Mr. Bryan McMath
Executive Administrator
Texas Water Development Board
1700 N. Congress
PO Box 13231
Austin, Texas 78711-3231

Dear Mr. McMath,

The Live Oak Underground Water Conservation District (LOUWCD) is pleased to submit to the Texas Water Development Board (TWDB) a copy of our amended Management Plan in accordance with chapter 36.1073. The Live Oak Underground Water Conservation District Management Plan (LOUWCDMP) was publicly adopted by the LOUWCD Board of Directors at their quarterly meeting on October 2, 2025, by unanimous vote. This plan was publicly adopted at the regular meeting of the LOUWCD October 2, 2025, by unanimous vote of all directors.

The LOUWCD, established in 1991, has historically had an excellent working relationship with the TWDB and it is our hope that we can count on your support as we implement the enclosed plan, it is the intent of our Board of Directors that we will begin implementation of this plan immediately to facilitate the success of our efforts.

The LOUWCDMP was developed during open meetings of the Board of Directors in accordance with all notice and hearing requirements stated in the District's procedures. Documentation that notice and hearing requirements were followed is presented in a separate attachment.

During preparation of the LOUWCD Management Plan, (LOUWCD MP) all planning efforts were coordinated with the Nueces River Authority, as mandated by TWC 36.1071 (a) and 31 TAC 356. Documentation of this coordinated effort is included in the packet for your review.

The rules of LOUWCD are available at our website which is www.louwcd.org. The LOUWCDMP will be in force for 5 years from the date of approval. If there is any other documentation we can provide to the TWDB that will ensure the prompt approval of the Live Oak Underground Water Conservation District Management Plan, please do not hesitate to call me or my staff. I look forward to working with you and your staff throughout the process.

Sincerely,

Scott Bledsoe III, President

DISTRICT MISSION

The Live Oak Underground Water Conservation District will strive to develop, promote, and implement water conservation, augmentation, and management strategies to protect water resources for the benefit of the citizens, economy, and environment of the district.

TIME PERIOD FOR THIS PLAN

This plan becomes effective upon approval by the Texas Water Development Board and remains in effect until a revised plan is approved or five years, whichever is earlier.

STATEMENT OF GUIDING PRINCIPLES

The district recognizes that the groundwater resources of the region are of vital importance. The preservation of this most valuable resource can be managed in a prudent and cost effective manner through regulation and permitting. This management document is intended as a tool to focus the thoughts and actions of those given the responsibility for the execution of district activities.

General Description

The District was created by the citizens of Live Oak County through election, November,1989. The current Board of Directors are Scott Bledsoe III - Chairman, Mark Katzfey - Vice-Chairman, Harriet Lamm, Stanley Schilling, and James Pawlik, Live Oak Underground Water Conservation District (LOUWCD) has the same areal extent as that of Live Oak County. The county has a vibrant economy dominated by agriculture and petroleum. The agriculture income is derived primarily from beef cattle production, wheat, corn, sorghum, and cotton, with some sheep and goat ranching.

Location and Extent

Live Oak County, consisting of 1,072 square miles, is located in South Texas. The county is bounded on the east by Bee, San Patricio, and Karnes counties, on the north by Atascosa county, on the west by McMullen County, and on the south by Jim Wells and Duval County. George West, which is centrally located in the county, is the county seat. Three Rivers, the only other municipality in the county, is located in the northern portion of the county.

Topography , Drainage and Groundwater Resources of Live Oak County

Live Oak County is on the Gulf Coastal Plain in southern Texas. Most the 1,072 square miles of the county is devoted to farming and ranching which provide the principal income for the 9,000 inhabitants. The production of oil is also an important industry.

The principal water-bearing formations underlying the county are the Carrizo Sand, Oakville Sandstone, Lagarto Clay, and Goliad Sand, and range in age from Eocene to Pliocene. The formations dip toward the coast at rates ranging from less than 20 to about 140 feet to the mile.

Some irrigation, municipal, and stock supplies is obtained from surface-water sources. In Live Oak County the water-bearing sands above a depth of 2,000 feet contain approximately 20 million acre-feet of fresh and slightly saline water. Even though it may be impractical to recover much of the stored water, the rate of withdrawal might increase several times more than the 1999 rate without appreciably depleting the water available from storage for many decades. A large but not estimated amount of fresh to slightly saline water occurs in the Carrizo Sand in the northern and northwestern parts of the county at depths as much as 6,000 feet. Most of the water in the Carrizo Sand in Live Oak County is more than 4,000 feet below land surface and therefore too deeply buried to be economically developed for most uses.

Most of the ground water in Live Oak County is brackish in quality for municipal, industrial, and irrigation uses. However, because better water is not available in most areas in the county, brackish water is being used successfully by users of all three categories. Generally, the Goliad Sand contains water of better quality than that in any formation except the Carrizo Sand. In favorable areas properly constructed wells in the Carrizo, Oakville, Lagarto, and Goliad may yield 1,000 gallons per minute or more. Yields from wells tapping the other water-bearing formations generally are small and the water commonly is suitable only for stock.

Most of Live Oak County is rolling to moderately hilly, although some areas are nearly flat. The altitude ranges from about 460 feet in the southwestern part of the county to about 90 feet near Lake Corpus Christi. The county is drained by the Nueces River and its tributaries, the Frio and Atascosa Rivers, with the exception of a small, elongated area near the Bee County line which is drained by tributaries of the Aransas River.

The water-bearing formations in Live Oak County is continually recharged by the infiltration of a small part of the precipitation, which falls on the more permeable strata.

However, most of the precipitation that falls in the county runs off in streams, evaporates, or is transpired by plants. The remaining water, probably less than five percent, may reach the zone of saturation where it moves slowly toward an area of discharge such as a well, natural outlet, or, under artesian pressure, it may seep or percolate slowly upward into overlying beds. Recharge might be enhanced by several methods: brush control, additional precipitation, and additional tanks to catch runoff from excessive precipitation.

Surface Water Resource of Live Oak County

There are two surface impoundments used to supply water other than for livestock consumption, the Choke Canyon reservoir and Lake Corpus Christi. The average annual supply from these impoundments is 241,000 acre-feet, however, the calculated firm yield is 206,000 acre-feet. For planning calculations, the impoundments will be assumed to supply 162,500 acre-feet per year by the year 2050. These figures came from the City of Corpus Christi. The owners and operators are the Nueces River Authority and the City of Corpus Christi within all reaches of the Nueces River in Live Oak County. The City of Corpus Christi is the major user of surface water in Live Oak County along with the City of Three Rivers and the petrochemical plant, Valero.

For additional information see Appendix A

Estimate of the amount of groundwater used from the latest version of the TWDB Estimated Historical Water Use/2022 State Water Plan, estimates of the projected total demand, projected surface water supply, water supply needs, and water management strategies from the 2022 State Water Plan. (See Appendix A) The District considered the water supply needs and water management strategies included in the state water plan. The water user groups in the District having needs are: Irrigation, and Manufacturing. The sum of projected water supply needs in acre-feet is 344 in the year 2020, increasing to 563 in years 2030, 2040, 2050, 2060, and 2070.The District considered the demand reduction for the municipalities and the water management strategies from the State Water Plan. The District's MAG is sufficient to provide the necessary groundwater for irrigation and manufacturing if a permit is applied for.

Groundwater Availability Modeling Information

This information came from the TWDB GAM Run 19-019. The TWDB GAM Run 21-021 MAG report is included in Appendix A and presents estimated data values for recharge, discharge, and volume of flow into the district, out of the district, and between aquifers.

Actions, Procedures, Performance and Avoidance for Plan Implementation
The District will implement the provisions of this plan and will utilize the provisions of this plan as a guidepost for determining the direction or priority for all District activities. All operations of the District, all agreements entered into by the District and any additional planning efforts in which the District may participate will be consistent with the provisions of this plan. The rules adopted by the District shall be pursuant to Texas Water Code Chapter 36 and the provisions of this plan. All rules will be adhered to and enforced. The promulgation and enforcement of the rules will be based on the best technical evidence available. The rules can be downloaded at http://www.louwcd.org/approved-rules.html under the tab “District Rules”.

Methodology for Tracking the District’s Progress in Achieving Management Goals
The District manager will prepare and present an annual report to the Board of Directors on District performance in regards to achieving management goals and objectives. The presentation of the report will occur during the last monthly Board meeting each fiscal year, beginning December 31, 2020. The report will include the number of instances in which each of the activities specified in the District’s management objectives was engaged in during the fiscal year. The Board will maintain the report on file, for public inspection at the District’s offices upon adoption. This methodology will apply to all management goals contained within this plan.

Management of Groundwater Supplies

The District will manage the supply of groundwater within the District in order to conserve the resource while seeking to maintain the economic viability of all resource user groups, public and private. In consideration of the economic and cultural activities occurring within the District, the District will identify and engage in such activities and practices that, if implemented, would result in a reduction of groundwater use. A monitor well observation network shall be established and maintained in order to evaluate changing conditions of groundwater supplies (water in storage) within the District. The District will make a regular assessment of water supply and groundwater storage conditions and will report those conditions to the Board and to the public.

The District will undertake, as necessary and cooperate with investigations of the groundwater resources within the District and will make the results of investigations available to the public upon adoption by the Board. The District has adopted rules to regulate groundwater withdrawals by means of well spacing and production limits. The District may deny a well construction permit or limit groundwater withdrawals in accordance with the guidelines stated in the rules of the District. In making a determination to deny a permit or limit groundwater withdrawals, the District will consider the public benefit against individual hardship after considering all appropriate testimony.

In pursuit of the Districts mission of protecting the resource, the District may require reduction of groundwater withdrawals to amounts, which will not cause harm to the aquifer. To achieve this purpose, the District may, at the Boards discretion, amend or revoke any permits after notice and hearing. The determination to seek the amendment or revocation of a permit by the District will be based on aquifer conditions observed by the District. The District will enforce the terms and conditions of permits and the rules of the District by enjoining the permit holder in a court of competent jurisdiction as provided for in Texas Water Code (TWC) 36.102.

Desired Future Condition and Modeled Available Groundwater

Member districts in GMA 16 adopted a desired future condition for the Gulf Coast Aquifer on June 28, 2022, and declared all the other aquifers non-relevant. The desired future condition for Live Oak UWCD is 45 feet of drawdown within the district. The Modeled Available Groundwater report, GAM Run 21-021 MAG, is in Appendix A.

**LIVE OAK UNDERGROUND WATER
CONSERVATION DISTRICT
MANAGEMENT PLAN**

MISSION STATEMENT

The mission of the Live Oak Underground Water Conservation District is to protect and assure a sufficient quantity and quality of groundwater for our constituents use.

We value:

*Collection and maintenance of data on water quantity and quality
*Efficient use of groundwater
*Conjunctive water management issues
*Development and enforcement of water district rules concerning conservation of ground water.

Management Goals, Objectives, and Performance Standards
Resource Goals

Goal 1.0: Providing the most efficient use of groundwater

Management Objective:

Each year the District will provide education materials concerning the efficient use of groundwater.

Performance standard:

Provide educational materials to at least one school annually.

Goal 2.0: Controlling and preventing waste of groundwater

Management Objective:

Measure water levels from the land surface on strategic wells on an annual basis and report waste to the District Board.

Performance standard:

(a) Report to the District Board annually the water level measurements for three wells.
(b) The District will investigate all reports of waste within 7 working days. The number of reports of waste as well as the investigation findings will be reported to the District Board annually.

Goal 3.0: Controlling and preventing subsidence

The District has reviewed the report: Identification of the Vulnerability of the Major and Minor Aquifers in Texas to Subsidence with regard to Groundwater Pumping – TWDB Contract Number 1648302062 by LRE Water: http://www.twdb.texas.gov/groundwater/models/research/subsidence/subsidence.asp. Figure 4.23 indicates a medium-to-high risk of subsidence in the district.
Due to the amount of current pumping, subsidence is not expected to occur, but the District will investigate all observations or reports of any subsidence.

Goal 4.0: Addressing Conjunctive surface water management issues

Management Objective:

The District will participate in the regional planning process by attending the Region N regional water planning group meetings to encourage the development of surface water supplies to meet the needs of water user groups within the District. A representative of the District will attend, at least, one meeting of the Region N regional water planning group.

Performance Standard:

The District will attend one meeting of the Region N regional water planning group in, and include the attendee's name in the Annual Report to the Board.

Goal 5.0: Addressing Natural Resource Issues

Management Objective:

The District may inspect suspended and abandoned wells to ensure proper closing of wells in accordance with the District rules. Notices will be sent and fines assessed against well owners whose wells are not in compliance with the District rules.

Performance Standard:

The District will report anything concerning the above to the Board in the Annual Report.

Goal 6.0: Addressing Drought Conditions

Management Objective:

The District will monitor the Palmer Drought Severity Index (PDSI). The link to the Drought index is www.waterdatafortexas.org/drought

Performance Standard:

A report of the Palmer Drought Severity Index will be presented to the District board on an annual basis. The link to the Drought index is www.waterdatafortexas.org/drought

Goal 7.0: Addressing Conservation

Management Objective:

Each year the District will provide educational material to the public promoting conservation methods and concepts.

Performance Standard:

The District will make at least one educational brochure available per year through service organizations, and on a continuing basis at the District office.

Goal 8.0: Addressing Precipitation Enhancement

The District has determined that this goal is not financially feasible at this time.

Goal 9.0: Recharge Enhancement

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

Goal 10.0: Addressing Rainwater Harvesting

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

Goal 11.0: Addressing Brush Control

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

Goal 12.0: Addressing the Desired Future Conditions of the groundwater resource in the District.

Management Objective:

The District will annually measure the water levels in at least three monitoring wells within the District and will determine the five-year water level averages based on the measurements are taken.
The District will compare the five-year water level averages to the corresponding five-year increment of its Desired Future Conditions in order to track its progress in achieving the Desired Future Conditions.

Performance Standard:

The District's Annual Report will include the water level measured taken each year for the purpose of measuring water levels to assess the District's progress towards achieving its Desired Future Conditions. Once the District has obtained water level measurements for five consecutive years and is able to calculate water level averages over five-year periods thereafter, the District will include a discussion of its comparison of water level averages to the corresponding five-year increment of its Desired Future Conditions in order to track its progress in achieving its Desired Future Conditions.

Management Objective:

The District will review and calculate its permit and well registration totals in light of the Desired Future Conditions of the groundwater resources within the boundaries of the District to assess whether the District is on target to meet the Desired Future Conditions estimates submitted to the TWDB.

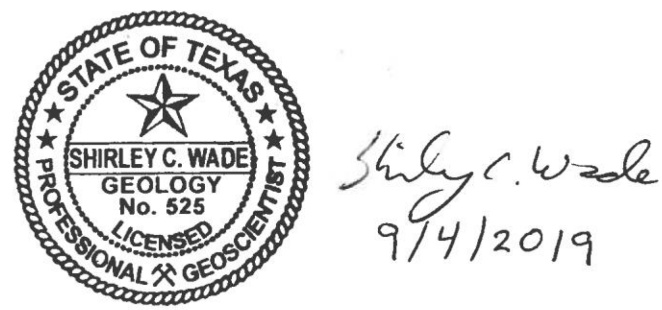
Performance Standard:

The District’s Annual Report will include a discussion of the District’s permit and well registration totals and will evaluate the District’s progress in achieving the Desired Future Conditions of the groundwater resources within the boundaries of the District and whether the District is on track to maintain the Desired Future Conditions estimates over the 50-year planning period.

Appendix A

GAM Run 19-019: Live Oak Underground Water Conservation District Management Plan

By Andrew Denham and Shirley C. Wade, Ph.D., P.G.
Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Department
(512) 936-0883
September 4, 2019



Cynthia K. Ridgeway is the manager of the Groundwater Availability Department and is responsible for the oversight of work performed by Andrew Denham under her direct supervision. The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G. 471 on September 4, 2019.

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GAM Run 19-019: Live Oak Underground Water Conservation District Management Plan

By Andrew Denham and Shirley C. Wade, Ph.D., P.G.
Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Department
(512) 936-0883
September 4, 2019

EXECUTIVE SUMMARY:

Texas State Water Code, Section 36.1071, Subsection (h) (Texas Water Code, 2011), states that, in developing its groundwater management plan, a groundwater conservation district shall use groundwater availability modeling information provided by the Executive Administrator of the Texas Water Development Board (TWDB) in conjunction with any available site-specific information provided by the district for review and comment to the Executive Administrator.

The TWDB provides data and information to the Live Oak Underground Water Conservation District in two parts. Part 1 is the Estimated Historical Water Use/State Water Plan dataset report, which will be provided to you separately by the TWDB Groundwater Technical Assistance Department. Please direct questions about the water data report to Mr. Stephen Allen at 512-463-7317 or stephen.allen@twdb.texas.gov. Part 2 is the required groundwater availability modeling information and this information includes:

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

The groundwater management plan for the Live Oak Underground Water Conservation District should be adopted by the district on or before June 17, 2020 and submitted to the executive administrator of the TWDB on or before July 17, 2020. The current management plan for the Live Oak Underground Water Conservation District expires on September 15, 2020.

We used three groundwater availability models to estimate the management plan information for the aquifers within the Live Oak Underground Water Conservation District. Information for the Carrizo-Wilcox Aquifer is from version 2.01 of the groundwater availability model for the southern part of the Carrizo-Wilcox, Queen City, and Sparta aquifers (Kelley and others, 2004). Information for the Yegua-Jackson Aquifer is from version 1.01 of the groundwater availability model for the Yegua-Jackson Aquifer (Deeds and others, 2010). Information for the Gulf Coast Aquifer System is from version 1.01 of the groundwater availability model for the central portion of the Gulf Coast Aquifer System (Chowdhury and others, 2004).

This report replaces the results of GAM Run 14-014 (Wade, 2014), as the approach used for analyzing model results has been since refined to more accurately delineate flows between hydraulically connected units. Tables 1, 2, and 3 summarize the groundwater availability model data required by statute and Figures 1, 2, and 3 show the area of the models from which the values in the tables were extracted. If, after review of the figures, the Live Oak Underground Water Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the TWDB at your earliest convenience.

METHODS:

In accordance with the provisions of the Texas State Water Code, Section 36.1071, Subsection (h), the groundwater availability models mentioned above were used to estimate information for the Live Oak Underground Water Conservation District management plan. Water budgets were extracted for the Carrizo-Wilcox Aquifer (1980-1999), Yegua-Jackson Aquifer (1980-1997), and Gulf Coast Aquifer System (1981-1999). We used ZONEBUDGET Version 3.01 (Harbaugh, 2009) to extract water budgets from the model results. The average annual water budget values for recharge, surface-water outflow, inflow to the district, and outflow from the district for the aquifers within the district are summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Carrizo-Wilcox Aquifer

- We used version 2.01 of the groundwater availability model for the southern part of the Carrizo-Wilcox, Queen City, and Sparta aquifers. See Deeds and others (2003) and Kelley and others (2004) for assumptions and limitations of the groundwater availability model for the southern part of the Carrizo-Wilcox, Queen City, and Sparta aquifers.

- This groundwater availability model includes eight layers which generally represent the Sparta Aquifer (Layer 1), the Weches Confining Unit (Layer 2), the Queen City Aquifer (Layer 3), the Reklaw Confining Unit (Layer 4), the Carrizo Aquifer (Layer 5), the Upper Wilcox (Layer 6), the Middle Wilcox (Layer 7), and the Lower Wilcox (Layer 8). The Sparta Aquifer (Layer 1), and Queen City Aquifer (Layer 3) are not present in Live Oak Underground Water Conservation District. Water budgets were extracted collectively for the Carrizo-Wilcox Aquifer (Layer 5 through Layer 8).

- Groundwater in the Carrizo-Wilcox, Queen City, and Sparta aquifers ranges from fresh to brackish in composition (Kelley and others, 2004). Groundwater with total dissolved solids of less than 1,000 milligrams per liter are considered fresh and total dissolved solids of 1,000 to 10,000 milligrams per liter are considered brackish.

- The model was run with MODFLOW-96 (Harbaugh and McDonald, 1996).

Yegua-Jackson Aquifer

- We used version 1.01 of the groundwater availability model for the Yegua-Jackson Aquifer. See Deeds and others (2010) for assumptions and limitations of the groundwater availability model.

- This groundwater availability model includes five layers which represent the outcrop section for the Yegua-Jackson Aquifer and younger overlying units (Layer 1), the upper portion of the Jackson Group (Layer 2), the lower portion of the Jackson Group (Layer 3), the upper portion of the Yegua Group (Layer 4), and the lower portion of the Yegua Group (Layer 5).

- An overall water budget for the District was determined for the Yegua-Jackson Aquifer (Layer 1 through Layer 5 collectively for the portions of the model that represent the Yegua-Jackson Aquifer). The net flow between aquifers within the district were determined by separating Layer 1 from the combined Layers of 2 through 5 from portions outside of the Yegua-Jackson Aquifer outcrop areas.

- The model was run with MODFLOW-2000 (Harbaugh and others, 2000).

Gulf Coast Aquifer System

- We used version 1.01 of the groundwater availability model for the central portion of the Gulf Coast Aquifer for this analysis. See Chowdhury and others (2004) and Waterstone and others (2003) for assumptions and limitations of the groundwater availability model.

- The model for the central portion of the Gulf Coast Aquifer assumes partially penetrating wells in the Evangeline Aquifer due to a lack of data for aquifer properties in the deeper section of the aquifer located closer to the Gulf of Mexico.

- This groundwater availability model includes four layers, which generally represent the Chicot Aquifer (Layer 1), the Evangeline Aquifer (Layer 2), the Burkeville Confining Unit (Layer 3), and the Jasper Aquifer including parts of the Catahoula Formation (Layer 4).

- The model was run with MODFLOW-96 (Harbaugh and McDonald, 1996).

- Because this model assumes a no-flow boundary condition at the base of the Gulf Coast Aquifer System, we used version 1.01 of the groundwater availability model for the Yegua-Jackson Aquifer to investigate groundwater flows between parts of the Catahoula Formation in direct hydrologic communication with the Gulf Coast Aquifer System and the Yegua-Jackson Aquifer and its equivalent downdip Yegua-Jackson confined units. See Deeds and others (2010) for assumptions and limitations of the groundwater availability model for the Yegua-Jackson Aquifer.

RESULTS:

A groundwater budget summarizes the amount of water entering and leaving the aquifer according to the groundwater availability model. Selected groundwater budget components listed below were extracted from the model results for the aquifers located within the district and averaged over the historical calibration periods, as shown in Tables 1, 2, and 3.

1. Precipitation recharge—the areally distributed recharge sourced from precipitation falling on the outcrop areas of the aquifers (where the aquifer is exposed at land surface) within the district.

2. Surface-water outflow—the total water discharging from the aquifer (outflow) to surface-water features such as streams, reservoirs, and springs.

3. Flow into and out of district—the lateral flow within the aquifer between the district and adjacent counties.

4. Flow between aquifers—the net vertical flow between the aquifer and adjacent aquifers or confining units. This flow is controlled by the relative water levels in each aquifer and aquifer properties of each aquifer or confining unit that define the amount of leakage that occurs.

The information needed for the district's management plan is summarized in Tables 1, 2, and 3. It is important to note that sub-regional water budgets are not exact. This is due to the size of the model cells and the approach used to extract data from the model. To avoid double accounting, a model cell that straddles a political boundary, such as a district or county boundary, is assigned to one side of the boundary based on the location of the centroid of the model cell. For example, if a cell contains two counties, the cell is assigned to the county where the centroid of the cell is located.

TABLE 1: SUMMARIZED INFORMATION FOR THE CARRIZO-WILCOX AQUIFER THAT IS NEEDED FOR THE LIVE OAK UNDERGROUND WATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Carrizo-Wilcox Aquifer	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers.	Carrizo-Wilcox Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Carrizo-Wilcox Aquifer	1,390
Estimated annual volume of flow out of the district within each aquifer in the district	Carrizo-Wilcox Aquifer	1,367
Estimated net annual volume of flow between each aquifer in the district	To the Carrizo-Wilcox Aquifer from the down-dip portions of the equivalent formations	33
	To the Reklaw confining unit from the Carrizo-Wilcox Aquifer	70

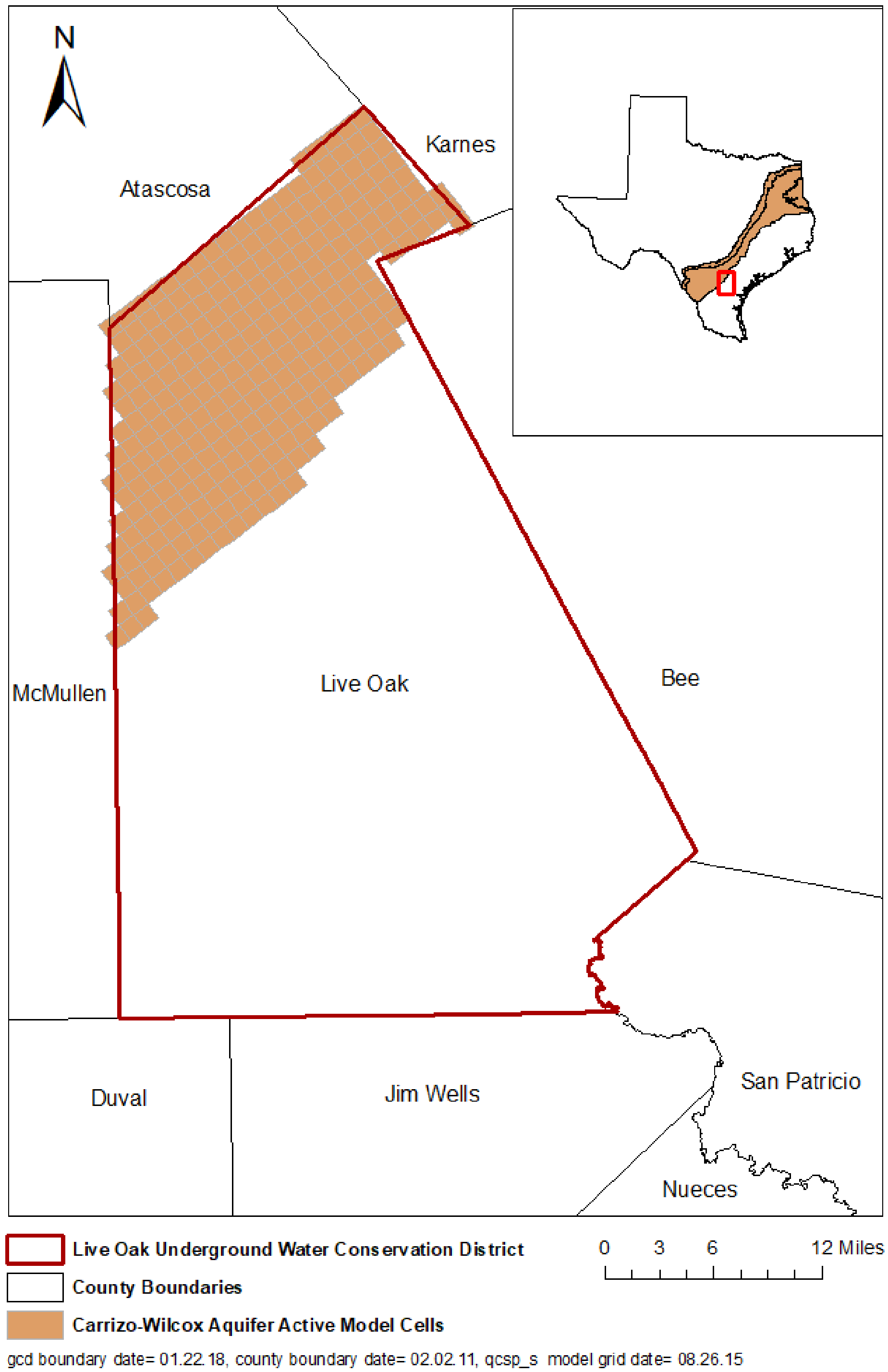


FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE SOUTHERN PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE CARRIZO-WILCOX AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 2: SUMMARIZED INFORMATION FOR THE YEGUA-JACKSON AQUIFER THAT IS NEEDED FOR THE LIVE OAK UNDERGROUND WATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Yegua-Jackson Aquifer	618
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Yegua-Jackson Aquifer	859
Estimated annual volume of flow into the district within each aquifer in the district	Yegua-Jackson Aquifer	798
Estimated annual volume of flow out of the district within each aquifer in the district	Yegua-Jackson Aquifer	585
Estimated net annual volume of flow between each aquifer in the district	Into the confined Yegua-Jackson units from the Yegua-Jackson Aquifer	13
	Into Yegua-Jackson Aquifer from the Catahoula Formation[1]	7
	Into the Catahoula Formation from the confined Yegua-Jackson units[2]	273

[1] The Catahoula Formation within and near its outcrop is considered part of the Gulf Coast Aquifer System by the TWDB. Flow values from the Catahoula Formation outcrop portion of the Gulf Coast Aquifer System into the Yegua-Jackson Aquifer were extracted from the groundwater availability model for the Yegua-Jackson Aquifer.

[2] Deeper parts of the Catahoula Formation in direct hydrologic communication with the Gulf Coast Aquifer System provide a semi-confined boundary between the Gulf Coast Aquifer system and the underlying confined Yegua-Jackson units (not considered part of the Yegua-Jackson Aquifer by the TWDB). Flow values from the Catahoula Formation in direct hydrologic communication with the Gulf Coast Aquifer System and into the confined Yegua-Jackson units were extracted from the groundwater availability model for the Yegua-Jackson Aquifer.

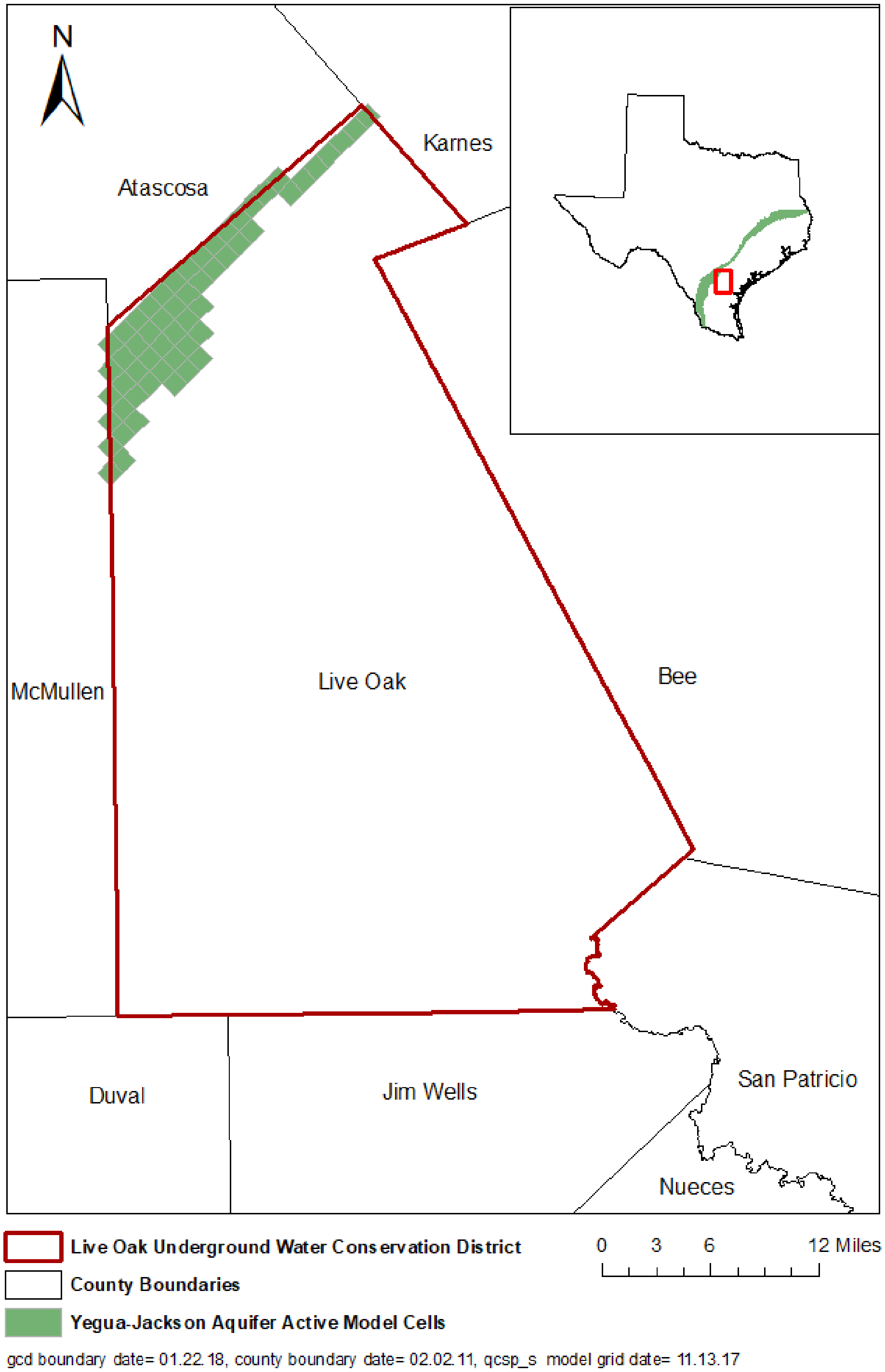


FIGURE 2: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE YEGUA-JACKSON AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE YEGUA-JACKSON AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 3: SUMMARIZED INFORMATION FOR THE GULF COAST AQUIFER SYSTEM THAT IS NEEDED FOR THE LIVE OAK UNDERGROUND WATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Gulf Coast Aquifer System	5,487
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Gulf Coast Aquifer System	10,378
Estimated annual volume of flow into the district within each aquifer in the district	Gulf Coast Aquifer System	4,124
Estimated annual volume of flow out of the district within each aquifer in the district	Gulf Coast Aquifer System	1,572
Estimated net annual volume of flow between each aquifer in the district	From the Catahoula Formation into Yegua-Jackson Aquifer[1]	7
	From the confined Yegua-Jackson units into the Catahoula Formation[2]	273

[1] The Catahoula Formation within and near its outcrop is considered part of the Gulf Coast Aquifer System by the TWDB. Flow values from the Catahoula Formation outcrop portion of the Gulf Coast Aquifer System into the Yegua-Jackson Aquifer were extracted from the groundwater availability model for the Yegua-Jackson Aquifer.

[2] Deeper parts of the Catahoula Formation in direct hydrologic communication with the Gulf Coast Aquifer System provide a semi-confined boundary between the Gulf Coast Aquifer System and the underlying confined Yegua-Jackson units (not considered part of the Yegua-Jackson Aquifer by the TWDB). Flow values from the Catahoula Formation in direct hydrologic communication with the Gulf Coast Aquifer System and into the confined Yegua-Jackson units were extracted from the groundwater availability model for the Yegua-Jackson Aquifer.

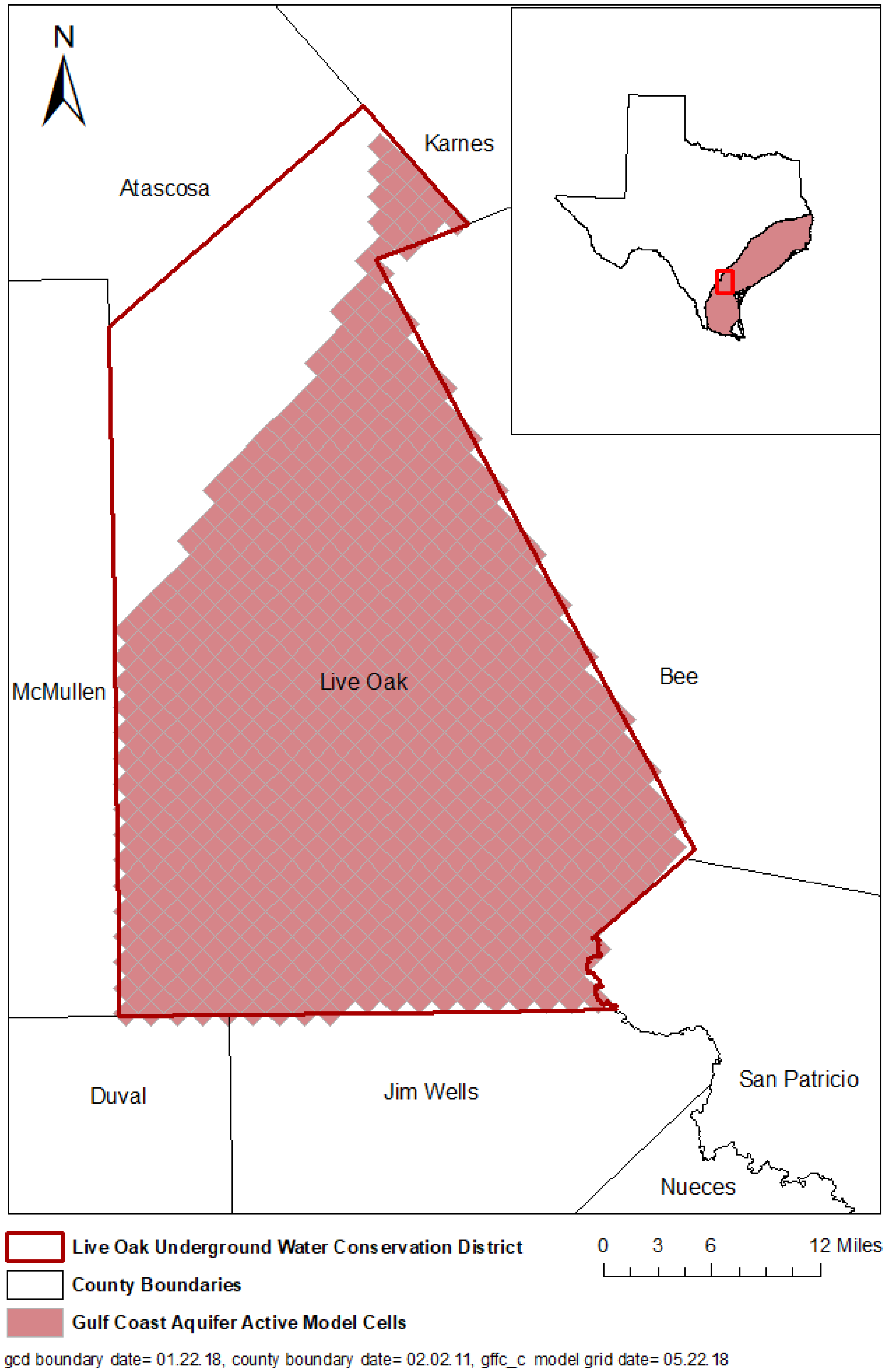


FIGURE 3: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE CENTRAL PORTION OF THE GULF COAST AQUIFER SYSTEM FROM WHICH THE INFORMATION IN TABLE 3 WAS EXTRACTED (THE GULF COAST AQUIFER SYSTEM EXTENT WITHIN THE DISTRICT BOUNDARY).

LIMITATIONS:

The groundwater models used in completing this analysis is the best available scientific tool that can be used to meet the stated objectives. To the extent that this analysis will be used for planning purposes and/or regulatory purposes related to pumping in the past and into the future, it is important to recognize the assumptions and limitations associated with the use of the results. In reviewing the use of models in environmental regulatory decision making, the National Research Council (2007) noted:

> *"Models will always be constrained by computational limitations, assumptions, and knowledge gaps. They can best be viewed as tools to help inform decisions rather than as machines to generate truth or make decisions. Scientific advances will never make it possible to build a perfect model that accounts for every aspect of reality or to prove that a given model is correct in all respects for a particular regulatory application. These characteristics make evaluation of a regulatory model more complex than solely a comparison of measurement data with model results."*

A key aspect of using the groundwater model to evaluate historic groundwater flow conditions includes the assumptions about the location in the aquifer where historic pumping was placed. Understanding the amount and location of historic pumping is as important as evaluating the volume of groundwater flow into and out of the district, between aquifers within the district (as applicable), interactions with surface water (as applicable), recharge to the aquifer system (as applicable), and other metrics that describe the impacts of that pumping. In addition, assumptions regarding precipitation, recharge, and interaction with streams are specific to particular historic time periods.

Because the application of the groundwater models was designed to address regional scale questions, the results are most effective on a regional scale. The TWDB makes no warranties or representations related to the actual conditions of any aquifer at a particular location or at a particular time.

It is important for groundwater conservation districts to monitor groundwater pumping and overall conditions of the aquifer. Because of the limitations of the groundwater model and the assumptions in this analysis, it is important that the groundwater conservation districts work with the TWDB to refine this analysis in the future given the reality of how the aquifer responds to the actual amount and location of pumping now and in the future. Historic precipitation patterns also need to be placed in context as future climatic conditions, such as dry and wet year precipitation patterns, may differ and affect groundwater flow conditions.

REFERENCES:

Chowdhury, Ali. H., Wade, S., Mace, R.E., and Ridgeway, C., 2004, Groundwater Availability Model of the Central Gulf Coast Aquifer System: Numerical Simulations through 1999- Model Report, 114 p., http://www.twdb.texas.gov/groundwater/models/gam/glfc_c/TWDB_Recalibration_Report.pdf.

Deeds, N., Kelley, V., Fryar, D., Jones, T., Whallon, A.J., and Dean, K.E., 2003, Groundwater Availability Model for the Southern Carrizo-Wilcox Aquifer: Contract report to the Texas Water Development Board, 452 p., http://www.twdb.texas.gov/groundwater/models/gam/czwx_s/CZWX_S_Full_Report.pdf.

Deeds, N.E., Yan, T., Singh, A., Jones, T.L., Kelley, V.A., Knox, P.R., Young, S.C., 2010, Groundwater availability model for the Yegua-Jackson Aquifer: Final report prepared for the Texas Water Development Board by INTERA, Inc., 582 p., http://www.twdb.texas.gov/groundwater/models/gam/ygjk/ygjk.asp.

Harbaugh, A. W., 2009, Zonebudget Version 3.01, A computer program for computing subregional water budgets for MODFLOW ground-water flow models, U.S. Geological Survey Groundwater Software.

Harbaugh, A. W., and McDonald, M. G., 1996, User's documentation for MODFLOW-96, an update to the U.S. Geological Survey modular finite-difference groundwater-water flow model: U.S. Geological Survey Open-File Report 96-485, 56 p.

Harbaugh, A.W., Banta, E.R., Hill, M.C., and McDonald, M.G., 2000, MODFLOW-2000, The U.S. Geological Survey modular ground-water model-User guide to modularization concepts and the ground-water flow process: U.S. Geological Survey, Open-File Report 00-92.

Wade, S., 2014, GAM Run 14-014: Texas Water Development Board, GAM Run 14-014 Report, 16 p., http://www.twdb.texas.gov/groundwater/docs/GAMruns/GR10-010.pdf.

Kelley, V.A., Deeds, N.E., Fryar, D.G., and Nicot, J.P., 2004, Groundwater availability models for the Queen City and Sparta aquifers: Contract report to the Texas Water Development Board, 867 p., http://www.twdb.texas.gov/groundwater/models/gam/qcsp/qcsp.asp.

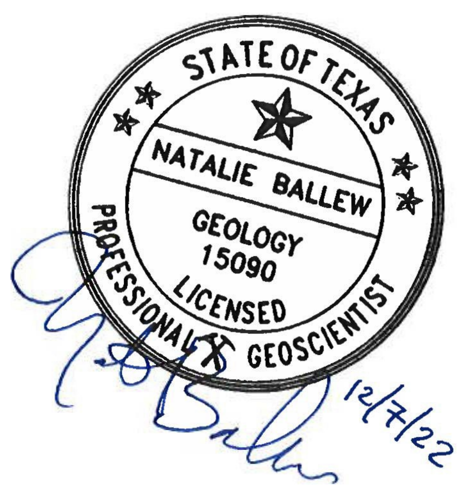
National Research Council, 2007, Models in Environmental Regulatory Decision Making Committee on Models in the Regulatory Decision Process, National Academies Press, Washington D.C., 287 p., http://www.nap.edu/catalog.php?record_id=11972.

Texas Water Code, 2011, http://www.statutes.legis.state.tx.us/docs/WA/pdf/WA.36.pdf

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

GAM RUN 21-021 MAG: MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 16

Ki Cha, Ph.D., EIT
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-463-5604
October 31, 2022



Natalie Ballew, P.G. 15090, is the Director of the Groundwater Division and is responsible for oversight of work performed by Ki Cha under her supervision.

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GAM RUN 21-021 MAG: MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 16

Ki Cha, Ph.D., EIT
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-463-5604
October 31, 2022

EXECUTIVE SUMMARY:

The modeled available groundwater for Groundwater Management Area 16 for the Gulf Coast Aquifer System is summarized by decade by groundwater conservation district and county (Table 1) and for use in the regional water planning process by county, regional water planning area, and river basin (Table 2). The modeled available groundwater estimates range from approximately 229,000 acre-feet per year in 2020 to approximately 294,000 acre-feet per year in 2080 (Tables 1 and 2). The estimates are based on the desired future conditions for the Gulf Coast Aquifer System adopted by groundwater conservation districts in Groundwater Management Area 16 on November 23, 2021 and re-adopted with minor clerical corrections on June 28, 2022. The explanatory report and other materials submitted to the TWDB were determined to be administratively complete on August 26, 2022.

REQUESTOR:

Mr. Scott Bledsoe, III, coordinator for Groundwater Management Area 16.

DESCRIPTION OF REQUEST:

In a letter dated January 22, 2022, Dr. Steve C. Young, consultant for Groundwater Management Area 16, provided the TWDB with the desired future conditions of the Gulf Coast Aquifer System adopted by the groundwater conservation district representatives in Groundwater Management Area 16. The Carrizo-Wilcox and Yegua-Jackson aquifers were declared non-relevant for joint planning purposes by Groundwater Management Area 16.

On June 2, 2022, TWDB requested clarifications about the wording of the desired future conditions, as some were unachievable based on TWDB analysis of the submitted model files during administrative review. In response, the Groundwater Management Area 16 consultant and groundwater conservation district representatives submitted an amended explanatory report (Young, 2022) on July 4, 2022. Groundwater Management Area 16 adopted a revised version of the desired future conditions for the Gulf Coast Aquifer System. The final desired future conditions adopted by the groundwater conservation district representatives in Groundwater Management Area 16 as described in Resolution No. 2022-01, on June 28, 2022 (Young, 2022; Appendix C), are presented below:

"Groundwater Management Area 16 adopts Desired Future Conditions for each county within the groundwater management area (county-specific DFC's) and adopts a Desired Future Condition for the counties in the groundwater management area (gma-specific DFC's). The Desired Future Condition for the counties in the groundwater management area shall not exceed an average drawdown of 78 feet for the Gulf Coast Aquifer System at December 2080. Desired Future Conditions for each county within the groundwater management area (county-specific DFC's) shall not exceed the values specified in Scenario 2 at December 2080.

Table A-1: Desired Future Conditions for GMA 16 expressed as an Average Drawdown between January 2010 and December 2079.

Bee GCD: 93 feet of drawdown of the Gulf Coast Aquifer System;

Live Oak UWCD: 45 feet of drawdown of the Gulf Coast Aquifer System;

McMullen GCD: 12 feet of drawdown of the Gulf Coast Aquifer System;

Red Sands GCD: 60 feet of drawdown of the Gulf Coast Aquifer System;

Kenedy County GCD: 27 feet of drawdown of the Gulf Coast Aquifer System;

Brush Country GCD: 89 feet of drawdown of the Gulf Coast Aquifer System;

Duval County GCD: 137 feet of drawdown of the Gulf Coast Aquifer System;

San Patricio County GCD: 69 feet of drawdown of the Gulf Coast Aquifer System;

Starr County GCD: 94 feet of drawdown of the Gulf Coast Aquifer System;

Cameron: 119 feet of drawdown of the Gulf Coast Aquifer System;

Hidalgo: 138 feet of drawdown of the Gulf Coast Aquifer System;

Kleberg: 21 feet of drawdown of the Gulf Coast Aquifer System;

Nueces: 26 feet of drawdown of the Gulf Coast Aquifer System;

Webb: 161 feet of drawdown of the Gulf Coast Aquifer System;

Willacy: 44 feet of drawdown of the Gulf Coast Aquifer System."

METHODS:

The alternative groundwater availability model for Groundwater Management Area 16 (version 1.01; Hutchison and others, 2011) was run using the predictive model files ("Pumping Scenario #2") submitted with the desired future condition explanatory report (Young, 2022). Model-calculated water levels were extracted for January 2010 (stress period 11) and December 2079 (stress period 81), and drawdown was calculated as the difference between these water levels. Drawdown averages were calculated for the Gulf Coast Aquifer System by county, groundwater conservation district, and the entire groundwater management area. The calculated drawdown averages were compared with the desired future conditions to verify that the submitted pumping scenario can achieve the desired future conditions within the three-foot tolerance specified by Groundwater Management Area 16.

The modeled available groundwater values were determined by extracting pumping rates by decade from the model results using ZONEBUDGET Version 3.01 (Harbaugh, 2009). The modeled available groundwater can be presented by groundwater conservation district and county within Groundwater Management Area 16 (Figure 1) and by county, regional water planning area, and river basin within Groundwater Management Area 16 (Figure 2)

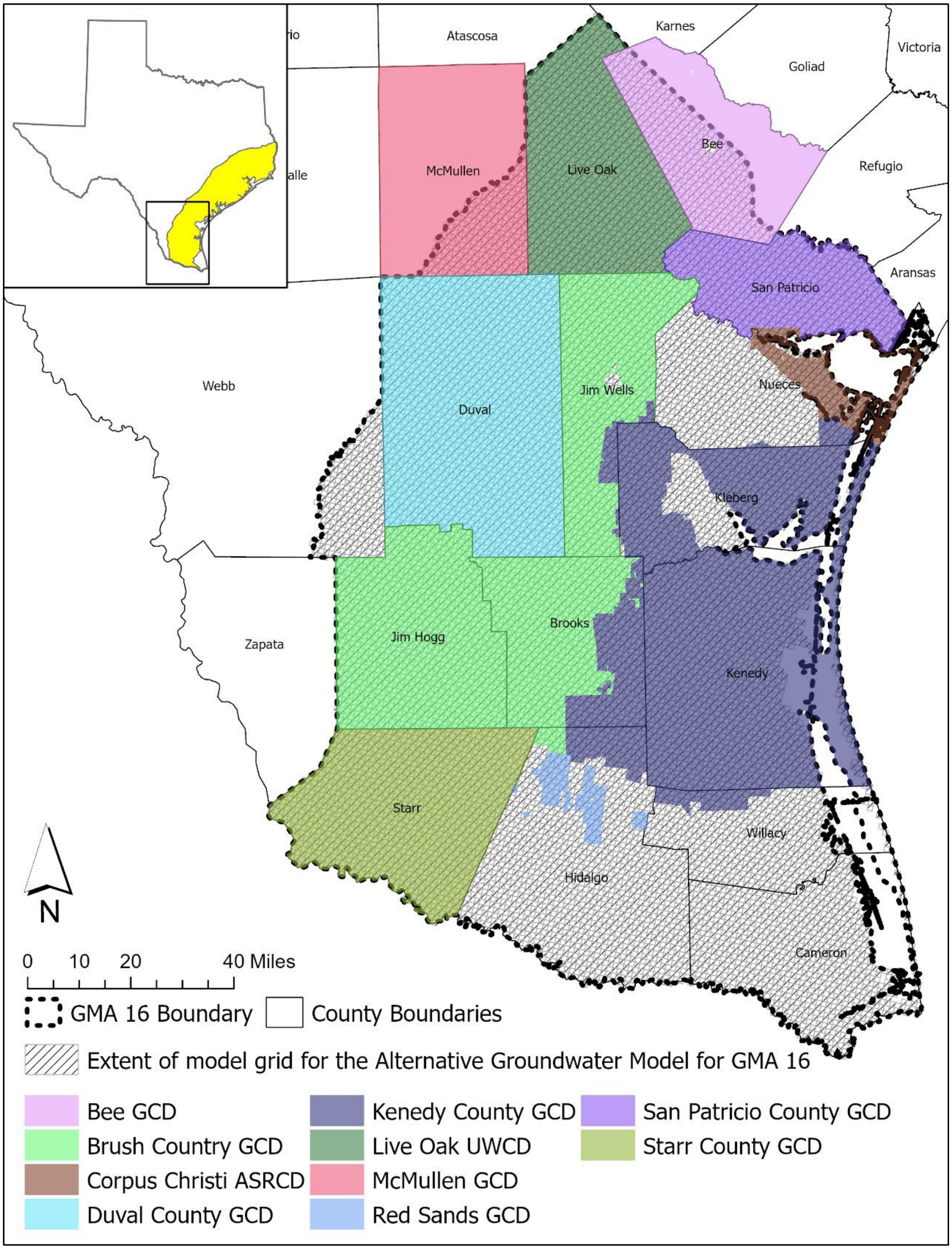

FIGURE 1. MAP SHOWING GROUNDWATER CONSERVATION DISTRICTS (GCDS) AND COUNTIES IN GROUNDWATER MANAGEMENT AREA 16, OVERLAIN ON THE EXTENT OF THE ALTERNATIVE GROUNDWATER AVAILABILITY MODEL FOR GROUNDWATER MANAGEMENT AREA 16.

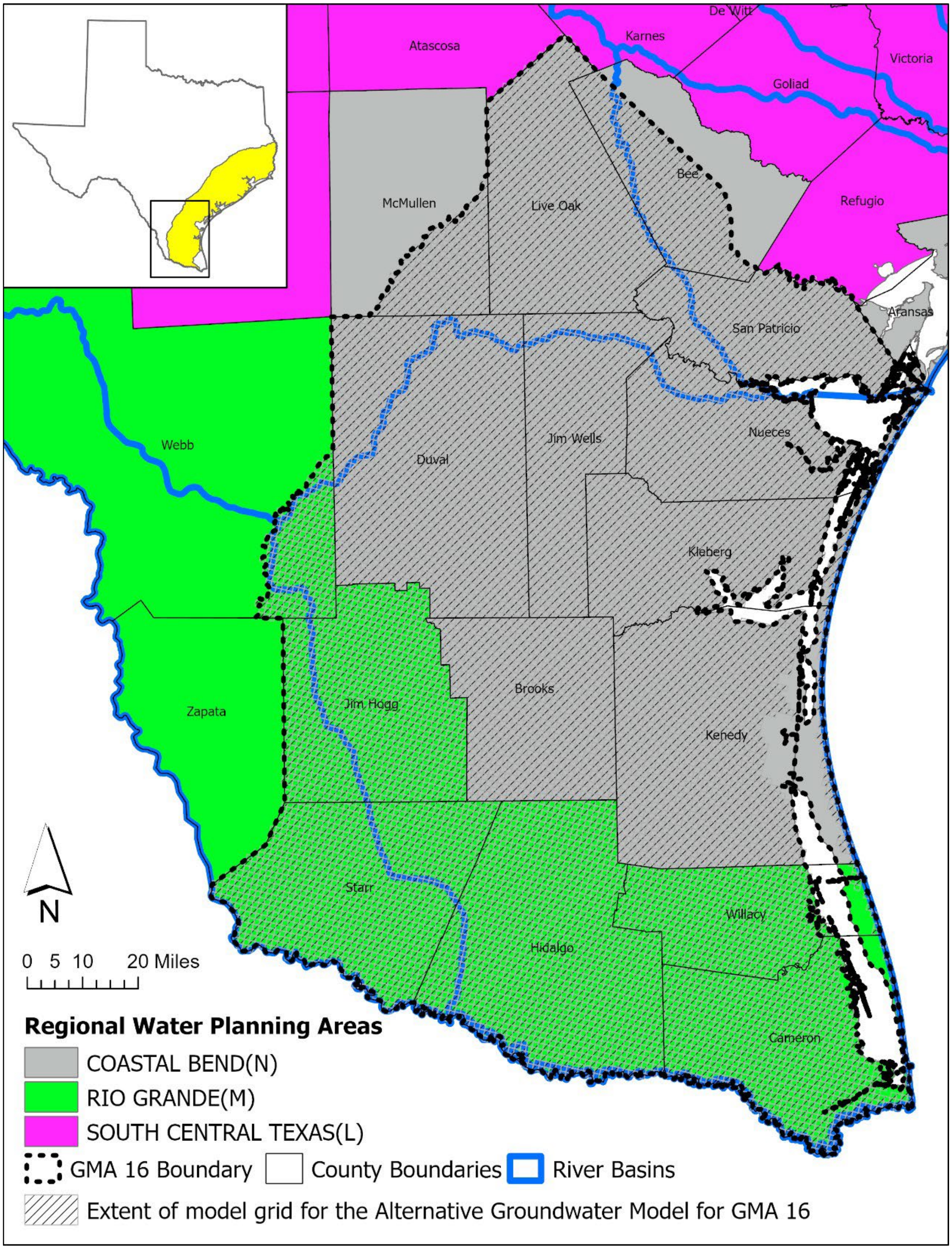

FIGURE 2. MAP SHOWING THE REGIONAL WATER PLANNING AREAS, COUNTIES, AND RIVER BASINS IN GROUNDWATER MANAGEMENT AREA 16, OVERLAIN ON THE EXTENT OF THE ALTERNATIVE GROUNDWATER AVAILABILITY MODEL FOR GROUNDWATER MANAGEMENT AREA 16.

Modeled Available Groundwater and Permitting

As defined in Chapter 36 of the Texas Water Code (2011), "modeled available groundwater" is the estimated average amount of water that may be produced annually to achieve a desired future condition. Groundwater conservation districts must consider modeled available groundwater when issuing permits in order to manage groundwater production to achieve the desired future condition(s). Districts must also consider annual precipitation and production patterns, the estimated amount of pumping exempt from permitting, existing permits, and a reasonable estimate of actual groundwater production under existing permits.

PARAMETERS AND ASSUMPTIONS:

The parameters and assumptions for the modeled available groundwater estimates are described below:

- Version 1.01 of the alternate groundwater availability model for Groundwater Management Area 16 was the base model for this analysis. See Hutchison and others (2011) for assumptions and limitations of the model. Groundwater Management Area 16 constructed a predictive model simulation to extend the base model to 2080 for planning purposes. See Young (2022) for the assumptions of this predictive model simulation.

- The model has six layers that represent the Chicot aquifer (Layer 1), the Evangeline aquifer (Layer 2), the Burkeville confining unit (Layer 3), the Jasper aquifer (Layer 4), the Yegua-Jackson Aquifer (Layer 5), and the Queen-City, Sparta and Carrizo-Wilcox Aquifer System (Layer 6). Layers 1 through 4 were lumped to calculate modeled available groundwater for the Gulf Coast Aquifer System.

- The model was run with MODFLOW-2000 (Harbaugh and others, 2000).

- To be consistent with Groundwater Management Area 16, the TWDB model grid file dated May 1, 2014 (alt1_gma16) was used to determine model cell entity assignment (county, groundwater management area, groundwater conservation district, river basin, regional water planning area).

- Although the original groundwater availability model was only calibrated to the end of 1999, an analysis during the previous round of joint planning verified that the measured water levels did not change significantly for the period from 2000 to 2010 (Goswami, 2017). For this reason, TWDB considers it acceptable to use 2010 as the reference year for drawdown calculations.

- Drawdown averages and modeled available groundwater values are based on the official TWDB boundary for the groundwater conservation district, county, regional water planning area, river basin, and Regional Water Planning Areas within Groundwater Management Area 16 (Figures 1 and 2).

- Drawdown values for cells with water levels below the base elevation of the cell ("dry" cells) were included in the average drawdown calculations. The groundwater availability model for Groundwater Management Area 16 was constructed using the confined aquifer assumption (and LAYCON=0 option), meaning the transmissivity of "dry" cells remains constant and pumping from those cells continues. The desired future conditions adopted by Groundwater Management Area 16 are based on the average drawdowns that include "dry" cells. Therefore, pumping values from "dry" cells were also included in the calculation of modeled available groundwater. Please note that the confined aquifer assumption may also lead to physically unrealistic conditions, with pumping in a model cell continuing even when water levels have dropped below the base of the model cell.

- Drawdown was calculated as the difference in modeled water levels between the baseline date January 2010 (stress period 11) and the final date December 2079 (stress period 81). Average drawdowns were calculated as the sum of drawdowns for all model cells within a specified area divided by the number of cells in that specified area.

- Estimates of modeled available groundwater from the model simulation were rounded to whole numbers.

RESULTS:

The modeled available groundwater for the Gulf Coast Aquifer System that achieves the desired future conditions adopted by Groundwater Management Area 16 increases from approximately 229,000 acre-feet per year in 2020 to 294,000 acre-feet per year in 2080. The modeled available groundwater is summarized by groundwater conservation district and county (Table 1) and by county, regional water planning area, and river basin (Table 2) for use in the regional water planning process.

TABLE 1. MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 16 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2080. VALUES ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District (GCD)	County	2020	2030	2040	2050	2060	2070	2080
Bee GCD	**Bee**	10,338	11,849	12,593	12,944	13,146	13,146	13,146
Brush Country GCD	Brooks	3,660	3,660	3,660	3,660	3,660	4,205	4,205
Brush Country GCD	Hidalgo	131	131	131	131	131	150	150
Brush Country GCD	Jim Hogg	6,167	6,167	6,167	6,167	6,167	7,084	7,084
Brush Country GCD	Jim Wells	8,701	9,065	9,393	9,758	10,050	11,544	11,544
Brush Country GCD Total		**18,659**	**19,023**	**19,351**	**19,716**	**20,008**	**22,983**	**22,983**
Duval County GCD	**Duval**	**20,571**	**22,169**	**23,764**	**25,363**	**26,963**	**26,963**	**26,963**
Kenedy County GCD	Brooks	1,308	1,463	1,693	1,847	2,078	2,232	2,232
Kenedy County GCD	Hidalgo	412	460	534	582	654	703	703
Kenedy County GCD	Jim Wells	296	330	383	417	469	505	505
Kenedy County GCD	Kenedy	9,040	10,104	11,698	12,762	14,358	15,421	15,421
Kenedy County GCD	Kleberg	4,291	4,796	5,553	6,058	6,815	7,320	7,320
Kenedy County GCD	Nueces	171	191	221	241	271	291	291
Kenedy County GCD	Willacy	328	365	424	462	520	558	558
Kenedy County GCD Total		**15,846**	**17,709**	**20,506**	**22,369**	**25,165**	**27,030**	**27,030**
Live Oak UWCD	**Live Oak**	**10,169**	**11,394**	**10,444**	**10,294**	**10,294**	**10,294**	**10,294**
McMullen GCD	**McMullen**	**510**	**510**	**510**	**510**	**510**	**510**	**510**
Red Sands GCD	**Hidalgo**	**1,667**	**1,966**	**2,265**	**2,563**	**2,863**	**2,863**	**2,863**
San Patricio County GCD	**San Patricio**	**43,611**	**45,016**	**46,422**	**47,828**	**49,234**	**49,234**	**49,234**
Starr County GCD	**Starr**	**3,798**	**4,797**	**5,797**	**6,794**	**7,795**	**7,795**	**7,795**

TABLE 1. CONTINUED

Groundwater Conservation District (GCD)	County	2020	2030	2040	2050	2060	2070	2080
No District-Cameron	Cameron	6,688	7,999	9,311	10,620	11,932	11,932	11,932
No District-Hidalgo	Hidalgo	85,634	90,905	96,175	101,445	106,715	106,715	106,715
No District-Kleberg	Kleberg	4,051	4,243	4,436	4,629	4,822	4,822	4,822
No District-Nueces	Nueces	6,339	6,596	6,857	7,115	7,372	7,372	7,372
No District-Webb	Webb	620	789	959	1,129	1,299	1,299	1,299
No District-Willacy	Willacy	664	785	905	1,024	1,145	1,145	1,145
No District-Total		**103,996**	**111,317**	**118,643**	**125,962**	**133,285**	**133,285**	**133,285**
GMA 16 Total		**229,165**	**245,750**	**260,295**	**274,343**	**289,263**	**294,103**	**294,103**

TABLE 2. MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 16. RESULTS ARE IN ACRE-FEET PER YEAR AND ARE SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2030 AND 2080.

County	RWPA	River Basin	2030	2040	2050	2060	2070	2080
Bee	N	Nueces	981	1,043	1,072	1,089	1,089	1,089
Bee	N	San Antonio-Nueces	10,868	11,550	11,872	12,057	12,057	12,057
Brooks	N	Nueces-Rio Grande	5,123	5,353	5,507	5,738	6,437	6,437
Cameron	M	Nueces-Rio Grande	7,536	8,771	10,005	11,241	11,241	11,241
Cameron	M	Rio Grande	463	540	615	691	691	691
Duval	N	Nueces	351	376	401	428	428	428
Duval	N	Nueces-Rio Grande	21,818	23,388	24,962	26,535	26,535	26,535
Hidalgo	M	Nueces-Rio Grande	91,421	96,658	101,867	107,103	107,171	107,171
Hidalgo	M	Rio Grande	2,041	2,447	2,854	3,260	3,260	3,260
Jim Hogg	M	Nueces-Rio Grande	5,230	5,230	5,230	5,230	6,008	6,008
Jim Hogg	M	Rio Grande	937	937	937	937	1,076	1,076
Jim Wells	N	Nueces	593	593	593	593	681	681
Jim Wells	N	Nueces-Rio Grande	8,802	9,183	9,582	9,926	11,368	11,368
Kenedy	N	Nueces-Rio Grande	10,104	11,698	12,762	14,358	15,421	15,421
Kleberg	N	Nueces-Rio Grande	9,039	9,989	10,687	11,637	12,142	12,142
Live Oak	N	Nueces	11,326	10,382	10,233	10,233	10,233	10,233
Live Oak	N	San Antonio-Nueces	68	62	61	61	61	61
McMullen	N	Nueces	510	510	510	510	510	510
Nueces	N	Nueces	756	787	816	845	845	845
Nueces	N	Nueces-Rio Grande	6,031	6,291	6,540	6,798	6,818	6,818
San Patricio	N	Nueces	4,502	4,874	5,247	5,619	5,619	5,619
San Patricio	N	San Antonio-Nueces	40,514	41,548	42,581	43,615	43,615	43,615

TABLE 2. CONTINUED

County	RWPA	River Basin	2030	2040	2050	2060	2070	2080
Starr	M	Nueces-Rio Grande	1,958	2,366	2,772	3,180	3,180	3,180
Starr	M	Rio Grande	2,839	3,431	4,022	4,615	4,615	4,615
Webb	M	Nueces	22	27	32	37	37	37
Webb	M	Nueces-Rio Grande	642	780	918	1,056	1,056	1,056
Webb	M	Rio Grande	125	152	179	206	206	206
Willacy	M	Nueces-Rio Grande	1,150	1,329	1,486	1,665	1,703	1,703
GMA 16 Total			**245,750**	**260,295**	**274,343**	**289,263**	**294,103**	**294,103**

*GCAS: Gulf Coast Aquifer System

LIMITATIONS:

The groundwater model used in completing this analysis is the best available scientific tool that can be used to meet the stated objectives. To the extent that this analysis will be used for planning purposes and/or regulatory purposes related to pumping in the past and into the future, it is important to recognize the assumptions and limitations associated with the use of the results. In reviewing the use of models in environmental regulatory decision making, the National Research Council (2007) noted:

> *"Models will always be constrained by computational limitations, assumptions, and knowledge gaps. They can best be viewed as tools to help inform decisions rather than as machines to generate truth or make decisions. Scientific advances will never make it possible to build a perfect model that accounts for every aspect of reality or to prove that a given model is correct in all respects for a particular regulatory application. These characteristics make evaluation of a regulatory model more complex than solely a comparison of measurement data with model results."*

A key aspect of using the groundwater model to evaluate historic groundwater flow conditions includes the assumptions about the location in the aquifer where historic pumping was placed. Understanding the amount and location of historic pumping is as important as evaluating the volume of groundwater flow into and out of the district, between aquifers within the district (as applicable), interactions with surface water (as applicable), recharge to the aquifer system (as applicable), and other metrics that describe the impacts of that pumping. In addition, assumptions regarding precipitation, recharge, and streamflow are specific to a particular historic time period.

Because the application of the groundwater model was designed to address regional scale questions, the results are most effective on a regional scale. The TWDB makes no warranties or representations relating to the actual conditions of any aquifer at a particular location or at a particular time.

It is important for groundwater conservation districts to monitor groundwater pumping and groundwater levels in the aquifer. Because of the limitations of the groundwater model and the assumptions in this analysis, it is important that the groundwater conservation districts work with the TWDB to refine this analysis in the future given the reality of how the aquifer responds to the actual amount and location of pumping now and in the future. Historic precipitation patterns also need to be placed in context as future climatic conditions, such as dry and wet year precipitation patterns, may differ and affect groundwater flow conditions.

REFERENCES:

Goswami, R.R., 2017, GAM Run 17-025 MAG: Modeled Available Groundwater for the Gulf Coast Aquifer System in Groundwater Management Area 16. Texas Water Development Board. Ay 2017

Hutchison, W.R., Hill, M.E., Anaya, R., Hassan, M.M., Oliver, W., Jigmond, M., Wade, S., and Aschenbach, E. 2011. Groundwater Management Are 16 Groundwater Flow Model, Texas Water Development Board,306 p. https://www.twdb.texas.gov/groundwater/models/alt/gma16/GMA16_Model_Report_DRAFT.pdf?d=3579

Harbaugh, A. W., 2009, Zonebudget Version 3.01, A computer program for computing subregional water budgets for MODFLOW ground-water flow models, U.S. Geological Survey Groundwater Software.

Harbaugh, A.W., Banta, E.R., Hill, M.C., and McDonald, M.G., 2000, MODFLOW-2000, The U.S. Geological Survey modular ground-water model- user guide to modularization concepts and the groundwater flow process: U.S. Geological Survey, Open-File Report 00-92.

National Research Council, 2007, Models in Environmental Regulatory Decision Making Committee on Models in the Regulatory Decision Process, National Academies Press, Washington D.C., 287 p.,http://www.nap.edu/catalog.php?record_id=11972.

Texas Water Code, 2011, http://www.statutes.legis.state.tx.us/docs/WA/pdf/WA.36.pdf.

Young, S., 2022. Desired Future Condition Explanatory Report for Groundwater Management Area 16. Prepared for Groundwater Management Area 16 Member Districts. July 2022.

TWDB Estimated Historical Groundwater Use and 2022 State Water Plan Datasets

Live Oak Underground Water Conservation District

Texas Water Development Board
Groundwater Division
Groundwater Technical Assistance Department
stephen.allen@twdb.texas.gov
(512) 463-7317
August 6, 2025

GROUNDWATER MANAGEMENT PLAN DATA

This set of water data tables (part one of a two-part package of information) is being provided to groundwater conservation districts to help them meet the requirements for approval of their five-year groundwater management plan. Each table addresses a specific numbered requirement in the Texas Water Development Board's groundwater management plan review checklist. The checklist can be found at this web address:

https://www.twdb.texas.gov/groundwater/docs/GCD/GMPChecklist0113.pdf

The five tables included in part one of this data package are:

TWDB Historical Water Use Survey (WUS)

- Estimated Historical Water Use (checklist item 2)

State Water Plan (SWP)

- Projected Surface Water Supplies (checklist item 6),
- Projected Water Demands (checklist item 7),
- Projected Water Supply Needs (checklist item 8),
- Projected Water Management Strategies (checklist item 9)

Part two of the two-part package is the groundwater availability model (GAM) run report for the district (checklist items 3 through 5). The district should have received, or will receive, this report from the TWDB Groundwater Modeling Department. Questions about the GAM can be directed to the Groundwater Modeling Team at gam@twdb.texas.gov.

DISCLAIMER:

Data presented in these tables are the most up to date WUS and SWP data available as of 8/6/2025. Although it does not happen often, these data are subject to change pending the availability of more accurate WUS data or an amendment to the 2022 SWP. District personnel should review the data table values and correct any discrepancies to ensure approval of their groundwater management plan.

The WUS data can be verified at this web address:

https://www.twdb.texas.gov/waterplanning/waterusesurvey/estimates/

The 2022 SWP data can be verified by contacting the Data Request Team at WRPdatarequests@twdb.texas.gov

The values presented in the data tables are county based. In cases where groundwater conservation districts cover only a portion of one or more counties the data values are modified with an apportioning multiplier to create new values that more accurately represent conditions within district boundaries. The multiplier used in the following formula is a land area ratio: (data value * (land area of district in county / land area of county)). For two of the four SWP tables (Projected Surface Water Supplies and Projected Water Demands) only the county-wide water user group (WUG) data values (county other, manufacturing, steam electric power, irrigation, mining, and livestock) are modified using the multiplier. WUG values for municipalities, water supply corporations, and utility districts are not apportioned; instead, their full values are retained when they are located within the district and eliminated when they are located outside (we offer districts the opportunity to review this determination).

The county values in two of the SWP tables (Projected Water Supply Needs and Projected Water Management Strategies) are not apportioned because district-specific values are not required to be presented in the groundwater management plan. However, a district is required to “consider” the county values in these two tables by drafting a short summary of the needs and strategies values in the groundwater management plan.

In the WUS table every category of water use (including municipal) is apportioned. Staff determined that breaking down the annual municipal values into individual WUGs was too complex.

TWDB recognizes that the apportioning formula used is not ideal but it is the best available process with respect to time and staffing constraints. If a district believes it has data that are more accurate, they can add those data to the plan with an explanation of how the data were derived. Apportioning percentages that the TWDB used are listed above each applicable table.

For additional questions regarding this data, please contact Stephen Allen (stephen.allen@twdb.texas.gov or 512-463-7317).

Estimated Historical Water Use
TWDB Historical Water Use Survey (WUS) Data

LIVE OAK COUNTY *100% (multiplier)* All values are in acre-feet

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2022	GW	1,440	2,081	1,292	0	755	351	5,919
	SW	1,276	410	0	0	0	151	1,837
2021	GW	1,330	1,773	980	0	454	431	4,968
	SW	1,066	539	0	0	0	185	1,790
2020	GW	1,431	1,839	444	0	717	443	4,874
	SW	985	359	49	0	0	190	1,583
2019	GW	983	2,054	2,123	0	825	444	6,429
	SW	1,004	271	236	0	0	190	1,701
2018	GW	971	1,895	1,070	0	678	444	5,058
	SW	932	336	119	0	0	190	1,577
2017	GW	921	1,312	763	0	696	427	4,119
	SW	929	878	85	0	0	183	2,075
2016	GW	905	947	593	0	695	461	3,601
	SW	842	1,332	66	0	369	197	2,806
2015	GW	1,156	912	904	0	301	505	3,778
	SW	917	1,231	100	0	658	216	3,122
2014	GW	1,291	896	1,615	0	651	573	5,026
	SW	553	1,256	179	0	507	246	2,741
2013	GW	1,042	965	1,433	0	806	451	4,697
	SW	508	1,309	159	0	520	193	2,689

Projected Surface Water Supplies
TWDB 2022 State Water Plan Data

LIVE OAK COUNTY *100% (multiplier)* All values are in acre-feet

RWPG	WUG	WUG Basin	Source Name	2020	2030	2040	2050	2060	2070
N	Irrigation, Live Oak	Nueces	Nueces Run-of-River	191	0	0	0	0	0
N	Livestock, Live Oak	Nueces	Nueces Livestock Local Supply	211	211	211	211	211	211
N	Manufacturing, Live Oak	Nueces	Nueces Run-of-River	1,309	1,500	1,500	1,500	1,500	1,500
N	Three Rivers	Nueces	Corpus Christi-Choke Canyon Lake/Reservoir System	545	530	518	512	511	511
N	Three Rivers	Nueces	Nueces Run-of-River	0	0	0	0	0	0
			Sum of Projected Surface Water Supplies (acre-feet)	**2,256**	**2,241**	**2,229**	**2,223**	**2,222**	**2,222**

Projected Water Demands
TWDB 2022 State Water Plan Data

Please note that the demand numbers presented here include the plumbing code savings found in the Regional and State Water Plans.

LIVE OAK COUNTY *100% (multiplier)* All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
N	County-Other, Live Oak	Nueces	637	622	610	604	602	602
N	El Oso WSC	Nueces	178	174	171	169	160	160
N	George West	Nueces	435	424	414	411	410	410
N	Irrigation, Live Oak	Nueces	1,630	1,630	1,630	1,630	1,630	1,630
N	Livestock, Live Oak	Nueces	740	740	740	740	740	740
N	Manufacturing, Live Oak	Nueces	2,274	2,493	2,493	2,493	2,493	2,493
N	McCoy WSC	Nueces	21	20	20	20	20	20
N	Mining, Live Oak	Nueces	814	917	907	729	492	332
N	Three Rivers	Nueces	545	530	518	512	511	511
		Sum of Projected Water Demands (acre-feet)	**7,274**	**7,550**	**7,503**	**7,308**	**7,058**	**6,898**

Projected Water Supply Needs
TWDB 2022 State Water Plan Data

Negative values (in red) reflect a projected water supply need, positive values a surplus.

LIVE OAK COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
N	County-Other, Live Oak	Nueces	0	0	0	0	0	0
N	El Oso WSC	Nueces	-1	-1	-1	-1	-2	-1
N	George West	Nueces	0	0	0	0	0	0
N	Irrigation, Live Oak	Nueces	-343	-534	-534	-534	-534	-534
N	Livestock, Live Oak	Nueces	0	0	0	0	0	0
N	Manufacturing, Live Oak	Nueces	0	-28	-28	-28	-28	-28
N	McCoy WSC	Nueces	0	0	0	0	0	0
N	Mining, Live Oak	Nueces	0	0	0	0	0	0
N	Three Rivers	Nueces	0	0	0	0	0	0
		Sum of Projected Water Supply Needs (acre-feet)	**-344**	**-563**	**-563**	**-563**	**-564**	**-563**

LIVE OAK COUNTY

WUG, Basin (RWPG)

All values are in acre-feet

Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
El Oso WSC, Nueces (N)							
Drought Management - El Oso WSC	DEMAND REDUCTION [Live Oak]	3	0	0	0	0	0
Gulf Coast Aquifer Supplies - Region N El Oso WSC	Gulf Coast Aquifer System [Bee]	15	20	20	20	0	0
Municipal Water Conservation - Region N El Oso WSC	DEMAND REDUCTION [Live Oak]	0	14	23	26	27	30
		18	**34**	**43**	**46**	**27**	**30**
George West, Nueces (N)							
Municipal Conservation - George West	DEMAND REDUCTION [Live Oak]	0	30	42	39	38	38
		0	**30**	**42**	**39**	**38**	**38**
Irrigation, Live Oak, Nueces (N)							
Gulf Coast Supplies - Live Oak Irrigation	Gulf Coast Aquifer System [Live Oak]	534	534	534	534	534	534
Irrigation Conservation - Live Oak County	DEMAND REDUCTION [Live Oak]	41	82	122	163	204	245
		575	**616**	**656**	**697**	**738**	**779**
Manufacturing, Live Oak, Nueces (N)							
Gulf Coast Supplies - Live Oak Manufacturing	Gulf Coast Aquifer System [Live Oak]	28	28	28	28	28	28
Manufacturing Water Conservation	DEMAND REDUCTION [Live Oak]	57	125	187	249	312	374
		85	**153**	**215**	**277**	**340**	**402**
Three Rivers, Nueces (N)							
Municipal Conservation - Three Rivers	DEMAND REDUCTION [Live Oak]	0	37	24	18	17	17
		0	**37**	**24**	**18**	**17**	**17**
Sum of Projected Water Management Strategies (acre-feet)		**678**	**870**	**980**	**1,077**	**1,160**	**1,266**