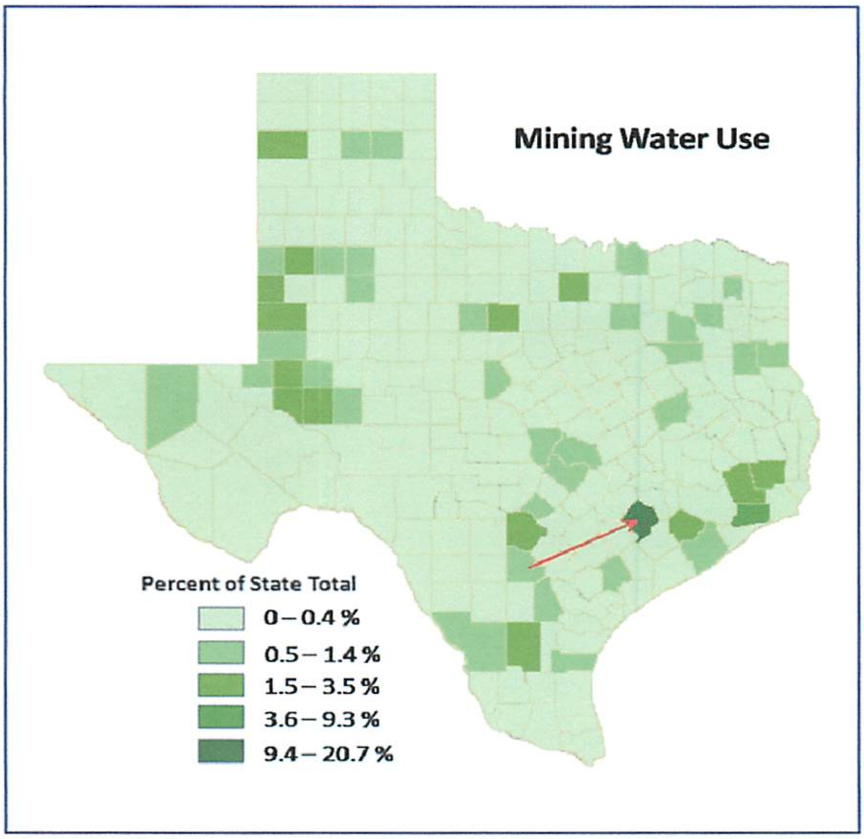

Figure 20: Summary estimate of mining operations use for counties as a percentage of state totals. Red arrow indicates location of Colorado County. Information from the TWDB Water Use Summary Estimate for 2003.

Subsection 5.1.3 – Municipal and Other Usage

The population of Colorado County in 2000 was 20,390. This population is similar to adjacent counties, but is dwarfed by the millions represented in districts around the metropolitan areas such as Houston, Dallas, San Antonio and Austin. The population of Colorado County is expected to only increase by a modest 10.6% over the next 50 years. Though virtually all of the municipal water is derived from groundwater, the total amount used is still relatively small when compared to irrigation (Figure 17). Other user groups, such as livestock and manufacturing, play an even lesser role in water usage.

SECTION 5.2 – Surface Water Supply

The Texas Water Development Board (TWDB) has directed to the Regional Water Planning Groups, including Region K, that the estimates of currently available water supplies shall reflect water that is reliably available to the area during a repeat of the "drought of record" (DOR) conditions. Groundwater supplies have been discussed in previous sections. Surface water availability includes any water source where water is obtained directly from a surface body of water including rivers, streams, creeks, lakes, ponds and tanks. In the State of Texas, all waters contained in a watercourse (rivers, natural streams, lakes and the storm water, flood water or rainwater of every river, natural stream, canyon, ravine, depression, and watershed) are waters of the State and thus belong to the State. The State grants individuals, municipalities, water suppliers and industries the right to divert and use this water through water rights permits. Water rights are considered property rights and can be bought, sold, or transferred with state approval. These permits are issued based on the concept of prior appropriation, or "first-in-time, first-in-right" (TWDB, 2007). Water rights issued by the State generally fall into three categories: run-of-river (ROR) rights; stored water rights; and, local surface water supplies.

Subsection 5.2.1 – Run-of-River Rights

ROR rights allow diversions of water directly from a water body as long as there is water in the stream and that water is not needed to meet a senior downstream water right. The State of Texas granted ROR rights through an adjudication process that considered historical use. As a result, some ROR rights may have been granted for more water than is available in a river during drought conditions. The use of water during drought conditions is controlled by the priority system, with the oldest water rights having first call on whatever water is in the river.

The TCEQ Colorado River Basin water availability model (WAM) was developed to simulate the amount of water available to the Colorado River under the basin water management scenarios (TWDB, 2007). Factors used to calculate the water availability include the following:

- Senior downstream water rights are assumed to be fully utilized
- Stored waters are released to the river based on the drought conditions
- Inflows to the Highland Lakes are passed through the lakes to the extent the water is needed to satisfy senior water rights downstream.

The Run 3 version of the model assumes full utilization of all water rights. Full utilization is defined as 100 percent of the authorized diversion with 100 percent reuse of return flows, i.e. no return flow to the river. This is the most conservative version of the model and will provide the most conservative results (TWDB, 2007).

The Lower Colorado River Authority (LCRA) has acquired the rights to significant quantities of water within Region K and has acquired many of the senior rights for irrigation waters in the lower basin. The results of the WAM model for major ROR rights holders in Colorado County are presented in Table 6 and shows the water availability based on the amount of ROR water that would be available during the driest year of the DOR (1952 WAM). Garwood and Lakeside are the significant irrigation districts present in Colorado County (Figure 21). The LCRA makes the majority of this water available to other entities for final consumption through water sales contracts.

Water Rights Holder	Maximum Permitted Diversion (ac-ft/yr)	Priority Date	Availability During DOR (2000) (ac-ft/yr)	Availability During DOR (2060) (ac-ft/yr)
LCRA-Garwood	133,000	Nov 1, 1990	133,000	133,000
LCRA–Lakeside #1	52,500	Jan 4, 1901	16,908	16,908
LCRA-Lakeside #1	78,750	Nov 1, 1987	4,977	4,977
Lakeside #2	55,000	Sept 2, 1907	21,923	21,923
City of Corpus Christi	35,000	Nov 2, 1900	31, 579	31,579

Table 6: Major ROR rights in Colorado and northern Wharton Counties for the Colorado River Basin. Complete listing of rights for all river basins is available in Appendix C. Downstream water availability reflects minimum year during the drought. Data Source: Colorado River WAM provided by TCEQ, November 2004, Run 3.

A complete listing of ROR rights holders in Colorado County are provided in Appendix E. Projections for surface and groundwater supply in CCGCD are provided in Appendix F.

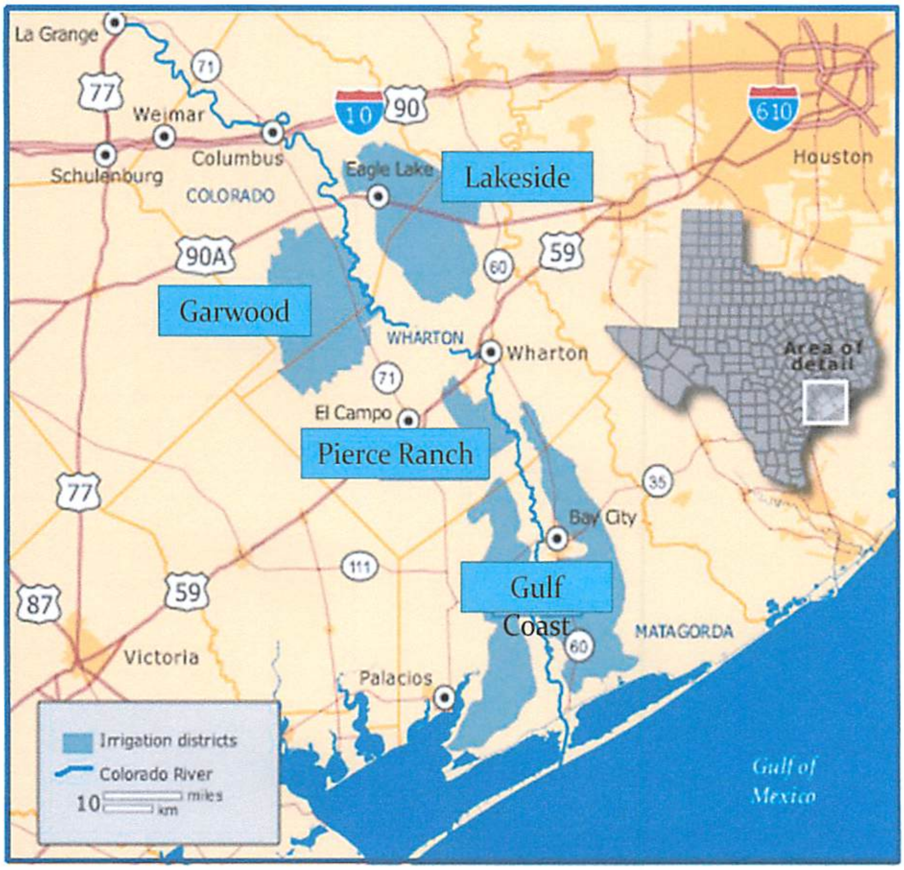

Figure 21: Location of LCRA controlled irrigation districts in Colorado and Wharton Counties.
http://www.lcra.org/water/supply/irrigation.html

The Garwood Irrigation District was 100 percent reliable for its fully authorized diversion amount of 133,000 ac-ft. Alternatively, the Lakeside Irrigation District shows low reliability due to a subordination agreement with the City of Austin. The water rights amount used for each irrigator was determined by the specific year in the model which had the minimum total diversion.

In addition to the standard WAM Run 3 described above, an alternative WAM run was developed which will be referred to as the "No Call" WAM Run 3. This scenario was developed as a result of a request from the Region F Planning Group (upstream of Region K) (Table 7).

Many of the reservoirs in Region F showed little to no firm yield in the WAM Run 3 scenario. These reservoirs are the only source of supply to numerous communities in Region F and the water supply scarcities are such that there are currently few additional economically viable alternatives for supply. Through joint meetings of Region K and Region F, it was decided to temporarily implement a "No Call" assumption. The modeling that was to be conducted would be a "what if" scenario that would generally assume that, during the 50-year planning period, certain large downstream senior water rights holders would not call for water they were legally entitled to by virtue of their priority and would instead allow that water to be impounded in upstream Region F reservoirs. The Colorado River surface water availability amounts developed through the "No Call" WAM are the amounts that were used in developing the 2007 State Water Plan.

Water Rights Holder	Maximum Permitted Diversion (ac-ft/yr)	Priority Date	Availability During DOR (2000) (ac-ft/yr)	Availability During DOR (2060) (ac-ft/yr)
LCRA-Garwood	133,000	Nov 1, 1990	111,740	111,740
LCRA-Lakeside #1	52,500	Jan 4, 1901	10,750	10,750
LCRA-Lakeside #1	78,750	Nov 1, 1987	2,925	2,925
Lakeside #2	55,000	Sept 2, 1907	21,923	21,923
City of Corpus Christi	35,000	Nov 2, 1900	25,021	25,021

Table 7: Major ROR rights in Colorado and northern Wharton Counties for the Colorado River Basin using the "No Call" WAM. Data Source: Colorado River WAM provided by TCEQ, November 2004, Run 3 modified by FNI. WRAP modeling program provided by Dr. Ralph Wurbs, Texas A&M University, July 2004 version.

Subsection 5.2.2 – Stored Water Rights

Stored water rights allow the impoundment of water by a permittee in a reservoir. Water can be held for storage as long as the inflow is not needed to meet a senior downstream water right. Water stored in the reservoir can be withdrawn by the permittee at a later date to meet water demands. The storage in a reservoir gives the permittee a buffer against drought conditions (TWDB, 2007).

There are no storage reservoirs in Colorado County. The nearest reservoir is Lake Fayette, which is in part owned and operated by the LCRA. The water in Lake Fayette is used for cooling purposes in the Fayette Power Project.

Subsection 5.2.3 – Local Surface Water Supplies

In addition to the water rights permits issued by the State, individual landowners may utilize state waters without a specific permit for certain types of use. The most common of these uses in Region K is domestic and livestock use although in Colorado County, mining use is also significant. Landowners are also allowed to construct impoundments on their own property with up to 200 acre-feet of storage for domestic and livestock or certain wildlife management purposes. These types of water sources are generally referred to as "Local Supply Sources." Many individuals with land along a river or stream that still have an old riparian right can also divert a reasonable amount of water for domestic and livestock uses without a permit (TWDB, 2007). Appendix F shows the local surface water supplies for the CCGCD.

SECTION 5.3 – Total Water Demand

A valid estimate of projected water demand is a key first step in determining whether a regional water supply system is adequate. Projected water demand is based partly on anticipated patterns of population growth and migration which are applied to standardized estimated water use rates for the recognized categories of water use. The water supply estimates assume supply from both surface water and groundwater. The total water demand for Region K is projected to increase by approximately 30% over the 60-year planning period. The increase is largely due to projected increases in municipal and manufacturing in the large population centers (namely Travis County), and in steam-electric water demand (such as in Fayette County).

Subsection 5.3.1 – CCGCD Demand

Projections for Colorado County do not reflect the Region K overall trend. The relatively low population of Colorado County is expected to change from 20,390 to 22,561 in 2060 (TWDB, 2007) representing a modest increase of only 10.6% during the planning period. Municipal and manufacturing water demands show only very slight gains. Colorado County's highest water demand comes from irrigation (primarily for rice). However, as has been the recent trend as depicted in Figure 17 and like the overall 2007 State Water Plan, the demand for irrigation over the 60-year planning period is projected to decrease. This decrease is expected due to improvements in irrigation

Water Right Holder	Maximum Authorized Diversion (ac-ft/yr)	Priority Date	Availability During DOR (1950s) (ac-ft/yr)	Availability During 2060 DOR (ac-ft/yr)
LCRA Garwood	133,000	Nov 1, 1900	111,740	111,746
LCRA Lakeside II	52,500	Jan 4, 1901	10,750	10,751
LCRA Lakeside I	78,750	Nov 1, 1957	2,025	2,943
Lakeside I	55,000	Sept 2, 1907	21,072	11,943
City of Corpus Christi	35,000	Nov 2, 1900	25,021	25,021

Table 17: Major IR rights in Colorado and northern Wharton Counties for the Colorado River Basin using the "No Call" WAM. Performance: Colorado River WAM provided by TCEQ, November 2004, Run 3 modified by R.V. WRAP modeling program provided by Dr. Ralph Wurbs, Texas A&M University, July 2005 version.

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Stored water right allows the impoundment of water by a permittee in a reservoir. Water can be held for storage as long as the inflow is not needed to meet a senior downstream water right. Water stored in the reservoir can be withdrawn by the permittee at a later date to meet water demands. The storage in a reservoir gives the permittee a buffer against drought conditions (TWDB, 2007).

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In addition to the water rights permits issued by the State, individual landowners may utilize state waters without a specific permit for certain types of use. The most common of these uses in Region K is domestic and livestock use although in Colorado County, mining use is also significant. Landowners are also allowed to construct impoundments on their own property with up to 200 acre-feet of storage for domestic and livestock or certain wildlife management purposes. These types of water sources are generally referred to as "Local Supply Sources." Many individuals with land along a river or stream that still have an old riparian right can also divert a reasonable amount of water for domestic and livestock uses without a permit (TWDB, 2007). Appendix F shows the local surface water supplies for the CCGCD.

SECTION 5.3 – Total Water Demand

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Subsection 5.3.1 – CCGCD Demand

Projections for Colorado County do not reflect the Region K overall trend. The relatively low population of Colorado County is expected to change from 20,390 to 22,452 in 2060 (TWDB, 2007) representing a modest increase of only 10% during the planning period. Municipal and manufacturing water demands show only very slight gains. Colorado County's highest water demand comes from irrigation (primarily for rice). However, as has been the recent trend as depicted in Figure 17 and like the overall 2007 State Water Plan, the demand for irrigation over the 60-year planning period is projected to decrease. This decrease is expected due to improvements in irrigation efficiency and reductions in irrigation acreage due to forecasted unfavorable farming economics. Since irrigation demand is still two orders of magnitude greater than projected municipal and manufacturing demand, the overall water demand trend for the county, largely mirrors the trend for irrigation demand (Table 8).

Usage	2010 (ac-ft/yr)	2020 (ac-ft/yr)	2030 (ac-ft/yr)	2040 (ac-ft/yr)	2050 (ac-ft/yr)	2060 (ac-ft/yr)
Irrigation	200,541*	192,196*	184,122*	176,308*	168,709*	161,437*
Mining	20,775*	21,167*	21,386*	21,593*	21,790*	21,965*
Municipal	1,939	1,983	1,994	1,976	1,969	1,948
County-Other	1,192*	1,204*	1,194*	1,164*	1,152*	1,140*
Livestock	1,471*	1,471*	1,471*	1,471*	1,471*	1,471*
Manufacturing	176*	192*	205*	217*	227*	245*
Total	226,094	218,213	210,372	202,729	195,318	188,206

Table 8: Projected total water demand by user group, based on 2007 State Water planning database. (*) – Apportioned from Colorado County figures to reflect total water demand for CCGCD.

The irrigation water use projections were developed by the TWDB and were determined with assistance from the Texas Agricultural Extension Service. Irrigation water demand in Region K is concentrated in the three southernmost counties – Matagorda, Wharton and Colorado. It is the southern portion of Colorado County, which includes the Lakeside and Garwood Irrigation Districts that has virtually all the irrigation in the county. As Table 9 shows, the water demand in Wharton County is even larger than in Colorado owing to the county-wide farming of rice. The northern portion of Colorado County is more similar to Fayette County which shows a dramatically lower projected demand for water than for Colorado or Wharton Counties. Over 80% of the water demand in Fayette county is from Steam-Electric Water Demands which is absent in Colorado County.

County	2010 (ac-ft/yr)	2020 (ac-ft/yr)	2030 (ac-ft/yr)	2040 (ac-ft/yr)	2050 (ac-ft/yr)	2060 (ac-ft/yr)
Fayette	49,923	50,978	60,720	72,406	72,895	79,539
Colorado	226,407	218,556	210,662	203,009	195,589	188,466
Wharton	305,176	294,933	284,878	275,108	265,689	240,118

Table 9: Comparisons of projected total water demand for Colorado, Fayette and Wharton Counties. Source: 2006 Adopted Regional Water Plans (Region K and Region P).

The population of Colorado County is projected to only increase by a modest 10.6% over the next 50 years. Even if the population of the county increased by a factor of 10, the total water usage would still only be about a quarter of the projected usage for irrigation.

Subsection 5.3.2 – The LCRA-SAWS Water Project (LSWP)

The LSWP was a project proposal put forth jointly by the Lower Colorado River Authority (LCRA) and the San Antonio Water System (SAWS). The project was designed to help meet the long-term water needs in the lower Colorado River basin and the city of San Antonio. House Bill 1629 stipulated that in order for the project to proceed, it must: protect and benefit the basin's interest; be consistent with the state's public planning process; ensure the health of Matagorda Bay; maintain necessary river flow projections; require stringent water conservations by SAWS; provide a broad public and scientific review process; and, raise the average levels of Lake Travis and Buchanan higher than they would be otherwise.

As of mid 2009, the proposal was in the sixth year of the study period that originally had the potential to extend to the year 2015. The project mandated that no water was to be sent to SAWS during the first 10 years of the 50-year contract. Depending on the study findings on water availability in the basin, SAWS could get up to 150,000 acre-efficiency and reductions in irrigation acreage due to forecasted unfavorable farming economics. Since irrigation demand is still two orders of magnitude greater than projected municipal and manufacturing demand, the overall water demand trend for the county largely mirrors the trend for irrigation demand (Table 8).

Use	2010 (ac-ft/yr)	2020 (ac-ft/yr)	2030 (ac-ft/yr)	2040 (ac-ft/yr)	2050 (ac-ft/yr)	2060 (ac-ft/yr)
Irrigation	200,541*	192,190*	184,122*	176,298*	168,709*	161,437*
Mining	20,775*	21,167*	21,386*	21,593*	21,790*	21,959*
Municipal	1,950	1,983	1,994	1,976	1,969	1,948
County-Other	1,192*	1,204*	1,194*	1,164*	1,152*	1,140*
Livestock	1,171*	1,471*	1,471*	1,472*	1,471*	1,471*
Manufacturing	170*	192*	205*	217*	227*	245*
Total	225,091	218,215	210,372	202,729	195,318	188,208

Table 8: Projected total water demand by user group based on 2007 State Water planning database. (*) = Apportioned from Colorado County figures to reflect total water demand for COCO.

The irrigation water use projections were developed by the TWDB and were determined with assistance from the Texas Agricultural Extension Service. Irrigation water demand in Region K is concentrated in the three southernmost counties - Matagorda, Wharton and Colorado. It is the southern portion of Colorado County which includes the Lakeside and Garwood Irrigation Districts that has virtually all the irrigation in the county. As Table 9 shows, the water demand in Wharton County is even larger than in Colorado owing to the county-wide farming of rice. The northern portion of Colorado County is more similar to Fayette County which shows a dramatically lower projected demand for water than for Colorado or Wharton Counties. Over 80% of the water demand in Fayette county is from Steam Electric Water Demands which is absent in Colorado County.

Use	2010 (ac-ft/yr)	2020 (ac-ft/yr)	2030 (ac-ft/yr)	2040 (ac-ft/yr)	2050 (ac-ft/yr)	2060 (ac-ft/yr)
Fayette	44,022	50,978	60,720	72,406	71,805	70,530
Colorado	225,091	218,215	210,372	202,729	195,318	188,208
Wharton	293,170	264,033	284,878	275,108	265,680	240,118

Table 9: Comparison of projected total water demand for Colorado, Fayette and Wharton Counties. Source: 2006 Adopted Regional Water Plans (Region K and Region P).

The population of Colorado County is projected to only increase by a modest 10.6% over the next 50 years. Even if the population of the county increased by a factor of 10, the total water usage would still only be about a quarter of the projected usage for irrigation.

Subsection 5.3.2 – The LCRA-SAWS Water Project (LSWP)

The LSWP was a project proposal put forth jointly by the Lower Colorado River Authority (LCRA) and the San Antonio Water System (SAWS). The project was designed to help meet the long-term water needs in the lower Colorado River basin and the city of San Antonio. House Bill 1629 stipulated that in order for the project to proceed, it must: protect and benefit the basin's interest; be consistent with the state's public planning process; ensure the health of Matagorda Bay; maintain necessary river flow projections; require stringent water conservations by SAWS; provide a broad public and scientific review process; and, raise the average levels of Lake Travis and Buchanan higher than they would be otherwise.

As of mid 2006, the proposal was in the sixth year of the study period that originally had the potential to extend to the year 2015. The project mandated that no water was to be sent to SAWS during the first 10 years of the 50-year contract. Depending on the study findings on water availability in the basin, SAWS could get up to 150,000 acre-feet per year.

HB 1629 specifically prohibited the LCRA from providing groundwater from the study area (inclusive of Colorado County) to SAWS. Instead, the project proposed using groundwater for agricultural irrigation when surface water wasn't available. Groundwater use would be limited to no more than 62,000 acre-feet a year on a 10-year rolling average. Average annual use over the life of the project was not to exceed 36,000 acre-feet. The maximum allowed use in any one year was to be 95,000 acre-feet. Groundwater for the proposal would be subject to the rules, regulations and permitting requirements of local groundwater conservation districts, including CCGCD, and would not be sold to SAWS (Quick Facts about the LCRA-SAWS Water Project, 2009).

Because groundwater would supplant surface water, the total water demand for Colorado County as depicted in Table 9 would not change appreciably. However, the potential for using groundwater in this project has not been specifically taken into account. The figures presented in the preceding paragraph represent groundwater that would be taken from Colorado, Wharton and Matagorda Counties. It is presumed that the pumpage from Colorado County would be about 40 – 50% of these figures. The LSWP study in part reviewed the impact of pumping up to an additional 45,000 acre-feet in a particular year from Colorado County aquifers. The conclusion was that there would be no discernable impact on water availability for Colorado County during the project life-time. Note that LSWP used their own groundwater simulation model and compared results to Central Gulf GAMS. The LSWP study suggested that the Gulf Coast GAMs supplied by the TWDB dramatically overestimated the impact of groundwater pumpage on water levels. The LSWP model is briefly discussed in Section 5.4.2.

In December 2008, the LCRA Board passed resolutions that began to define what conditions the project would have to meet in order to protect and benefit the basin's interests. The Board directed staff to include the following into its project studies: use newly updated long-term water demand projections; plan for all agricultural irrigation needs identified by Region K using a combination of conservation, surface water and groundwater; groundwater used for irrigation to be limited to dry periods when there is not enough surface water available for agricultural demands; and, a 50,000 acre-foot reserve in LCRA's Water Management Plan was not be used in conjunction with the project. After incorporating the new policy guidelines, it was determined that there would be insufficient water available for SAWS in order for the project to meet its goals. It was decided that the funding for the project would be suspended. In August of 2009, LCRA and SAWS went to a mediator to settle disputes about the viability of the project among other things. No agreements have been reached to date and the project is currently in limbo.

SECTION 5.4 – Water Needs and Management

Sections above have discussed District water demand and supply. From this, it should be possible to determine where there should be a sufficient supply and where a shortfall of water might be expected. If a shortfall exists, then a water management strategy is needed to help circumvent this shortfall.

Subsection 5.4.1 – CCGCD Projected Water Needs

The water needs reported in this section are the result of subtracting the projected water demands for the District from the projected supply. In some cases, this resulted in a surplus and in others, a shortage. As mentioned in sections above, irrigation by far accounts for the largest foreseeable demand. Table 10 shows the primary water user groups (WUG) and the anticipated surplus or shortfall of water. These numbers are broken down according to River Basin. Though the Colorado River bisects the county, the associated basin is confined to only a narrow span, especially in the southern portion of the county where rice irrigation is prevalent. To the west of the Colorado River Basin lies the Lavaca River Basin and to the east lies the combined Colorado-Brazos River Basin. There is a surplus of water projected for irrigation in the Colorado River Basin.

However, the most severe shortage is projected in the Lavaca River Basin, most of which may be attributed to the Garwood Irrigation District. Almost as severe is the shortage anticipated for the Brazos-Colorado River Basin which may be attributable to the Lakeside Irrigation District (Table 10). The shortage decline for irrigation from 2010 through 2060 is mostly attributable to the projected decrease in demand owing to the decrease in acres farmed and feet per year.

This Act specifically prohibited the LCRA from providing groundwater from the study area (inclusive of Colorado County) to SAWS. Instead, the project proposed using groundwater for agricultural irrigation when surface water wasn't available. Groundwater use would be limited to no more than 62,000 acre-feet a year on a 10-year rolling average. Average annual use over the life of the project was not to exceed 96,000 acre-feet. The maximum allowed use in any one year was to be 95,000 acre-feet. Groundwater for the proposal would be subject to the rules, regulations and permitting requirements of local groundwater conservation districts, including CCGCD, and would not be sold to SAWS (Quick Facts about the LCRA-SAWS Water Project, 2006).

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WUG	River Basin	2010 (ac-ft/yr)	2020 (ac-ft/yr)	2030 (ac-ft/yr)	2040 (ac-ft/yr)	2050 (ac-ft/yr)	2060 (ac-ft/yr)
Irrigation	Lavaca	-36,216*	-31,292*	-26,529*	-21,918*	-17,436*	-13,145*
	Brazos-Colorado	-17,610*	-15,307*	-13,079*	-10,922*	-8,825*	-6,817*
	Colorado	1,851*	2,969*	4,051*	5,098*	6,116*	7,091*
Mining	Lavaca	-100*	-132*	-151*	-168*	-184*	-199*
	Brazos-Colorado	-19*	-22*	-23*	-24*	-25*	-26*
	Colorado	-8,438*	-7,914*	-7,062*	-5,911*	-4,477*	-4,636*
Livestock	Lavaca	-11*	-11*	-11*	-11*	-11*	-11*
	Brazos-Colorado	1*	1*	1*	1*	1*	1*
	Colorado	-14*	-14*	-14*	-14*	-14*	-14*
Manufacturing	Colorado	1,038*	1,091*	1,146*	1,199*	1,252*	1,234*
Columbus	Colorado	324	293	283	288	290	302
Eagle Lake	Brazos-Colorado	267	264	264	267	268	270
	Colorado	30	25	25	31	33	37
Weimar	Lavaca	2,016	2,015	2,014	2,016	2,016	2,017
	Colorado	1,567	1,563	1,563	1,565	1,567	1,569
County-Other	Lavaca	-105*	-109*	-106*	-97*	-93*	-90*
	Brazos-Colorado	8*	7*	8*	11*	12*	13*
	Colorado	76*	68*	75*	93*	100*	108*

Table 10: Projected water needs for CCGCD sorted by water-user group (WUG) and river basin. Source is 2007 State Water Plan. (*) – values apportioned form Colorado County data.

Mining accounts for the next largest projected shortfall of water in the District. Most of the mining is attributable to gravel extraction in the southern portion of the county adjacent to the Colorado River. Consequently, the largest shortfall by far is within the Colorado River Basin. Shortfalls in the other two basins, by comparison, are relatively minor. The decline in mining shortfall in the Colorado River Basin is mostly attributable to the anticipated decline in gravel extraction through the next fifty years.

In the towns of Columbus, Eagle Lake and Weimar, there is an anticipated surplus of supply over the next fifty years. Weimar accounts for about 85% of the total municipal surplus split between the Lavaca and Colorado River Basins. There is a small projected surplus for residents outside the towns listed above in the Brazos-Colorado and the Colorado River Basins. There is a small projected shortage for residents within the Lavaca River Basin. There is a small projected shortage for livestock water users and a somewhat large surplus for manufacturing.

Subsection 5.4.2 – Water Management Strategies

Where there is a projected shortfall in water needs, Regional Water Planning Groups (RWPG) are mandated with the task of deriving a water management strategy to address that shortfall. A recommended water management strategy is a specific plan to increase water supply or maximize existing supply to meet a specific need (TWDB, 2007). The shortfalls that impact the CCGCD are listed as the negative numbers in Table 10. The CCGCD falls wholly within the Lower Colorado Regional Water Planning Group jurisdiction and it is therefore, those strategies that were included in the 2007 State Water Plan and that are provided in Table 11. The projected quantitative contributions of the specific strategies are provided in Appendix G.

WUG	River Basin	Strategy	Source Name
Irrigation	Lavaca and Brazos-Colorado	COA Return Flows	Indirect Reuse
		Downstream Return Flows	Indirect Reuse
		Conjunctive Use of Groundwater	Gulf Coast Aquifer
		Development of New Rice Varieties	Conservation
		Irrigation District Conveyance Improvements	Conservation
		On-Farm Conservation	Conservation
		Irrigation Supply Reduction due to LSWP	Colorado River ROR
		Firm Up ROR with Off-Channel Reservoir	Colorado River ROR Excess Flows Permit
		LCRA WMP Interruptible Water Supply	Colorado River Combined ROR Interruptible
Mining	Colorado	Development of Other Aquifer	Other Aquifer
		Expansion of Gulf Coast Aquifer	Gulf Coast Aquifer
	Brazos-Colorado	Expansion of Gulf Coast Aquifer	Gulf Coast Aquifer
	Lavaca	Expansion of Gulf Coast Aquifer	Gulf Coast Aquifer
Livestock	Colorado	Expansion of Gulf Coast Aquifer	Gulf Coast Aquifer
	Lavaca	Expansion of Gulf Coast Aquifer	Gulf Coast Aquifer
County-Other	Lavaca	Expansion of Gulf Coast Aquifer	Gulf Coast Aquifer

Table 11: Water management strategies for various water-user groups in the CCGCD. Projected savings for each strategy are presented in Appendix G. Source is 2007 State Water Plan.

Return flow is the term for water that has been beneficially used and then is discharged to a receiving river or stream. Return flows from the City of Austin (COA) and to a lesser extent downstream from Austin, can provide a supplement to supply that can be used as long as the return flow continues. This type of indirect reuse occurs when treated wastewater is discharged to a stream or reservoir and then mixed with existing stream water and then diverted downstream. Return flow reuse can provide an immediate supplement to shortages but not generally of a large scale. Appendix G shows specific contributions from return flows for the next fifty years.

Conservation is another strategy to address water shortages. As it applies to irrigation in the CCGCD, conservation is divided into three types: development of new rice varieties; improvements in irrigation conveyance; and, on-farm conservation. Although it may take some time to develop these conservation measures, the impact could be significant (Appendix G).

By far the largest near and mid-term impact on irrigation water shortages is contribution from the interruptible water supply. The LCRA Water Management Plan for Interruptible Supplies allows the LCRA to supply rice irrigators in the CCGCD with interruptible supplies of water from the Highland Lakes, when available.
This supply would obviously not be available during drought conditions in the Highland Lakes area. It is projected that the impact of interruptible supplies of water would decline to the year 2060.

As discussed in Subsection 5.3.2 above, the LSWP was designed to help meet the long-term water needs of the lower Colorado River Basin and the City of San Antonio. No groundwater was to be provided to SAWS, but rather the project proposed using groundwater for agricultural irrigation when surface water was not available. Currently the LSWP is on hiatus and no water contribution is depicted (Appendix G).

Through the years there have been numerous studies on the feasibility of an off-channel reservoir in Colorado

County. Such studies have usually run into significant local opposition. The 2007 State Water Plan projects that there could be such a reservoir in Matagorda County. This could help alleviate irrigation water shortages in the Lavaca and Brazos-Colorado River Basins by year 2060 (Appendix G).

The last significant water management strategy is an expansion of the Gulf Coast Aquifer and addresses not only projected irrigation shortages, but shortages for livestock, mining and domestic uses. The projections of groundwater availability are in part assessed through groundwater availability modeling and will be discussed more below. Development of an additional groundwater aquifer could also contribute water. This other aquifer is most likely to be associated with the Colorado River alluvium and could help alleviate projected shortages for gravel extraction.

SECTION 5.5 – Modeling Runs

As part of the GAM program, the TWDB developed three new regional models of the Gulf Coast Aquifer of Texas: (1) the northern area, developed by Kasmarek and Robinson (2004) in cooperation with TWDB and the Harris-Galveston Subsidence District; (2) the central area, developed by Waterstone (2003) and Chowdhury et al (2004); and, (3) the southern area developed by Chowdhury and Mace (2003). The CCGCD is located on the boundary of the northern and central Gulf Coast Aquifer models (Figure 22). The GAM run provided by the TWDB used the Central Gulf Coast GAM. Details of that model will be discussed below. Additionally, a model of the Gulf Coast Aquifer in the vicinity of the Colorado River was developed by the LCRA-SAWS for the purposes of the LSWP (Young et al, 2007). This model will also be discussed in a section below.

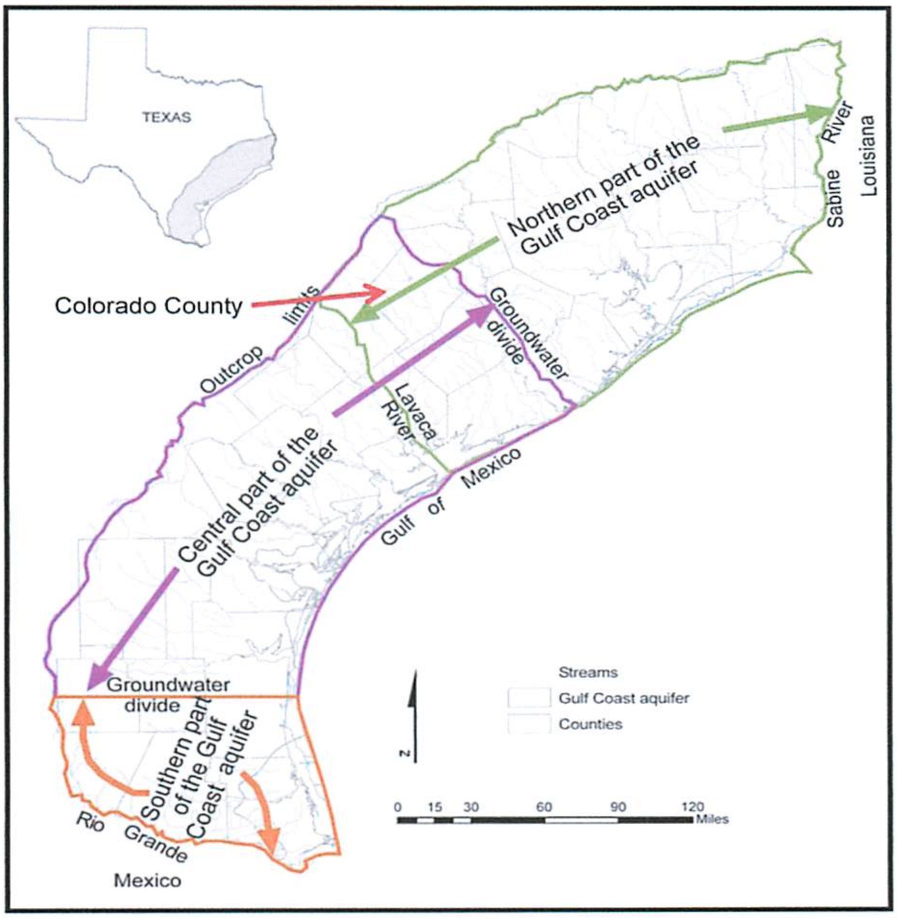

Figure 22: Map showing the groundwater model areas for the northern, central and southern parts of the Gulf Coast Aquifer. Red arrow designates the location of Colorado County. Source: Chowdhury and Mace, 2006.

In a groundwater resource assessment, modeling needs to focus not only on the heads, but on the components of the flow balance. Model inflows include recharge, stream loss and irrigation return flows. Model outflows would include stream gains, springs, groundwater evapotranspiration and pumping. These items were discussed in Chapter 4. Prior to development, the aquifer would be in a steady state where aquifer recharge is balanced by aquifer discharge. Once development (pumping) begins, the aquifer enters a transient state where more groundwater is being taken out of the aquifer than is replacing it. After a period of time however, assuming the pumping has been consistent and severe mining of the storage is not occurring, the aquifer may reach dynamic equilibrium where pumping is balanced by a reduction in discharge. Bredehoeft (2002) would define this as sustainable development. The model provides a physical description of impacts of development by describing the sources of groundwater capture and the timing. This, in turn, provides a means to define aquifer sustainability and ultimately, determine MAG (Young et al., 2009).

Subsection 5.5.1 – Central Gulf Coast GAMS

The Central Gulf Coast GAM extends roughly through Colorado, Wharton and Matagorda counties to the northeast, down to Kenedy, Brooks and Jim Hogg counties to the south. The Gulf Coast Aquifer is the only major aquifer in the GAM area. The shallowest of the aquifers is the Chicot and its outcrop area is by far the largest (Figure 22). The Evangeline Aquifer, Burkeville Confining Unit and Jasper Aquifer are progressively deeper through the section. These three units generally parallel the coast and their outcrops are generally thinner and located further to the northwest than the Chicot (Figure 23).

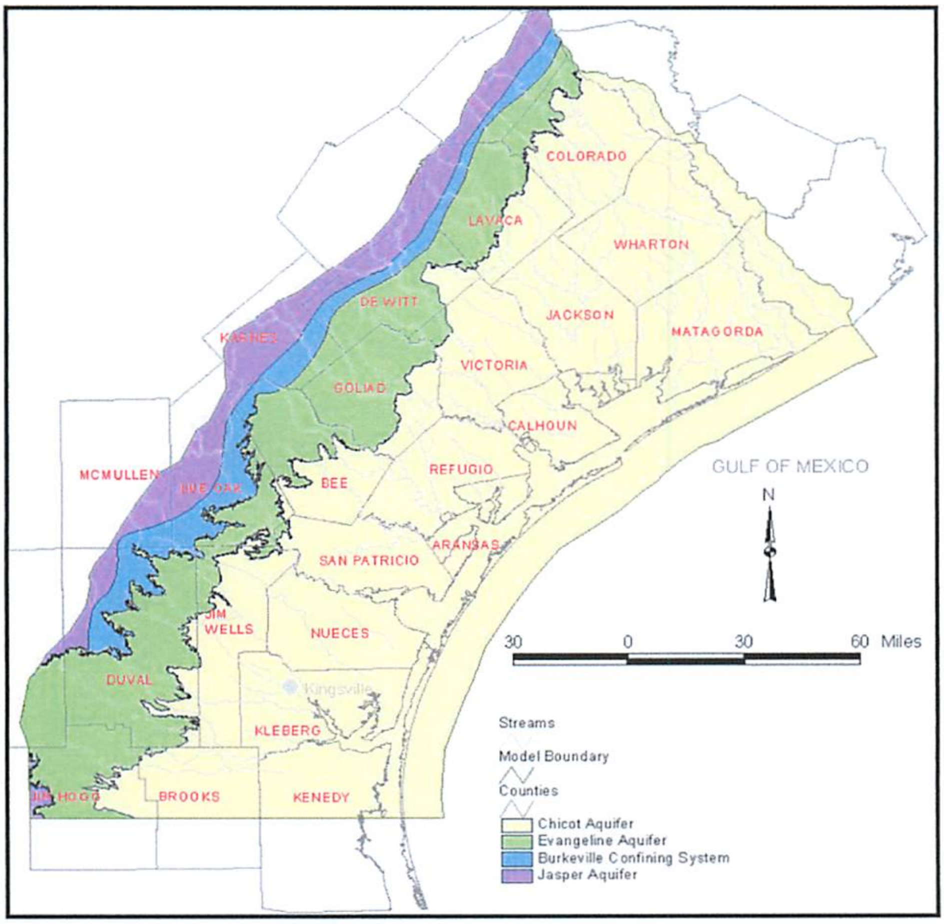

Figure 23: Map showing the limits of the outcrop areas, model boundaries, and counties within the study area.

Table 12 shows recent runs of the Central Gulf Coast GAM that included Colorado County. Total volume pumped varied between 33,000 ac-ft per year to 48,000 ac-ft per year over a 60 year period.

The split of volumes for each of the GAM runs for the Chicot, Evangeline and Jasper were 50.9%, 47.2% and 1.9% respectively. The corresponding average drawdown for each aquifer is shown as well. Figure 24 is a graphical display of volume pumped versus average drawdown and is based on the data displayed in Table 12. Presumably, points vary off a straight-line trend because additional data has been added to the model with the later GAM runs. Note that no drawdown is expected for the Chicot and Evangeline when pumpage is about 19,500 and 17,500 acre-feet per year respectively. Despite only small production from the Jasper aquifer, there is appreciably higher average drawdown than the other two reservoirs. This can be attributed to the sands of the Jasper being tighter and to the fact that there is much higher pumpage in Fayette County immediately to the northwest.

GAM Run	Total Volume (ac-ft/yr)	Volume Chicot (ac-ft/yr)	Volume Evangeline (ac-ft/yr)	Volume Jasper (ac-ft/yr)	Ave. Chicot Drawdown (feet)	Ave. Evangeline Drawdown (feet)	Ave. Jasper Drawdown (feet)
07-12	33,236	16,930	15,681	624			
07-14	47,857	24,378	22,580	900	-7.4	-11.7	-26.3
07-35	47,857	24,378	22,580	900	-7.3	-11.5	-25.1
07-36	47,857	24,378	22,580	900	-7.3	-11.5	-25.1
07-43	40,000	20,379	18,875	754	-1.3	-3	-18.9
07-42	33,000	16,810	15,569	620	4.3	5	-12.5
08-17	47,857	24,378	22,580	900	-7.5	-11.6	-26.2
08-56	48,000	24,450	22,650	900	-5.2	-8.8	-20.3

Table 12: GAM Runs for Colorado County. Source: Donnelly (2007a & b; 2008a, b, c & d; Jones, 2008; and, Anaya, 2009).

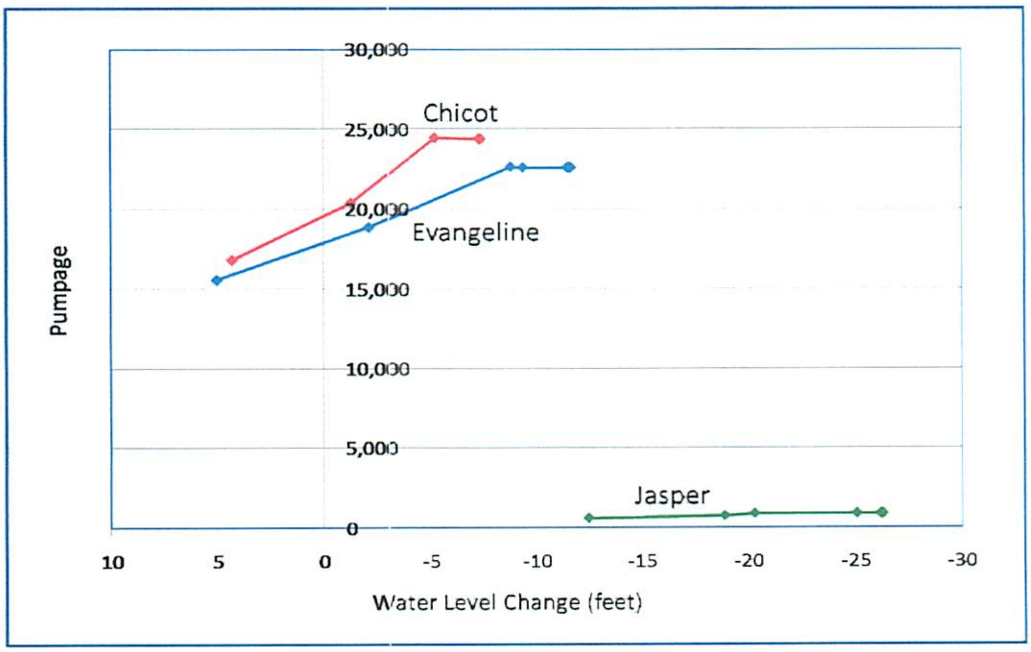

Figure 24: Plots of pumpage versus projected water level changes in Colorado County Aquifers.

As noted above, the drawdown figures represent averages. Figure 25 shows the distribution of pumpage assumed for the GAM runs. The higher pumpage in the south and southeastern parts of Colorado County correspond to the irrigation districts depicted in Figure 21. Within areas of higher pumpage such as in the Garwood or Lakeside Irrigation Districts, drawdown figures could be appreciably higher than represented in Table 12. The GAM 08-56 run showed that the maximum water-level drop in any given area was about 27 feet for the Chicot and about 33 feet for the Evangeline. Likewise, areas in the northern part of the county where pumpage is lower may show actual signs of rebound from initial calibrated levels (year 2000).

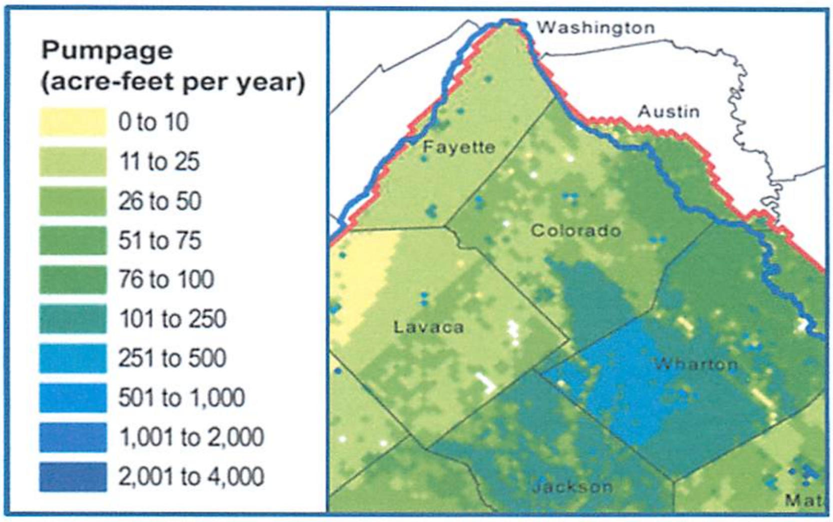

Figure 25: Distribution of pumpage assumed in GAM runs of the Central Gulf Coast model around Colorado County. Red line represents the model edge. Blue line represents the boundary of GMA 15. Source GAM Run 08-56 (Anaya, 2009).

Subsection 5.5.2 – Lower Colorado River Basin (LCRB) Model

A model was constructed for the purpose of evaluating the viability of the LCRA-SAWS Water Project. The LCRB model was build independently of the Central Gulf Coast GAM used by the TWDB. In mid-2009, the LCRB model was run using similar parameters as the GAM as a means of comparing the two. The results were appreciably di□erent (Figure 26). While the GAM run showed a net loss for the Chicot and Evangeline Aquifers in Colorado County, the LSWP model showed a gain (rebound). Similarly di□erent results were depicted for Wharton and Matagorda Counties.

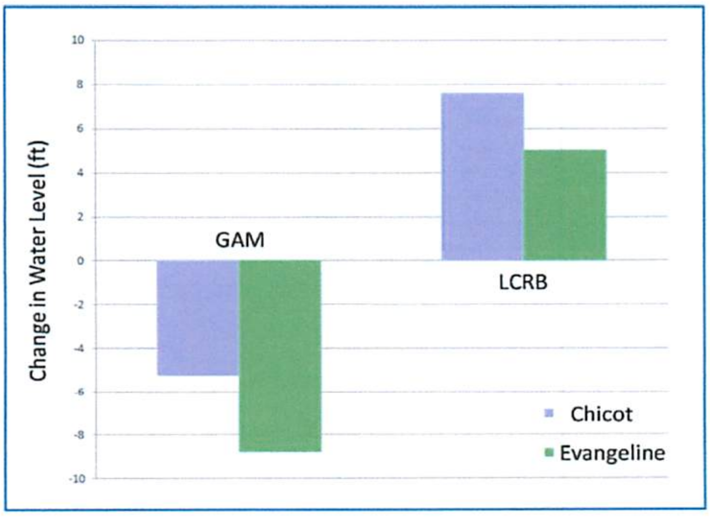

Figure 26: Comparison of LSWP model and GAM Run 08-56 on water level for the Chicot and Evangeline. From Young et al., 2009.

There are numerous factors that contributed to the di□erences. Recharge rates in the LSWP model were dramatically greater than in the GAM. There were also di□erences in transmissivity rates. The LSWP model assumed that the rivers were largely gaining from groundwater whereas the GAM assumed they were losing. There were di□erences in the pumping e□ect from adjacent counties, especially to the northeast. One of the biggest di□erences was the model layering and gridding. The LSWP model used four layers within the Chicot and two layers within the Evangeline. The GAM assumed that the Chicot and Evangeline is one layer each. Pumping was therefore distributed di□erently. Also, well screens were placed using the LCRA-SAWS stratigraphy rather than that utilized by the TWDB. Consequently, the proportionate breakdown between the Chicot and Evangeline is di□erent.

For the purposes of this report, the desired future conditions (DFC) and managed available groundwater (MAG) will be based on the TWDB GAM runs.

However, the District is evaluating the di□erences in the models and working to determine whether the LSWP model may ultimately be a better option for determining MAG.

SECTION 5.6 – Managed Available Groundwater

Before HB 1763 was passed, it was arguable whether or not GCDs had the ability to place a cap on groundwater production. After passage of the legislation, statue now states that "[a] district, to the extent possible, shall issue permits up to the point that the total volume of groundwater permitted equals the managed available groundwater (MAG). HB 1763 further declared that the Desired Future Conditions of the aquifer is to be determined through joint planning with other GCDs in the same Groundwater Management Area (GMA). The Colorado County Groundwater Conservation District (CCGCD) is part of GMA 15 (Figure 27) which is currently in the process of developing Desired Future Conditions that will lead to the quantitative estimate of MAG that will be developed by the Texas Water Development Board. Presently, no DFC has been adopted and therefore, no estimate of MAG is available.

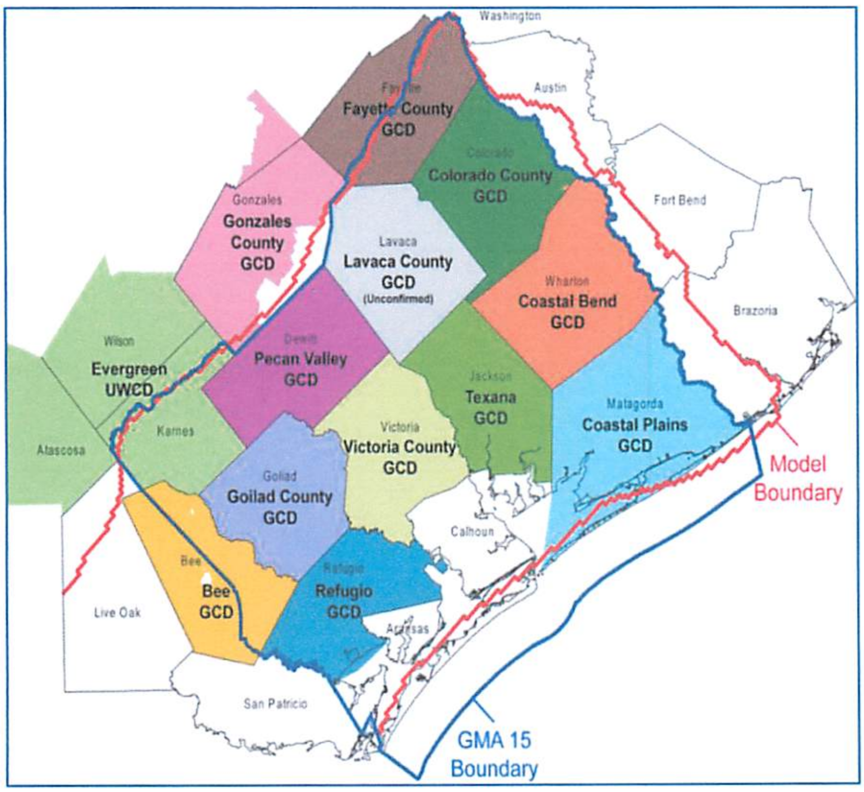

Figure 27: Groundwater Conservation Districts that comprise GMA 15.

The most recent GAM run requested by GMA 15 was 08-56. For average water level drops of 5.2 feet for the Chicot, 8.8 feet for the Evangeline, and 20.3 feet for the Jasper (Table 12), 48,000 acre-feet of groundwater would need to be pumped each year until 2060.

Figure 28 shows the change in water level for the Chicot in year 2060 after pumping 24,450 acre-feet per year. The average water level drop was 5.2 feet for the Chicot, but some areas of the county experienced significantly higher drawdown. Results from GAM 08-56 showed a maximum drop in the Chicot of over 27 feet. The most severe area of potential water level drop is in the extreme southern portion of the county, adjacent to Wharton and Jackson Counties (Figure 28). Conversely, the model suggests that in the extreme northeastern portion of the county, water levels could rebound as much as 17 feet. The Chicot Aquifer is absent in the northwestern portion of the county.

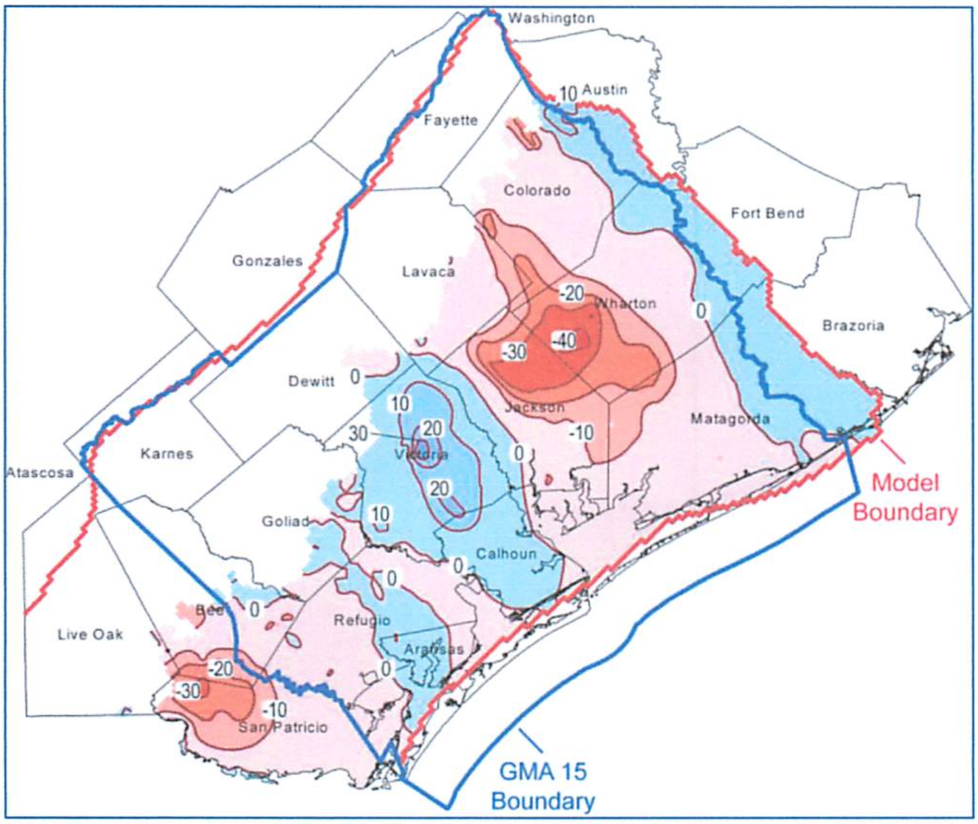

Figure 28: Changes in water level for the Chicot Aquifer over districts in GMA 15. Source: GAM Run 08-56 for GMA 15 (Anaya, 2009).

The average water level drop modeled by GAM 08-56 for Colorado County in the Evangeline is 8.8 feet which occurred as the result of pumping 22,500 acre-feet per year until 2060. Localized drawdown can be substantially greater. Maximum water level drop in the Evangeline was recorded as 33 feet and likely occurred in the northern portion of the county (Figure 29) (Anaya, 2009). Like the Chicot, a more severe drawdown was recorded in the southern portion of Colorado County corresponding to the Garwood Irrigation District. Water level was virtually unchanged in the northeastern portion of the county.

The Jasper Aquifer does not have the same robust transmissivity as the Chicot and Evangeline. Because the aquifer displays relatively low transmissibility, the water level is more sensitive to pumpage. The average drawdown in the Jasper was about 20 feet, despite the county only pumping 900 acre-feet per year until the year 2060. The low pumping of the Jasper is o□set by more prolific production across the county line in Fayette County. As would be expected, water level drops are greatest in the northwestern portions of the county (Figure 29). The model showed a maximum drawdown of over 66 feet.

Despite the fact that there is not production of the Jasper in the southeastern ¾ of the county, there are still recorded areas of over 20 feet of water level drop. The minimum drawdown was only about seven feet and occurred in the eastern portion of the county (Anaya, 2009).

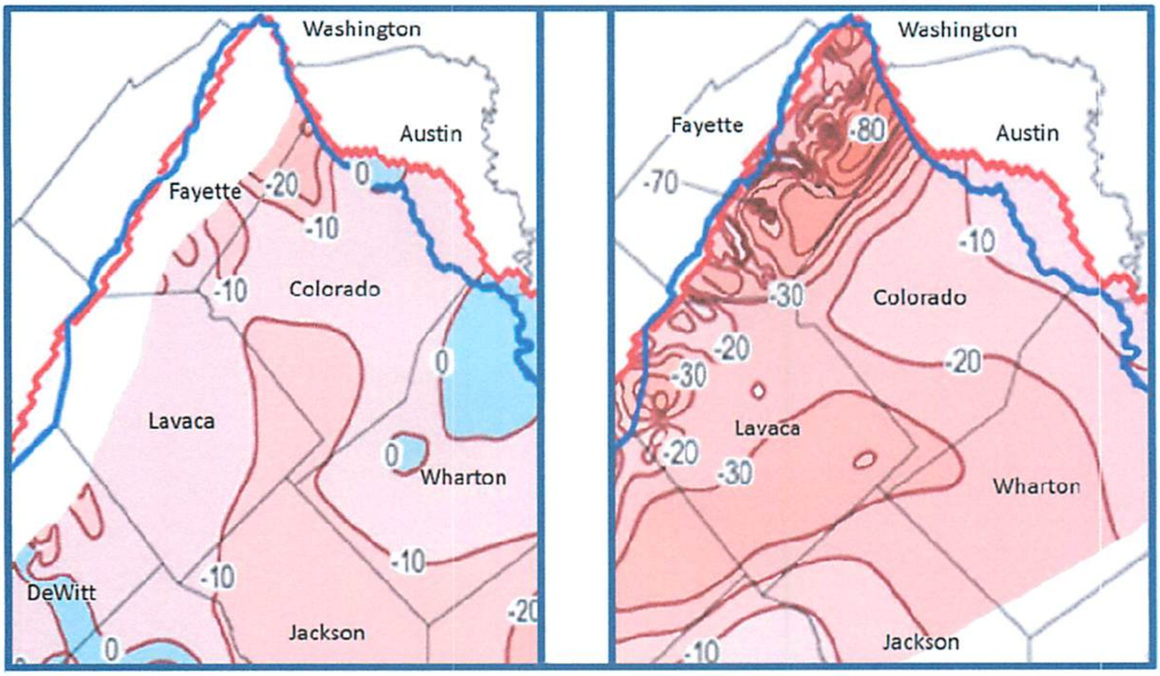

Figure 29: Simulated changes in water level for the year 2060 using GAM 08-56 in the area near Colorado County. Evangeline is shown on the left and Jasper on the right. Source: GAM Run 08-56 (Anaya, 2009).

CHAPTER 6 – EFFECTUATING AND TRACKING THE MANAGEMENT PLAN

Per the guidelines set forth in Section 36.1071 of the Texas Water Code, the CCGCD is responsible, in coordination with surface water management entities, for developing a comprehensive management plan which addresses specific goals. The District will adopt rules and regulations necessary to implement the management plan (Texas Water Code, Section 36.1071.f). The CCGCD will also adopt amendments to the management plan as necessary (Section 36.1071.g).

SECTION 6.1 – Actions, Procedures, and Avoidance Necessary to Effectuate the Management Plan

The CCGCD will implement the provisions of this management plan through the application of rules consistent with the management plan, using it as a guide to its principles and policies. The rules adopted by the District shall be pursuant to Chapter 36, Texas Water Code and the provisions of this plan. The CCGCD will adhere to and enforce the rules it develops. The promulgation and enforcement of the rules will be based on the best technical evidence available. 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 or subsequent plans adopted by the CCGCD and approved by the TWDB.

The District will seek cooperation from municipalities, water supply companies, irrigators, and all other users of groundwater pumped in Colorado County in the implementation of this plan and the management of groundwater supplies within the District. The CCGCD also will seek to cooperate and coordinate with state and regional water planning authorities and agencies and adjacent GCDs.

The CCGCD will treat all citizens equally. Citizens may apply to the District for discretion in enforcement of the rules on grounds of adverse economic effect or unique local conditions. The Board shall consider the potential adverse effect on adjacent landowners in granting any discretionary ruling. Exercise of its discretion should not be construed as limiting the power and authority of the CCGCD.

SECTION 6.2 – Methodology for Tracking the Progress in Achieving CCGCD Management Goals

An annual report will be prepared and presented to the Board of Directors on District performance with regard to achieving management goals and objectives. The presentation of this report will occur within 60 days of the end of each fiscal year. The Annual Report will be prepared in a format that will be reflective of the performance standards listed following each management objective. A copy of the annual audit of District financial records will also be included in the annual report. The District will maintain the report on file for public inspection at the District's office upon adoption.

CHAPTER 6 – EFFECTUATING AND TRACKING THE MANAGEMENT PLAN

Per the guidelines set forth in Section 36.1071 of the Texas Water Code, the CCGCD is responsible, in coordination with surface water management entities, for developing a comprehensive management plan which addresses specific goals. The District will adopt rules and regulations necessary to implement the management plan (Texas Water Code, Section 36.1071). The CCGCD will also adopt amendments to the management plan as necessary (Section 36.1072).

SECTION 6.1 - Actions, Procedures, and Avoidance Necessary to Effectuate the Management Plan

The CCGCD will implement the provisions of this management plan through the application of rules consistent with the management plan, using it as a guide to its principles and policies. The rules adopted by the District shall be pursuant to Chapter 36, Texas Water Code and the provisions of this plan. The CCGCD will adhere to and enforce the rules it develops. The promulgation and enforcement of the rules will be based on the best technical evidence available. 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 or subsequent plans adopted by the CCGCD and approved by the TWDB.

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CHAPTER 7 – MANAGEMENT GOALS, OBJECTIVES AND PERFORMANCE STANDARDS

The CCGCD management plan shall address the goals, as applicable and specified by the Texas Water Code (Sec. 36.1071). Additionally, the management plan shall identify the management objectives and performance standards under which the District will operate to achieve the management goals identified.

Upon completion, the CCGCD management plan will be forwarded to Regional Water Planning Group K and Groundwater Management Area 15 member districts for used in their planning process (Texas Water Code, Sec. 36.071.b).

SECTION 7.1 – Provide the Most Efficient Use of Groundwater (Goal 1)

The CCGCD will implement the steps necessary to assure the most efficient use of groundwater in the District (Texas Water Code, Sec. 36.1071.a.1). Determination of groundwater usage efficiency will necessitate knowledge of current and past groundwater usage and storage conditions. To facilitate this, the CCGCD will implement a water-level monitoring program and track changes that could indicate usage may be exceeding an optimum rate. Furthermore, the district will implement well registration and permitting rules that will help track take points across the District. The District will also have the ability to set maximum allowable production limits and to investigate and if necessary, to enforce violations.

Subsection 7.1.1 – Establishing a Water Level Monitoring Program

Management Objective – The CCGCD will establish a water-level monitoring network which will include data from existing monitoring programs performed by the Texas Water Development Board baseline. Additionally, CCGCD will add at least five new water-level monitoring wells by year end 2010 and ensure that there are no less than five monitor wells available in any calendar year. Volunteers will be solicited from District landowners to allow testing of these additional key wells. Locations will be chosen that best complement the existing monitor wells and represent current water conditions within the district boundaries. The depth to the water level will be measured at least once annually and results will be recorded in the district's database.

Performance Standard – The following will be the expected key metrics used to measure progress of management objectives:

- The number of new CCGCD monitor wells established by year end 2010; and,
- The number of total CCGCD monitor wells at the end of each calendar year.
- The number of wells with water levels measured once annually.

Subsection 7.1.2 – Implement a Well Registration Process

Management Objective – Upon adoption of the rules, the CCGCD will require all exempt and non-exempt wells, both future and present, to be registered with the District. These registrations will allow the District to record exact take-point locations and to provide more reliable estimates of current water usage and future projections.

The CCGCD staff will provide an annual report to the District Board each January that will disclose the number of registrations of new and existing wells.

Performance Standard – The following will be the expected key metrics used to measure progress of management objectives:

- The annual number of exempt well registration applications;
- The annual number of non-exempt well registration applications; and,
- The total number of historical and current well registrations in the District.

Subsection 7.1.3 – Implement a Well Permitting Process

Management Objective – Upon adoption of the rules, the CCGCD will require that 100 percent of the non-exempt wells be permitted. Operating permits will be issued within 30 days of application or as soon as possible thereafter.

CHAPTER 7 – MANAGEMENT GOALS, OBJECTIVES AND PERFORMANCE STANDARDS

The CCGCD's management plan shall address the goals, as applicable and specified by the Texas Water Code (Sec. 36.1071). Additionally, the management plan shall identify the management objectives and performance standards under which the District will operate to achieve the management goals identified.

Upon completion, the CCGCD management plan will be forwarded to Regional Water Planning Group K and Groundwater Management Area 15 member districts for used in their planning process (Texas Water Code, Sec 36.1071).

SECTION 7.1 – Provide the Most Efficient Use of Groundwater (Goal 1)

The CCGCD will implement the steps necessary to assure the most efficient use of groundwater in the District (Texas Water Code, Sec. 36.1071(a)(1)). Determination of groundwater usage efficiency will necessitate knowledge of current and past groundwater usage and storage conditions. To facilitate this, the CCGCD will implement a water-level monitoring program and track changes that could indicate usage may be exceeding an optimum rate. Furthermore, the district will implement well registration and permitting rules that will help track take points across the District. The District will also have the ability to set maximum allowable production limits and to investigate and if necessary, to enforce violations.

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Performance Standard – The following will be the expected key metrics used to measure progress of management objectives:

- The number of new CCGCD monitor wells established by year end 2010; and,
- The number of total CCGCD monitor wells at the end of each calendar year.
- The number of wells with water levels measured once annually.

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Management Objective – Upon adoption of the rules, the CCGCD will require all exempt and non-exempt wells, both future and present, to be registered with the District. These registrations will allow the District to record exact take-point locations and to provide more reliable estimates of current water usage and future projections.

The CCGCD staff will provide an annual report to the District Board each January that will disclose the number of registrations of new and existing wells.

Performance Standard – The following will be the expected key metrics used to measure progress of management objectives:

- The annual number of exempt well registration applications;
- The annual number of non-exempt well registration applications; and,
- The total number of historical and current well registrations in the District.

Subsection 7.1.3 – Implement a Well Permitting Process

Management Objective – Upon adoption of the rules, the CCGCD will require that 100 percent of the non-exempt wells be permitted. Operating permits will be issued within 90 days of application or as soon as possible thereafter

This process will help to ensure that drilling and completions of wells are being done safely and efficiently. The CCGCD staff will provide an annual report to the District Board each January that will disclose the number of permits applied for, granted and pending.

Water-well drillers and pump installers operating in the District will be notified of the requirement for owners of non-exempt wells to obtain an operating permit and the requirement that the driller and/or pump installer insure that no non-exempt well, not otherwise excluded, is placed into service within the District without an operating permit. Notifications will be sent out no later than one month after the adoption of District Rules and Regulations. The CCGCD staff will provide the total number of notifications sent out at the next scheduled Board meeting after adoption of District Rules.

Random inspections of new well sites will help to assure compliance to the District's completion and spacing standards. CCGCD will conduct at least one random inspection of a new well site annually. Written notice will be sent to the well owner and/or driller should the well fail to meet the standards within 30 days of inspection. The governing board of the District will vote on final approval of the permit at the next scheduled meeting. The CCGCD staff will provide in its annual report to the District Board each January, the total number of on-site inspections performed and the total number of notices sent out informing well owners or drillers that the well failed to meet proper District standards.

Performance Standard – The following will be the expected key metrics used to measure progress of management objectives:

- The total number of permits applied for and issued annually in the CCGCD;
- The number of pending requests at year end;
- The total number of notifications informing recipients of requirements for permitting that were sent out to water-well drillers and pump installers within one month of District Rules adoption;
- The total number of on-site inspections performed; and,
- The number of letters delivered to permit applicants requesting additional information or to make changes to comply with District rules.

SECTION 7.2 – Preventing Waste of Groundwater (Goal 2)

The CCGCD will establish strategies to protect and enhance the quantity and quality of useable groundwater by controlling and preventing contamination and waste (Texas Water Code, Sec. 36.1071.a.2). Waste can be reduced by ensuring proper adherence to production limits and well spacing regulations. Proper maintenance, closing, and abandonment of wells can help prevent waste also. The constituents of CCGCD will benefit from dissemination of information on groundwater waste prevention.

Subsection 7.2.1 – Set and Enforce Maximum Allowable Production Limits

Management Objective – The CCGCD reserves the right to set and enforce maximum allowable production limits should it be deemed that there is unnecessary waste of groundwater resources. The District Rules and Regulations will specify the production limitations for certain types of wells. The CCGCD will investigate 100 percent of reports filed by District constituents regarding pumpage of groundwater in excess of the allowable set under the District Rules and Regulations. Investigation of each occurrence shall occur within 30 days of receiving the report. Each case will be addressed according to specifications put forth in the District Rules. The CCGCD staff will provide in its annual report to the District Board each January, the total number of investigations, the average time taken for investigations and the total number of incidences where violations occurred.

Performance Standard – The following will be the expected key metrics used to measure progress of management objectives:

- The number of and percentage of reports investigated annually;
- The average time taken to investigate these reports; and,
- The number of incidences where violations occurred.

Subsection 7.2.2 – Set and Enforce Spacing Requirement Regulations

Management Objective – In order to minimize the potential waste of groundwater resources, the CCGCD, in the District's Rules and Regulations, shall mandate minimum spacing regulations from water production wells from property lines and from each other. The District shall also provide input as to where new property lines may run relative to existing water well producers. The CCGCD will investigate 100 percent of reports filed regarding spacing infractions per District Rules. Investigation of each occurrence shall occur within 30 days of receiving the report. CCGCD staff will provide in its annual report to the District Board each January, the total number of investigations, the average time taken for investigations and the total number of incidences where violations occurred.

Performance Standard – The following will be the expected key metrics used to measure progress of management objectives:

- The number of and the percentage of filed reports investigated annually;
- The average time taken to investigate these reports; and,
- The number of incidences where violations occurred.

Subsection 7.2.3 – Establish and Maintain a Water-Quality Monitoring Program

Management Objective – The CCGCD will establish a water-quality monitoring network which will include data from existing monitoring programs performed by the Texas Water Development Board (TWDB) and other entities in order to access historical data that will be necessary to establish a baseline. Additionally, CCGCD will act on requests from constituents involving water quality concerns as early as practically possible following approval of District Rules. Data acquired from CCGCD investigations will be added to the TWDB database. CCGCD will proactively test wells in areas where likelihood for increased contamination is deemed highest. CCGCD will ensure at least one well will be tested annually. CCGCD staff will provide in its annual report to the District Board each January, the total number of monitor wells established, total number of samples collected and analyzed and any results that may directly or indirectly infer contamination.

Performance Standard - The following will be the expected key metrics used to measure progress of management objectives:

- The number of water-quality monitoring wells;
- The number of samples collected and analyzed annually; and,
- The annual number and locations of wells where contamination has been discovered or reported and the associated results of analysis.

Subsection 7.2.4 – Encourage Proper Maintenance of Producing or Suspended Wells

Management Objective – The District will monitor and communicate to well owners any indications of inefficiency in well operations that might cause waste of groundwater. The CCGCD will conduct at least one random inspection of well operations in the district annually. Not only will mechanical inefficiencies be monitored and reported as needed, but indications of contamination due to faulty equipment will be reported. The CCGCD staff will provide in its annual report to the District Board each January, the number of site visits to check equipment, the number of notices and violations of District rules, and the number of wells the District required to be closed.

Performance Standard - The following will be the expected key metrics used to measure progress of management objectives:

- The annual number of site visits to check equipment;
- The annual number of notices and violations of District rules regarding well maintenance; and,
- The number of wells the District required to be closed each year.

Subsection 7.2.5 – Encourage Plugging of Abandoned Wells

Management Objective – The CCGCD will inspect abandoned wells to assure proper closing of wells in accordance to rules set forth by the Water Well Drillers Board (WWDB). Notices will be sent to well owners or operators whose wells do not meet WWDB requirements and District Rules and Regulations. CCGCD staff will provide in its annual

Subsection 7.2.2 – Set and Enforce Spacing Requirement Regulations

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Performance Standard – The following will be the expected key metrics used to measure progress of management objectives:

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Performance Standard – The following will be the expected key metrics used to measure progress of management objectives:

- The annual number of site visits to check equipment;
- The annual number of notices and violations of District rules regarding well maintenance; and,
- The number of wells the District required to be closed each year.

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Management Objective – The CCGCD will inspect abandoned wells to assure proper closing of wells in accordance to rules set forth by the Water Well Drillers Board (WWDB). Notices will be sent to well owners or operators whose wells do not meet WWDB requirements and District Rules and Regulations. CCGCD staff will provide in its annual report to the District Board each January, the total number of reported abandoned wells, the number of inspections of abandoned wells and the number of subsequent notices sent out.

Performance Standard - The following will be the expected key metrics used to measure progress of management objectives:

- The number of reported wells abandoned each year;
- The number of inspections of abandoned wells each year; and,
- The annual number of notices sent out to well owners or operators concerning violations of WWDB or District rules.

Subsection 7.2.6 – Disseminate Information on Waste Prevention to the Residents of CCGCD

Management Objective – In conjunction with efforts in water conservation, the CCGCD will implement a waste prevention program with the purpose of educating constituents of the District on ways to prevent waste of water. Among the items that may be presented are rainwater harvesting, brush control and recharge projects. The District staff will implement this waste prevention program annually through at least one publication written in brochures or in media outlets (newspapers), and at least one update to the District web site and through at least one oral program or curriculum provided to schools or other community outlets. The District staff will also ensure that the web site will have available links to CCGCD presentations and other useful sources on waste prevention and/or conservation.

Performance Standard - The following will be the expected key metrics used to measure progress of management objectives:

- The number of oral presentations to schools and community and government groups each year;
- The number of printed (or web-site oriented) waste prevention articles presented to the public each year; and,
- The number of published brochures made available to the public during each calendar year.

SECTION 7.3 – Conjunctive Surface Water Management (Goal 3) 27

Since the Colorado River bisects the CCGCD, it is necessarily an important source of water for the District and as such has implications on overall groundwater usage. The boundary of the CCGCD falls wholly within the bounds of 29
the Lower Colorado River Authority (LCRA) and the Region K Regional Water Planning Group. The District will 30
work with these entities to ensure that there is ongoing communication on how best to address the water needs of the people of Colorado County.

Subsection 7.3.1 – Participation in Regional Planning Processes

Management Objective – Each year, the District will participate in the regional planning process by attending at least 50% of the Region K Water Planning Group meetings. The CCGCD will work with the surface water suppliers to ensure adequate water supplies are available to the present and future constituents of Colorado County. The CCGCD will have Region K and/or LCRA representatives on their mailing list informing them of District meetings and events.

Performance Standard – The following will be the expected key metrics used to measure progress of management objectives:

- Number of Region K meetings held and attended by a District representative each year; and,
- Number of District meetings and events in which invitations were mailed to Region K and LCRA representatives.

Subsection 7.3.2 – Identify and Address Projects that Might Affect Groundwater Resources

Management Objective – CCGCD staff will provide in its annual report to the District Board each January, the total number of notifications provided to the public concerning legislative, judicial, or other government or private activities that could affect the groundwater resources of the CCGCD. As long as it is considered a potential impact report to the District Board each January, the total number of reported abandoned wells, the number of inspections of abandoned wells and the number of subsequent notices sent out.

Performance Standard - The following will be the expected key metrics used to measure progress of management objectives:

- The number of reported wells abandoned each year;
- The number of inspections of abandoned wells each year; and,
- The annual number of notices sent out to well owners or operators concerning violations of TWDB or District rules.

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Performance Standard – The following will be the expected key metrics used to measure progress of management objectives:

- Number of Region K meetings held and attended by a District representative each year; and,
- Number of District meetings and events in which invitations were mailed to Region K and LCRA representatives.

Subsection 7.3.2 – Identify and Address Projects that Might Affect Groundwater Resources

Management Objective – CCGCD staff will provide in its annual report to the District Board each January, the total number of notifications provided to the public concerning legislative, judicial, or other government or private activities that could affect the groundwater resources of the CCGCD. As long as it is considered a potential impact on District groundwater resources, the CCGCD will actively participate in and influence as necessary the LCRA-SAWS Water Project or any similar projects and update the District Board at least once quarterly.

Performance Standard – The following will be the expected key metrics used to measure progress of management objectives:

- Total number of notifications to the public each year of key government or private activities that could affect CCGCD groundwater resources;
- Activity on the LCRA-SAWS Water Project and the number of updates to the Board.

SECTION 7.4 – Natural Resource Issues (Goal 4)

According to the Texas Water Code, Sec. 36.1071.a.5, groundwater districts are expected to establish strategies that address natural resource issues as they affect groundwater in the CCGCD. The primary natural resource developments in Colorado County are oil and gas production and mining for gravel.

Considerable amounts of brine have been produced in Colorado County in conjunction with production of oil and gas. Since 1967, the danger of contamination has been minimized by State regulations that eliminate the use of unlined surface pits for the disposal of oil-field brines (Railroad Commission of Texas, 1973). Lostkot et al. (1982) cite chemical analyses of shallow water samples that show a generally higher than normal mineralization of the water in the aquifers which they attribute to contamination from oil and gas fields with previously un-lined open pits.

The alluvium in the flood plain of the Colorado River, especially south of Columbus, has been a rich source of construction grade sand and gravel materials for decades. Numerous commercial gravel mining operations have operated in this area. These operations excavate large pits to expose deposits of sand and gravel, and then remove these materials, some of which then undergo rinsing to remove clays and other fine sediments. Because of the shallow groundwater levels in these flood plain areas, these pits invariably fill with groundwater, often of a fairly brackish nature, which is then used to rinse the excavated materials. The rinsing operations sometime generate discharges into creeks and other tributary streams, potentially impacting the Colorado River. Remnant pits from suspended operations also exist throughout the area.

The formation of the CCGCD by the constituents of Colorado County was in part, a testament to the importance of groundwater as a natural resource. One of the charges of the CCGCD is to ensure an adequate supply of water for future and current residents. To that end, the District has the right to prohibit transport of groundwater outside the District's boundaries unless the District Board has issued the well owner or operator a Transport Permit.

Subsection 7.4.1 – Request Information from the Texas Railroad Commission

Management Objective – The District will communicate with the Texas Railroad Commission at least once annually asking for the following: location of existing salt water or waste disposal injection wells permitted by the Texas Railroad Commission within the District; location of any new salt water or waste disposal wells permitted to operate within the District; and, results of integrity tests performed on salt water or waste disposal injection wells permitted within the District.

Performance Standard – The following will be the expected key metrics used to measure progress of management objectives:

- The number of District communications with the Texas Railroad Commission regarding the location of existing salt water or waste disposal injection wells permitted by the Texas Railroad Commission within the District; and,
- One hundred percent communications with the Texas Railroad Commission will be submitted to the Board annually.

Subsection 7.4.2 – Inform Constituents on Groundwater-Related Natural Resource Issues

Management Objective – Information will be provided to the public via updates to the District web site about the on District groundwater resources, the CCGCD will actively participate in and influence as necessary the LCRA-SAWS Water Project or any similar projects and update the District Board at least once quarterly.

Performance Standard – The following will be the expected key metrics used to measure progress of management objectives:

- Total number of notifications to the public each year of key government or private activities that could affect CCGCD groundwater resources;
- Activity on the LCRA-SAWS Water Project and the number of updates to the Board.

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Management Objective – The District will communicate with the Texas Railroad Commission at least once annually to inquire on the following: location of existing salt water or waste disposal injection wells permitted by the Texas Railroad Commission within the District; location of any new salt water or waste disposal wells permitted to operate within the District; and, results of integrity tests performed on salt water or waste disposal injection wells permitted within the District.

Performance Standard – The following will be the expected key metrics used to measure progress of management objectives:

- The number of District communications with the Texas Railroad Commission regarding the location of existing salt water or waste disposal injection wells permitted by the Texas Railroad Commission within the district and,
- One hundred percent communications with the Texas Railroad Commission will be submitted to the Board annually.

Subsection 7.4.2 – Inform Constituents on Groundwater-Related Natural Resource Issues

Management Objective – Information will be provided to the public via updates to the District web site about the status of groundwater use, availability, and water levels and a description of natural resource issues, e.g., mining, out of District transport of groundwater, protection of endangered species, or the spread of phreatophytic vegetation, that impact the use and availability of groundwater or which are affected by the use and availability of groundwater. The information will be distributed to the public via the District's website at least once annually. If evidence of drawdown on the water table or reduction of artesian pressure in groundwater or in an area of an aquifer indicates a groundwater or an aquifer mining situation, that is, a non-sustainable yield, the Board may declare the area a Critical Groundwater Depletion Area (CGDA). Within a month of District Rules approval, the CCGCD will develop the specific criteria for declaring a Critical Groundwater Depletion Area (CGDA) and the necessary contingencies. CCGCD staff will provide in its annual report to the District Board each January, the status of groundwater use, availability, and water levels within the District. Upon approval from the Board, this information will be disseminated to the public on the District web-site and/or local newspapers. Additionally, the CCGCD staff will provide in its annual report the number of active water quality permits in the Texas Commission on Environmental Quality (TCEQ) Water Quality Permit Application database for facilities in Colorado and adjacent counties.

Performance Standard – The following will be the expected key metrics used to measure progress of management objectives:

- Water levels and availability of groundwater within the CCGCD;
- Manner and timing of the distribution of water level and groundwater availability to the public; and,
- Development of CGDA and associated contingencies within a month of District Rules and Regulations approval.

Subsection 7.4.3 – Analyze and Act on Requests for Transfer of Groundwater Out of CCGCD

Management Objective – The District evaluates and acts upon requests for transfer of groundwater out of CCGCD without regard to the manner the water is transferred out of the District. This specifically includes discharges into watercourses to convey water, as well as pipelines, conduits and aqueducts. The CCGCD staff will provide in its annual report to the District Board each January, the total number of transfer permits and amendments requested and issued annually.

Performance Standard – The following will be the expected key metrics used to measure progress of management objectives:

- The number of permits or permit amendments requested annually; and,
- The number of permits or permit amendments issued annually.

SECTION 7.5 – Drought Conditions (Goal 5)

An important goal for groundwater conservation district (GCD) consideration in the Texas Water Code is consideration of drought conditions (Sec. 36.1071.a.6). Dry periods and drought events are not uncommon in the Gulf Region and can occur every five to six years with typical durations of 18 to 24 months (Bradley, 2006). Two significant ways to monitor for dry periods and drought events are with the long-term Palmer Drought Severity Index (PDSI) and the 12-month Standardized Precipitation Index (SPI). The PDSI is the most commonly used drought index in the United States and in Texas, it is the standard "Drought Index" for determining dry or drought conditions (Bradley, 2006). Based on the PDSI, the most severe event occurred in the southern climate division of the Texas Gulf Coast and lasted 85 months from 1950 to 1957. Severe to extreme drought conditions dominated the area. Based on SPI values, the longest duration and most severe event occurred at Corpus Christi and lasted for 72 months between 1909 and 1911 (Bradley, 2006). The District will have the responsibility to monitor these indices for weather/climate changes and alert constituents of potential oncoming drought conditions.

The District will provide information to constituents who want to conserve water in preparation for potential drought conditions. Note however that preparations for drought conditions are not to be confused with conservation. Conservation measures are applicable at all times whereas drought contingencies are only used when conditions warrant it.

The CCGCD will have emergency water conservation measures ready in case of extended drought conditions and will work with all other public water suppliers, irrigations districts, and state water agencies to ensure the drought conditions are being addressed in the most efficient and beneficial means possible. Should it become necessary and in order to ensure adequate water is available for the people of Colorado County, the District reserves the right to curtail production of groundwater in extreme situations.

Subsection 7.5.1 – Monitor Weather Indices

Management Objective – The CCGCD will track rainfall records from nearby weather stations on an ongoing basis. This data will be compared to hydrographs in monitoring wells used by the CCGCD. Additionally, the District will monitor the updated PDSI map by downloading at least one map monthly and check for periodic updates to the Drought Preparedness Council Situation Report posted on the Texas Department of Public Safety web site and the Agricultural Drought Task Force hosted by the Texas Agrilife Extension. The CCGCD staff will provide in its annual report in January the precipitation amounts, water levels and any apparent associated trends. Upon Board approval, information will be disseminated to the public by the District's web site and/or local newspapers.

Performance Standard – The following will be the expected key metrics used to measure progress of management objectives:

- Report on precipitation amounts as compared to water levels within CCGCD; and,
- Manner and timing of distribution of precipitation and water level data to the public.

Subsection 7.5.2 – Implement Emergency Water Conservation Measures

Management Objective – The annual amount of groundwater permitted by the District for withdrawal from the portion of the aquifers located within the District may be curtailed during periods of extreme drought in the recharge zones of the aquifers or because of other conditions that cause significant declines in groundwater surface elevations. Within twelve months of approval of District Rules and Regulations, District staff will develop criteria for implementing emergency water conservation measures. District staff will notify the Board immediately of any situation where the measurements obtained from the water level monitoring network may require curtailment of groundwater. The Board may order curtailment based on the District's monitoring wells or by recommendation of the TWDB or a comparable agency.

Performance Standard – The following will be the expected key metrics used to measure progress of management objectives:

- Development of criteria for implementing emergency water conservation measures within 12 months of District Rules and Regulations approval.
- Report to the Board on any situation where the measurements obtained from the water level monitoring network were utilized to identify and anticipate, if possible, any situations that may require curtailment of groundwater withdrawal; and,
- Report to the Board any significant warnings about drought conditions put forth by the government agencies.
- Report to the Board the number of months the District was in a severe drought conditions and the amount of pumpage curtailment that may have resulted.

SECTION 7.6 – Conservation (Goal 6)

The Texas Water Code, Sec. 36.1071.a.7.a, directs the District's management plan to consider conservation. The primary mechanism for the CCGCD to promote conservation is through public education programs and media publications.

Subsection 7.6.1 – Establish Program to Emphasize Water Conservation

Management Objective – In coordination with efforts in waste prevention, the CCGCD will implement a conservation program with the purpose of educating the constituents of the District on ways to conserve water. The District staff will implement this conservation program annually through at least one publication written in brochures or in media outlets (newspapers), and at least one update to the District web-site and through at least one oral program or curriculum provided to schools or other community outlets. The District staff will also ensure that the web site will have available links to CCGCD presentations and other useful sources on water conservation and/or waste prevention.

Performance Standard – The following will be the expected key metrics used to measure progress of management objectives:

- Number and copies of media publications per year;
- Number and copies of updates to the District web site per year;
- Number of oral presentations to schools, community or government groups each year; and,
- Number of published brochures made available to the public during each calendar year.

SECTION 7.7 – Addressing in a Quantitative Manner the Desired Future Conditions (Goal 7)

The Texas Water Code, Sec. 36.108 (Joint Planning in Management Area) requires representatives of each District located in whole or in part of a GMA to meet at least annually to conduct joint planning with the other districts in the GMA. In reviewing the management plans, the districts shall consider the degree to which each management plan achieves the desired future conditions established during the joint planning process.

Not later than September 1, 2010, and every five years thereafter, the districts shall consider the GAM and other data or information for the management area and shall establish desired future conditions for the relevant aquifers within the management area. The CCGCD resides wholly within GMA 15. Each district in GMA 15 shall ensure that its management plan contains goals and objectives consistent with achieving the desired future conditions of the relevant aquifers as adopted during the joint planning process.

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 the joint planning process in GMA 15 and the development of a desired future condition for the portion of the aquifer(s) within the District. Therefore, this goal is not applicable to the District at this time.

SECTION 7.8 – Management Goals Not Applicable to the District

As stated in the Texas Water Code, Sec. 36.1071.a, the District shall address the specified management goals as applicable or where appropriate and cost-effective (Sec. 36.1071.a.7). Listed and described below are the goals not considered applicable to CCGCD.

Controlling and Preventing Subsidence

As part of the TWDB Groundwater Availability Modeling (GAM) program, the USGS developed and tested a model that simulates groundwater flow and land-surface subsidence in the northern part of the Gulf Coast aquifer system in Texas from predevelopment (before 1891) through 2000. Two significant areas of concentrated groundwater withdrawal are in the GAM area. By far the largest water withdrawals have been from Harris and Galveston Counties (Houston area). Because of the adverse effects of groundwater withdrawal, the Harris-Galveston Coastal Subsidence District (HGCSD) was created in 1975 and the Fort Bend Subsidence District was created in 1989. The second principal area of withdrawal is the coastal irrigation area centered in Wharton and Jackson Counties and extending into southern Colorado County. Most of the irrigation withdrawals are from the Chicot aquifer for rice (Kasmarek and Robinson, 2004).

Groundwater development has caused as much as 350 ft of decline of the potentiometer surface of the Chicot aquifer in the Houston area. Although appreciable amounts of water have been withdrawn from the Chicot aquifer in the coastal irrigation area for decades, relatively little long-term drawdown (tens of feet) has occurred there. Rice-irrigation return flow and withdrawals from relatively shallow zones (under water-table conditions) that are each year in media outlets (newspapers), and at least one update to the District web-site and through at least one oral program or curriculum provided to schools or other community outlets. The District staff will also ensure that the web site will have available links to CCGCD presentations and other useful sources on water conservation and/or waste prevention.

Performance Standard – The following will be the expected key metrics used to measure progress of management objectives:

- Number and copies of media publications per year;
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- Number of oral presentations to schools, community or government groups each year; and,
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SECTION 7.7 – Addressing in a Quantitative Manner the Desired Future Conditions (Goal 7)

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Not later than September 1, 2010, and every five years thereafter, the districts shall consider the GAM and other data or information for the management area and shall establish desired future conditions for the relevant aquifers within the management area. The CCGCD resides wholly within GMA 15. Each district in GMA 15 shall ensure that its management plan contains goals and objectives consistent with achieving the desired future conditions of the relevant aquifers as adopted during the joint planning process.

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 the joint planning process in GMA 15 and the development of a desired future condition for the portion of the aquifer(s) within the District. Therefore, this goal is not applicable to the District at this time.

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Groundwater development has caused as much as 350 ft of decline of the potentiometric surface of the Chicot aquifer in the Houston area. Although appreciable amounts of water have been withdrawn from the Chicot aquifer in the coastal irrigation area for decades, relatively little long-term drawdown (tens of feet) has occurred there, since irrigation return flow and withdrawals from relatively shallow zones (under water-table conditions) that are readily recharged probably have helped to lessen long term water-level declines in the area (Kasmarek and Robinson, 2004).

As much as 10 ft of subsidence has occurred in southeastern Harris County near the northern end of Galveston Bay. A larger geographic are including much of central to southeastern Harris County has subsided at least six feet (Figure 30). No appreciable subsidence was simulated in the coastal irrigation area centered in southern Wharton County (Kasmarek and Robinson, 2004). Only small amounts of subsidence (less than two feet) have been historically documented.

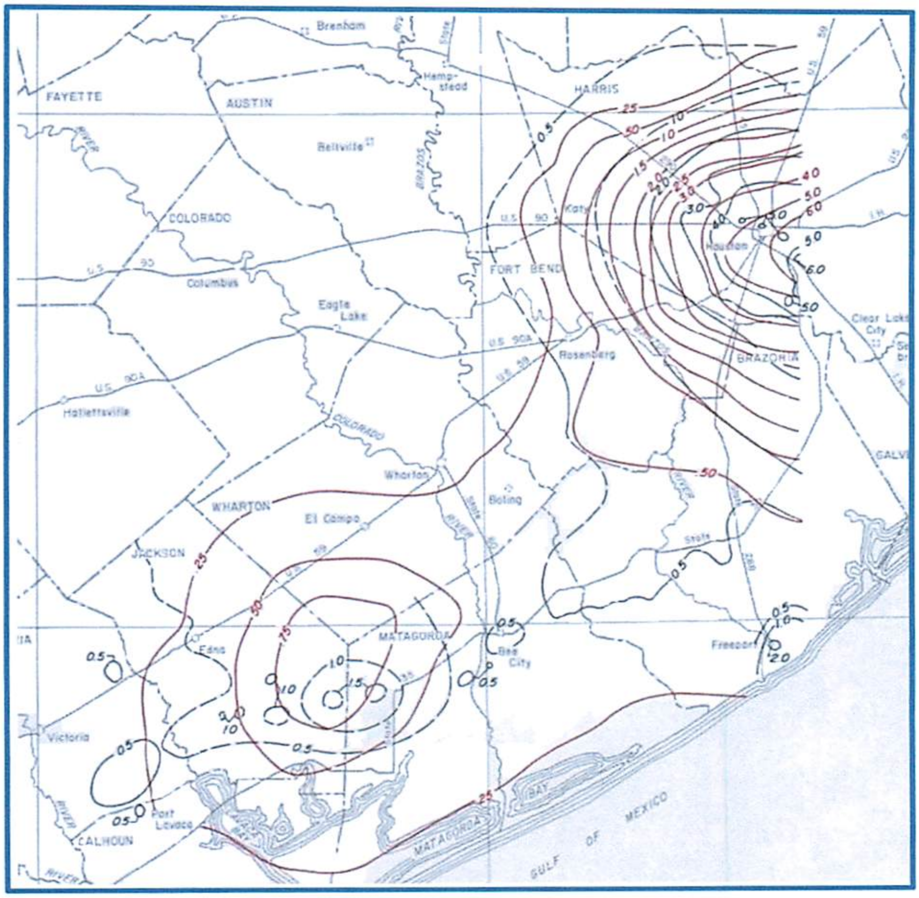

Figure 30: Subsidence map showing lines of equal subsidence (black) and equal modeled subsidence (red). Source: Carr et al., 1985. Contours in feet.

Because Colorado County is a relatively sparsely populated county, the projected subsidence in Colorado County from the GAM employed by the TWDB to look at land subsidence was small. As a result, a subsidence goal will not be included in the CCGCD management plan. The Coastal Bend and Coastal Plain Groundwater Conservation Districts, located directly south of Colorado County are monitoring subsidence. The District will receive regular updates from these districts and will address the issue should it become relevant.

Recharge Enhancement

Surface water can be intentionally directed to areas where permeable soils or fractured rocks exist. This would allow more rapid infiltration of the surface water into the subsurface so as to increase localized groundwater recharge. This process is referred to as recharge enhancement and would include any man-made structure that would hold surface water and increase the probability of groundwater recharge.

A study was performed on the Brazos Alluvium Aquifer which was modeled with the intent of determining, in part, whether there was potential for enhancing recharge of the aquifer. Model results indicated that it could be a viable concept (O'Rourke, 2006). Although Colorado River alluvium is not designated as a separate unit, it might be possible that at some point in the future, a similar project might be anticipated. However, at this time, the District is not aware of any practical near-term recharge enhancement scenarios that would be applicable for the CCGCD and this goal will not be considered in the District's management plan.

There has been to date, significant sponsored research on recharge enhancement by the South Central Texas Regional Water Planning Area (Region L) and the CCGCD will work with Region K and the LCRA to monitor any advances made in this area that might be viable and practical to recharge of the Gulf Coast Aquifer.

Rainwater Harvesting
Senate Bill 2 of the 77th Legislature exempts rainwater harvesting equipment from sales tax, and allows local governments to exempt rainwater harvesting systems from ad valorem (property) taxes. The TWDB has issued a manual on rainwater harvesting (TWDB et al., 2005), that serves as a primer in the basics of residential and small-scale commercial rainwater harvesting systems design. Rainwater harvesting systems can be as simple as a rain barrel for garden irrigation at the end of a downspout, or as complex as a domestic potable system or a multiple end-use system at a large corporate campus. However, rainwater harvesting is practical only when the volume and frequency of rainfall and size of catchment surface can generate sufficient water for the intended purpose (TWDB et al., 2005).

While rainwater harvesting may have some practical domestic use in Colorado County, it is not currently viewed as having a significant impact on overall groundwater management for the CCGCD. Until there is demonstrated that rainwater harvesting can compete effectively with current water sources for the District, addition of this goal to the District's management plan is not warranted. However, the benefits of rainwater harvesting will be discussed and included in future communications regarding conservation to District constituents.

Precipitation Enhancement
Weather modifications, as it has been applied in Texas over the past 25 to 30 years, involves cloud seeding to increase rain above what would have naturally occurred. The result of cloud seeding is referred to as rainfall enhancement. The TWDB is charged with the licensing and permitting of weather modification programs in the state. As of 2000, there were nine weather modifications programs in operation in Texas covering 44 million acres in Texas. The programs are intended to be an integral part of a long-term water management strategy by water conservation districts and other management authorities to replenish fresh water supplies in aquifers and reservoirs in order to meet growing water demands (Adams and Harris, 2001).

Studies on precipitation enhancement in Texas are geared more for areas west of Colorado County where rainfall is less frequent. The CCGCD does not have the resources to investigate the potential use of this method as it applies to groundwater resources. The District will monitor developments in this area of potential future applications.

Brush Control
In 1985, Senate Bill 1083 implemented the State Agriculture Code that provide for "the select control, removal, or reduction of noxious brush such as mesquite, prickly pear, salt cedar, or other spermatophytes that consume water to a degree that is detrimental to water conservation" (Agricultural Code, Chapter 203, Brush Control). In his overview of brush control as a means to increase stream flow and water supplies in major reservoirs, Hart (2004) expressed that there is no doubt that brush control is a viable water conservation practice for Texas rangelands. However, there is some question as to where and when brush control will produce economically viable increases in stream flow augmentation to reservoirs.

There have been numerous recent studies by consultants in support of groundwater management areas, regional water planning areas and the TWDB. Since the impact of brush control on groundwater management is still in research or early implementation stages, the CCGCD is not in a position to support this as a goal in the District's management plan. The CCGCD will monitor research performed on behalf of GMA 15, Region K or the TWDB that may be relevant to the District.

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CHAPTER 8 – APPROVAL CRITERIA

Upon adoption of the CCGCD Management Plan, the plan will remain in effect from the date of approval by the Texas Water Development Board until the plan is readopted unless the District adopts an amended management plan that is approved by TWDB. In accordance with Chapter 36 of the Texas Water Code, the District's management plan will be reviewed periodically and shall be submitted to the TWDB and readopted with or without revisions at least every five years.

SECTION 8.1 – Regional Cooperation and Coordination

Subsection 8.1.1 – Lower Colorado River Regional Planning Group (Region K)

According to Section 356.4 of the Texas Administrative Code, "each district shall forward a copy of its approved management plan to the chair of each regional water planning group with territory within the district's boundaries." The CCGCD is wholly within the Lower Colorado River Regional Planning Group, designated as Region K and representatives for CCGCD regularly attend Region K planning meetings. A draft version of the CCGCD Management Plan was sent to Region K in order to solicit comments. Appendix H shows the correspondence with Region K.

Subsection 8.1.2 – LCRA/SAWS Water Project

The first Region L (South Central Texas Regional Water Planning Group) water plan identified 13 options to take surface water and groundwater from the lower Colorado River basin. Region K and the LCRA decided to cooperate with Region L in finding a solution that could benefit both regions. Ultimately, under the direction of Region K and Region L, the LCRA and San Antonio Water System (SAWS) negotiated a water supply agreement to fund measures to conserve and develop water in the lower Colorado River basin and to help San Antonio meet some of its water shortages for a specific time. The details of the LCRA/SAWS Water Project were discussed more thoroughly in Section 5.3.2 of this document.

The CCGCD has actively been monitoring and participating in discussions with Coastal Bend and Coastal Plains Groundwater Conservation Districts, the LCRA and SAWS personnel and their consultants and TWDB personnel. A draft copy of the CCGCD Management Plan has been provided to the LCRA. Correspondence can be viewed in Appendix H.

SECTION 8.2 – Certified Copy of Resolution Adopting the Management Plan

According to Section 356.6 of the Texas Administrative Code, a certified copy of the District's resolution adopting the plan must be submitted to the executive administrator. Appendix I contains the aforementioned resolution. The approved management plan will be available for viewing to the general public on the District website, www.ccgcd.net.

SECTION 8.3 – Evidence of Public Notice and Hearing

According to Section 356.6 of the Texas Administrative Code, evidence must be presented to the executive administrator that the management plan was adopted only after public hearing and appropriate prior notice. A notarized Colorado County posting document and appropriate county newspaper notices are provided as evidence in Appendix J.

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The CCGCD has actively been monitoring and participating in discussions with Coastal Bend and Coastal Plains Groundwater Conservation Districts, the LCRA and SAWS personnel and their consultants and TWDB personnel. A draft copy of the CCGCD Management Plan has been provided to the LCRA. Correspondence can be viewed in Appendix H.

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APPENDIX A – Definitions, Units of Measure, Acronyms and Abbreviations

DEFINITIONS

- **Abandoned well** – a well that has not been used for six consecutive months. A well is considered to be in use in the following cases:
  - A non-deteriorated well which contains the casing, pump, and pump column in good condition; or,
  - A non-deteriorated well which has been capped.

- **Acre-foot** - the volume of water necessary to cover one acre of land one foot deep. Equivalent to about 43,560 cubic ft or 325,851 gallons. **

- **Aggregate withdrawal** - the amount of water withdrawn from two or more wells which are permitted for a total pumpage volume of all wells in the aggregate.

- **Agricultural use** - any use or activity involving agriculture, including irrigation. *

- **Agriculture** - any of the following activities:
  - Cultivating the soil to produce crops for human food, animal feed, or planting seed or for the production of fibers;
  - The practice of floriculture, viticulture, silviculture, and horticulture, including the cultivation of plants in containers or non-soil media, by a nursery grower;
  - Raising, feeding, or keeping animals for breeding purposes or for the production of food or fiber, leather, pelts, or other tangible products having a commercial value;
  - Planting cover crops, including cover crops cultivated for transplantation, or leaving land idle for the purpose of participating in any governmental program or normal crop or livestock rotation procedure;
  - Wildlife management area; and,
  - Raising or keeping equine animals. *

- **Alluvium** – for the purposes of this report, an unconsolidated terrestrial sediment composed of sorted or unsorted sand, gravel, and clay deposited by water from rivers, streams or tributaries.

- **Annular space** - the space between two concentric cylindrical objects, one of which surrounds the other, such as the space between the walls of a drilled hole and the installed casing.

- **Aquifer** - a geologic formation that contains sufficient saturated permeable material to yield water to a spring or well in sufficient quantities to make the production of water from this formation feasible for beneficial use. The formation could be sand, gravel, limestone, sandstone, or fractured igneous rocks. **

- **Aquifer emergency warning** - a groundwater condition that may be declared by the District when water quality or water quantity becomes detrimental to public health or the beneficial use of water from the aquifer.

- **Artesian Zone** - a zone where water is confined in an aquifer under pressure so that the water will rise in the well casing or drilled hole above the bottom of the confining bed overlying the aquifer.

- **Artificial Recharge** – the unnatural addition of surface waters to groundwater. **

- **Availability** – maximum amount of water available during the drought of record, regardless of whether the supply is physically or legally available. #

- **Beneficial purpose** - use for:

- Agriculture, gardening, domestic, stock raising, municipal, mining, manufacturing, industrial, commercial, recreational, or pleasure purposes;
- Exploring for, producing, handling, or treating oil, gas, sulfur, or other minerals;
- Any other purpose that is useful and beneficial to the user. *

- **Board** – the board of directors of the CCGCD unless otherwise specified.

- **Brackish water** – water with total dissolved solids between 1,000 and 10,000 milligrams per liter. #

- **Brush control** – the select control, removal, or reduction of noxious brush that consume water to a degree that is detrimental to water conservation.

- **Capped well** - a well that is closed or capped with a covering capable of preventing surface pollutants from entering the well and sustaining weight of at least 400 pounds and constructed in such a way that the covering cannot be easily removed by hand.

- **Casing** - a watertight pipe which is installed in an excavated or drilled hold, temporarily or permanently, to maintain the hole sidewalls against caving, advance the borehole, and in conjunction with cementing and/or bentonite grouting, to confine the groundwaters to their respective zones of origin, and to prevent surface contaminant infiltration.

- **Commercial use** - a well used to supply water to properties or establishments which are in business to provide goods or services or repairs and which use water in those processes or incidental to the maintenance of the property or establishment including landscape irrigation; or a well used to supply water to the business establishment primarily for employee and customer sanitary purposes.

- **Conductivity, hydraulic** – the ease with which water moves through soil or a saturated geologic material. It is influenced by the type of material comprising the formations, the slope of the water table, the type of fluid, and the degree to which existing pores are interconnected. **

- **Confined aquifer** – an aquifer that lies between two relatively impermeable rock layers and has artesian pressure. **

- **Confining unit** – a hydrogeologic unit of impermeable or distinctly less permeable material bounding one or more aquifers and is a general term that replaces aquitard, aquifuge, aquiclude.

- **Conjunctive use** - the combined use of groundwater and surface water sources that optimize the beneficial characteristics of each source. *

- **Conservation** - those water saving practices, techniques, and technologies that will reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water, or increase the recycling and reuse of water so that a water supply is made available for future or alternative use. **

- **Cross section** - a drawing showing the features that would be exposed by a vertical cut through a structure.

- **Desalination** – process of removing salt from seawater or brackish water. **

- **Desired future conditions (DFC)** – the desired, quantified conditions of groundwater resources (such as water levels, water quality, spring flows, or volumes) at a specified time or times in the future or in perpetuity.

- **Director** - a member of a CCGCD Board unless otherwise specified.

- **Discharge** - the amount of water that leaves an aquifer by natural or artificial means. *

- **District** - any district or authority created under Section 52, Article III, or Section 59, Article XVI, Texas Constitution that has the authority to regulate the spacing of water wells, the production from water wells, or both. *

- **District monitor well** - a well designated as such by the District Board or staff which is used for specific District needs or programs such as water quality monitoring, measuring aquifer levels, or determination of drought conditions.

- **Domestic use** - the use of water not delivered through a public water system for personal hygiene needs or for household purposes such as drinking, bathing, heating, cooking, or cleaning in a residence, including pleasure uses, landscape irrigation, and non-commercial gardening use so long as no more than 50% of the garden product is sold or leased.

- **Drawdown** – a lower of the groundwater surface (potentiometric surface) caused by withdrawal or pumping of water from a well. At the well, it is the difference between the static water level and the pumping water level in a well pumped at a constant flow rate.

- **Drill** - drilling, equipping, completing wells, or modifying the size of wells or well pumps/motors (resulting in an increase in pumpage volume) whereby a drilling or service rig must be on location to perform the activity.

- **Drillers' logs** – a record by the driller of a well of the depth to a specific identifiably distinct unit, the thickness of that unit and a basic description of the unit. Distinct from a well or electric log.

- **Drought** – generally applied to periods of less than average precipitation over a certain period of time. Associated definitions include *meteorological drought* (abnormally dry weather), *agricultural drought* (adverse impact on crop or range production), and *hydrologic drought* (below average water contents in aquifers and/or reservoirs). **

- **Drought conditions** – an extended period of dryness in a region where water resource availability becomes a priority. The most commonly used way for determining dry or drought conditions is by the Palmer Drought Severity Index.

- **Drought of record:** period of time during recorded history when natural hydrological conditions provided the least amount of water supply. For Texas as a whole, the drought of record is generally considered to be from about 1950 to 1957. #

- **Electric logs** - see Well log

- **Escarpment** - a steep face terminating high lands abruptly.

- **Estuary** – bay or inlet, often at the mouth of a river, in which large quantities of freshwater and seawater mix together. #

- **Evapotranspiration** – the loss of water to the atmosphere through the process of evaporation from the soil or transpiration through plants.

- **Evidence of historic or existing use** - evidence that is material and relevant to a determination of the amount of groundwater beneficially used without waste by a permit applicant during the relevant time period set by district rule that regulates groundwater based on historic use. Evidence in the form of oral or written testimony shall be subject to cross-examination. The Texas Rules of Evidence govern the admissibility and introduction of evidence of historic or existing use, except that evidence not admissible under the Texas Rules of Evidence may be admitted if it is of the type commonly relied upon by reasonably prudent persons in the conduct of their affairs. *

- **Exempt well** - a well that is exempt from the requirements to obtain a permit.

- **Existing water supply** – maximum amount of water available from existing sources for use during drought of record conditions that is physically and legally available for use.

- **Existing well** - any well in the District that was drilled, properly completed, and recorded with the Water Well Drillers Team on or before (date).

- **Export (or transfer) fee** – a fee assessed by the District for water that is exported out of the District. The fee may be assessed against pumpage from permitted and unpermitted wells.

- **Fees** - charges imposed by the District pursuant to Rule, Order, or the Act.

- **Firm yield** – maximum water volume a reservoir can provide each year under a repeat of the drought of record.

- **Fiscal year** - the business year of the District beginning January 1 of each year and ending on December 31 of the same year.

- **Flood control storage** – storage in a lake or reservoir, being two designated water surface elevations, that is dedicated to storing floodwater so that flood damages downstream are eliminated or reduced.

- **Fluvial** - of or pertaining to a river.

- **Formation** - the basic unit for the naming of rocks in lithostratigraphy: a set of rocks that are or once were, horizontally continuous, that share some distinctive feature of lithology, and that are large enough to be mapped.

- **Freshwater inflow needs** – freshwater flows required to maintain the natural salinity and nutrient and sediment delivery in a bay or estuary that supports their unique biological communities and ensures a healthy ecosystem. #

- **General Manager** – an individual employed by the Board of Directors of a district that is the chief administrator of the office and who has full authority to manage and operate the affairs of the district subject to Board approval.

- **Geologic time scale** - the divisions of geologic history into eras, periods, and epochs accomplished through stratigraphy and paleontology.

- **Groundwater** – water located beneath the earth's surface.

- **Groundwater availability model (GAM)** – numerical groundwater flow models used by the TWDB to determine groundwater availability of the major and minor aquifers in Texas. **
- **Groundwater management area (GMA)** – a group of district representatives covering an area designated by the TWDB, that have the task of, at least every five years, considering groundwater availability models and other data or information for the management area and establishing desired future conditions for the relevant aquifers within the area.

- **Growth faults** – displacement of strata most often caused by rapid sedimentary loading whereby one side of the fault displays a dramatically thicker stratigraphic column than the other side.

- **Gulf Coast Aquifer** – groundwater located in the Chicot, Evangeline or Jasper formations and related water bearing units.

- **Hand-dug well** - wells with a diameter greater than two feet and less than 100 feet in depth installed by hand digging or by auger drilling are considered to be hand-dug wells.

- **Highland lakes** – lake system composed of two major storage reservoirs – Lake Buchanan and Travis – which are owned and operated by the LCRA. In addition, the system contains three intermediary lakes owned and operated by the LCRA – Inks Lake, Lake LBJ, and Lake Marble Falls. Lake Austin is owned by the City of Austin and is operated by the LCRA through an agreement.

- **Historic low water level elevation** - the lowest measured or observed water level elevation in a well as determined by the District.

- **Hydrogeological report** - a report that identifies the availability of groundwater in a particular area and formation, and which also addresses the issues of quantity and quality of that water and the impacts of pumping that water on the surrounding environment including impacts to nearby or adjacent wells.

- **Hydrograph** – a graph relating stage, flow, velocity, or other characteristics of water with respect to time.

- **Hydrologic properties** – those properties of a rock that govern the entrance of water and the capacity to hold, transmit, and deliver water, such as porosity, effective porosity, specific retention, permeability, and the directions of maximum and minimum permeabilities.

- **Incidental use** - a beneficial use of water which is of a minor nature. Transport of water outside the District by a permittee which totals 5% or less, but in no case more than 5,000,000 gallons, of the permittee's annual permitted pumpage is considered incidental use.

- **Industrial use** - the use of water integral to the production of primary goods and/or services provided by industrial, manufacturing or commercial facilities and used primarily in the building, production, manufacturing, or alteration of a product or goods, or a well used to wash, cleanse, cool, or heat such goods or products; does not include agricultural use.

- **Inflows** - the amount of water that flows into an aquifer from another formation. *

- **Infrastructure** – physical means for meeting water and wastewater needs, such as dams, wells, conveyance systems, and water treatment plants. #

- **Injection well** - an artificial excavation or opening in the ground made by digging, boring, drilling, jetting, driving, or some other method, and used to inject, transmit, or dispose of industrial and municipal waste or oil and gas waste into a subsurface stratum; or a well initially drilled to produce oil and gas which is used to transmit, inject, or dispose of industrial and municipal waste or oil and gas waste into a subsurface stratum; or a well used for the injection of any other fluid; but the term does not include any surface pit, surface excavation, or natural depression used to dispose of industrial and municipal waste or oil and gas waste. ##

- **Instream flow** – water flow and water quality regime adequate to maintain an ecologically sound environment in streams and rivers. #

- **Interbasin transfer** – physical conveyance of surface water from one river basin to another. #

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- Hydrograph - a graph relating stage, flow, velocity, or other characteristics of water with respect to time.

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- Industrial use - the use of water integral to the production of primary goods and/or services provided by industrial manufacturing or commercial facilities and used primarily in the building, production, manufacturing, or alteration of a product or goods, or a well used to wash, cleanse, cool, or heat such goods or products; does not include agricultural use.

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- Instream flow - water flow and water quality regime adequate to maintain an ecologically sound environment in streams and rivers.

- Interbasin transfer - physical conveyance of surface water from one river basin to another.

- **Irrigation Use** – the use of water for the purpose of providing water to crops with the intent of growing and sustaining those crops for the consumption by humans or other domestic animals. In Colorado County, rice-growers are the heaviest users of irrigation water.

- **Irrigation Districts** – privately owned irrigation systems that have subsequently been purchased by the LCRA. These purchases gives the LCRA senior water rights for direct diversion of water from the Colorado River thereby relieving LCRA from responsibility of releasing water from storage in the Highland Lakes.

- **Leachate well** - a well used to remove leachate from soil or groundwater. For the purposes of this definition, "leachate" means a liquid that has percolated through or drained from solid waste or hazardous waste and contains soluble, suspended, or miscible materials removed from such waste.

- **Leakage** – the flow of water from one hydrogeologic unit to another. The leakage may be natural, as through semi-impervious confining layer, or human-made, as through an uncased well.

- **Licensed water well driller** - any person who holds a license issued by the State of Texas pursuant to the provisions of the Texas Water Well Drillers Act and the substantive rules of the Texas Department of Licensing and Regulation's Water Well Drillers and Pump Installers Program.

- **Licensed water well pump installer** - any person who holds a license issued by the State of Texas pursuant to the provisions of the Texas Water Well Pump Installers Act and the substantive rules of the Texas Department of Licensing and Regulation's Water Well Drillers and Pump Installers Program.

- **Lithology** - The systematic description of rocks, in terms of mineral composition and in texture.

- **Major reservoir** – reservoir having a storage capacity of 5,000 acre-feet or more.

- **Managed available groundwater** - the amount of water that may be permitted by a district for beneficial use in accordance with the desired future conditions of the aquifer as determined under Section 36.108.

- **Management area** - an area designated and delineated by the Texas Water Development Board under Chapter 35 as an area suitable for management of groundwater resources. *

- **Management plan** – a plan approved by the TWDB's Executive Administrator, that addresses the efficiency of groundwater use, the prevention of waste and subsidence, the conjunctive use of surface water, natural resource issues, drought conditions and conservation. The plan identifies a district's performance standards and management objectives under which it will operate, and includes groundwater availability and use estimates. Regional water planning groups are required to consider these plans in developing their regional plans. **

- **Meter** - A water flow measurement device which meets AWWA standards for the line size, pressures, and flows, and which is properly installed according to the manufacturer's specifications.

- **Mining use** – use of water for mining processes, including hydraulic use, drilling, washing sand and gravel, and oil field repressuring. **

- **Modify** - to alter the physical or mechanical characteristics of a well, its equipment, or production capabilities. This does not include repair of equipment, well houses or enclosures, or replacement with comparable equipment.

- **Monitor or observation well** - a well that is used to measure or monitor the level, quality, quantity, or movement of subsurface waters. ##

- **Municipal use** - the use of water for a public water system for residential, commercial, or public and institutional uses, including the application of potable water for irrigation of golf courses, parks and recreational uses; it does not include water for industrial uses even when industrial users are receiving potable water.

- **Needs** – projected water demands in excess of existing water supplies for a water user group or a wholesale water provider. #

- **New well** - any well that is not an existing well or any existing well which has been modified to increase water production after March 15, 2004.

- **Non-Agricultural irrigation use** – use of water to directly and independently irrigate landscaping, golf courses, parks, rights of ways or other recreational or open spaces.

- **Nonexempt well** - a well required to obtain a permit for the production of groundwater from within the District and required to report groundwater use.

- **On-site inspections** – the right of District's agents and employees to conduct investigations or inspections on a landowner's property without impediment in order to carry out the implementation of District rules.

- **Open or uncovered well** - an artificial excavation at least 10 feet deep and not more than six feet in diameter, that is dug or drilled for the purpose of producing the groundwater, or for injection, monitoring, or de-watering purposes, and is not capped or covered as required by the District.

- **Open Meetings Act** – provides that meetings of governmental bodies must be open to the public, except for expressly authorized executive or closed sessions, and that the public must be given notice of the time, place, and subject matter of such meetings. *

- **Open Records Act** – provides that governmental bodies shall prepare and keep minutes or make tape recordings of each open meeting which indicate each deliberation and vote. **

- **Operate or operations** - to produce or cause to produce water from a well or to use a well for injection or closed loop heat exchange purposes. **

- **Operating/drilling permit** – a right granted by the groundwater District to drill and/or operate a well for the purposes of producing water in excess of an amount defined for an exempt well.

- **Outcrop** - a segment of rock exposed to the atmosphere.

- **Over-pumpage** - to produce water from a well in excess of the amount authorized to be withdrawn in accordance with the permitted pumpage volume issued by the District.

- **Paleontological analysis** – the use of fossils or fossil remnants, often of microscopic size, to help determine the age of and/or environment in which sediments were deposited.

- **Per capita** - one individual or person, a unit of population; may be phrased as a standard value such as: one active residential account or meter equals 3.0 per capita.

- **Permit** - an authorization issued by the District allowing the withdrawal of a specific amount of groundwater from a nonexempt well for a designated period of time, generally in the form of millions of gallons or acre-feet per year.

- **Permit amendment** - a minor or major change in the permit.
- **Person** - includes a corporation, individual, organization, cooperative, government or governmental subdivision or agency, business trust, estate, trust, partnership, association, or any other legal entity.
- **Planning group** – team of regional and local leaders of different backgrounds and various social, environmental, and economic interests responsible for developing and adopting a regional water plan for their planning area at five-year intervals. #
- **Plug** - to close a well permanently in accordance with approved District standards.
- **Potentiometric surface** - the elevation to which water from a specific aquifer will rise in a well (water level).
- **Priority groundwater management area** - an area designated and delineated by the commission under Chapter 35 as an area experiencing or expected to experience critical groundwater problems. *
- **Public water supply well** - a well that produces the majority of its water for use by a public water system.
- **Public water system** – a system that provides water for human consumption as defined by the rules of the Texas Commission on Environmental Quality.
- **Pumpage or groundwater production** - all water withdrawn from the ground, measured at the wellhead.
- **Pyroclastic** - volcanic rock scattered by volcanic explosions.
- **Rainwater harvesting** – use of water from precipitation as a supplement to normal water usage.
- **Recharge** - the amount of water that infiltrates to the water table of an aquifer. *
- **Recharge enhancement** – intentionally directing surface waters to areas where permeable soils or fractured rocks exist to allow for more rapid infiltration of the water into the subsurface so as to increase localized groundwater recharge.
- **Recharge zone** - the area of the aquifer in which water infiltrates the surface and enters permeable rock layers.
- **Recommended water management strategy** – specific project or action to increase water supply or maximize existing supply to meet a specific need. **
- **Recreational use** – the use of water for fishing, swimming, water skiing, boating, hunting, and other forms of water recreation, including aquatic and wildlife enjoyment, and aesthetic land enhancement of a subdivision, golf course or similar development.
- **Red tag** - An official seal, tag, or label placed on a well or its equipment, or the act of placing the tag or label, to indicate that further pumping of groundwater, or operation of the well, or continuing with other District regulated activities is not permitted by the District, will be in violation of District Rules, and may subject the well owner and operator to civil suit and/or penalties.
- **Regional Water Planning Group** – a quasi-governmental body representing local interests and having voting as well as nonvoting members who develop a regional water plan. It recommends the selection of consultants who carry out technical work and provides direction and guidance, determines policy issues, and oversees the progress of the regional plan. The interests presented generally include counties municipalities, industries, the public, agriculture, environmental interests, small businesses, electric generating utilities, river authorities,

water districts and water utilities. ** CCGCD is wholly within the Region K Regional Water Planning Group. The TWDB is the lead state agency for coordinating the regional water planning process and developing a comprehensive state water plan.

- **Registration** – basic information provided to the groundwater District by the well or landowner usually containing information about the well capacity, well location, and property information. This provides the owner or operator of the well with documentation for the purposes of determining Historical User status and also provides spacing protection according to District Rules.

- **Replacement wells** – a well drilled to replace an existing well that has ceased production. The well must be drilled in the immediate vicinity of the original well.

- **Reuse** – the authorized use, for one or more beneficial purposes, of water that remains unconsumed after the water is used for the original purpose of use and before that water is either disposed of or discharged or otherwise allowed to flow into a watercourse, lake, or other body of state-owned water. Reuse prior to its return to the watercourse is referred to as "direct use". The asserted right to return water to a stream and divert it farther downstream and reuse it again is referred to as "indirect reuse". **

- **Riparian rights** – the right to the use of riverbed by one who owns river frontage land.

- **River basin** - a river or coastal basin designated as a river basin by the board under Section 16.501. The term does not include waters of the bays or arms originating in the Gulf of Mexico. *

- **ROR (run-of-river) water rights** - water right permit that allows the permit holder to divert water directly out of a stream or river. #

- **Rule of capture** – the legal principle that allows a person to use as much water as can be withdrawn as long as it is for a beneficial use.

- **Rules** - standards and regulations promulgated by the District.

- **Safe yield** – firm yield in addition to an amount of water supply for an additional period of time. #

- **Salt dome** – geologic structure resulting from the upward movement of a salt mass caused by gravitational instability of a low density salt layer overlain by high density layer.

- **Seal** - the impermeable material, such as cement grout, bentonite, or puddling clay, placed in the annular space between the borehole wall and the casing to prevent the downhole movement of surface water or the vertical mixing of groundwater.

- **Sedimentation** – action or process of depositing sediment in a reservoir, usually silts, sands, or gravel. #

- **Shrinkage** - the loss of water between the producing well(s) meter and the customers meter in a water system. [Note: when the amount of shrinkage becomes excessive (greater than 15% of pumpage volume) the loss of water may become waste. May also be termed "line loss".]

- **Sinkhole** - a naturally-occurring solution or collapse depression characterized by subterranean drainage.

- **Spacing** – a mandated distance between wells implemented to conserve the aquifer.

- **Special provisions** - conditions or requirements added to a permit which may be more or less restrictive than the Rules as a result of circumstances unique to a particular situation.

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- Spacing - a mandated distance between wells implemented to conserve the aquifer.

- Special provisions - conditions or requirements added to a permit which may be more or less restrictive than the Rules as a result of circumstances unique to a particular situation.

- **Spring** – location from which groundwater flows form rock or soil onto the land surface or into a water body. The occurrence of a spring is dependent upon the location of permeable and impermeable rock layers, the level of the water table, and the local topography. **

- **Stratum** - a layer of rock having a similar composition throughout.

- **Stock-raising/Livestock use** - domesticated horses, cattle, goats, sheep, swine, poultry, ostriches, emus, rheas, exotic deer and antelope, and other similar animals involved in farming or ranching operations on land recorded and taxed in the county as an agricultural land use. Dogs, cats, birds, fish, reptiles, small mammals, potbellied pigs, and other animals typically kept as pets are not considered livestock. Livestock-type animals kept as pets or in a pet-like environment are not considered livestock.

- **Sub-aquifer** - an identifiable unit within a larger aquifer. In this report, sub-aquifers are units of the Gulf Coast Aquifer.

- **Subdivision of groundwater reservoir** - a definable part of a groundwater reservoir in which the groundwater supply will not be appreciably affected by withdrawing water from any other part of the reservoir, as indicated by known geological and hydrological conditions and relationships and on foreseeable economic development at the time the subdivision is designated or altered.

- **Subordination agreement** – contracts between junior and senior water right holders where the senior water right holder agrees not to assert its priority right against the junior. #

- **Surface completion** - sealing off access of undesirable water, surface material, or other potential sources of contamination to the well bore by proper casing and/or cementing procedures.

- **Subsidence** – sinking of a portion of the land surface resulting from removal of fluids from subsurface reservoirs such as oil deposits, groundwater, or salt domes * ; *(Geol)* a gentle but large-scale movement where a broad are of the crust sinks without appreciable deformation.

- **Tectonics** - movements and deformation of the Earth's crust on a large scale, including folding, faulting, and plate movements.

- **Terrigenous** - deposited on the surface or on the land.

- **Test well permit** – a right granted by the groundwater District for the purposes of drilling a well that tests aquifer conditions.

- **Texas Administrative Code** – the codified body of laws that define the processes and operations of state agencies and their rulemaking authority. TWDB and TCEQ are generally governed by Title 30, Environmental Quality, and Title 31, Natural Resources and Conservation, of the Code. **

- **Texas Railroad Commission** – the Railroad Commission has primary regulatory jurisdiction over oil and natural gas industry, pipeline transporters, natural gas and hazardous liquid pipeline industry, natural gas utilities, the LP-gas industry, and coal and uranium surface mining operations.

- **Texas Water Code** – the codified portion of state water laws. It is the public policy of the state to provide for the conservation and development of the state's natural resources. **

- **Total aquifer storage** - the total calculated volume of groundwater that an aquifer is capable of producing.

- *Spring* - location from which groundwater flows from rock or soil onto the land surface or into a water body. The occurrence of a spring is dependent upon the location of permeable and impermeable rock layers, the level of the water table, and the local topography. **

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- *Total aquifer storage* - the total calculated volume of groundwater that an aquifer is capable of producing.

- **Total dissolved solids (TDS)** - a measurement of the quantity of minerals, chemicals, elements, or other matter contained in a state of solution by water.

- **Transfer permit** – a right granted by the groundwater District to transfer or transport water outside the boundaries of the District beyond what is considered incidental quantities.

- **Transmissivity, hydraulic** – the capacity of an aquifer to transmit water. It is dependent on the water-transmitting characteristics of the saturated formation (hydraulic conductivity) and the saturated thickness. It is expressed as the rate at which water at the prevailing water temperature is transmitted through a unit width of the aquifer under a unit hydraulic gradient; being expressed as gallons per day through a vertical strip of the aquifer one ft wide under a gradient of one ft per ft, or as cubic ft per day under the same conditions. **

- **Unconfined aquifer** – an aquifer or portion of an aquifer that exists under water table conditions.

- **Unconformity** - a surface that separates two strata. It represents an interval of time in which deposition stopped, erosion removed some sediments and rock, and then deposition resumed.

- **Unconsolidated formations** - naturally-occurring earth formations that are not lithified. Alluvium, soil, gravel, clay, and overburden are some of the terms used to describe this type of formation.

- **Unmet needs** – portion of the demand for water that exceeds water supply after inclusion of all recommended water management strategies in a regional water plan. **

- **User** - a person who produces, distributes, or uses water from the aquifer(s).

- **Void** - a general term for pore space or other opening in rock. The openings can be very small to cave size, and are filled with water below the water table.

- **Waste** - any one of the following:
  - Withdrawal of groundwater from a groundwater reservoir at a rate and in an amount that causes or threatens to cause intrusion into the reservoir of water unsuitable for agriculture, gardening, domestic, or stock raising purposes;
  - The flowing or producing of wells from a groundwater reservoir if the water produced is not used for a beneficial purpose;
  - Escape of groundwater from a groundwater reservoir to any other reservoir or geologic strata that does not contain groundwater;
  - Pollution or harmful alteration of groundwater in a groundwater reservoir by saltwater or by other deleterious matter admitted from another stratum or from the surface of the ground;
  - Willfully or negligently causing, suffering, or allowing groundwater to escape into any river, creek, natural watercourse, depression, lake, reservoir, drain, sewer, street, highway, road, or road ditch, or onto any land other than that of the owner of the well unless such discharge is authorized by permit, rule, or order issued by the commission under Chapter 26;
  - Groundwater pumped for irrigation that escapes irrigation tailwater onto land other than that of the owner of the well unless permission has been granted by the occupant of the land receiving the discharge; or,
  - For water produced from an artesian well, "waste" has the meaning assigned by Section 11.205. *

- **Water availability model (WAM)** – numerical surface water flow models to determine the availability of surface water for permitting in the state. **

- **Water budget** – an accounting of the water that enters and leaves an aquifer

- **Water demand** – quantity of water projected to meet the overall necessities of a water user group in a specific

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- **Water level elevation** - the measure or estimate of a water surface in a well or aquifer as measured in feet above mean sea level.
- **Water-level monitoring program** – a sustained program of checking the water level of multiple wells in a given area in order to determine the status of the aquifer.
- **Water management strategy** – a strategy or specific project identified in a water plan whose purpose is to provide water to meet a demand or identified need. These water management strategies must be specific and provide sufficient detail to allow state agencies to make financial or regulatory decisions. **
- **Water meter seal** - a physical seal that is installed in or on the water meter to prevent tampering with meter readings.
- **Water needs** – see Needs.
- **Water-quality report** - a report prepared by the Texas Department of Health, the U.S.G.S. or any other governmentally or District-approved laboratory that is the product of testing the water for bacteria, solids, elements, chemicals, or contaminants.
- **Water table** - the upper boundary of the saturated zone in an unconfined aquifer.
- **Water table zone** - that part of the aquifer confined only by atmospheric pressure (water levels will not rise in the well above the water table).
- **Water tight seal** - a seal, which prohibits the entrance of liquids or solutions, including water, which may enter through the wellhead and potentially, contaminate the well.
- **Water-user group (WUG)** - identified user or group of users for which water demands and water supplies have been identified and analyzed and plans developed to meet water needs. Water user groups are defined at the county level for the manufacturing, irrigation, livestock, steam-electric power generation, and mining water use categories. Municipal water user groups include (a) incorporated cities and selected Census Designated Places with a population of 500 or more; (b) individual or groups of selected water utilities serving smaller municipalities or unincorporated areas; and (c) rural areas not included in a listed city or utility, aggregated for each county. #
- **Watershed** – the region draining into a river, river system, or body of water.
- **Well** - any artificial excavation or borehole constructed for the purposes of exploring for or producing groundwater, or for injection, monitoring, or dewatering purposes.
- **Well elevation** - the ground surface elevation of the well bore.
- **Well log** - an accurately kept record made during the process of drilling on forms prescribed by the Water Well Drillers Team, showing the depth of the well bore, thickness of the formations, character of casing installed, together with any other data or information required by the Water Well Drillers Team; or any other special purpose well log that may be available for a given well, such as a gamma ray log, a temperature log, an electric log, or a caliper log.
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- *Well pumps and equipment* - devices and materials used to obtain water from a well, including the seals and safeguards necessary to protect the water from contamination.

- **Well registration** - the creation of a record of the well by use and a well identification number for purposes of registering the well as to its geographic location and for notification to the well owner in cases of spills or accidents, data collection, record keeping and for future planning purposes.

- **Withdraw or withdrawal** - the act of extracting groundwater by pumping or any other method, other than the discharge of natural springs.

- **Whole-sale water supplier** - person or entity, including river authorities and irrigation districts, that had contracts to sell more than 1,000 acre-feet of water wholesale in any one year during the five years immediately preceding the adoption of the last regional water plan. #

* - definitions taken from Chapter 36 of the Texas Water Code
** - definitions were taken from the "Texas Water Law Glossary" (Flores and Wasinger, 2005)
# - definitions taken from 2007 State Water Plan (TWDB, 2007)
- definitions taken from Chapter 27 of the Texas Water Code

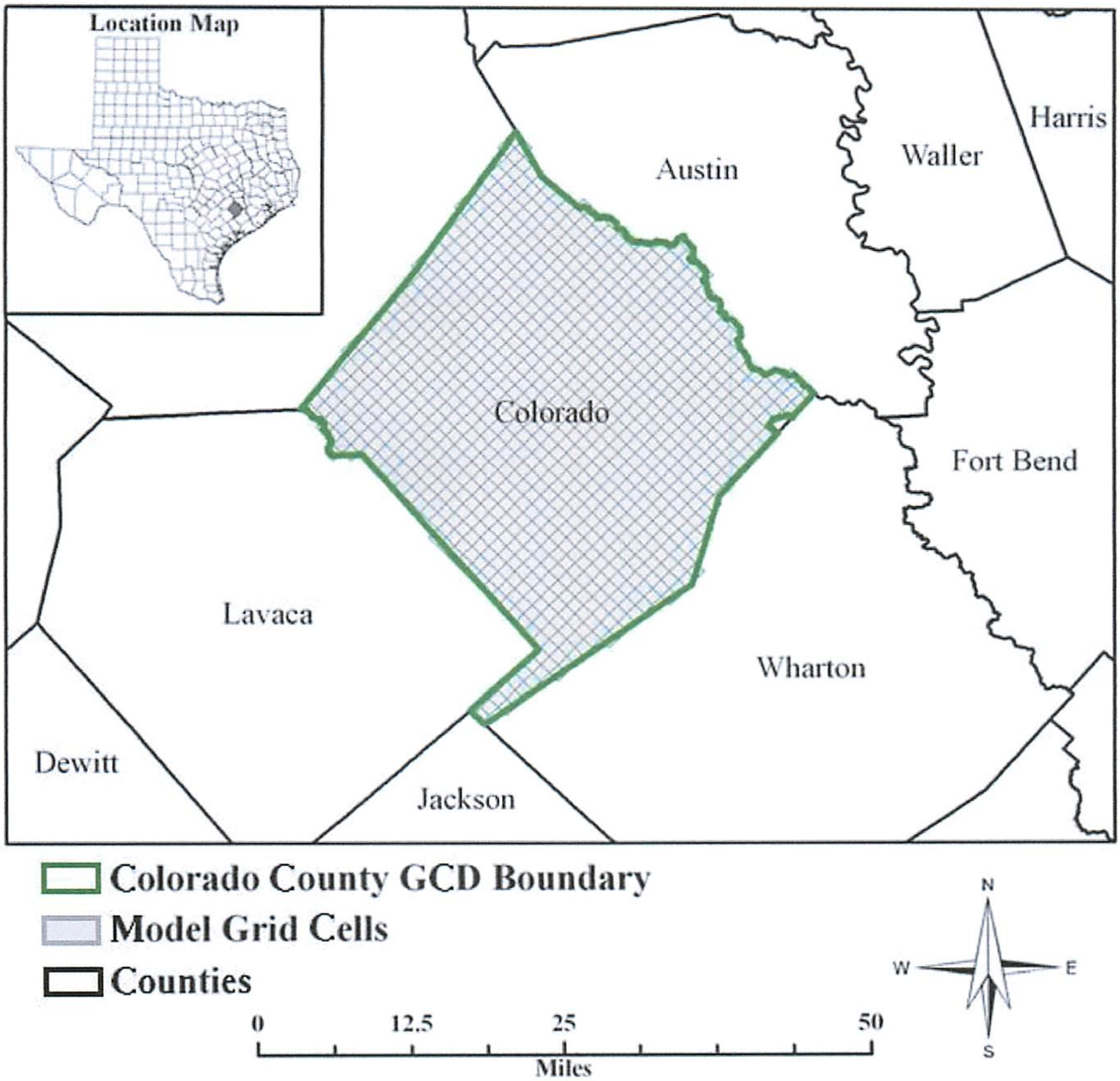
UNITS OF MEASURE

- **°F** - degree Fahrenheit
- **Ac** – acres
- **Ac-ft** - acre-feet
- **ac-ft/yr** - acre-feet per year
- **mg/L** - milligrams per liter
- **mi^2** - square miles

ACRONYMS AND ABBREVIATIONS

- **AWWA** – American Water Works Association
- **CCGCD** – Colorado County Groundwater Conservation District
- **CGDA** – critical groundwater depletion area
- **COA** – city of Austin
- **DOR** - drought of record
- **ET** - evapotranspiration
- **GAM** - groundwater availability model
- **GCD** - Groundwater Conservation District
- **GMA** – groundwater management area
- **HGCSD** – Harris-Galveston Coastal Subsidence District
- **LCRA** - Lower Colorado River Authority
- **LCRB** – Lower Colorado River Basin
- **LCRPG** – Lower Colorado River Planning Group (Region K)
- **LSWP** – LCRA-SAWS Water Project
- **MAG** – managed available groundwater
- **PDSI** – Palmer Drought Severity Index
- **ROR** - run-of-river
- **RWPG** - Regional Water Planning Group
- **SAWS** – San Antonio Water System
- **SPI** – Standardized Precipitation Index
- **TCEQ** -Texas Commission on Environmental Quality
- **TDA** - Texas Department of Agriculture
- **TDS** - total dissolved solids
- **TDWR** - Texas Department of Water Resources
- **TNRCC** - Texas Natural Resource Conservation Commission (now TCEQ)
- **TNRIS** - Texas Natural Resources Information System
- **TWDB** - Texas Water Development Board
- **USDA** - U.S. Department of Agriculture
- **WAM** - water availability model
- **WRAP** – Water Rights Analysis Package
- **WUG** - water user group
- **WWP** - wholesale water providers

APPENDIX B – Model Area and Summary of Information Provided by GAM Run 09-009, Colorado County



Management Plan Requirement	Aquifer or Confining Unit	Results (ac-ft/yr)
Estimated annual amount of recharge from precipitation to the district	Chicot Aquifer	32,376
	Evangeline Aquifer	2,311
	Burkeville Confining Unit	0
	Jasper Aquifer	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams and rivers	Chicot Aquifer	9,060
	Evangeline Aquifer	2,363
	Burkeville Confining Unit	0
	Jasper Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Chicot Aquifer	9,050
	Evangeline Aquifer	8,509
	Burkeville Confining Unit	42
	Jasper Aquifer	533
Estimated annual volume of flow out of the district within each aquifer in the district	Chicot Aquifer	19,429
	Evangeline Aquifer	17,273
	Burkeville Confining Unit	49
	Jasper Aquifer	293
Estimated net annual volume of flow between each aquifer in the district	Chicot to Evangeline	23,110
	Burkeville to Evangeline	502
	Jasper to Burkeville	67

Source: Oliver, 2009.

APPENDIX C – Water Budget from GAM Runs in Colorado County

Chicot	GAM 07-12		GAM 07-14		GAM 07-43		GAM 08-56	
	Pumpage (ac-ft/yr)							
	In	Out	In	Out	In	Out	In	Out
Storage	183	15	1,463	0	415	0	820	0
Reservoirs (River Package)	1,408	0	1,408	0	1,408	0	1,408	0
Springs (Drain Package)	0	6	0	5	0	6	0	5
General Head Boundaries	0	0	0	0	0	0	0	0
Wells	0	16,930	0	24,378	0	20,379	0	24,452
Streams and Rivers	28,347	12,482	33,916	8,349	28,408	10,889	32,511	8,631
Recharge	35,704	0	35,074	0	35,074	0	35,125	0
Evapotranspiration	0	57	0	54	0	57	0	55
Vertical Leakage from Layer Above	0	0	0	0	0	0	0	0
Lateral Inflow	8,838	21,384	8,743	20,894	8,174	18,490	9,379	20,182
Vertical Leakage from Layer Below	703	23,677	322	27,245	505	24,136	332	26,251
Total	74,553	74,551	80,926	80,925	73,984	73,987	79,575	79,576

Evangeline	GAM 07-12		GAM 07-14		GAM 07-43		GAM 08-56	
	Pumpage (ac-ft/yr)							
	In	Out	In	Out	In	Out	In	Out
Storage	5	4	70	0	35	0	50	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0
Springs (Drain Package)	0	0	0	0	0	0	0	0
General Head Boundaries	0	0	0	0	0	0	0	0
Wells	0	15,681	0	22,580	0	18,875	0	22,629
Streams and Rivers	3,928	3,103	5,238	1,978	4,585	2,381	5,115	1,995
Recharge	2,515	0	2,515	0	2,515	0	2,515	0
Evapotranspiration	0	0	0	0	0	0	0	0
Vertical Leakage from Layer Above	0	0	0	0	0	0	0	0
Lateral Inflow	8,786	19,394	8,880	18,816	7,813	16,889	8,981	17,729
Vertical Leakage from Layer Below	473	508	565	813	405	844	541	752
Total	39,384	39,393	44,513	44,509	39,489	39,494	43,439	43,437

Jasper	GAM 07-12		GAM 07-14		GAM 07-43		GAM 08-56	
	Pumpage (ac-ft/yr)							
	In	Out	In	Out	In	Out	In	Out
Storage	112	1	481	0	317	0	354	0
Reservoirs (River Package)	0	0	0	0	0	0	0	0
Springs (Drain Package)	0	0	0	0	0	0	0	0
General Head Boundaries	0	0	0	0	0	0	0	0
Wells	0	624	0	900	0	754	0	900
Streams and Rivers	0	0	0	0	0	0	0	0
Recharge	0	0	0	0	0	0	0	0
Evapotranspiration	0	0	0	0	0	0	0	0
Vertical Leakage from Layer Above	0	0	0	0	0	0	0	0
Lateral Inflow	595	341	268	819	248	667	296	485
Vertical Leakage from Layer Below	0	0	0	0	0	0	0	0
Total	1,192	1,192	1,778	1,778	1,521	1,521	1,506	1,505

Source: Donnelly, 2007a, 2007b; Donnelly 2008d; Anaya, 2009.

APPENDIX D – Historical Water Use Summary

Year	Source	Municipal (ac-ft/yr)	Manufacturing (ac-ft/yr)	Irrigation (ac-ft/yr)	Mining (ac-ft/yr)	Livestock (ac-ft/yr)	Total (ac-ft/yr)
1974	GW	2,499*	65*	59,620*	2,635*	335*	65,154
	SW	0	0	118,257*	0	1,930*	120,187
	Total	**2,499**	**65**	**177,877**	**2,635**	**2,265**	**185,341**
1980	GW	3,046*	62*	60,913*	4,426*	979*	69,426
	SW	0	0	162,685*	2,496*	613*	165,794
	Total	**3,046**	**62**	**223,598**	**6,922**	**1,592**	**235,220**
1984	GW	2,854*	18*	38,141*	1,068*	895*	42,976
	SW	0	803*	177,971*	42,438	596*	221,808
	Total	**2,854**	**821**	**216,112**	**43,506**	**1,491**	**264,784**
1985	GW	3,122*	17*	37,411*	950*	977*	42,477
	SW	0	1,469*	178,936*	54,674*	650*	235,729
	Total	**3,122**	**1,486**	**216,347**	**55,624**	**1,627**	**278,206**
1986	GW	2,816*	93*	38,683*	857*	1,033*	43,482
	SW	0	1,235*	167,150*	40,330*	688*	209,403
	Total	**2,816**	**1,328**	**205,833**	**41,187**	**1,721**	**252,885**
1987	GW	2,767*	110*	34,023*	877*	824*	38,601
	SW	0	1,483*	147,010*	12,093*	549*	161,135
	Total	**2,767**	**1,593**	**181,033**	**12,970**	**1,373**	**199,736**
1988	GW	2,953*	100*	48,232*	1,798*	863*	53,946
	SW	0	1,137*	208,411*	11,641*	575*	221,764
	Total	**2,953**	**1,237**	**256,643**	**13,439**	**1,438**	**275,710**
1989	GW	2,829*	99*	25,759*	992*	848*	30,527
	SW	0	956*	158,723*	30,931*	564*	191,174
	Total	**2,829**	**1,055**	**184,482**	**31,923**	**1,412**	**221,701**
1990	GW	2,923*	96*	44,218*	992*	836*	49,065
	SW	0	981*	162,991*	30,931*	557*	195,460
	Total	**2,923**	**1,077**	**207,209**	**31,923**	**1,393**	**244,525**
1991	GW	2,646*	116*	41,791*	2,565*	855*	47,973
	SW	0	225*	154,783*	21,333*	570*	176,911
	Total	**2,646**	**341**	**196,574**	**23,898**	**1,425**	**224,884**
1992	GW	2,676*	168*	42,226*	1,582*	867*	47,519
	SW	0	0	156,392*	26,384*	578*	183,354
	Total	**2,676**	**168**	**198,618**	**27,966**	**1,445**	**230,873**
1993	GW	2,778*	160*	18,594*	1,560*	971*	24,063
	SW	0	0	125,823*	29,410*	646*	155,879
	Total	**2,778**	**160**	**144,417**	**30,970**	**1,617**	**179,942**
1994	GW	2,641*	157*	23,066*	2,386*	1,021*	29,271
	SW	0	0	151,459*	29,410*	681*	181,550
	Total	**2,641**	**157**	**174,525**	**31,796**	**1,702**	**210,821**

Year	Source	Municipal (ac-ft/yr)	Manufacturing (ac-ft/yr)	Irrigation (ac-ft/yr)	Mining (ac-ft/yr)	Livestock (ac-ft/yr)	Total (ac-ft/yr)
1995	GW	2,896*	160*	22,205*	2,386*	1,059*	28,706
	SW	0	0	140,984*	28,815*	706*	170,505
	Total	**2,896**	**160**	**163,189**	**31,201**	**1,765**	**199,211**
1996	GW	3,078*	176*	29,734*	2,386*	1,056*	36,430
	SW	0	0	188,792*	28,815*	704*	218,311
	Total	**3,078**	**176**	**218,526**	**31,201**	**1,760**	**254,741**
1997	GW	2,852*	186*	21,737*	2,397*	1,048*	28,220
	SW	0	0	138,007*	26,918*	699*	165,624
	Total	**2,852**	**186**	**159,744**	**29,315**	**1,747**	**193,844**
1998	GW	3,049*	176*	25,375*	1,570*	921*	31,091
	SW	0	0	161,119*	18,083*	613*	179,815
	Total	**3,049**	**176**	**186,494**	**19,653**	**1,534**	**210,906**
1999	GW	3,178*	171*	29,481*	1,570*	933*	35,333
	SW	0	0	187,175*	18,083*	622*	205,880
	Total	**3,178**	**171**	**216,656**	**19,653**	**1,555**	**241,213**
2000	GW	3,120*	144*	20,587*	1,564*	883*	26,298
	SW	0	0	117,724*	18,083*	588*	136,395
	Total	**3,120**	**144**	**138,311**	**19,647**	**1,471**	**162,693**
2001	GW	2,381*	120*	17,364*	1,564*	444*	21,873
	SW	0	0	156,180*	18,082*	1,098*	175,360
	Total	**2,381**	**120**	**173,544**	**19,646**	**1,542**	**197,233**
2002	GW	2,106*	89*	16,233*	2,345*	444*	21,217
	SW	0	0	91,989*	49,156*	1,098*	142,243
	Total	**2,106**	**89**	**108,222**	**51,501**	**1,542**	**163,460**
2003	GW	2,242*	104*	16,920*	2,345*	495*	22,106
	SW	0	0	143,000*	49,156*	1,222*	193,378
	Total	**2,242**	**104**	**159,920**	**51,501**	**1,717**	**215,484**
2004	GW	2,218*	100*	18,166*	2,345*	493*	23,322
	SW	0	0	101,108*	49,156*	1,217*	151,481
	Total	**2,218**	**100**	**119,274**	**51,501**	**1,710**	**174,803**
2005	GW						
	SW						
	Total	**2,917***	**111***	**116,102***	**51,898***	**1,646***	**172,674**
2006	GW						
	SW						
	Total	**3,054***	**174***	**112,018***	**16,922***	**1,521***	**133,689**

(*) – Apportioned for CCGCD from Colorado County data. Source: TWDB, Historical Water Use Survey. Data Web Interface http://www.twdb.state.tx.us/wushistorical/ReportViewer.aspx?ReportName=rptWaterUseSummaryByCountySource&ReportParameters=Num%3d45%26Year%3d+

APPENDIX E – Surface Water Rights held in Colorado County

Water Right #	Owner	Basin	Use	Max Permitted Diversion (ac-ft/yr)	Priority Date
3415	John & Ora Mae Batla	Brazos-Colorado	Irrigation	11	5/31/1964
3415	Ora Lee Batla Plengemeyer	Brazos-Colorado	Irrigation	14	5/31/1964
3416	John W Adkins	Brazos-Colorado	Irrigation	150	7/14/1980
3417	Alice M Adkins et al	Brazos-Colorado	Irrigation	150	7/14/1980
5156	US Dept of Interior	Brazos-Colorado	Irrigation		9/15/1987
5523	Clark & Vicki Powers	Brazos-Colorado	Irrigation	300	3/01/1995
5429	C G Johnson	Colorado	Irrigation	73	7/31/1949
5432	Charles T Trefny	Colorado	Irrigation	21	8/31/1951
5434	LCRA	Colorado	Irrigation	133,000	11/01/1900
5434	LCRA	Colorado	Municipal		11/01/1900
5434	LCRA	Colorado	Industrial		11/01/1900
5434	City of Corpus Christi	Colorado	Municipal	35,000	11/02/1900
5434	City of Corpus Christi	Colorado	Industrial		11/02/1900
5434	City of Corpus Christi	Colorado	Irrigation		11/02/1900
5475	LCRA	Colorado	Irrigation	131,500	1/04/1901
5475	LCRA	Colorado	Irrigation	55,000	9/01/1907
5728	City of Weimar	Colorado	Irrigation		1/25/2001
2079	Lake Sheridan Estates Inc	Lavaca	Recreation	455	10/07/1963
2080	Engstrom Brothers Partnership	Lavaca	Irrigation	248	12/31/1938
2081	Truman Engstrom Jr et al	Lavaca	Irrigation	683	4/30/1955
2085	William Mark Wied	Lavaca	Irrigation	13	12/31/1962
2086	AJ Richter et al	Lavaca	Irrigation	282	4/30/1955
2087	Leo M Korenek	Lavaca	Irrigation	84	4/30/1946
2088	Leo M Korenek	Lavaca	Irrigation	45	4/30/1924
2089	Louis P Hoffman	Lavaca	Irrigation	48	5/31/1966
4160	Nobert Weid & Pat Wishert	Lavaca	Irrigation	60	11/16/1981
4162	Herbert J & Josephine Popp	Lavaca	Irrigation	140	11/16/1981
4164	Lorena Miller	Lavaca	Irrigation	279	11/16/1981

Source: TWDB and Lower Colorado River Regional Water Planning Group.

APPENDIX F – Projected Water Supply for CCGCD

SURFACE WATER SUPPLY

WUG Name	WUG River Basin	Specific Source Name	Year 2010 (ac-ft/yr)	Year 2020 (ac-ft/yr)	Year 2030 (ac-ft/yr)	Year 2040 (ac-ft/yr)	Year 2050 (ac-ft/yr)	Year 2060 (ac-ft/yr)
Irrigation	Brazos-Colorado	LCRA-Garwood ROR	21,558*	21,558*	21,558*	21,558*	21,558*	21,558*
Irrigation	Brazos-Colorado	LCRA-Lakeside ROR	8,417*	8,417*	8,417*	8,417*	8,417*	8,417*
Irrigation	Colorado	LCRA-Garwood ROR	10,466*	10,466*	10,466*	10,466*	10,466*	10,466*
Irrigation	Colorado	LCRA-Lakeside ROR	4,086*	4,086*	4,086*	4,086*	4,086*	4,086*
Irrigation	Colorado	Combined ROR	2,996*	2,996*	2,996*	2,996*	2,996*	2,996*
Irrigation	Lavaca	LCRA-Garwood ROR	46,084*	46,084*	46,084*	46,084*	46,084*	46,084*
Irrigation	Lavaca	LCRA-Lakeside ROR	17,992*	17,992*	17,992*	17,992*	17,992*	17,992*
Irrigation	Lavaca	Combined ROR	3,996*	3,996*	3,996*	3,996*	3,996*	3,996*
Livestock	Brazos-Colorado	Local Supply	39*	39*	39*	39*	39*	39*
Livestock	Colorado	Local Supply	859*	859*	859*	859*	859*	859*
Livestock	Lavaca	Local Supply	177*	177*	177*	177*	177*	177*
Manufac	Colorado	Other Local Supply	1,213*	1,283*	1,351*	1,416*	1,479*	1,479*
Mining	Colorado	Other Local Supply	10,493*	11,375*	12,426*	13,766*	15,380*	15,380*
Total			128,376	129,328	130,447	131,852	133,529	133,529

GROUNDWATER SUPPLY

WUG Name	WUG River Basin	Specific Source Name	Year 2010 (ac-ft/yr)	Year 2020 (ac-ft/yr)	Year 2030 (ac-ft/yr)	Year 2040 (ac-ft/yr)	Year 2050 (ac-ft/yr)	Year 2060 (ac-ft/yr)
Columbus	Colorado	Gulf Coast Aquifer	1,350	1,350	1,350	1,350	1,350	1,350
Eagle Lake	Brazos-Colorado	Gulf Coast Aquifer	440	440	440	440	440	440
Eagle Lake	Colorado	Gulf Coast Aquifer	430	430	430	430	430	430
Weimar	Colorado	Gulf Coast Aquifer	1,804	1,804	1,804	1,804	1,804	1,804
Weimar	Lavaca	Gulf Coast Aquifer	2,119	2,119	2,119	2,119	2,119	2,119
County-Other	Brazos-Colorado	Gulf Coast Aquifer	122*	122*	122*	122*	122*	122*
County-Other	Colorado	Gulf Coast Aquifer	799*	799*	799*	799*	799*	799*
County-Other	Lavaca	Gulf Coast Aquifer	250*	250*	250*	250*	250*	250*
Irrigation	Brazos-Colorado	Gulf Coast Aquifer	7,764*	7,764*	7,764*	7,764*	7,764*	7,764*
Irrigation	Colorado	Gulf Coast Aquifer	11,175*	11,175*	11,175*	11,175*	11,175*	11,175*
Irrigation	Lavaca	Gulf Coast Aquifer	14,030*	14,030*	14,030*	14,030*	14,030*	14,030*
Livestock	Brazos-Colorado	Gulf Coast Aquifer	65*	65*	65*	65*	65*	65*
Livestock	Colorado	Gulf Coast Aquifer	25*	25*	25*	25*	25*	25*
Livestock	Lavaca	Gulf Coast Aquifer	283*	283*	283*	283*	283*	283*
Mining	Brazos-Colorado	Gulf Coast Aquifer	100*	100*	100*	100*	100*	100*
Mining	Lavaca	Gulf Coast Aquifer	1,625*	1,625*	1,625*	1,625*	1,625*	1,625*
Total			42,381	42,381	42,381	42,381	42,381	42,381

(*) – Apportioned for CCGCD from Colorado County data. Source: 2007 State Water Planning database.

APPENDIX G – Water Management Strategies and Projected Water Savings in CCGCD

WUG	River Basin	Water Mgmt Strategy	Source Name	Source County	2010 (ac-ft/yr)	2020 (ac-ft/yr)	2030 (ac-ft/yr)	2040 (ac-ft/yr)	2050 (ac-ft/yr)	2060 (ac-ft/yr)
Irrigation	Lavaca	City of Austin Return Flows	Indirect Reuse	Travis	1,055*	1,476*	1,897*	2,318*	2,738*	3,161*
		Downstream Return Flows	Indirect Use	Travis	0*	0*	13*	56*	113*	158*
		Conjunctive Use of GW – Includes Overdrafts	Gulf Coast Aquifer	Colorado	0*	9,906*	9,906*	9,906*	9,906*	9,906*
		Development of New Rice Varieties	Conservation	Colorado	0*	9,034*	9,034*	9,034*	9,034*	9,034*
		Irrigation District Conveyance Improvements	Conservation	Colorado	0*	11,688*	11,688*	11,688*	11,688*	11,688*
		On-Farm Conservation	Conservation	Colorado	0*	9,392*	9,392*	9,392*	9,392*	9,392*
		Irrigation Supply Reduction due to LSWP	Colorado River ROR	Colorado	0*	0*	0*	0*	0*	0*
		Firm Up ROR with Off-Channel Reservoir	Colorado River ROR Excess Flow Permits	Matagorda	0*	0*	0*	0*	0*	22,748*
		LCRA WMP Interruptible Water Supply	Colorado River Combined ROR Interruptible	Travis	48,906*	45,673*	34,454*	23,232*	12,012*	791*
	Brazos-Colorado	COA Return Flows	Indirect Reuse	Travis	519*	727*	935*	1,141*	1,349*	1,557*
		Downstream Return Flows	Indirect Use	Travis	0*	0*	6*	28*	55*	78*
		Conjunctive Use of GW – Includes Overdrafts	Gulf Coast Aquifer	Colorado	0*	4,879*	4,879*	4,879*	4,879*	4,879*
		Development of New Rice Varieties	Conservation	Colorado	0*	4,542*	4,542*	4,542*	4,542*	4,542*
		Irrigation District Conveyance Improvements	Conservation	Colorado	0*	5,922*	5,922*	5,922*	5,922*	5,922*
		On-Farm Conservation	Conservation	Colorado	0*	4,708*	4,708*	4,708*	4,708*	4,708*
		Irrigation Supply Reduction due to LSWP	Colorado River ROR	Colorado	0*	0*	0*	0*	0*	0*
		Firm Up ROR with Off-Channel Reservoir	Colorado River ROR Excess Flow Permits	Matagorda	0*	0*	0*	0*	0*	11,204*
		LCRA WMP Interruptible Water Supply	Colorado River Combined ROR Interruptible	Travis	24,028*	22,496*	16,969*	11,443*	5,916*	389*

Continued next page

WUG	River Basin	Water Mgmt Strategy	Source Name	Source County	2010 (ac-ft/yr)	2020 (ac-ft/yr)	2030 (ac-ft/yr)	2040 (ac-ft/yr)	2050 (ac-ft/yr)	2060 (ac-ft/yr)
Mining	Colorado	Development of Other Aquifer	Other Aquifer	Colorado	4,263*	4,263*	4,263*	4,263*	4,263*	4,263*
		Expansion of Gulf Coast Aquifer	Gulf Coast Aquifer	Colorado	3,620*	3,620*	2,799*	1,648*	214*	372*
		Expansion of Gulf Coast Aquifer	Gulf Coast Aquifer	Colorado	553*	30*	0*	0*	0*	0*
	Brazos-Colorado	Expansion of Gulf Coast Aquifer	Gulf Coast Aquifer	Colorado	19*	22*	23*	24*	25*	26*
	Lavaca	Expansion of Gulf Coast Aquifer	Gulf Coast Aquifer	Colorado	100*	132*	151*	168*	184*	199*
Livestock	Colorado	Expansion of Gulf Coast Aquifer	Gulf Coast Aquifer	Colorado	14*	14*	14*	14*	14*	14*
	Lavaca	Expansion of Gulf Coast Aquifer	Gulf Coast Aquifer	Colorado	11*	11*	11*	11*	11*	11*
County - Other	Lavaca	Expansion of Gulf Coast Aquifer	Gulf Coast Aquifer	Colorado	105*	109*	106*	97*	93*	90*

(*) – Apportioned for CCGCD from Colorado County data. Source: TWDB, Regional Water Planning Data Web Interface (http://www.twdb.state.tx.us/DATA/db07/default.asp).

APPENDIX H – Correspondence

The following is a list of surface water management entities that are present within the Colorado County Groundwater Conservation District boundaries. These entities have been forwarded a copy of the District's adopted Management Plan.

List of Texas Water Districts

- Colorado County Water Control and Improvement District 2 (WCID 2)
  Gay Stephens, President
  P.O. Box 317
  Garwood, TX 77442
- Glidden Fresh Water Supply District (FWSD 1)
  Edward Pavlicek, President
  P.O. Box 85
  Columbus, TX 78934-0085
- Lower Colorado River Authority (LCRA)
  Joseph J. Beal, General Manager
  P.O. Box 220
  Austin, TX 78767-0220
- The Falls Municipal Utility District (MUD)
  Steven Rogers, President
  1100 Louisiana St., Ste 400
  Houston, TX 77002-5211

List of Texas Utilities (Water or Sewers)

- Barten Water Supply Corporation (WSC)
  Donnie Templeton, President
  P.O. Box 805
  Columbus, TX 78934-0805
- City of Columbus (Water and Sewer Utilities)
  City Manager
  P.O. Box 87
  Columbus, TX 78934-0087
- City of Eagle Lake (Water and Sewer Utilities)
  Mayor, Ray Morales
  P.O. Box 38
  Eagle Lake, TX 77434-0038
- City of Weimar (Water and Sewer Utilities)
  City Manager, Randall Jones
  106 E. Main St.
  Weimar, TX 78962-2009
- Forest Oaks Water Supply Corporation (Water Utility)
  Joyce Chastain, President

P.O. Box 325
Altair, TX 77412-0325

- New Ulm Water Supply Corporation (Water Utility)
  Eddie Marx, President
  P.O. Box 73
  New Ulm, TX 78950-0073
- Rock Island Water Supply Corporation (Water Utility)
  Harvey Speck, President
  P.O. Box 144
  Rock Island, TX 77470
- Sheridan Water Supply Corporation (Water Utility)
  Gordon Mercer, President
  P.O. Box 206
  Sheridan, TX 77475

List of Regional Water Planning Groups

- Lower Colorado River Regional Planning Group (Region K)
  Ronald G. Fieseler, Chair – GW Management Plan Review Committee
  P.O. Box 1516
  Johnson City, Texas 78636-1516

CCGCD
COLORADO COUNTY
GROUNDWATER
CONSERVATION DISTRICT

James E. Brasher, General Manager
425 Spring Street
P.O. Box 667
Columbus, Texas 78934
Phone 979 732 9300
Fax 979 732 9301

November 24, 2009

Donnie Templeton, President
Barten Water Supply Corporation (WSC)
P.O. Box 805
Columbus, TX 78934-0085

Dear Mr. Templeton:

Please find enclosed a digital copy of the adopted District Management Plan for the Colorado County Groundwater Conservation District. The Management Plan can also be viewed at the District's website, www.ccgcd.net. This plan is being provided for your review at the direction of the Texas Water Development Board. The Management Plan includes a copy of the signed resolution of the Board of Directors and notice of public hearing.

Pursuant to the Texas Water Code, §36.1072, the District has sent a copy of the adopted District Management Plan to the Texas Water Development Board for review and approval.

If you have any questions, please feel free to call.

Sincerely,

James E. Brasher

James E. Brasher
General Manager

cc: City of Columbus (Water and Sewer Utilities)
City of Eagle Lake (Water and Sewer Utilities)
City of Weimar (Water and Sewer Utilities)
Colorado County WCID 2
Forest Oaks Water Supply Corporation
Glidden WCID 1
Lower Colorado River Authority
Lower Colorado River Regional Water Planning Group (Region K)
New Ulm Water Supply Corporation
Rock Island Water Supply Corporation
Sheridan Water Supply Corporation
The Falls MUD

CCGCD
Colorado County
Groundwater
Conservation District

James E. Brasher, General Manager
425 Spring Street
P.O. Box 667
Columbus, Texas 78934
Phone 979 732 9300
Fax 979 732 9301

November 24, 2009

City Manager
City of Columbus
P.O. Box 87
Columbus, TX 78934-0087

Dear City Manager:

Please find enclosed a digital copy of the adopted District Management Plan for the Colorado County Groundwater Conservation District. The Management Plan can also be viewed at the District's website, www.ccgcd.net. This plan is being provided for your review at the direction of the Texas Water Development Board. The Management Plan includes a copy of the signed resolution of the Board of Directors and notice of public hearing.

Pursuant to the Texas Water Code, §36.1072, the District has sent a copy of the adopted District Management Plan to the Texas Water Development Board for review and approval.

If you have any questions, please feel free to call.

Sincerely,

James E. Brasher

James E. Brasher
General Manager

cc: Barten Water Supply Corporation
City of Eagle Lake (Water and Sewer Utilities)
City of Weimar (Water and Sewer Utilities)
Colorado County WCID 2
Forest Oaks Water Supply Corporation
Glidden WCID 1
Lower Colorado River Authority
Lower Colorado River Regional Water Planning Group (Region K)
New Ulm Water Supply Corporation
Rock Island Water Supply Corporation
Sheridan Water Supply Corporation
The Falls MUD

CCGCD
COLORADO COUNTY GROUNDWATER CONSERVATION DISTRICT

James E. Brasher, General Manager
425 Spring Street
P.O. Box 667
Columbus, Texas 78934
Phone 979 732 9300
Fax 979 732 9301

November 24, 2009

William J. Rankin, City Manager
City of Eagle Lake (Water and Sewer Utilities)
P.O. Box 38
Eagle Lake, TX 77434-0038

Dear Mr. Rankin:

Please find enclosed a digital copy of the adopted District Management Plan for the Colorado County Groundwater Conservation District. The Management Plan can also be viewed at the District's website, www.ccgcd.net. This plan is being provided for your review at the direction of the Texas Water Development Board. The Management Plan includes a copy of the signed resolution of the Board of Directors and notice of public hearing.

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Colorado County Groundwater Conservation District

James E. Brasher, General Manager
425 Spring Street
P.O. Box 667
Columbus, Texas 78934
Phone 979 732 9300
Fax 979 732 9301

November 24, 2009

Randal Jones, City Manager
City of Weimar
106 E. Main St.
Weimar, TX 78962

Dear Mr. Jones:

Please find enclosed a digital copy of the adopted District Management Plan for the Colorado County Groundwater Conservation District. The Management Plan can also be viewed at the District's website, www.ccgcd.net. This plan is being provided for your review at the direction of the Texas Water Development Board. The Management Plan includes a copy of the signed resolution of the Board of Directors and notice of public hearing.

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General Manager

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COLORADO COUNTY GROUNDWATER CONSERVATION DISTRICT

James E. Brasher, General Manager
425 Spring Street
P.O. Box 667
Columbus, Texas 78934
Phone 979 732 9300
Fax 979 732 9301

November 24, 2009

Gay Stephens, President
Colorado County Water Control and Improvement District 2
P.O. Box 317
Garwood, TX 77442-0317

Dear Ms. Stephens:

Please find enclosed a digital copy of the adopted District Management Plan for the Colorado County Groundwater Conservation District. The Management Plan can also be viewed at the District's website, www.ccgcd.net. This plan is being provided for your review at the direction of the Texas Water Development Board. The Management Plan includes a copy of the signed resolution of the Board of Directors and notice of public hearing.

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James E. Brasher, General Manager
425 Spring Street
P.O. Box 667
Columbus, Texas 78934
Phone 979 732 9300
Fax 979 732 9301

November 24, 2009

Joyce Chastain, President
Forest Oaks Water Supply Corporation
P.O. Box 325
Altair, TX 77412-0325

Dear Ms. Chastain:

Please find enclosed a digital copy of the adopted District Management Plan for the Colorado County Groundwater Conservation District. The Management Plan can also be viewed at the District's website, www.ccgcd.net. This plan is being provided for your review at the direction of the Texas Water Development Board. The Management Plan includes a copy of the signed resolution of the Board of Directors and notice of public hearing.

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City of Columbus (Water and Sewer Utilities)
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CCGCD
Colorado County Groundwater Conservation District

James E. Brasher, General Manager
425 Spring Street
P.O. Box 667
Columbus, Texas 78934
Phone 979 732 9300
Fax 979 732 9301

November 24, 2009

Edward Pavlicek, President
Glidden Fresh Water Supply District (FWSD 1)
P.O. Box 85
Columbus, TX 78934-0085

Dear Mr. Pavlicek:

Please find enclosed a digital copy of the adopted District Management Plan for the Colorado County Groundwater Conservation District. The Management Plan can also be viewed at the District's website, www.ccgcd.net. This plan is being provided for your review at the direction of the Texas Water Development Board. The Management Plan includes a copy of the signed resolution of the Board of Directors and notice of public hearing.

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CCGCD
Colorado County Groundwater Conservation District

James E. Brasher, General Manager
425 Spring Street
P.O. Box 667
Columbus, Texas 78934
Phone 979 732 9300
Fax 979 732 9301

November 24, 2009

Joseph J. Beal, General Manager
Lower Colorado River Authority
P.O. Box 220
Austin, TX 78767-0220

Dear Mr. Beal:

Please find enclosed a digital copy of the adopted District Management Plan for the Colorado County Groundwater Conservation District. The Management Plan can also be viewed at the District's website, www.ccgcd.net. This plan is being provided for your review at the direction of the Texas Water Development Board. The Management Plan includes a copy of the signed resolution of the Board of Directors and notice of public hearing.

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COLORADO COUNTY GROUNDWATER CONSERVATION DISTRICT

James E. Brasher, General Manager
425 Spring Street
P.O. Box 667
Columbus, Texas 78934
Phone 979 732 9300
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November 24, 2009

Ronald G. Fieseler, Chair – Groundwater Mgt. Plan Review Committee
Lower Colorado River Regional Planning Group (Region K)
P.O. Box 1516
Johnson City, TX 78636-1516

Dear Mr. Fieseler:

Please find enclosed a digital copy of the adopted District Management Plan for the Colorado County Groundwater Conservation District. The Management Plan can also be viewed at the District's website, www.ccgcd.net. This plan is being provided for your review at the direction of the Texas Water Development Board. The Management Plan includes a copy of the signed resolution of the Board of Directors and notice of public hearing.

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425 Spring Street
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Columbus, Texas 78934
Phone 979 732 9300
Fax 979 732 9301

November 24, 2009

Eddie Marx, President
New Ulm Water Supply Corporation
P.O. Box 73
New Ulm, TX 78950-0073

Dear Mr. Marx:

Please find enclosed a digital copy of the adopted District Management Plan for the Colorado County Groundwater Conservation District. The Management Plan can also be viewed at the District's website, www.ccgcd.net. This plan is being provided for your review at the direction of the Texas Water Development Board. The Management Plan includes a copy of the signed resolution of the Board of Directors and notice of public hearing.

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General Manager

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COLORADO COUNTY GROUNDWATER CONSERVATION DISTRICT

James E. Brasher, General Manager
425 Spring Street
P.O. Box 667
Columbus, Texas 78934
Phone 979 732 9300
Fax 979 732 9301

November 24, 2009

Harvey Speck, President
Rock Island Water Supply Corporation
P.O. Box 144
Rock Island, TX 77470

Dear Mr. Speck:

Please find enclosed a digital copy of the adopted District Management Plan for the Colorado County Groundwater Conservation District. The Management Plan can also be viewed at the District's website, www.ccgcd.net. This plan is being provided for your review at the direction of the Texas Water Development Board. The Management Plan includes a copy of the signed resolution of the Board of Directors and notice of public hearing.

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Columbus, Texas 78934
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November 24, 2009

Gordon Mercer, President
Sheridan Water Supply Corporation
P.O. Box 206
Sheridan, TX 77475

Dear Mr. Mercer:

Please find enclosed a digital copy of the adopted District Management Plan for the Colorado County Groundwater Conservation District. The Management Plan can also be viewed at the District's website, www.ccgcd.net. This plan is being provided for your review at the direction of the Texas Water Development Board. The Management Plan includes a copy of the signed resolution of the Board of Directors and notice of public hearing.

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CCGCD
Colorado County
Groundwater
Conservation District

James E. Brasher, General Manager
425 Spring Street
P.O. Box 667
Columbus, Texas 78934
Phone 979 732 9300
Fax 979 732 9301

November 24, 2009

Steven Rogers, President
The Falls Municipal Utility District
1100 Louisiana St., Ste 400
Houston, TX 77002-5211

Dear Mr. Rogers:

Please find enclosed a digital copy of the adopted District Management Plan for the Colorado County Groundwater Conservation District. The Management Plan can also be viewed at the District's website, www.ccgcd.net. This plan is being provided for your review at the direction of the Texas Water Development Board. The Management Plan includes a copy of the signed resolution of the Board of Directors and notice of public hearing.

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APPENDIX I – District Resolution

WHEREAS, The Colorado County Groundwater Conservation District (the "District") is a political subdivision of the State of Texas, created under authority of Section 59, article XVI of the Texas Constitution by the 80th Texas Legislature with the Act of May 23, 2007, House Bill 4032, as a governmental agency and a body politic and corporate; and,

WHEREAS, the District was subsequently approved by voters of the District, and has operated under the rights, powers, privileges, authority, functions, duties, and requirements of Chapter 36 of the Texas Water Code, other provisions of the Texas Water Code, provisions of the general law of Texas and the Texas Constitution and under sections of the Texas Administrative Code since its creation; and,

WHEREAS, the District's enabling legislation requires the District to adopt a Management Plan pursuant to the Texas Water Code, §36.1071-36.108; and,

WHEREAS, The Texas Water Code, §36.1071 requires the Management Plan address the following: providing the most effective use of groundwater, controlling and preventing waste of groundwater, controlling and preventing subsidence, conjunctive surface water management issues, natural resource issues, drought conditions, and conservation; and,

WHEREAS, The Texas Water Code, §36.1071(e) requires the District to identify the performance standards and management objectives under which the District will operate to achieve the management goals; and,

WHEREAS, the Board of Directors of the Colorado County Groundwater Conservation District believes that the Management Plan of the District reflects the best management of the groundwater for the District and meets the requirements of the Texas Water Code, §36.1071; and,

WHEREAS, the District is preparing and reviewing proposed rules, resolutions, orders, and directives to implement this plan; and,

WHEREAS, the District is fully prepared to amend and or adopt additional rules or adopt resolutions and orders or issue directives in the future as determined by the Board of Directors and in accordance with applicable laws of the state in order to address issues identified in the future; and,

NOW THEREFORE BE IT RESOLVED THAT The Board of Directors of the Colorado County Groundwater Conservation District does hereby adopt and approve the Colorado County Groundwater Conservation District Management Plan and directs the submission of such Management Plan to the Texas Water Development Board for approval.

Tom Kelley, President

Scott Brasher, Vice-President

Marion Schonenberg, Secretary

Jim Wiese, Treasurer

Thomas Hudec

Whyman Psensik

CONSIDERED, PASSED, APPROVED, ADOPTED, RESOLVED, SIGNED AND DONE IN OPEN MEETING on this 23rd day of November, 2009.

By: Thomas L. Kelley

Tom Kelley, President

Attested by: Jim Wiese Treasurer

Marian Schonenburg, Secretary

Jim Wiese for Marian Schonenburg

APPENDIX J – Evidence of Public Notice

CCGCD
Colorado County
Groundwater
Conservation District

NOTICE OF OPEN MEETING OF THE BOARD OF DIRECTORS
COLORADO COUNTY GROUNDWATER CONSERVATION DISTRICT

SPECIAL MEETING - HEARING

Notice is hereby given that a special meeting of the directors of the Colorado County Groundwater Conservation District will be held on:

Monday, November 23, 2009
6:00 P.M.
Stafford Opera House
425 Spring Street, Columbus, Texas

AGENDA

Matters to be discussed that are subject to vote by the Directors of the Colorado County Groundwater Conservation District are as follows:

1. Call special meeting to order
2. Pledge of Allegiance and Invocation
3. Public hearing to receive public comments on the District's proposed Management Plan
4. Consider and take appropriate action on the District's proposed Management Plan
5. Adjournment

*During this agenda item, citizens may comment for the record on items which are not on the agenda. The Board may not participate in discussion or deliberation of any item that is not on the agenda. Citizens may request that a topic be added to a future agenda. Citizens who wish to comment on a posted agenda item should sign a speaker's information card. Citizens may comment when the item is addressed by the board president. Citizens' comments are limited to three (3) minutes.

*Limited to statements. Issues raised by directors under this item cannot be deliberated by the Board. The Open Meetings Act does not allow the Board to deliberate items that do not appear on the agenda.

*The Board of Directors of the Colorado County Groundwater Conservation District reserves the right to adjourn into executive session at any time during the course of this meeting to discuss any of the matters listed above, as authorized by Texas Government Code Sections 551.071 (Consultation with Attorney), 551.072 (Deliberations about Real Property), 551.073 (Deliberations about Gifts and Donations), 551.074 (Personnel Matters), 551.076 (Security Devices).

*An electronic draft of the District's proposed Management Plan is located on the District's web site at www.ccgcd.net.

The Stafford Opera House is wheelchair accessible, and accessible parking spaces are available.

THE BANNER PRESS NEWSPAPER

Serving Austin, Colorado and Fayette Counties

1217 Bowie P.O. Box 490 Columbus, Texas 78934 (979) 732-6243 FAX: (979) 732-6245

STATE OF TEXAS

COUNTY OF COLORADO

PUBLISHER'S AFFIDAVIT OF PUBLICATION

Before me, the undersigned authority, on this day personally appeared Chad Ferguson, who being by me duly sworn, deposes and says that (s)he is the Editor/Publisher of THE BANNER PRESS NEWSPAPER; that said newspaper is regularly published in Colorado County, Texas, and generally circulated in Austin, Fayette, and Colorado Counties, Texas; that the attached notice was published in said newspaper on the following date(s), to wit: October 29, 2009, ____________, 20__, ____________, 20 and ____________, 20__.

Chad Ferguson

Newspaper Representative's Signature

Attach Copy of Advertisement

Subscribed and sworn to before me this the 23rd day of Nov., 2009 to certify which witness my hand and seal of office.

Nora Rollins

Notary Public in and for the State of Texas

NORA ROLLINS
Notary Public, State of Texas
My Commission Exp. 3-8-2012

Nora Rollins

Print or Type Name of Notary Public

My Commission Expires 3/8/2008

NOTICE OF PUBLIC HEARING
COLORADO COUNTY GROUNDWATER CONSERVATION DISTRICT

MANAGEMENT PLAN HEARING

The CCGCD will hold a public hearing on the District's proposed Management Plan:

Monday, November 23, 2009
6:00 P.M.
Stafford Opera House
425 Spring Street, Columbus, Texas

Matters to be discussed that are subject to vote by the Directors of the Colorado County Groundwater Conservation District are as follows:

Public hearing to receive public comments on the District's proposed Management Plan

Consider and take appropriate action on the District's proposed Management Plan

An electronic draft of the District's proposed Management Plan is located on the District's web site at www.ccgcd.net.

Colorado County Groundwater Conservation District, P.O. Box 667, Columbus, TX 78934.

AFFIDAVIT OF PUBLICATION

THE STATE OF TEXAS,
COUNTY OF COLORADO

BEFORE ME, in person came Bruce Beal, the publisher of the Weimar Mercury, a newspaper published in Weimar, Colorado County, Texas, who being by me duly sworn says, that he published in said newspaper once a week for one week, the attached **(Colorado County Groundwater Conservation District – Budget and Tax Rate Hearing)** the first insertion whereof was on the 10th day of September, A.D. 2009. Subsequent insertion was none.

Bruce Beal
Publisher

SHANNON ROSENAUER
NOTARY PUBLIC
STATE OF TEXAS
My Commission Expires 4-6-2013

SUBSCRIBED AND SWORN TO BEFORE ME on this the 23rd day of November A.D. 2009.

Shannon Rosenauer
Notary Public in and for Colorado County, Texas

(My Commission expires 4-6-2013)

NOTICE OF PUBLIC HEARING
COLORADO COUNTY GROUNDWATER CONSERVATION DISTRICT

MANAGEMENT PLAN HEARING

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- Consider and take appropriate action on the District's proposed Management Plan

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Colorado County Groundwater Conservation District, P.O. Box 667, Columbus, TX 78934.

PUBLISHER'S AFFIDAVIT

STATE OF TEXAS §
COUNTY OF COLORADO §

BEFORE ME, the undersigned authority, on this day personally appeared CAROL CARDENAS, who being by me duly
(name of newspaper representative)

sworn, deposes and says that (s)he is the Office Manager
(title of newspaper representative)

of the Eagle Lake Headlight; that this newspaper is
(name of newspaper)

a newspaper of largest circulation in Colorado County, Texas
(name of county)

or is a newspaper of general circulation in Eagle Lake, Texas
(name of municipality)

and that the attached notice was published in said newspaper on the following date(s):

October 29, 2009.

Subscribed and sworn to before me this the 24 day of November, 2009,

by Carol Cardenas.
Newspaper Representative's Signature

(Personalized Seal)

THERESA A. ZAPALAC
NOTARY PUBLIC STATE OF TEXAS
COMMISSION EXPIRES:
01-11-2012

Theresa A. Zapalac
Notary Public in and for the State of Texas

NOTICE OF PUBLIC HEARING
COLORADO COUNTY
GROUNDWATER CONSERVATION DISTRICT

MANAGEMENT PLAN HEARING

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Colorado County Groundwater Conservation District,
P.O. Box 667, Columbus, TX 78934.

home | contact list | add user | logout | MLS Procedures

Mail Log

-- Administrative Use Only --

Edit Mail Log

Contact Name	Brasher, James	Start Date (Auto)	12/1/2009 2:45:23 PM
Job Title	General Manager	Due Date	2/1/2010
Company Name	Colorado County Groundwater C	Review Date	12/2/2009
Operator	pd	Complete Date	
		Incoming Correspondence (upload)	JamesBrasher120109.
		Path	\aspsmartupload\uplo

Subject

View Incoming Document

11/30/09 Priority Mail ltr- Enclosed is the Management Plan for the Colorado County Groundwater Conservation District.

Update

Tasked to Respond

add task

User	Date	Comments	Completed Date	Delete
rpetrossian	12/1/2009 2:49:40 PM	Rima to respond by 12/1/2010.		

Notified (No response necessary)

add notification

User	Date	Comments	Delete
kward	12/1/2009 2:45:29 PM		
lglenn	12/1/2009 2:45:35 PM		
Debbie	12/1/2009 2:45:39 PM		
rgoike	12/1/2009 2:45:43 PM		
skaiser	12/1/2009 2:45:49 PM		
WFoster	12/1/2009 2:45:59 PM		
lwurst	12/1/2009 2:46:04 PM		
rmace	12/1/2009 2:46:21 PM		
pblanton	12/1/2009 2:46:27 PM		
bhutchison	12/1/2009 2:46:40 PM		
dflores	12/1/2009 2:47:04 PM		
lchristian	12/1/2009 2:47:15 PM		

Outgoing Correspondence

add correspondence

User	Date	File Name	Path	Comments	Delete
		No documents added.			

Admin Use Only

add comments

User	Date	Comments	Delete
Phyllis	12/2/2009 8:54:38 AM	Original to Rima Petrossian.	