2023 GROUNDWATER MANAGEMENT PLAN

Goliad County Groundwater Conservation District

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GOLIAD COUNTY GROUNDWATER CONSERVATION DISTRICT
MANAGEMENT PLAN
2023

The Goliad County Groundwater Conservation District (GCGCD) was created in 2001 by authority of HB3651 of the 77th Texas Legislature. The District was created to serve a public use and benefit, and is essential to accomplish the objectives set forth in Section 59, Article XVI, of the Texas Constitution. The District's boundary is coextensive with the boundary of Goliad County and contains 551,040 acres of land with approximately 90 percent of the acreage being utilized as rangeland for livestock production. The District is bounded on the north by DeWitt County, on the east by Victoria County, on the south by Refugio County, and on the west by Bee and Karnes Counties.

DISTRICT MISSION

The mission of the GCGCD is to develop rules to provide for the protection, preservation, and conservation of groundwater, and to prevent waste of groundwater from the Gulf Coast Aquifer System to the extent of which the District has jurisdiction.

The District is committed to manage and protect the groundwater resources within its jurisdiction and to work with others to ensure a sustainable, adequate, high quality and cost-effective supply of water, now and in the future. The District strives to develop, promote, and implement water conservation and management strategies to protect water resources for the benefit of the citizens, economy, and environment of the District. The preservation of this most valuable resource is achieved in a prudent and cost-effective manner through conservation, education, management, and cooperation

STATEMENT OF GUIDING PRINCIPLES

Goliad and surrounding counties have a large agriculturally based rural community, which relies heavily on groundwater and exclusively on groundwater during periods of drought. Therefore, groundwater resources are of vital importance to the continued vitality of the citizens, economy, and environment within the District area.

The Goliad County groundwater supply comes from the Gulf Coast Aquifer System. It is imperative that the Gulf Coast Aquifer System be managed on a sustainable basis to protect the domestic and livestock supply wells in the County. These drinking water supply wells are the lifeblood for the County population and agricultural economy.

TIME PERIOD OF THIS PLAN

This District's groundwater management plan becomes effective immediately following adoption by the GCGCD Board of Directors and is approved as administratively complete by the Texas Water Development Board (TWDB). This plan will remain in effect for a period of five years or until a revised or amended plan may be approved, whichever comes first.

GROUNDWATER RESOURCES – GOLIAD COUNTY

The primary groundwater supply comes from the Evangeline component of the Gulf Coast Aquifer System. The Chicot component only exists in the southern 1/3 of the County and supplies this area. The Jasper and Burkeville components underly the Evangeline and Chicot components and currently do not provide a significant domestic and livestock supply.

GULF COAST AQUIFER SYSTEM OVERVIEW

The Gulf Coast Aquifer System forms a wide belt along the Gulf of Mexico from Florida to 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. Municipal and irrigation uses account for approximately 90 percent of the total pumpage from the aquifer. The aquifer consists of complex interbedded clays, silts, sands, and gravels of Cenozoic Era, which are hydrologically connected to form a large, leaky artesian aquifer system. This system comprises four major components consisting of the following generally recognized water-producing formations. The deepest is the Catahoula, which contains ground water near the outcrop in relatively restricted sand layers. Above the Catahoula is the Jasper Aquifer, primarily contained within the Oakville Sandstone. The Burkeville confining layer separates the Jasper from the overlying Evangeline Aquifer, which is contained within the Fleming and Goliad sands. The Chicot Aquifer, or upper component of the Gulf Coast Aquifer System, consists of the Lissie, Willis, Bentley, Montgomery, and Beaumont formations, and overlying alluvial deposits. Not all formations are present throughout the system, and nomenclature often differs from one end of the system to the other.

Water quality is generally good in the shallower portion of the Gulf Coast Aquifer System. From the San Antonio River Basin southwestward to Mexico, quality deterioration is evident in the form of increased chloride concentration and saltwater encroachment along the coast. Little of this ground water is suitable for prolonged irrigation due to either high salinity or alkalinity, or both. In several areas at or near the coast, including Galveston Island and the central and southern parts of Orange County, heavy municipal or industrial pump age had previously caused an updip migration, or saltwater intrusion, of poor-quality water into the aquifer. Recent reductions in pumpage here have resulted in stabilization and, in some cases, even improvement of ground-water quality. Years of heavy pumpage for municipal and manufacturing use in portions of the aquifer have resulted in areas of significant water-level decline. Declines of 200 feet to 300 feet have been measured in some areas of eastern and southeastern Harris and northern Galveston counties. Other areas of significant water-level declines include the Kingsville area in Kleberg County and portions of Jefferson, Orange, and Wharton counties. Some of these declines have resulted in compaction of dewatered clays and significant land surface subsidence. Subsidence is generally less than 0.5 foot over most of the Texas coast, but has been as much as nine feet in Harris and surrounding counties. As a result, structural damage and flooding have occurred in many low-lying areas along Galveston Bay in Baytown, Texas City, and Houston. Conversion to surface-water use in many of the problem areas has reversed the decline trend. The portion of the Gulf Coast Aquifer System in the Goliad County area contains generally good quality water. The aquifer depth ranges from approximately 450 feet in north Goliad County to approximately 1200 feet in south Goliad County. Reference: Baker, E.T., Jr., 1979, Stratigraphic and hydrologic framework of part of the Coastal Plain of Texas: TWDB Report 236. http://www.twdb.texas.gov/publications/reports/numbered_reports/doc/R236/Report236.asp

GROUNDWATER RECHARGE IN GOLIAD COUNTY

Groundwater recharge in Goliad County has become a very critical issue. Surface land use has changed significantly since the drought of the 1950s. Prior to the 1950s, much of the land use was for row crops such as cotton, corn, and milo. Since the 1950s, there has been a steady transition phasing out row crops to pasture land. This change in land use greatly changed the surface recharge characteristics. Land use for row crops provides for much greater opportunity for rainwater to percolate into the soil. Row crops are seasonal and so water use is less. With untilled pastures, there is a greater percentage of rainfall runoff and brush and the tree cover requires additional moisture and therefore higher transevaporation. The Development of an EDYS (Ecological DYnamics Simulation) Model for Goliad County, Texas brush management study validates this change in recharge. This EDYS model can be found on the District website at www.goliadcogcd.org.

GCGCD in conjunction with Texas Tech University (TTU) since 2018, has been recording surface soil moisture down to 10 feet. Four years of data has shown that only minimum amounts of moisture have occasionally been detected at the lower probes (see the District website http://www.goliadcogcd.org). Recharge values used in modeling the Central Gulf Coast Aquifer System may have been valid historically but are no longer valid.

GCGCD has an extensive water level monitoring program that has gathered data from approximately 60 wells since 2003. A steady decline of groundwater level has been recorded (see Appendix A).

The EDYS brush management study, the TTU soil moisture data, and the measured water level decline (Appendix A) recorded by GCGCD provides proof that very little, if any, recharge occurs in Goliad County. Only during a year with above average rainfall is there a possibility for some recharge.

Current modeling needs to take into consideration the scientific data that GCGCD has provided. Previous estimates of 0.25'' to 1'' per year presented by the Bureau of Economic Geology study for TWDB in 2011 and one percent of rainfall estimated recharge do not represent current scientific recharge data presented by GCGCD. Historic recharge values do not support the steady drop in groundwater levels recorded starting in 1980.

AMOUNT OF GROUNDWATER BEING USED WITHIN THE DISTRICT ANNUALLY

There are two sets of data provided for groundwater use. In Appendix B, TWDB Estimated Historic Water Use Survey (WUS) Data from 2004 through 2019 is shown. The TWDB Estimated Historic Water Use shows municipal use that includes the La Bahia, Fannin, and Berclair water supply corporations in Goliad County. In Appendix C, Documented Water Use data prepared by GCGCD is shown. Data provided by GCGCD is based on Historic Use Allocations on file, estimated exempt use, and permitted water use.

The 2022 regional water plan water demand projections for Goliad County from 2020 – 2070 are shown in Appendix D.

TWDB GROUNDWATER AVAILABLILITY MODEL (GAM) RUN 12-018 V2 DATA

Estimated annual amount of recharge from precipitation to the District is shown in Appendix E.

Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers is shown in Appendix E.

Estimated annual volume of flow into the District, out of the District, and estimated net volume of flow between each aquifer in the district, is shown in Appendix E.

GCGCD has reviewed the new draft GAM and has chosen not to use it when it becomes available. The GCGCD Board is using the water budget data from GAM Run 12-018 Version 2 (Appendix E). See Appendix F for a recalibrated model run done for GCGCD by LRE Water. This recalibrated model used a recharge value of zero and provides results that match GCGCD field data.

2022 TEXAS STATE WATER PLAN DATA

PROJECTED SURFACE WATER SUPPLIES 2020 – 2070 within the District is shown in Appendix G.

PROJECTED WATER DEMANDS 2020 – 2070 for water within the District is shown in Appendix G.

PROJECTED WATER SUPPLY NEEDS is shown in Appendix G.

The District has considered the projected water supply needs and water management strategies included in the adopted 2022 State Water Plan. For Goliad County, a water supply need exists for the Goliad Irrigation water user group (WUG). The projected need is 338 acre-feet for each of years 2020, 2030, 2040, 2050, 2060. 2070. There are no other needs in the county.

PROJECTED WATER MANAGEMENT STRATEGIES is shown in Appendix G.

For Goliad County the proposed water management strategy is demand reduction in the form of Goliad WUG municipal water conservation. Reduction in demand is projected to increase from 15 acre-feet in 2020 to 135 acre-feet in 2070.

GCGCD's HISTORIC WATER USAGE INFORMATION

GOLIAD COUNTY ESTIMATED HISTORIC MUNICIPAL AND DOMESTIC GROUNDWATER USE for 1980 – 2019 is shown in Appendix H. Groundwater use is based on total county population multiplied by 127 gallons per person per day. This value is used by Region L.

GOLIAD COUNTY ESTIMATED HISTORIC OIL, GAS, AND URANIUM GROUNDWATER USE for 2004 – 2019 is shown in Appendix H. Mining use is based on the number of oil and gas wells drilled multiplied by an average of five-acre feet per well. Water use reported by DCP Midstream at the Berclair oil and gas processing facility and Uranium Energy Corp in Goliad County are also included in total usage.

GOLIAD COUNTY HISTORIC USE ALLOCATIONS for domestic/municipal, industrial, livestock, wildlife, other, and irrigation use are shown in Appendix H.

In Appendix B, TWDB 2019 estimated historic use for irrigation is 3,872-acre feet per year. GCGCD anticipates this demand to continue to rise. 2020 and forward projected demand should be no less than use in 2019. Therefore, the projected water demands for irrigation from 2020 – 2070 should be at least 3,872-acre feet per year. In Appendix G, TWDB projected water demands for 2020 - 2070 irrigation is 2,839-acre feet.
For mining, In-Situ uranium mining is permitted at a site in the Guadalupe basin. The projected waste water disposal, which is contaminated groundwater, is 323-acre feet per year.

MANAGEMENT OF GROUNDWATER SUPPLIES

The district will manage and conserve the supply of groundwater within the District in order to maintain the economic viability of the District, county, and region. This will be done through coordination with and cooperation with Groundwater Conservation Districts in GMA 15.

A monitor well observation network is established to track any changes in water level or quality. The District will make a regular assessment of findings and report those findings to the public.
The District has adopted and will update 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 district rules.

GCGCD's water level monitoring program has been recording data since 2003. This program consists of approximately 60 unused wells that are measured one to two times annually. Results of these measurements are shown in Appendix A.

One permit for in-situ mining of uranium has been approved in Goliad County. Chapter 36 Texas Water Code does not address groundwater contamination and loss of supply associated with uranium exploration and mining.

A necessary ingredient in the management of groundwater supplies is an accurate identification of historic, current, and future use. GCGCD has determined that historic pumping has been greatly understated primarily for oil and gas exploration and for irrigation.

In 2018, GCGCD contracted Daniel B. Stephens and Associates to do an assessment of water levels, recharge, desired future conditions, and historic pumpage. This report dated February 26, 2018 continues to be very helpful to GCGCD in the management of groundwater supplies. See Appendix I for the report.

SURFACE WATER SUPPLIES

The San Antonio River runs through Goliad County. The only use of river water in the District is for irrigation. There is one major surface water lake in the District. Coleto Creek Reservoir is located at the boundary of Victoria and Goliad counties in the lower Guadalupe River Basin, and is a cooling reservoir for steam electric power generation. This constructed reservoir supplies water for steam-electric power generation at Coleto Creek Power Station located in Goliad County. Because the predominant agriculture product is the raising of livestock, there are numerous stock tanks located within the District. These stock tanks provide surface water for livestock and wildlife consumption and provide some aquifer recharge. Many of these stock tanks go dry during drought periods requiring additional pumping of groundwater. The District has participated in two programs with USGS and others to qualify and quantify interface between the Gulf Coast Aquifer System and the San Antonio River and between the Gulf Coast Aquifer System and the Coleto Creek Basin. Both studies concluded that the Aquifer provides a gaining stream to the two listed surface streams. The reports of these two studies can be accessed at www.goliadcogcd.org.

REGIONAL (L) WATER PLAN

As required by Texas Water Code Chapter 36.1071(b) this management plan and any amendments thereon shall be considered in the development of the regional water plan. Considering this local management plan will meet the intent of Senate Bill #1 and therefore, result in a regional management plan, which is consistent with this local management plan, resulting in the protection of the local control of groundwater management by the local people who elected the Board of Directors to manage the District.

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 of priority for District activities. Operations of the District, agreements entered into by the District and planning efforts in which the District may participate will be consistent with the provisions of this plan. A copy of the Rules of Goliad County Groundwater Conservation District may be found at www.goliadcogcd.org.

The District will update and adopt rules relating to the permitting of wells and the production of groundwater. The rules adopted by the District shall be pursuant to the 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 District shall treat all citizens with equality. Citizens may apply to the District for discretion in enforcement of the rules on grounds of adverse economic effect or unique local conditions. In granting of

discretion to any rule, the Board shall consider the potential for adverse effect on adjacent landowners. The exercise of said discretion by the Board shall not be construed as limiting the power of the Board.

The District may amend the District rules as necessary to comply with changes to Chapter 36 of the Texas Water Code and to insure the best management practices of the groundwater in the District. The implementation of the rules of the District will be based on the best available scientific and technical data, and on fair and reasonable evaluation.

The District has encouraged and will continue to encourage public cooperation in the continued implementation of the management plan for the District.

ESTABLISHMENT OF DESIRED FUTURE CONDITIONS (DFC) AND ESTIMATE OF THE MODELED AVAILABLE GROUNDWATER

The district is a member of groundwater management area 15 (GMA 15) composed wholly or in part of 14 groundwater districts. On October 14, 2021, GMA 15 members adopted the desired future conditions (DFC) to manage the groundwater resource in such a way as to achieve no more than 13 feet of average drawdown in the Gulf Coast Aquifer System in 2080 within the GMA 15 boundary relative to model grid file dated June 26, 2020 conditions based on results presented in Groundwater Availability Model (GAM) Run 21-020 Modeled Available Groundwater (MAG) (Appendix J). The GMA 15 Resolution, Transmittal Letter, and Explanatory Report are included in Appendix K.

For the District, the modeled drawdown is:
Chicot: 4ft rise +/-17ft
Evangeline: 2ft rise +/- 36ft
Burkeville: 7ft decline +/-14ft
Jasper: 14ft decline +/- 7ft
The modeled available groundwater is 6,972-acre feet in 2080.

METHODOLOGY FOR TRACKING DISTRICT PROGRESS IN ACHIEVING MANAGEMENT GOALS

A Performance Review is prepared annually by the general manager and staff of the District. The annual Performance Review covers the activities of the District including information on the District's performance in regards to achieving management goals and objectives. The presentation of the report occurs during a monthly Board meeting in the first quarter of the next fiscal year beginning October 1, 2022. 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. Each activity will be referenced to the estimated expenditure of staff time and budget in accomplishment of the activity. The notations of activity frequency, staff time and budget will be referenced to the appropriate performance standard for each management objective describing the activity, so that the effectiveness and efficiency of the District's operations may be evaluated. The Board will maintain the report on file, for public inspection at the District's offices upon adoption and on the District website at www.goliadcogcd.org.

GOAL 1.0
PROVIDING THE MOST EFFICIENT USE OF GROUNDWATER

Management Objective - The District maintains an aquifer water level program monitoring a minimum of 50 wells in the District annually.
Performance Standard - The District includes water level monitoring data on its website and in the Annual Performance Review Report.

Management Objective - The District will continue to require the registration and location of all new and replacement wells drilled within the boundary of the District.
Performance Standard - The number of wells drilled each year will be included in the Performance Review. The wells are to be reported by category as replacement, new exempt, and new permitted.

GOAL 2.0
CONTROLLING AND PREVENTING WASTE OF GROUNDWATER

Management Objective - Each year, the District will sample the water quality in at least five (5) selected wells in order to monitor water quality trends and identify if contamination of groundwater is occurring. The District will also make available to well owners a service for well water quality analysis, to be paid for by the well owner.
Performance Standard – 1. Annual report of wells sampled for water quality by the District. 2. Annual report of wells sampled by the District upon request.
Management Objective - When processing an application for a production permit, the District will evaluate and recommend selection of efficient pumping and distribution equipment. For process applications, the District will evaluate reprocessing and recovery options.
Performance Standard - Recommendations will be included in the approved application.

GOAL 3.0
CONTROLLING AND PREVENTING SUBSIDENCE

The GCGCD has reviewed the TWDB subsidence risk report that can be found at http://www.twdb.texas.gov/groundwater/models/research/subsidence/subsidence.asp. This report is the best available science on the matter of subsidence in Texas. According to Figure 4.23 of the subsidence report, Goliad County is in the medium risk category trending slightly higher in the northern part of the county. As shown in Figure 4.22, clay thickness trends higher in the northern part of the county which is consistent with the report that lower clay thickness provides a lower risk for subsidence. The GCGCD will work diligently to review signs of subsidence and will respond to any signs or reports of potential subsidence. GCGCD has not physically observed any subsidence. This goal is not applicable to the District.

GOAL 4.0
ADDRESSING CONJUNCTIVE SURFACE WATER MANAGEMENT ISSUES

Management Objectives - Each year the District will participate in the regional water planning process by attending at least one meeting of Region L Planning Group where we will encourage the development of surface water supplies to meet the needs of WUGs in the district.
Performance Standard – The district will, in each annual report, document the participation of district representation in Region L meetings and the number of meetings where GCGCD participated.

GOAL 5.0
ADDRESSING NATURAL RESOURCE ISSUES THAT IMPACT THE USE AND AVAILABILITY OF GROUNDWATER AND WHICH ARE IMPACTED BY THE USE OF GROUNDWATER

Management Objectives - Each year the District will locate all of the wells drilled that year for compliance of well spacing including minimum distance from septic systems or other defined potential contamination.
Performance Standard - The District will include in the Performance Review a record of any deficiencies found and the corrective action that was taken.

GOAL 6.0
ADDRESSING DROUGHT CONDITIONS

Management Objectives - Semiannually the District will update the rainfall values for the District for the previous six months.
Performance Standard - The District will issue one report semiannually, listing the rainfall values for the county. This report will be entered on the District website and included in the Performance Review. The following link has much useful information and includes links to major drought reporting websites: https://waterdatafortexas.org/drought

GOAL 7.0
ADDRESSING CONSERVATION, RECHARGE ENHANCEMENT, RAINWATER HARVESTING, PRECIPITATION ENHANCEMENT AND BRUSH CONTROL

CONSERVATION
Management Objective - The District will at least on two occasions each year provide public information on water conservation and waste prevention through presentations at public schools, civic organizations, newspaper articles, or articles posted on the District website.
Performance Standard - The District will report the number of speaking appearances made by the District each year and the number of newspaper articles published in the local newspaper and on the District website each year addressing conservation.

RECHARGE ENHANCEMENT
Management Objective - The District recommends that the most efficient method for increasing recharge is continued brush and weed control.
Performance Standard - See "Brush Control" Goal.

RAINWATER HARVESTING
Management Objectives - The District will continually provide current information on rainwater harvesting on both the District web site and through literature in the office.
Performance Standard - The District will include the number of persons receiving literature from the office on rainwater harvesting and report any known District application in the annual Performance Review.

PRECIPITATION ENHANCEMENT
The District has evaluated a precipitation enhancement program and has determined that it is not appropriate or cost effective. Therefore, the District has determined that a precipitation enhancement goal is not applicable at this time.

BRUSH CONTROL
Management Objective - Brush control is extensively practiced in the county and the practice is encouraged by the Farm Service Agency Program and the GCGCD. The District will continually support an educational program to inform the stakeholders of the benefits of controlling brush on their property. The educational program will consist of current information on brush control available on both the District web site and through literature in the office.
Performance Standard – GCGCD initiated a soil moisture measurement program with Texas Tech University (TTU) in 2018. The results of this ongoing study are published on the district website. This study has shown that the presence of brush greatly reduces the possibility of recharge. The results of this study are available on the GCGCD website: http://www.goliadcoged.org/.

GOAL 8.0
ADDRESSING THE DESIRED FUTURE CONDITIONS (DFC)

Management Objective - At the end of each fiscal year, the District will prepare an updated data sheet of the estimated total groundwater use in the District for the past year. The District Board of Directors will review the total groundwater use data along with the water level data from Goal 1 and make an evaluation of the current status in reference to the drawdown and the modeled water availability determined by the current DFC.

The District will maintain annual water level data in spread sheet and graphic form and do an annual assessment of this data to track results in relation to achieving the desired future conditions.

Performance Standard – The District's annual report will include the water level measurements taken each year to assess the District's progress towards achieving its desired future conditions. The District will include a discussion of current water levels to historic data in order to track its progress in achieving its desired future conditions. A review of existing rules will be included to determine if changes need to be considered.

Goliad County Groundwater Conservation District Management Plan Appendices

Appendix A -	Water Level Monitoring Data 2003-2022: Goliad County Groundwater Conservation District
Appendix B -	TWDB Estimated Historical Water Use Survey (WUS) Data
Appendix C -	2011-2021 Documented Water Use: Goliad County Groundwater Conservation District
Appendix D -	2022 Region L Water Plan, Goliad County Water Demand Projections 2020-2070
Appendix E -	GAM Run 12-018 (Version 2): Goliad County Groundwater Conservation District Management Plan
Appendix F -	GCGCD's and LRE's Comments on New Model and Recalibrated Model Report
Appendix G -	2022 State Water Plan Data sets
Appendix H -	GCGCD's Historic Water Use: Goliad County Estimated Historic Municipal and Domestic Groundwater Use; Estimated Historic Oil, Gas, and Uranium Groundwater Use; and Historic Use Allocations
Appendix I -	Daniel B. Stephens and Associates, Inc. Memorandum 2018 Report on Recharge, DFCs, Pumpage
Appendix J -	Gam Run 21-020 MAG: Modeled Available Groundwater
Appendix K -	GMA 15 Resolution, Transmittal Letter and Explanatory Report
Appendix L -	Administrative Items

APPENDIX A

Water Level Monitoring Data 2003-2022: Goliad County Groundwater Conservation District

2022 Water Level Monitoring Update

Landowners Name	Tag #	Latitude	Longitude	First Date Measured	Water Level	Last Date Measured	Water Level	Water Level Difference
Elder Abrameit	1	28.8286	-97.44103	4/29/2003	99.75	10/24/2022	112.9	-13.15
Art Dohmann	4	28.79782	-97.42313	4/29/2003	121.10	10/24/2022	134.53	-13.43
Allan Dohmann	6	28.841667	-97.424467	4/29/2003	36.75	10/24/2022	56.1	-19.35
Art Dohmann	7	28.8439	-97.43169	4/29/2003	10.10	10/24/2022	18.73	-8.63
Art Dohmann	8	28.84389	-97.43167	4/29/2003	51.20	10/24/2022	52.35	-1.15
Janet Tumlinson	11	28.77465	-97.21466	11/11/2003	49.7	11/15/2022	53.8	-4.10
Christi Rushing	12	28.81313	-97.23324	11/11/2003	79.8	11/15/2022	78.45	1.35
Wexford Cattle Co.	13	28 29.857	97 19.151	5/2/2003	29.50	11/9/2022	38.4	-8.90
Wexford Cattle Co.	14	28.47385	-97.273667	5/2/2003	18.40	11/9/2022	24	-5.60
Wexford Cattle Co.	15	28.469933	-97.3120833	5/2/2003	25.20	1/9/2022	30.08	-4.88
David Wright	16	28.721133	-97.31355	2/27/2003	52.98	11/15/2022	61.6	-8.62
Margie Dreier	17	28.694067	-97.32505	2/27/2003	52.58	11/15/2022	60.1	-7.52
Keith Lemke	21	28.92248	-97.40919	6/6/2003	9.20	10/27/2022	20.7	-11.50
Mance Cutbirth	24	28.7703	-97.418967	12/9/2008	83.8	11/3/2022	94.45	-10.65
Wexford Cattle Co.	26	28.5618	-97.2045833	5/2/2003	36.40	11/9/2022	39.78	-3.38
Jim Worley	28	28.85705	-97.45466	2/24/2003	63.60	10/24/2022	80.25	-16.65
Ronnie Roberts	33	28.4009166	-97.37433	3/9/2004	12psi/15"	5/5/2022	1 gallon/ 8 minutes	n/a
Robert Smith	34	28.40253	-97.39197	3/9/2004	35.15	12/7/2022	37.2	-2.05
Robert Smith	35	28.40202	-97.38967	3/9/2004	20.1	12/7/2022	29.73	-9.63
Robert Smith	36	28.40225	-97.38945	3/9/2004	trickle	12/7/2022	NOT FLOWING	n/a
Robert Smith	37	28.40751	-97.3892	3/9/2004	flowing in hose	5/5/2022	1.0 gal/min	n/a
Ben Parma	40	28.89363	-97.37844	11/8/2004	39.66	10/27/2022	52.58	-12.92
Ben Parma	41	28.89565	-97.37772	11/8/2004	13.62	10/27/2022	27.5	-13.88
Mary Jean Valdez	42	28.8944	-97.38151	6/16/2003	32.60	10/27/2022	53.15	-20.55
Diebel Family Trust	43	28.85033	-97.51233	1/15/2005	72.95	11/4/2022	89.05	-16.10
Beverly Neal	45	28.752717	-97.530467	3/20/2006	137.8	5/25/2022	148.71	-10.91
Joe Poses	46	28.40538	-97.36906	10/29/2008	34.7	5/5/2022	33.01	1.69
Dye Estate	50	28.765564	-97.43933	10/8/2008	53.75	11/3/2022	67.77	-14.02

2022 Water Level Monitoring Update

Landowners Name	Tag #	Latitude	Longitude	First Date Measured	Water Level	Last Date Measured	Water Level	Water Level Difference
Mai Joy Harwell	53	28.848167	-97.44167	11/9/2004	43.8	10/24/2022	59.63	-15.83
Leon Dohmann	57	28.82917	-97.41264	4/14/2005	83.72	9/6/2022	99.55	-15.83
B. H. Billo	61	28.827833	-97.43015	10/21/2008	87.55	11/3/2022	101.45	-13.90
Dye Estate	62	28.76425	-97.43395	12/9/2008	72.75	11/3/2022	85.09	-12.34
Felton Dohmann	63	28.86225	-97.475633	4/14/2005	51.4	11/4/2022	72.55	-21.15
Louis Willeke	73	28.59194	-97.62675	12/27/2007	63	11/17/2022	91.5	-28.50
Dye Estate	74	28.76361	-97.43091	12/9/2008	67.45	11/3/2022	80.87	-13.42
Pam Christopher	75	28.765483	-97.429067	12/9/2008	92.35	11/3/2022	106.47	-14.12
Louis Willeke	76	28.76748	-97.43389	12/9/2008	86.15	11/3/2022	99.45	-13.30
Christopher W. W.	77	28.769383	-97.431967	12/9/2008	64.2	11/3/2022	77.17	-12.97
Ronnie Roberts	90	28.39864	-97.37049	10/29/2008	23	12/7/2022	27	-4.00
Dye Estate	91	28.76734	-97.43934	12/9/2008	32.6	11/3/2022	45.77	-13.17
Wexford Cattle Co.	96	28.49533	-97.24523	9/2/2004	17.55	11/9/2022	25.05	-7.50
James & Helen Friedel	99	28.8694	-97.42175	8/9/2005	59.4	10/27/2022	75.4	-16.00
Louis Willeke	100	28.76806	-97.43671	10/12/2008	84.33	11/3/2022	96.05	-11.72
Bob Gayle	104	28.59306	-97.50164	10/5/2006	90.65	11/17/2022	79.8	10.85
Richard Ball	105	28.59323	-97.5108	10/5/2006	79.4	5/26/2022	90.46	-11.06
Raymond Arnold	107	28.88629	-97.36115	2/27/2007	51.55	10/27/2022	68.98	-17.43
Ty Luddeke.	108	28.89046	-97.37759	2/27/2007	59.8	10/27/2022	69.15	-9.35
Rachel Dang	110	28.88572	-97.38656	10/9/2008	75.6	10/27/2022	81.8	-6.20
Craig Duderstadt	111	28.875467	-97.35189	10/5/2006	63.2	10/27/2022	69.5	-6.30
Pamela Christopher	117	28.77197	-97.42549	1/10/2007	70	11/3/2022	83.05	-13.05
Nick Arredondo	122	28.40632	-97.37969	11/19/2009	38.65	5/5/2022	39.29	-0.64
Nick Arredondo	123	28.40564	-97.38155	11/19/2009	46.4	5/5/2022	42.87	3.53
Larry Sisson.	124	28.84025	-97.30061	4/2/2009	43.6	11/15/2022	49.95	-6.35
Art Dohmann	125	28.84349	-97.42737	8/22/2003	10.35	10/25/2022	16.32	-5.97
Wexford Cattle Co.	136	28.52155	-97.24815	5/31/2011	21.5	11/9/2022	23.65	-2.15
Wexford Cattle Co.	137	28.495867	-97.28285	5/31/2011	28.55	11/9/2022	32.28	-3.73
Ty Luddeke	149	28.88756	-97.38267	10/23/2013	71.87	10/27/2022	72.6	-0.73
Richard Ball	151	28.60014	-97.50979	10/25/2007	107	11/17/2022	110.95	-3.95

2022 Water Level Monitoring Update

Landowners Name	Tag #	Latitude	Longitude	First Date Measured	Water Level	Last Date Measured	Water Level	Water Level Difference
Wexford Cattle Co.	152	28.495	-97.26528	10/31/2017	24.54	11/9/2022	25.83	-1.29
William Niemeier	154	28.77557	-97.61128	6/2/2017	60.1	11/17/2022	61.5	-1.40
Clayton Mayfield	156	28.79712	-97.52303	6/8/2018	95.21	11/17/2022	99.47	-4.26
James Fuller	157	28.66568	-97.60749	5/31/2018	64.04	11/8/2022	64.84	-0.80
Jack E. Crow	158	28.59639	-97.30466	6/7/2018	45.21	11/9/2022	46.32	-1.11
Chris Ulrich	159	28.60563	-97.25192	6/7/2018	41.59	11/9/2022	46.3	-4.71
James Fuller	160	28.65413	-97.61958	5/31/2018	93.87	11/8/2022	88.74	5.13
David Bruns	161	28.72972	-97.37667	7/20/2018	73.94	11/15/2022	75.47	-1.53
Barnhart Family Partnership LTD	162	28.61752	-97.67316	11/30/2018	92.22	11/17/2022	91.87	0.35
Art Dohmann	163	28.79358	-97.42259	5/1/2019	127.95	11/3/2022	143.1	-15.15
Michael Warzecha	164	28.85757	-97.34165	7/9/2019	36.28	11/15/2022	38.6	-2.32
Cash Fortenberry Trust	165	28.72311	-97.52927	7/16/2019	70.56	11/17/2022	73.96	-3.40
Carl Hummel	166	28.68209	-97.75119	7/16/2019	117.64	11/17/2022	119.7	-2.06
Cuervo Ranch Holdings LTD	168	28.5879	-97.40881	8/1/2019	79.95	6/1/2022	86.32	-6.37
Cuervo Ranch Holdings LTD	170	28.68317	-97.26259	8/1/2019	61.46	5/31/2022	69.80	-8.34
Georgia Lee Swickheimer	171	28.63999	-97.22363	4/28/2020	38.31	11/15/2022	43.09	-4.78
Rajesh Bhakta	172	28.67832	-97.38757	5/28/2020	72.49	11/15/2022	75.18	-2.69
Gentry Powell	173	28.70109	-97.67577	11/23/2020	58.9	11/17/2022	59.64	-0.74
JSDSED LLC	174	28.83111	-97.44306	12/14/2020	127.42	10/24/2022	128.9	-1.48

APPENDIX B

TWDB Estimated Historical Water use Survey (WUS) Data

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

Groundwater and surface water historical use estimates are currently unavailable for calendar year 2020. TWDB staff anticipates the calculation and posting of these estimates at a later date.

GOLIAD COUNTY

100% (multiplier)

All values are in acre-feet

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2019	GW	769	0	0	191	3,872	589	5,421
	SW	0	0	0	4,803	58	147	5,008
2018	GW	773	0	2	178	3,599	589	5,141
	SW	0	0	0	1,383	63	147	1,593
2017	GW	786	0	2	163	3,835	566	5,352
	SW	0	0	0	1,337	75	142	1,554
2016	GW	797	0	1	153	2,506	610	4,067
	SW	0	0	0	1,111	0	153	1,264
2015	GW	824	0	0	159	3,057	598	4,638
	SW	0	0	0	25	0	150	175
2014	GW	943	0	0	171	2,770	587	4,471
	SW	0	0	0	495	96	147	738
2013	GW	945	0	11	177	2,785	592	4,510
	SW	0	0	1	1,595	158	148	1,902
2012	GW	970	0	0	193	2,884	637	4,684
	SW	0	0	0	1,670	127	160	1,957
2011	GW	1,043	0	0	166	3,436	772	5,417
	SW	0	0	0	1,086	0	193	1,279
2010	GW	912	0	41	189	1,937	775	3,854
	SW	0	1	8	1,069	0	193	1,271
2009	GW	919	0	43	285	2,454	870	4,571
	SW	0	1	8	1,569	0	218	1,796
2008	GW	833	0	46	399	2,257	802	4,337
	SW	0	1	8	1,471	0	201	1,681
2007	GW	731	1	0	174	1,065	911	2,882
	SW	0	0	0	1,481	0	228	1,709
2006	GW	854	1	0	1,197	2,176	1,045	5,273
	SW	0	0	0	1,476	0	261	1,737
2005	GW	804	1	0	134	2,539	885	4,363
	SW	0	0	0	1,570	0	222	1,792
2004	GW	768	0	0	2,154	1,585	40	4,547
	SW	0	0	0	1,540	0	1,100	2,640

APPENDIX C

2011-2021 Documented Water Use: Goliad County Groundwater Conservation District

2011-2021 Goliad County Historic Use Allocations						
Year	Municipal	Mining	Power	Irrigation	Livestock	Totals
2011	1,024	171	166	2,506	971	4,816
2012	1,041	149	193	3,006	591	4,958
2013	1,058	96	177	3,002	534	4,845
2014	1,066	172	171	3,006	635	5,028
2015	1,066	121	159	3,084	744	5,074
2016	1,100	96	165	3,162	786	5,131
2017	1,074	71	162	3,318	778	5,069
2018	1,074	75	311	3,350	990	5,800
2019	1,074	95	311	3,350	997	5,827
2020	722	21	311	2,548	998	4,734
2021	704	21	311	2,312	826	4,281

APPENDIX D

2022 Region L Water Plan, Goliad County Water Demand Projections 2020-2070

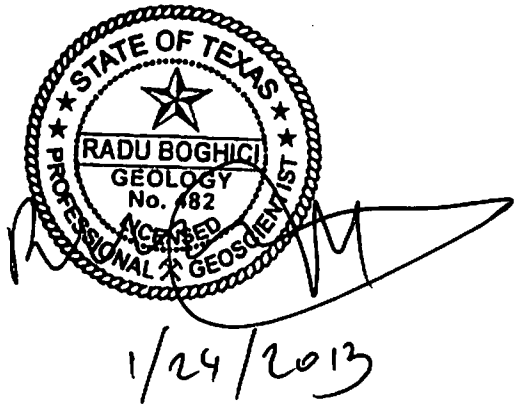
2022 Regional Water Plan Water Demand Projections by County for 2020-2070 in Acre-Feet							
County	WUG Type	2020	2030	2040	2050	2060	2070
GOLIAD	IRRIGATION	2839	2839	2839	2839	2839	2839
GOLIAD	LIVESTOCK	841	841	841	841	841	841
GOLIAD	MANUFACTURING	1	1	1	1	1	1
GOLIAD	MINING	450	450	450	450	450	450
GOLIAD	MUNICIPAL	1211	1324	1395	1423	1449	1466
GOLIAD	STEAM ELECTRIC POWER	1863	1863	1863	1863	1863	1863
Goliad Total		7205	7318	7389	7417	7443	7460

APPENDIX E

GAM Run 12-108 (Version 2): Goliad County Groundwater Conservation District Management Plan

GAM RUN 12-018 (VERSION 2): GOLIAD COUNTY GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN

by Radu Boghici
Texas Water Development Board
Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 463-5808
January 24, 2013



The seal appearing on this document was authorized by Radu Boghici, P.G. 482 on January 24, 2013.

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GAM RUN 12-018 (VERSION 2): GOLIAD COUNTY GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN

by Radu Boghici
Texas Water Development Board
Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 463-5808
January 24, 2013

EXECUTIVE SUMMARY:

Texas State Water Code, Section 36.1071, Subsection (h), 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. Information derived from groundwater availability models that shall be included in the groundwater management plan includes:

- the annual amount of recharge from precipitation to the groundwater resources within the district, if any;
- 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
- the annual volume of flow into and out of the district within each aquifer and between aquifers in the district.

This report is a revision to the GAM Run 12-018 report dated November 30, 2012. We have included an updated water budget to fulfill the requirements noted above (Table 1) and an addendum requested by the district on December 18, 2012. GAM Run 12-018 (Version 2) is Part 2 of a two-part package of information from the TWDB to Goliad County Groundwater Conservation District management plan to fulfill the requirements noted above. The groundwater management plan for the Goliad Groundwater Conservation District is due for approval by the executive administrator of the TWDB before November 14, 2013.

This report discusses the method, assumptions, and results from model runs using the groundwater availability model for the central portion of the Gulf Coast. Table 1 summarizes the groundwater availability model data required by the statute, and Figure 1 shows the area of the model from which the values in the table was extracted. This model run replaces the results of GAM Run 12-018. GAM Run 12-018 (Version 2) meets current standards. If after review of the figure, Goliad County Groundwater Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the Texas Water Development Board immediately. The TWDB has also approved, for planning purposes, alternative models that can have water budget information extracted for the district. These alternative models include the Groundwater Management Area 16 model and the fully penetrating alternative model for the central portion of the Gulf Coast. Please contact the author of this report if a comparison report using these models is desired.

METHODS:

In accordance with the provisions of the Texas State Water Code, Section 36.1071, Subsection (h), the groundwater availability model for the central portion of the Gulf Coast Aquifer was run for this analysis. Goliad County Water budgets for 1981 through 1999 were extracted using ZONEBUDGET Version 3.01 (Harbaugh, 2009) The average annual water budget values for recharge, surface water outflow, inflow to the district, outflow from the district, net inter-aquifer flow (upper), and net inter-aquifer flow (lower) for the portions of the aquifers located within the district are summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Gulf Coast Aquifer

- Version 1.01 of the groundwater availability model for the central portion of the Gulf Coast Aquifer was used 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 section of the Gulf Coast Aquifer assumes partially penetrating wells in the Evangeline Aquifer due to a lack of data for aquifer properties in the lower section of the aquifer.
- This groundwater availability model includes four layers, which generally correspond to (from top to bottom):

1. the Chicot Aquifer,
2. the Evangeline Aquifer,
3. the Burkeville Confining Unit, and
4. the Jasper Aquifer including parts of the Catahoula Formation.

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 duration of the calibration and verification portion of the model runs in the district, as shown in Table 1. The components of the modified budget shown in Table 1 include:

- 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.
- Surface water outflow—The total water discharging from the aquifer (outflow) to surface water features such as streams, reservoirs, and drains (springs).
- Flow into and out of district—The lateral flow within the aquifer between the district and adjacent counties.
- Flow between aquifers—The net vertical flow between aquifers or confining units. This flow is controlled by the relative water levels in each aquifer or confining unit and aquifer properties of each aquifer or confining unit that define the amount of leakage that occurs. "Inflow" to an aquifer from an overlying or underlying aquifer will always equal the "Outflow" from the other aquifer.

The information needed for the District's management plan is summarized in Table 1. In addition, we have provided a detailed water budget that averages the Gulf Coast Aquifer inflows and outflows for Goliad County by each model layer from 1981 to 1999 (Addendum, Table 2). 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 (Figure 1).

TABLE 1: SUMMARIZED INFORMATION FOR THE GULF COAST AQUIFER THAT IS NEEDED FOR GOLIAD COUNTY GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT. THESE FLOWS MAY INCLUDE BRACKISH WATERS.

Management Plan requirement	*Aquifer or confining unit*	*Results*
Estimated annual amount of recharge from precipitation to the district	Gulf Coast Aquifer	16,603
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	21,645
Estimated annual volume of flow into the district within each aquifer in the district	Gulf Coast Aquifer	4,665
Estimated annual volume of flow out of the district within each aquifer in the district	Gulf Coast Aquifer	14,872
Estimated net annual volume of flow between each aquifer in the district	Not Applicable	Not Applicable

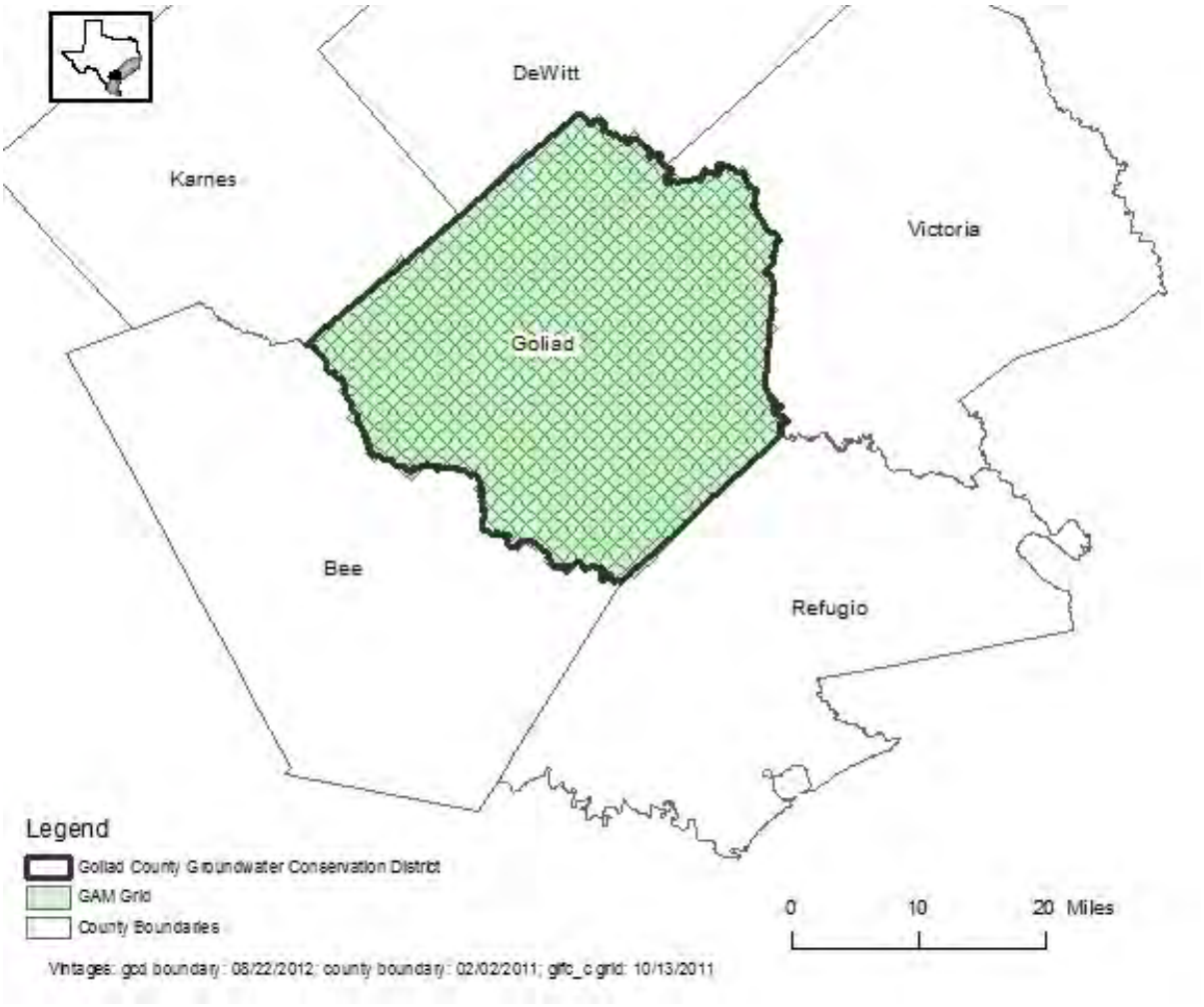


FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE CENTRAL PORTION OF THE GULF COAST AQUIFER FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE GULF COAST AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

LIMITATIONS

The groundwater model(s) used in completing this analysis is the best available scientific tool that can be used to meet the stated objective(s). 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 model 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.

GAM Run 12-018 Addendum

TABLE 2. GROUNDWATER FLOW BUDGET FOR EACH AQUIFER, INTO AND OUT OF, GOLIAD GROUNDWATER CONSERVATION DISTRICT, IN THE GROUNDWATER AVAILABLILITY MODEL OF THE CENTRAL PART OF THE GULF COAST AQUIFER. FLOWS ARE IN ACRE-FEET PER YEAR. VALUES HAVE BEEN ROUNDED TO WHOLE NUMBERS.

	Central Gulf Coast GAM 1981-99				
	Chicot	Evangeline	Burkeville	Jasper	**Total Gulf Coast Aquifer**
Inflow					
Lakes	1,510	0	0	0	**1,510**
Recharge	9,440	7,163	0	0	**16,603**
Streams/Rivers	1,935	11,879	0	0	**13,815**
Vertical Leakage Upper	0	1,430	285	290	**-**
Vertical Leakage Lower	666	575	440	0	**-**
Lateral Flow	684	3,375	39	565	**4,665**
Total Inflow	14,235	24,422	764	855	**36,593**
Outflow					
Wells	122	1,068	0	0	**1,191**
Springs	11	1	0	0	**13**
Evapotranspiration	706	74	0	0	**780**
Streams/Rivers	8,153	13,479	0	0	**21,632**
Vertical Leakage Upper	0	666	575	440	**-**
Vertical Leakage Lower	1,430	285	290	0	**-**
Lateral Flow	4,438	9,722	57	656	**14,872**
Total Outflow	14,860	25,295	922	1,096	**38,488**
Inflow - Outflow	-625	-873	-158	-241	**-1,895**
Storage Change	-626	-873	-155	-241	**-1,896**
Model Error	1	0	-3	0	**1**
Model Error (percent)	0.01%	0.00%	0.31%	0.00%	**0.00%**

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.

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.

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.

Tu, K., 2008, GAM Run 08-09: Texas Water Development Board, GAM Run 08-09 Report, 7 p., http://www.twdb.texas.gov/groundwater/docs/GAMruns/GR08-09.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.

APPENDIX F

GCGCD's and LRE's Comment on New Model and Recalibrated Model Report

GOLIAD COUNTY GROUNDWATER CONSERVATION DISTRICT
118 S. Market St., P.O. Box 562, Goliad, Texas 77963-0562
Telephone: (361) 645-1716 Facsimile: (361) 645-1772
website: www.goliadcogcd.org | email: gcgcd@goliadgcd.org

July 23, 2022

Texas Water Development Board
Attn: Groundwater Modeling
Daryn Hardwick, Ph.D.
1700 North Congress Avenue
P.O. Box 13231
Austin, Texas 78711-3231

RE: Goliad County Groundwater Conservation District (GCGCD) comments on the new TWDB GAM for GMA-15 & 16.

GCGCD staff and consultants worked with Dr. Shi and others at the TWDB for months providing comments and corrected data for the new GAM. Upon release of the new GAM, GCGCD contracted with LRE Water to run the new GAM on its water level monitor wells. Their comments are attached. Despite the TWDB's and GCGCD's best efforts, the new GAM gives a similar rising water level trend as the old GAM in Goliad County. Unless the new GAM is corrected, it is of no value in the management and planning of groundwater in Goliad County by the GCGCD.

The new GAM covers the area of GMA-15 & 16. It is considered a Regional GAM. Is it possible to model a large area as this and accurately model what is occurring in Goliad County? If this is not feasible and doable, then TWDB and GCDs should use local data and localized models that accurately represent what is occurring in that GCD and is usable to manage groundwater and to set a practical DFCs and associated MAGs. This direction must be provided early to provide an efficient plan by the GMAs.

The new GAM was developed using base data from 1980 to 2015. There was a gradual increase in groundwater pumping in Goliad County during those years primarily due to a steady slow increase in population and additional irrigation installations with a resulting steady decrease in water level. In contrast, there were significant changes in groundwater use in both the updip and downdip counties.

In the downdip counties, in earlier records going back to the 1950's, there was substantial municipal and irrigation use of groundwater. Over the years, irrigation use of groundwater has decreased substantially with the decrease of rice production being one major component. Cities such as Victoria and Port Lavaca have converted from groundwater to river water. One example is a City of Victoria well that measured at 82 foot level in 1958 and had a drawdown to 150 feet in 1992. With the reduction of

irrigation and the conversion to river water by cities, the downdip Counties to Goliad County are in a groundwater rising (recovery) mode.

In the updip counties, Eagleford Shale production started around 2010 and has been a large new user of groundwater. There are many large, lined reservoirs in evidence to support this large increase in groundwater use. There also have been many service calls for well pump lowering and new wells. A well belonging to a director of Evergreen UWCD went dry prompting Evergreen to curtail pumping from the Gulf Coast Aquifer for hydraulic fracturing in the area. Not only has groundwater usage increased for hydraulic fracturing in Karnes and Dewitt County, but it has also increased due to a large increase in temporary workers in those counties. The pumping numbers in Appendices C and D (water budget) of the Numerical Model Report do not reflect these increases. This causes ground water flowing into Goliad County to be higher than what it is.

In Goliad County pumping in the model does not fit amount of pumping that is occurring at a given location. For instance, Well # 7913501 undergoes an order of magnitude increase in pump from 4,979 to 37,589 cubic feet per day between 2002 and 2003. Then pumping increases to 60,639 cubic feet per day (508 acre-feet per year) in 2015. A single well in the model represents one sixth of the documented irrigation pumping in Goliad County in 2015. It is unlikely the above well has been used this century and is likely no longer in use. Modeled pumping for Well # 7919302 is from 18780 to 74192 cubic feet per day (157 to 622 acre feet per year respectively). This was an oil exploration well that was modified to water production. There isn't any data that this well was ever used. Modeled pumping for Well # 7923401 is from 14642 to 15351 cubic feet per day (123 to 129 acre feet per year respectively). This is the Fannin Battle Ground State Historic Site. It is a 13 acre site according to the Texas Historical Commission. Irrigating the whole site with 2 feet per year would only be 26 acre feet per year. In order for the modeled pumping to be correct around 100 acre feet of water would be used for restrooms, cleaning, etc. This well was a windmill that has not be used since 1967. The well that replaced it is deeper. For a model to be accurate on the local level it must in some degree match local conditions. For example, Well # 7921601 is a City of Goliad Well. The modeled pumping drops from 167,377 cubic feet per day in 2008 to 94057 cubic feet per day in 2015. There has not been the business and population decrease in the City of Goliad that would be necessary to make the decrease in modeled pumping make any physical, real-world sense. Well # 7923205 is an exempt domestic well. Modeled pumping is 22864 cubic feet per day in 2010. This is almost seven times what an exempt well is authorized to produce by statute. There is much more that should be discussed about the modeled pumping. This is a good overall view.

Most of the wells chosen by the TWDB for calibration do not have any water level readings within the calibration period, 1980 to 2015, or any water level readings at all. This makes it impossible to check or correlate rising and falling water levels with rising and falling modeled pumping.

Some of the Calibration Corrections utilized are way too large. Just their size should have raised questions and led to looking for cause and correction. Well # 7905707 is a windmill. TWDB records show that it is in Dewitt County not Goliad County. The Calibration Correction applied to it ranges from 494 to 747 cubic feet per day. This a too large a correction for a windmill. The Calibration Correction for Well #

7923401 ranges from 8,259 to 30,207 cubic feet per day. The is the well for the Fannin Battleground State Historic Site discussed above. The Calibration Correction is as much as twice the modeled pumping. The Calibration Correction for Well #7928101 ranges from 10,722 to 35,171 cubic feet per day. The is a well on Naval Auxiliary Landing Field Berclair. It is simply a landing strip for Naval Air Training Command. Water use is limited. It would be domestic and firefighting. Nothing in the range of modeled pumping or the Calibration Correction. There are other wells with Calibration Corrections that are too large. Instead of making these large Calibration Corrections the TWDB should have determined why the model was modeling these pumping values and fixed it.

The TWDB doesn't have any storativity values for Goliad County. Any method used to determine storativity values from nothing could be problematic. This a known problem that for many years the TWDB has failed to correct. Even the Total Estimated Recoverable Storage (TERS) for Goliad County is highly suspect without any storativity values. This along with modeled pumping probably explains some of the large deviations we are seeing in measured and modeled water levels in Goliad County as illustrated in the attached comments from LRE Water.

The recharge values shown in Table C14 of the Numerical Model Report for Goliad County are totally unrealistic. These values are generated using a curve developed based on stream baseflow data. This curve may be valid to be used in an aquifer application like the Edwards Aquifer, but it is absurd to use this methodology for Goliad County recharge. Dr Shi by his own comments state that rainfall patterns such as duration and intensity do influence groundwater recharge. He further stated that there was a lack of data and other influencing factors which would alter the use of the curve. His final comment was that "was the best I could do". Referring to the report titled "Estimation of Groundwater Recharge to the Gulf Coast Aquifer in Texas, USA" prepared for TWDB in 2011, estimated groundwater recharge in Goliad County is shown to be approximately 0.25 to 0.5 inches per year. Based on the recharge studies being conducted by GCGCD working with Texas Tech University, these numbers are shown to be too high. On page 3 of the referenced report, comments are made about the validity of using streamflow hydrographs. Recharge values must be revised to be at least reasonable and defensible.

The water budget values for Goliad County for aquifer to stream flow and for evapotranspiration are not representative of the scientific studies in which GCGCD is involved. Aquifer to stream flow values is much too high. Many years ago, there was extensive spring flow and artesian wells flowing. With the steady decline of the aquifer since 1980, there are virtually no streams or artesian wells flowing. TWDB is requested to provide physical information to counter this observation. As to evapotranspiration, this value for Goliad County is much too low. The brush and hardwood tree cover that currently exists in Goliad County is a major user of shallow groundwater. The TWDB chose to assume that all evapotranspiration for the aquifer stopped once the water level was greater than 10 feet. While this assumption may be valid in most of GMA-15 and GMA-16, it is not accurate for Goliad County. Much of Goliad County is covered by Large Oak, Mesquite, Huisache and other varieties of trees that are known to root 20 feet and deeper. In large parts of Goliad County evapotranspiration from the aquifer would occur to 20 feet, possibly deeper.

In conclusion, if the new draft GAM is not revised to reflect a declining water level and a realistic groundwater level drawdown for Goliad County, GCGCD will not be able to use the new GAM for management of groundwater in Goliad County. It will be necessary to create a local model that will reflect the aquifer conditions that GCGCD has recorded in the last 20 years and provide a realistic DFC. GCGCD requests that the TWDB do a local calibration, local error checking or a local model utilizing our monitor wells to provide an accurate modeled groundwater level for Goliad County. GCGCD also requests that more time be allowed for comments to allow other districts and stakeholders to comment.

Respectfully,

GCGCD Board of Directors

LRE WATER
CONNECTING WATER TO LIFE

August 10, 2022

Daryn Hardwick, PhD
Groundwater Modeling Manager
Texas Water Development Board
Daryn.hardwick@twdb.texas.gov
512-475-0470

RE: Comments on the Gulf Coast Aquifer System Groundwater Availability Model

Dear Dr. Hardwick,

LRE Water ("LRE") was engaged by the Goliad County Groundwater Conservation District (GCGCD) to review how the newly developed Gulf Coast Aquifer System Groundwater Availability Model (GAM) represents observed groundwater trends within Goliad County. Our review was limited in scope only to Goliad County, and the comments we provide in this document stem from this review performed by my modeling team.

I hold a PhD in Civil Engineering from the University of Texas at Austin, and have been working in the Texas water resources area for over 22 years. I am a licensed professional engineer (#97316) and geologist (#11002) in Texas, and have been a testifying expert in water rights cases before the Texas Commission on Environmental Quality and the State Office of Administrative Hearings. I am well qualified to review GAMs produced by the Texas Water Development Board (TWDB), and I professionally oversee a team of four expert groundwater modelers skilled in MODFLOW and Groundwater Vistas.

Based on our review and the comments provided here, LRE cannot support GCGCD's acceptance of the Gulf Coast Aquifer System GAM as the modeling tool it uses to manage groundwater within Goliad County. The GAM is incapable of reproducing the decreasing water level trends evident in GCGCD's extensive monitoring network data, and often greatly under predicts or over predicts observed water levels.

Sincerely,

Jordan Furnans, PhD, PE, PG

COMMENTS ON THE GULF COAST AQUIFER SYSTEM GAM

The TWDB has an "official" GAM model including Goliad County, which was recently used in completing the 3rd round of joint planning for GMA-15. This official model is referred to as the "Old Model" for the purposes of these comments. Goliad County Groundwater Conservation District (GCGCD) has previously informed TWDB that it does not find that the Old Model is acceptable with respect to its ability to model observed declining water levels in wells located throughout the county. In a 2021 study performed by LRE Water for the GCGCD, it was determined that model re-calibration could increase the agreement between observed water levels and those computed by the Old Model. Specifically, LRE Water obtained improved modeling results when eliminating recharge within Goliad County and when modifying the modeled hydraulic conductivity values for all cells within model layer 2 within Goliad County.

TWDB has recently created a "New Model" for simulating water levels within the entire GMA 15 and GMA 16 planning regions, which includes Goliad County. LRE Water was asked to review this "New Model" on behalf of GCGCD, and to ascertain if the "New Model" adequately reproduces observed decreasing trends in water levels within Goliad County. The "New Model" is the Gulf Coast Aquifer System GAM detailed by TWDB at the URL:

https://www.twdb.texas.gov/groundwater/models/gam/gma15_16/gma15_16.asp

To perform this review, I compared water levels measured from GCGCD observation wells to modeled water levels at the well locations. I reviewed comparisons of time-histories for 81 pairs of observed and modeled water levels. My comparisons were performed in bulk, where I compared modeled and observed elevations over time and calculated statistics on the agreement between the two datasets. I used the same statistics as reported by TWDB within their draft report on the "New Model," and found my statistics for Goliad County were in general agreement with the overall model statistics reported by TWDB (pertaining to the entire model domain). I also compared modeled and observed time-histories of water levels for each of the 81 observation wells within the GCGCD monitoring network. Through this comparison, I found that the New Model does not accurately reproduce the decreasing water level trends observed in Goliad County.

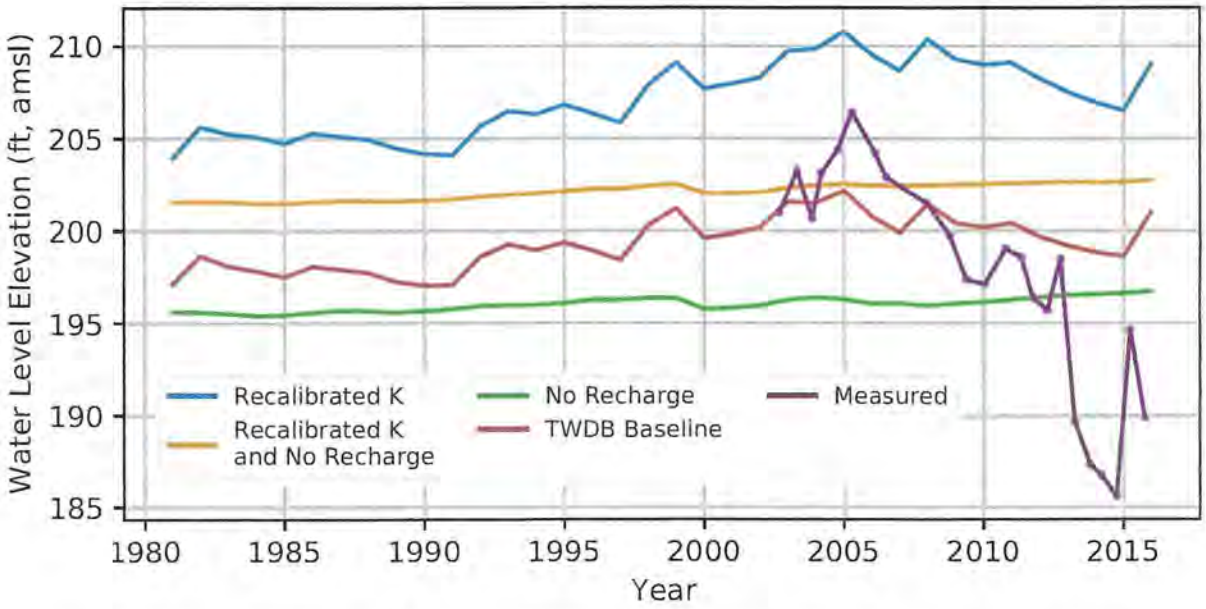


Figure 1 – Modeled and Observed Water Levels in Observation Well 7913223 within Goliad County.

Figure 1 presents plots of modeled and observed water levels for well 7913223, located within Goliad County. The modeled water levels are computed at the center of the grid cell location containing the physical well 7913223; I did not interpolate water levels to the exact well location (as TWDB has reportedly done as documented in their draft report detailing the "New Model.") I also did not adjust the modeled water levels to simulate drawdown expected from a pumping well, as TWDB did for this particular well. This topic will be discussed later.

As shown in Figure 1, there is an observed decrease in measured water levels, from approximately 201 ft MSL in 2003 to 190 ft MSL in 2016 with year-to-year fluctuations in between. Water levels modeled by the "New Model" (Shown in red as the "TWDB Baseline" results) suggest water level fluctuations over this time period, but do not indicate a decline in water levels. In fact, over the entire model period, the TWDB Baseline results suggest water levels range from 197 ft to 202 ft MSL, and show a generally increasing trend.

To assess the sensitivity of the modeled results to recharge and hydraulic conductivity values, I modified the New Model to incorporate changes that yielded improvement to the Old Model's ability to reproduce GCGCD observed water levels. The modified New Model results are shown in Figure 1 as the "No Recharge," "Recalibrated K," and "Recalibrated K and No Recharge" results. These result sets indicate that by eliminating recharge, the modeled year-to-year annual water level fluctuations are greatly reduced, resulting in a much "flatter" time series. These flatter time-series datasets also indicate that water levels were generally increasing over the modeled period of record. Through changing the modeled hydraulic

conductivity, the modeled water levels tended to increase or decrease relative to the TWDB Baseline water levels. Similar changes to the modeled time histories were observed for other GCGCD wells. County-wide gross statistics resulting from each modeled vs. observed water level dataset (i.e. the "No Recharge," "Recalibrated K," and "Recalibrated K and No Recharge") did not indicate generally better or worse agreement than indicated statistically by the TWDB Baseline model.

Based on Figure 1, it is possible to imagine that better agreement between modeled and observed water levels for well 7913223 could be achieved through further fine-tuning of the hydraulic conductivity of the model cells adjacent to the well, perhaps along with refining the magnitude of the aquifer response to changes in annual recharge. Within Appendix A of their draft "New Model" report, TWDB indicated that it used data from this well when compiling its regional model statistics. I concluded that TWDB actually used modeled water levels (from the TWDB baseline model) and then modified them to simulate the effects of local drawdown due to well pumping. I was able to calculate the same water levels as TWDB published in Appendix A when I ran the model and applied TWDB's simulated effects of local drawdown due to well pumping. However, I determined that well 7913223 is NOT a pumping well, and therefore TWDB incorrectly applied the well pumping adjustments to this well. As such, the agreement between the modeled and observed water levels at this location is artificially high within the TWDB New Model database. I do not know if TWDB made similar errors at other well locations listed within Appendix A, but this discovery with respect to well 7913223 does not provide confidence in TWDB's overall model verification process.

Other examples of the disagreement between modeled water levels and those obtained from wells within the GCGCD monitoring network are shown in subsequent images. Each graphic was selected to illustrate the various ways in which the modeled and observed water levels differed. For example, the observed water level in well 722903 is approximately 15 ft higher than the modeled water levels (Figure 2). In contrast, measured water levels for well 7913111 were about 25 ft below the modeled water levels (Figure 3). In both instances, a decreasing trend in observed water levels is evident.

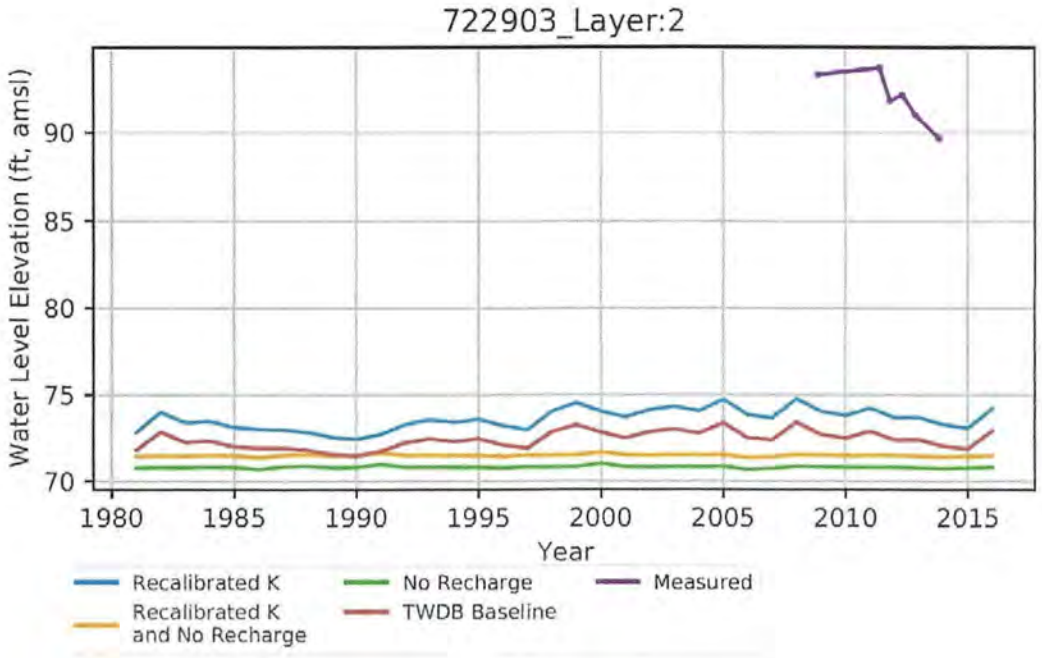


Figure 2 - Modeled and Observed Water Levels in Observation Well 722903 within Goliad County.

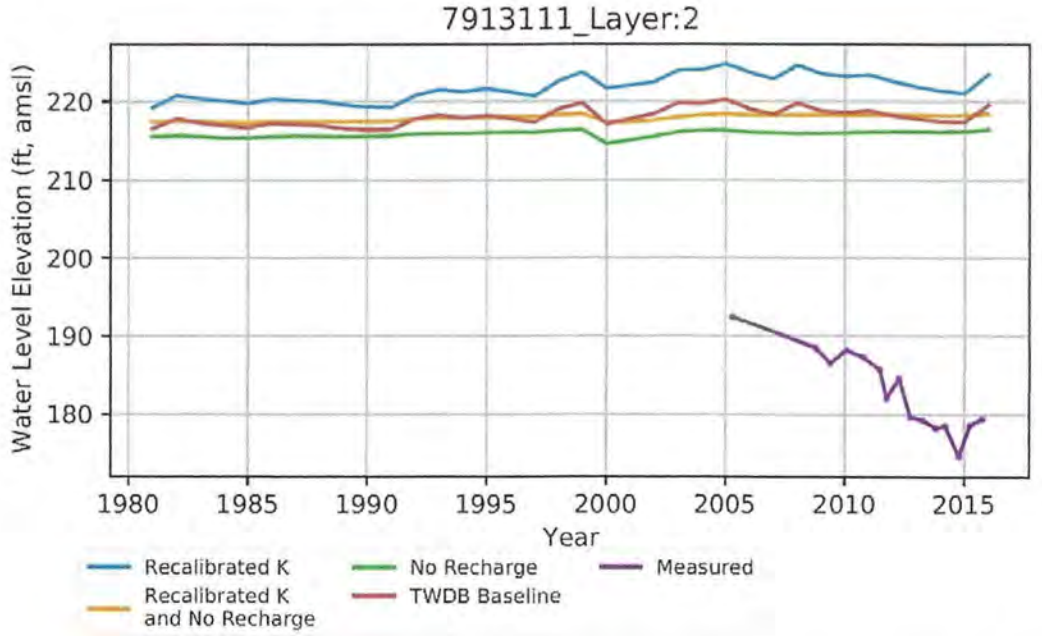


Figure 3 - Modeled and Observed Water Levels in Observation Well 7913111 within Goliad County.

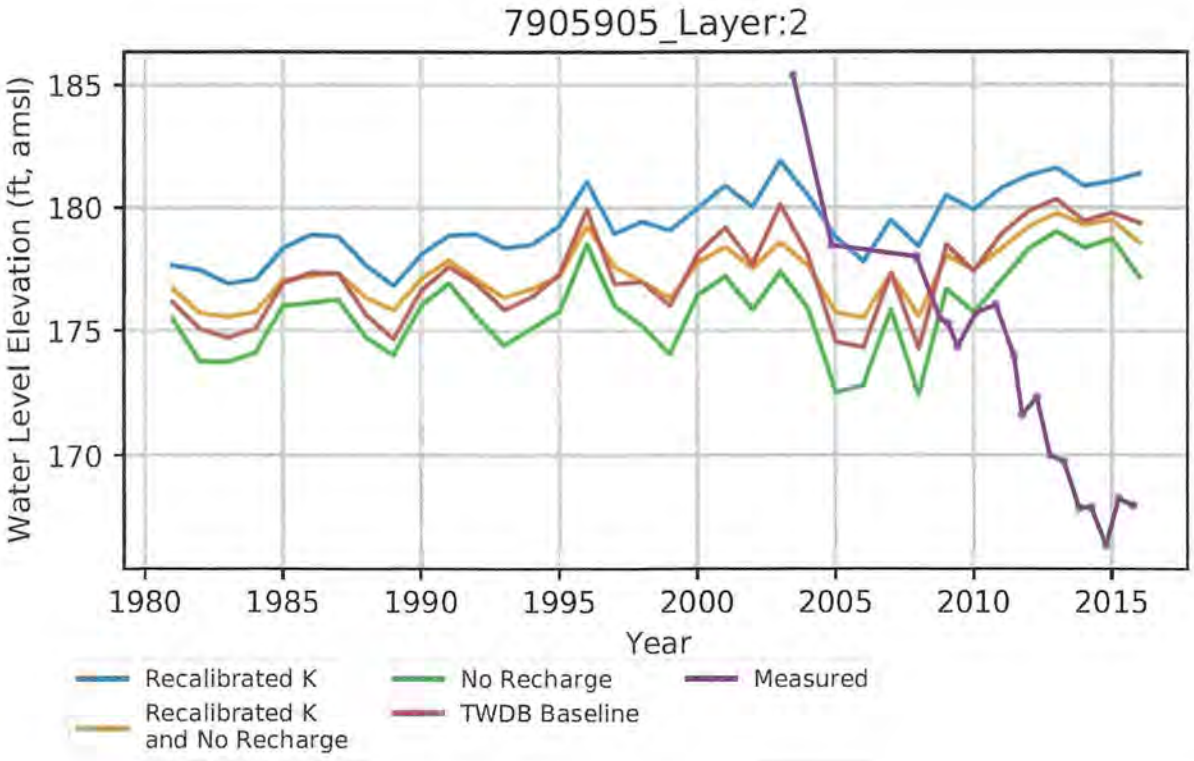


Figure 4 - Modeled and Observed Water Levels in Observation Well 7905905 within Goliad County.

For well 7905905, the 2004 water level exceeded the TWDB Baseline water level by approximately 8 ft, but by 2016 observed water levels were about 10 ft below modeled water levels (Figure 4). For well 7905606, the magnitude and range of modeled water levels match the observed magnitude and range of the measured water level, yet modeled levels show and increasing trend whereas the observed water levels decreased from 2004 to 2016 (Figure 5).

Of the 81 modeled vs. measured well comparisons for the GCGCD monitoring well network, each comparison told the same story. The modeled water levels do not exhibit the decreasing trends evident within each GCGCD monitoring well time-series of water levels.

As the TWDB model for GMA 15-16 is unable to reproduce the observed trends in water levels within Goliad County, it would be impossible for Goliad County GCD to effectively use the model to manage available groundwater within the county. Any DFCs set using the GMA 15-16 model would be impossible for the GCD to enforce, as observed water level declines are not indicated within the GMA 15-16 model output.

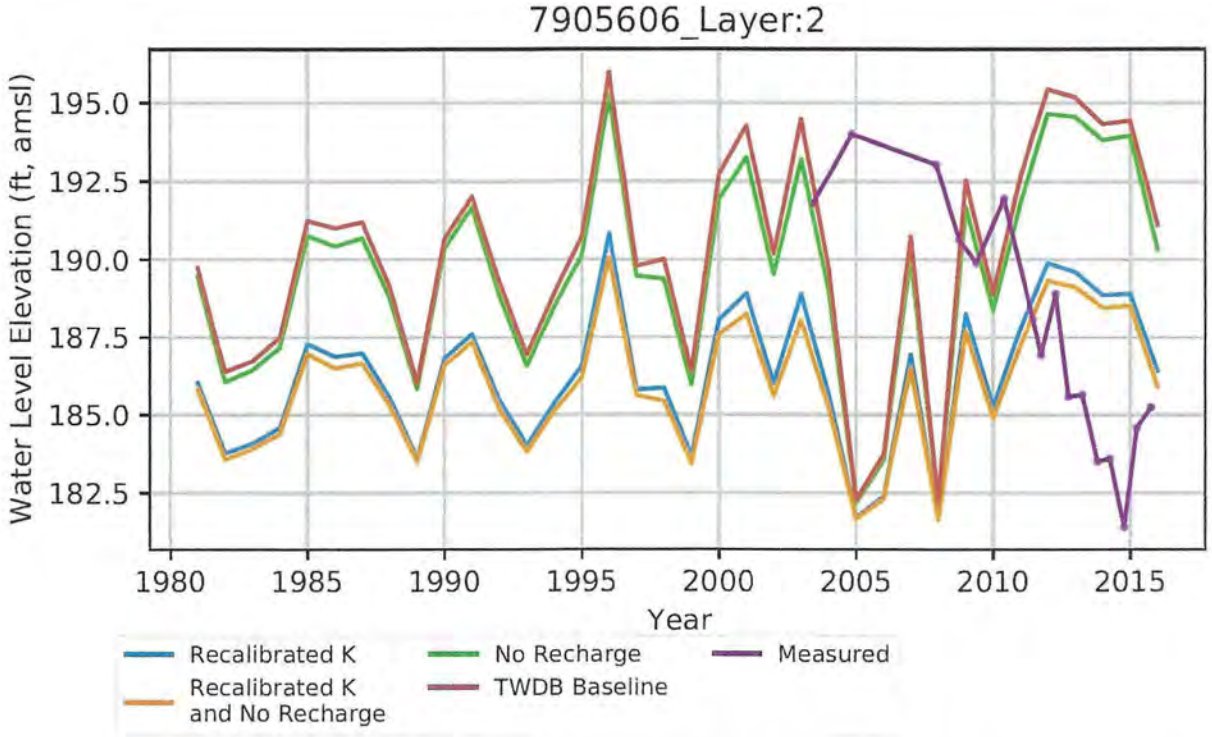


Figure 5 - Modeled and Observed Water Levels in Observation Well 7905606 within Goliad County.

APPENDIX G

2022 State Water Plan Data sets

Projected Surface Water Supplies
TWDB 2022 State Water Plan Data

GOLIAD COUNTY

100% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	Source Name	2020	2030	2040	2050	2060	2070
L	Livestock, Goliad	Guadalupe	Guadalupe Livestock Local Supply	42	42	42	42	42	42
L	Livestock, Goliad	San Antonio	San Antonio Livestock Local Supply	88	88	88	88	88	88
L	Livestock, Goliad	San Antonio-Nueces	San Antonio-Nueces Livestock Local Supply	80	80	80	80	80	80
L	Steam-Electric Power, Goliad	Guadalupe	Coleto Creek Lake/Reservoir	24,160	24,160	24,160	24,160	24,160	24,160
	Sum of Projected Surface Water Supplies (acre-feet)			**24,370**	**24,370**	**24,370**	**24,370**	**24,370**	**24,370**

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.

GOLIAD COUNTY

100% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
L	County-Other, Goliad	Guadalupe	368	401	421	429	436	441
L	County-Other, Goliad	San Antonio	300	327	344	350	357	361
L	County-Other, Goliad	San Antonio-Nueces	83	90	95	96	98	99
L	Goliad	San Antonio	460	506	535	548	558	565
L	Irrigation, Goliad	Guadalupe	493	493	493	493	493	493
L	Irrigation, Goliad	San Antonio	1,988	1,988	1,988	1,988	1,988	1,988
L	Irrigation, Goliad	San Antonio-Nueces	358	358	358	358	358	358
L	Livestock, Goliad	Guadalupe	195	195	195	195	195	195
L	Livestock, Goliad	San Antonio	334	334	334	334	334	334
L	Livestock, Goliad	San Antonio-Nueces	312	312	312	312	312	312
L	Manufacturing, Goliad	San Antonio	1	1	1	1	1	1
L	Mining, Goliad	Guadalupe	126	126	126	126	126	126
L	Mining, Goliad	San Antonio	275	275	275	275	275	275
L	Mining, Goliad	San Antonio-Nueces	49	49	49	49	49	49
L	Steam-Electric Power, Goliad	Guadalupe	1,863	1,863	1,863	1,863	1,863	1,863
	Sum of Projected Water Demands (acre-feet)		**7,205**	**7,318**	**7,389**	**7,417**	**7,443**	**7,460**

Projected Water Supply Needs
TWDB 2022 State Water Plan Data

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

GOLIAD COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
L	County-Other, Goliad	Guadalupe	289	255	234	226	219	214
L	County-Other, Goliad	San Antonio	1	7	11	12	14	15
L	County-Other, Goliad	San Antonio-Nueces	67	60	55	54	52	51
L	Goliad	San Antonio	460	414	385	372	362	355
L	Irrigation, Goliad	Guadalupe	46	46	46	46	46	46
L	Irrigation, Goliad	San Antonio	-388	-388	-388	-388	-388	-388
L	Irrigation, Goliad	San Antonio-Nueces	342	342	342	342	342	342
L	Livestock, Goliad	Guadalupe	0	0	0	0	0	0
L	Livestock, Goliad	San Antonio	0	0	0	0	0	0
L	Livestock, Goliad	San Antonio-Nueces	0	0	0	0	0	0
L	Manufacturing, Goliad	San Antonio	3	3	3	3	3	3
L	Mining, Goliad	Guadalupe	0	0	0	0	0	0
L	Mining, Goliad	San Antonio	0	0	0	0	0	0
L	Mining, Goliad	San Antonio-Nueces	0	0	0	0	0	0
L	Steam-Electric Power, Goliad	Guadalupe	24,160	24,160	24,160	24,160	24,160	24,160
	Sum of Projected Water Supply Needs (acre-feet)		**-388**	**-388**	**-388**	**-388**	**-388**	**-388**

Projected Water Management Strategies
TWDB 2022 State Water Plan Data

GOLIAD COUNTY

WUG, Basin (RWPG) All values are in acre-feet

Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
Goliad, San Antonio (L)							
Municipal Water Conservation	DEMAND REDUCTION [Goliad]	15	51	93	111	123	135
		15	**51**	**93**	**111**	**123**	**135**
Sum of Projected Water Management Strategies (acre-feet)		**15**	**51**	**93**	**111**	**123**	**135**

APPENDIX H

GCGCD's Historic Water Use: Goliad County Estimated Historic Municipal and Domestic Groundwater Use; Estimated Historic Oil, Gas, and Uranium Groundwater Use; and Historic Use Allocations

Goliad County Estimated Historic Oil, Gas, and Uranium Groundwater Use

Year	Oil & Gas Wells Drilled	Average Usage of Oil & Gas Wells (# Wells x 5ac/ft)	DCP Midstream Annual Water Usage (ac/ft)	UEC Annual Water Usage (ac/ft)	Total Usage (ac/ft)
2004	179	895	*	*	**895**
2005	227	1135	*	*	**1135**
2006	159	795	*	*	**795**
2007	126	630	*	3.11	**633.11**
2008	143	715	*	8.42	**723.42**
2009	28	140	*	0.57	**140.57**
2010	58	290	*	0.18	**290.18**
2011	37	185	*	0.74	**185.74**
2012	26	130	*	3.41	**133.41**
2013	15	75	0.13	0.03	**75.16**
2014	29	145	3.51	0.62	**149.13**
2015	13	65	4.25	0	**69.25**
2016	10	50	2.48	0	**52.48**
2017	18	90	2.32	0	**92.32**
2018	19	95	4.02	0	**99.02**
2019	2	10	3.43	0	**13.43**
2020	3	15	0.94	0	**15.94**
2021	5	25	1.09	0	**26.09**
2022	9	45	1.23	0	**46.23**
* signifies no data					

Golaid County Estimated Historic Municipal Domestic Water Use

Year	Population	Estimated Usage (Population x 127)
2019	7,592	964,184
2018	7,562	960,374
2017	7,562	960,374
2016	7,751	984,377
2015	7,510	953,770
2014	7,504	953,008
2013	7,451	946,277
2012	7,332	931,164
2011	7,208	915,416
2010	7,219	916,813
2009	7,033	893,191
2008	7,029	892,683
2007	7,001	889,127
2006	6,999	888,873
2005	6,969	885,063
2004	6,987	887,349
2003	7,067	897,509
2002	7,009	890,143
2001	6,997	888,619
2000	6,997	888,619
1999	7,125	904,875
1998	6,989	887,603
1997	6,814	865,378
1996	6,542	830,834
1995	6,342	805,434
1994	6,066	770,382
1993	6,083	772,541
1992	6,026	765,302
1991	6,014	763,778
1990	5,980	759,460
1989	6,003	762,381
1988	5,877	746,379
1987	5,864	744,728
1986	5,791	735,457
1985	5,818	738,886
1984	5,813	738,251
1983	5,876	746,252
1982	5,541	703,707
1981	5,324	676,148
1980	5,193	659,511

GCGCD Historic Use Allocations

Permit #	Land Owner	Latitude And Longitude	Areage Considered	Physical Location	Domestic/ Municipal	Industrial	Livestock	Wildlife	Other	Irrigation	Allocated Usage (ac/ ft per year)
1	David Landgrebe	28.88218 -97.39616	283	FM 1961			20	5			25
2	Owl Ranch LLC		50	58 S Hossier Creek Road	2		1				3
3	Owl Ranch LLC	28.8915 -97.3822	40	58 S Hossier Creek Road			2			18	20
4	Connie Arnold		110	1723 North Kolodziejcyk Road	2		0.5			0.5	3
5	Conover Charco Properties		560	Chicken Creek Ranch Road	1.6		6.4				8
6	David Landgrebe		185	Diebel Road	4		4				8
7	BDL Family Ltd.	28.80417 -97.436944	125	2506 Enke Road			4			56	60
8	Art Dohmann	28 50.520 -97 26.385	108	4679 Hwy 119 & Hallemann Rd			1.7			8.3	10
10	George R. Kullick		12	793 Deer Trail Ln				6.8		2.2	9
11	Kimberly & Paul Olson		244	3748 Old Goliad Road	0.6		3.4				4
12	Maurice Reitz	28.84722 -97.45556	43	48 Seiler Rd						56	56
13	Mike Abrameit		93	6884 FM 1961	1					1	2
14	Raymond L. Bednorz	28.8094 -97.208	60	382 Coletoville Road South						19	19
15	David Post	28 50.705 -97 14.291	61	1048 Berger Rd.	2					5	7
16	Michael Reagan		200	St. Hwy 239						200	200
17	Louis Willeke	28 43.0 97 36.0	416	Charco St						83	83
18	James W. Cosper	28.7152 -97.4333	175	3816 FM 1726			10				10
20	Timothy Meyer	28.725 -97.5928	1001	434 John Pettus Road			10			150	160
21	Michael Reagan	28.75457 -97.6291	100	736 Chicken Creek Rd.						187	187
22	Goliad Golf Course	28.664733 -97.406333	100	1103 W. Fannnin					24		24
24	Mildred Johnson Estate	28.66 -97.4161	2	2304 Horseshoe Bend		7					7
25	Lamar and Edna Mae Riggs Life Estate		94	570 Midway Road			4				4
26	David Bruns and Carol Rains	28 43.672N 97 22.535W	50	Fm 622		13					13
27	Gary Voigt	28.7349 -97.2984	13	553 Pesek Road			1			2	3
28	Gary Voigt	28.7327 -97.2981	45	553 Pesek Road	2		2			6	10
29	Janice Ohrt	28.7193 -97.3028	221	Frank Road @ Hall Rd.			2				2
30	Randy Riggs		75	3163 HWY 183 N			4				4
31	Wanda Pounds		12.5	474 Hennig Rd.			2				2
32	James A. Young	28.7287 -97.302	120	448 Hall Road	1		2				3
33	Carl W. Barrett	2844.306 9713.106	215	3072 FM 2987	2		11				13
34	Clifford W. Carter	28 42.28 -97 11.40	2	234 Lakeview Dr.	3						3
35	GBRA - Coleto Creek Park	2843.039N 9710.242W	190	365 Coleto Park Rd					5		5

GCGCD Historic Use Allocations

Permit #	Land Owner	Latitude And Longitude	Areage Considered	Physical Location	Domestic/ Municipal	Industrial	Livestock	Wildlife	Other	Irrigation	Allocated Usage (ac/ ft per year)
36	Coleto Creek Power Station	28.71333 -97.2158333	6367	Fm 2987	3	308					311
37	Coleto Creek Power Station		6367	Fm 2987							0
38	Robert J. Gardner	28.7127 -97.1716	24	129 Coleto Park Dr						5.4	5.4
39/40	Barnhart Family Partnership	28.621083 -97.67185	706	8212 FM 883	23		23	24			70
42	Dale and Patsy Rasco	28.5609 -97.6389	60	519 Oak Creek Ranch Rd.			13			4	17
43	Morgan Dunn O'Connor	28.619030 -97.303283	350	5420 St. Hwy 239 East			35				35
44	Cravens LLC	2823.587 9723.263	1120	11973 Hwy 202, Beeville						200	200
45	Tierra Padre Partners, Et al		10,000	Hwy. 183 South			50				50
46	City of Goliad	28.67255 -97.394217	N/A	434 N. Chilton	202						202
47	City of Goliad	28.66612 -97.3985	N/A	626 W. Franklin	215						215
48	Larry Lange	28.773 -97.3977	880	7483 US HWY 183 N				14			14
49	Sidney Arnold		49.8	844 Bethke Rd						25	25
50	Nolan Jacob	28.8416 -97.4436	75	1708 Weise Rd. Goliad Co., TX	0.5	0.5	0.5				1.5
51	JRG Service		544	6.5 miles N. on 183/77			10			30	40
52	Nolan Jacob	28.86611 -97.437778	212	1708 Weise Rd. Goliad Co., TX	2	3	4			51	60
53	A11 Acres LLC	28.856 -97.4256	273	1481 Dohmann Rd. Weesatche, TX			4				4
54	Coleto Creek Power Station		6367	45 FM 2987 Fannin, TX	1						1
55	Coleto Creek Power Station	28.71639 -97.215833	6367	45 FM 2987 Fannin, TX	1						1
56	Richard Schendel	28.66913 -97.45216	1555	3884 State Hwy 239 W,			50			100	150
				TOTAL:	**468.70**	**331.50**	**280.50**	**49.80**	**29.00**	**1,209.40**	**2,368.90**

APPENDIX I

Daniel B. Stephens and Associates, Inc. Memorandum 2018 Report on Recharge, DFCs, Pumpage

Memorandum

To: Heather Sumpter, General Manager
Goliad County Groundwater Conservation District

From: Andrew Donnelly

Date: February 26, 2018

Subject: Task One results

1. Introduction

Goliad County Groundwater Conservation District (District) contracted with Daniel B. Stephens and Associates, Inc. (DBS&A) to conduct a preliminary assessment of water levels, recharge, desired future conditions (DFCs), and historic pumpage. The Task 1 Scope of Work items are as follows:

- Construct a baseline geographic information system (GIS) for the District.
- Evaluate all existing District monitor wells and water level data. Data will be imported and plotted. A determination or confirmation of the aquifer assigned to each monitoring well will be done. An analysis of the quality of coverage of the water level monitoring well network will be made.
- Evaluate permits, pumpage, water levels, and well information.
- Construct hydrographs for all available water level data from District files.
- Evaluate the distribution of water level declines to determine if there is consistency of trends and/or whether they are localized or widespread.
- Compare water level trends to the DFCs for Goliad County. A preliminary evaluation of the compliance of the District with their approved DFCs and recommendations on potential DFC compliance monitoring methods will be made.
- Evaluate the Central Gulf Coast Groundwater Availability Model (GAM) to determine historic recharge values used for Goliad County as well as historic pumpage amounts and distribution of this pumpage.
- Review the report for the EDYS model for any information pertinent to this evaluation.
- Gather available data on historic precipitation, and compare to recharge estimates from the GAM.

- Gather permit and pumpage data from the District and evaluate to determine pumpage trends within the District.
- Compare water level, pumpage, and precipitation data.
- Produce a report that summarizes the issues with water level trends compared to recharge/precipitation trends and groundwater production trends.

This memo report provides the results of the Task 1 scope of work, and summarizes technical concerns that the District has with the current DFCs and GAM drawdown predictions. Recommendations are provided on how the District may proceed with groundwater level monitoring and DFC compliance.

2. Available Data

The following reports were reviewed as part of this investigation:

- Texas Water Commission (TWC) Bulletin 5711 (Dale and others, 1957). This report provides a general overview of the groundwater resources of Goliad County.
- TWDB Recharge Study (Scanlon and others, 2010). This study evaluates recharge estimate methodologies and provides recharge estimates for the major aquifers in Texas, including the Gulf Coast Aquifer System.
- EDYS Model report (McLendon and others, 2016). This report documents an ecological model constructed for Goliad County.
- Intera Gulf Coast Hydrostratigraphy report (Young and others, 2010). This report evaluates the hydrostratigraphy of the Gulf Coast Aquifer System within Texas.
- TWDB Report 236- Gulf Coast Stratigraphy (Baker, 1979). This report evaluates the stratigraphy of the Gulf Coast Aquifer System for the state of Texas.
- GMA 15 Reports. Various reports done as part of the joint groundwater planning process for Groundwater Management Area (GMA) 15, which includes Goliad County.
- GAM Report (Chowdhury and others, 2004). This report documents the GAM constructed for the central portion of the Gulf Coast Aquifer System, which includes Goliad County.

These reports provided background information on the aqufiers in Goliad County, the nature of recharge to the Gulf Coast Aquifer System, and the amount of historic pumpage estimated to occur within the county.

Data available from the TWDB was also gathered and evaluated for this investigation. This data includes historic water use surveys, historic groundwater pumpage, and historic recharge and pumpage inputs used in the GAM. Precipitation data was also reviewed for comparison to recharge rates. GIS data was gathered and used to create a baseline template for the District. Specific data received from the District was also added to this template to help evaluate the data for this investigation and produce this report.

At the beginning of this investigation, DBS&A was provided the water level monitoring data that the District has been collecting since 2002. This data set contains water level monitoring data from over 100 wells within Goliad County, of which approximately 70 are currently monitored. According to the District none of the monitor wells are utilized as production wells. These monitor wells were incorporated into the GIS template developed for the District. The District also provided data on permitted wells and production under permits, which was evaluated and compared to TWDB estimates.

Data used by Groundwater Management Area (GMA) 15 was reviewed to determine how current water level declines compare to the DFCs and how the modeled available groundwater (MAG) for Goliad County compares to estimates of current groundwater pumping.

3. Results and Discussion

a. Water Levels

Water level data obtained from the District was organized and evaluated. Because many of the wells in the District's monitoring well network were installed for oil and gas supply, the well locations tend to be geographically clustered. Therefore, in order to accurately assess the water level changes across all of Goliad County, it was necessary to organize the monitor wells into groups based on the well locations to avoid potential bias due to the distribution of wells. The following steps were completed to accomplish this:

- Well locations and depths were plotted in GIS. Well locations are shown in Figure 1.
- The specific aquifer (either Chicot, Evangeline, or Jasper) that each monitoring well is completed in was determined based on well location and depth. Nearly all of the monitoring wells in the southeastern third of the county, along the Refugio County line, are Chicot wells. All of the remaining monitoring wells in the county are completed the Evangeline Aquifer, with the exception of one well that appears to be completed in the Jasper Aquifer.
- The monitoring wells were divided into 14 separate groups based on their location. Each group consists of one to twenty wells (Figure 2).
- Hydrographs were made were and then organized by group. These are provided in Appendix A. Water level changes were evaluated by group.

Each group of monitoring wells is summarized in Table 1, and water level declines for each well group are summarized in Table 2. As shown in Table 2, not all well groups (areas) indicate declines in water levels, although most do. Three well groups show overall increases in water levels, six groups indicate a small amount of decline in water levels (less than 0.5 feet/year), and three groups indicate significant declines in water levels (approximately 1 foot/year). Most of the well groups have at least one well that exhibits increasing water levels.

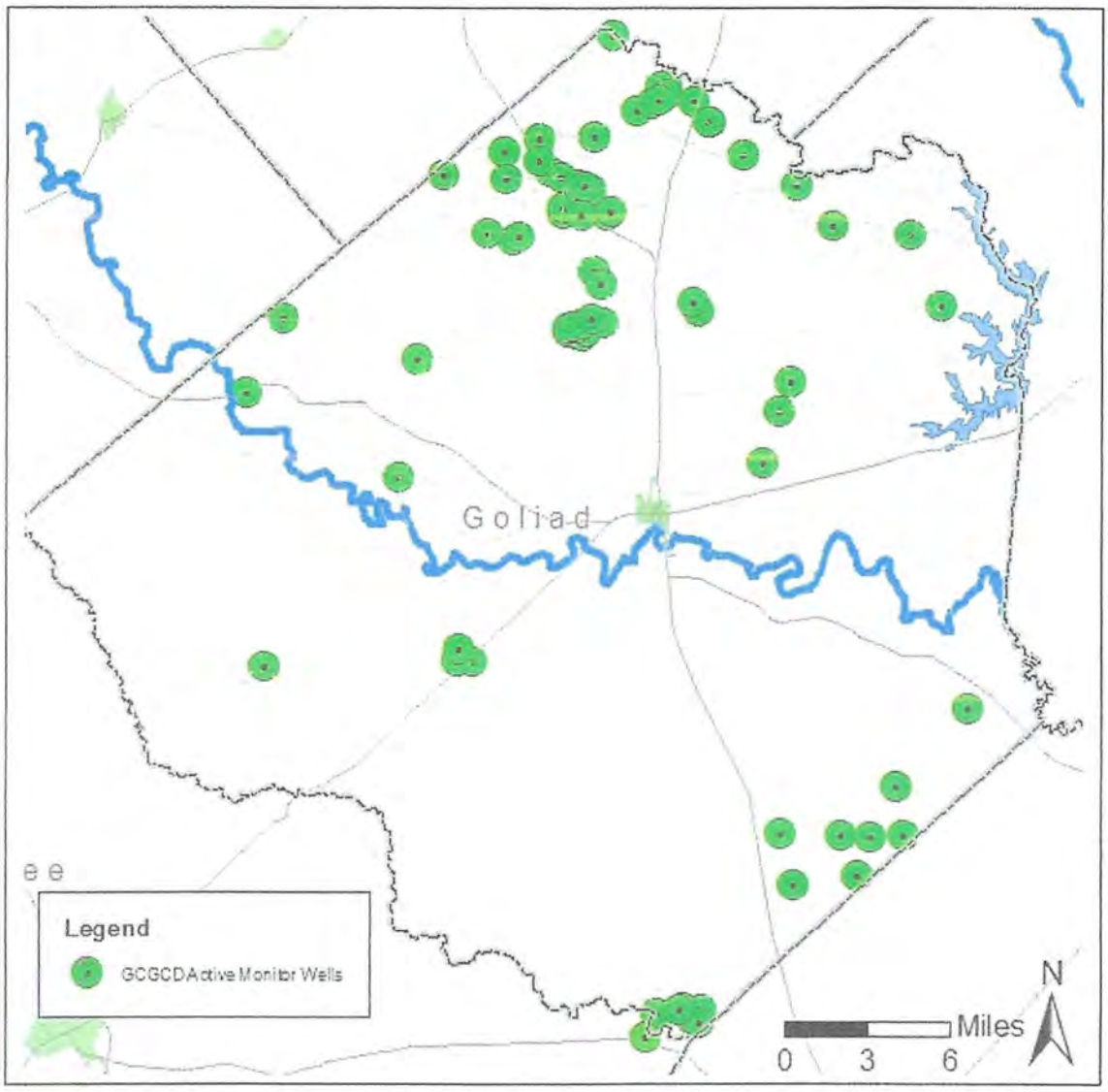


Figure 1. Locations of Goliad County GCD water level monitoring wells.

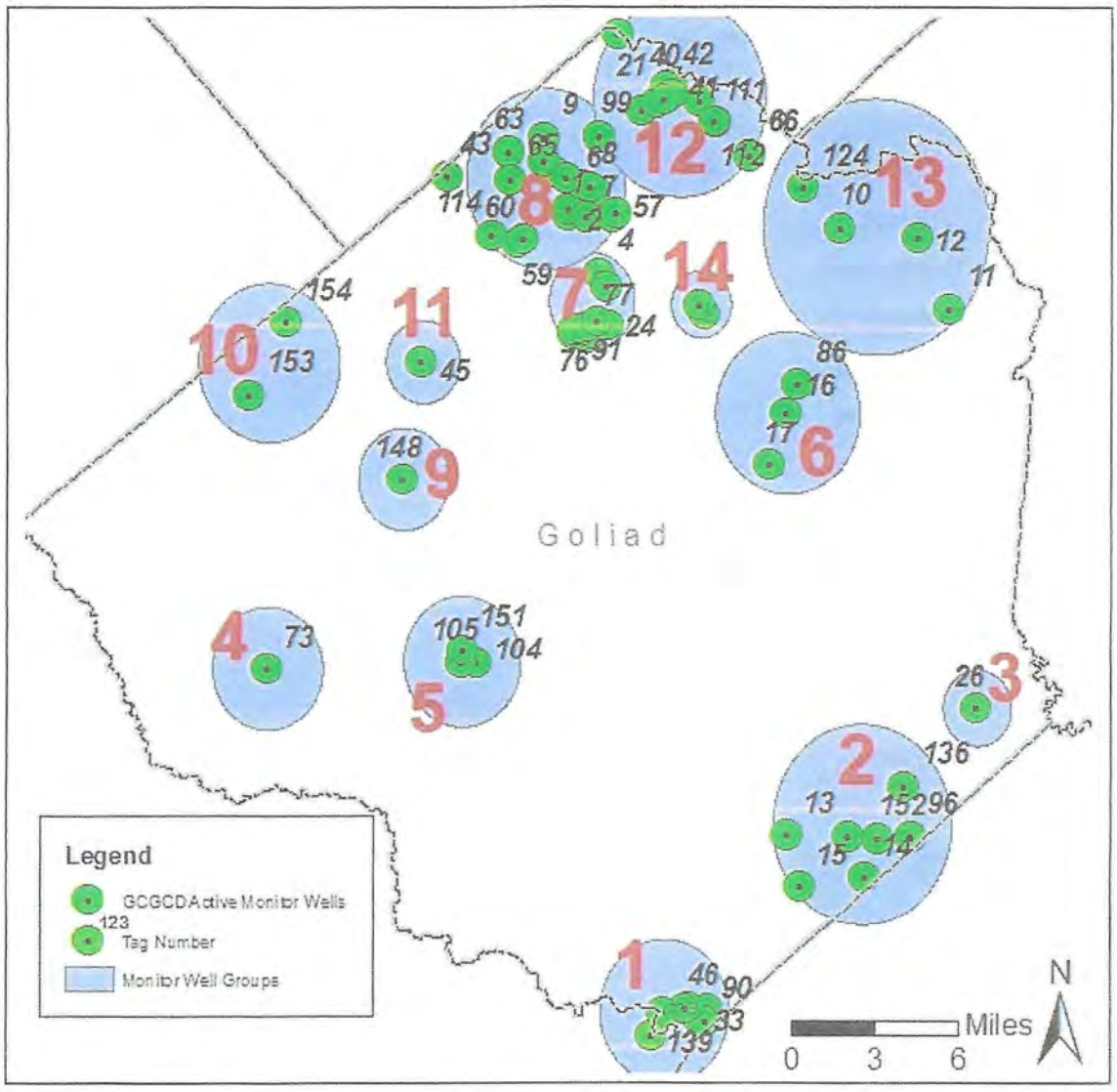


Figure 2. Locations of Goliad County GCD water level monitoring well groups.

Table 1. Summary of monitoring well groups.

Group	Aquifer	No. of Wells	Depth Range of Wells (feet)	Average Number of Years Monitoring
1	Chicot	6	96 - 325	7
2	Chicot	7	62 - 218	11
3	Chicot	1	204	14
4	Evangeline	1	280	8
5	Evangeline	3	95 - 320	11
6	Evangeline	3	160 - 263	13
7	Evangeline	13	105 - 331	9
8	Evangeline	20	25 - 324	13
9	Evangeline	1	187	15
10	Evangeline	1	290	0
11	Jasper	1	850	11
12	Evangeline	8	80 - 314	9
13	Evangeline	4	180 - 250+	13
14	Evangeline	2	300 - 320	5

Table 2. Summary of declines observed in monitoring well groups.

Group	Aquifer	No. of Wells Declining	No. of Wells Increasing	Range of Water Level Change (ft)	Average Water Level Change (ft)	Average Annual Change (ft)
1	Chicot	3	3	-2.5 to +4.2	0.4	0
2	Chicot	6	0	-0.6 to -9.5	-4.2	-0.4
3	Chicot	1	0	-2.1	-2.1	-0.15
4	Evangeline	1	0	-4.6	-4.6	-0.6
5	Evangeline	1	2	-6.9 to +8.6	1.2	0.1
6	Evangeline	2	1	-3.9 to +2.25	-1.5	-0.14
7	Evangeline	12	1	-15.7 to +10.5	-8.0	-0.9
8	Evangeline	19	1	-25 to +14.8	-10.8	-0.9
9	Evangeline	0	1	+5.5	5.5	0.4
10	Evangeline	--	--	--	--	--
11	Jasper	1	0	-11.2	-11.2	-1.0
12	Evangeline	7	1	-16.2 to +6.2	-4.6	-0.4
13	Evangeline	3	1	-4.2 to +1.6	-2.5	-0.2
14	Evangeline	1	1	-3 to +0.25	-1.4	-0.3

Note: Not all wells in the District monitoring well network have sufficient historic data to be included in this table.
Group 10 has one well, but insufficient data to determine water level changes at the time of this investigation.

b. Water Level Changes Compared to DFCs

The approved DFC for the Gulf Coast Aquifer System in Goliad County is 10 feet of drawdown from January, 2000 to December, 2069 (70 years). In order for the District to have the most flexibility in monitoring water levels and managing groundwater use, we recommend that each of the individual aquifer units within the Gulf Coast Aquifer System (i.e. the Chicot, Evangeline, and Jasper Aquifers) be monitored and compared to a DFC separately. This approach will allow the District to determine which aquifer may experience compliance issues with the DFC, and groundwater usage from the individual aquifer can be managed, rather than groundwater use from all aquifers within the county.

A DFC of 10 feet over 70 years is equivalent to less than two inches of average annual decline every year over the 70-year planning horizon. This is a very small rate of decline. Based on the water level data provided by the District, Goliad County appears to be experiencing drawdown rates greater than the DFC, even when the potential bias due to monitor well locations is accounted for.

Chicot Aquifer- There are 13 monitoring wells in the Chicot Aquifer in the District monitoring well network. These wells are divided into three groups based on their location. Group 1 has an equal number of wells showing an increase in water levels and a decline in water levels; overall this group of wells indicates no change in water levels since 2008 (Table 2). Group 2 indicates declining water levels in all six wells, which have been measured for up to 14 years (Table 2). Average declines in individual wells range from 0.1 to 0.7 feet/year, and average 0.4 feet/year overall. Group 3 consists of one well with an average annual decline of 0.15 feet/year over the 14 years it has been measured. Based on these data, county-wide declines in the Chicot Aquifer appear to exceed the DFC.

Evangeline Aquifer There are 55 Evangeline Aquifer monitor wells divided into 10 groups based on location, with group sizes ranging from 1 to 20 wells. All but one group have at least one well that shows an increase in water levels since the start of water level measurement collection, but only two groups show an overall increase in water levels (Table 2). Nine of the 10 groups show an overall decline in water levels, ranging from an average decline of 0.1 feet/year to nearly 1 foot/year. Significantly, the two groups with the greatest number of wells (Groups 7 and 8) also exhibit the largest annual decline in water levels.

Jasper Aquifer There is one Jasper Aquifer monitor well (Group 11). This well shows an annual decline of approximately 1 foot/year, and a total decline of 11.2 feet over 11 years, which is more than the entire 70-year DFC of 10 feet of drawdown (Table 2). Significantly, no pumpage from the Jasper Aquifer within Goliad County was identified in the preliminary data evaluation completed for this study. The cause of the observed water level decline in this well is currently unknown.

c. Evaluation of Recharge

An important part of the current investigation is an evaluation of recharge and its potential impact on water level declines observed within the District. The GAM was evaluated to determine the recharge rates applied in Goliad County, and other studies and data were reviewed to determine if the rates used in the GAM appear to be appropriate.

Recharge rates from the GAM used in the predictive GMA 15 simulations are shown in Figure 3. Recharge rates in the northwestern two-thirds of the county, where the Evangeline Aquifer outcrops, average slightly less than 0.25 inches/year. Recharge rates in the southeastern third of the county, where the Chicot Aquifer outcrops, are higher, averaging approximately 0.9 inches/year. As indicated in Figure 3, these recharge rates are consistent across county boundaries and are not significantly different than in Bee County to the southwest or DeWitt and Victoria Counties to the north and east, respectively.

The total amount of recharge applied to Goliad County in the GAM runs was also calculated and is shown in Figure 4. This figure shows that from 1920 to 1980, prior to the model calibration time period of1980 through 1999, a total of slightly over 18,000 acre-feet/year was applied to the county, and approximately 18,500 acre-feet/year is used in the predictive model runs. During most of the calibration time period, the simulated recharge varies from approximately 11,000 acre-feet/year to nearly 30,000 acre-feet/year. However, the total recharge applied to Goliad County in 1998 and 1999 appears to be erroneous, at only 1,351 acre-feet in 1998 and 650 acre-feet in 1999. This apparent error needs to be corrected in future model runs; the effects of this error on the predictive simulations and the DFCs are currently unknown.

Precipitation data obtained from the TWDB indicates that for Quadrangle 910, which includes all of Goliad County, annual precipitation from 1940 to 2016 ranged from 12.85 to 52.97 inches, with an average of 35.21 inches. Based on these values, the average annual recharge rates used in the GAM are less than 1 percent of average annual precipitation in the part of the

county where the Evangeline Aquifer outcrops (the northern three-quarters of the county), and approximately 2.5 percent of average annual precipitation in the part of the county where the Chicot Aquifer outcrops (the southeastern quarter of the county). These average annual recharge rates are similar to those applied in the GAM for counties that adjoin Goliad County (Figure 3).

A review of a TWDB groundwater recharge study (Scanlon and others, 2010) indicates that the recharge rates used in the GAM are similar to recharge rates determined in multiple other studies for the Gulf Coast Aquifer System. Recharge rates throughout the Gulf Coast Aquifer compiled by Scanlon and others (2010) are variable, ranging from zero to several inches/year. In the Central Gulf Coast region, which includes Goliad County, recharge rates compiled by Scanlon and others (2010) range from zero to 1.3 inches/year. The recharge rates used in the historic calibration of the model and the predictive simulations using the GAM fall within this range.

An ecological model of Goliad County was constructed using the Ecological Dynamics Simulation (EDYS) model. The final report describing this model was reviewed for this investigation. The EDYS model is a mechanistic general ecosystem simulation model that simulates ecological processes on a small scale and links them in an overall large scale landscape model. This model is primarily used to evaluate various land management alternatives by assessing changes in landscape that may result. The EDYS model includes numerous components as inputs, including climatic simulators, soil type, plant type, animal type, and so on. Although groundwater is one of the model inputs, it is considered in a simplified manner. Most of the emphasis with respect to water in the subsurface appears to be within the root zones of the different plant communities; changes in groundwater levels through time due to recharge, pumpage or other factors are not assessed or considered in the EDYS model.

Although considerable effort is made to develop input parameters for many of the inputs used in this model, we were unable to determine how the EDYS model can be used to quantitatively assess the accuracy of the recharge rates used in the GAM. Major components of the groundwater budget are not incorporated into the EDYS model, and simulation of the groundwater regime is highly simplified. This approach appears to be reasonable for purposes of the EDYS model, but it is insufficient for conducting a quantitative comparison or evaluation of groundwater recharge rates used in the GAM.

The District notes that the EDYS model and report contain information indicating that the historic recharge should be significantly higher than the current recharge, and that historic recharge should also be significantly higher than the recharge used in the predictive model runs. The change in recharge is related to the change in land use that occurred in Goliad County from the 1950s to the 1980s. After the drought of the 1950s, much of the area that had been cultivated in northern Goliad County transitioned to permanent pasture, with the transition completed by about 1980. The District believes that this change in land use impacted recharge rates, and that the recharge used in the predictive model runs should be reduced by 40 to 50 percent.

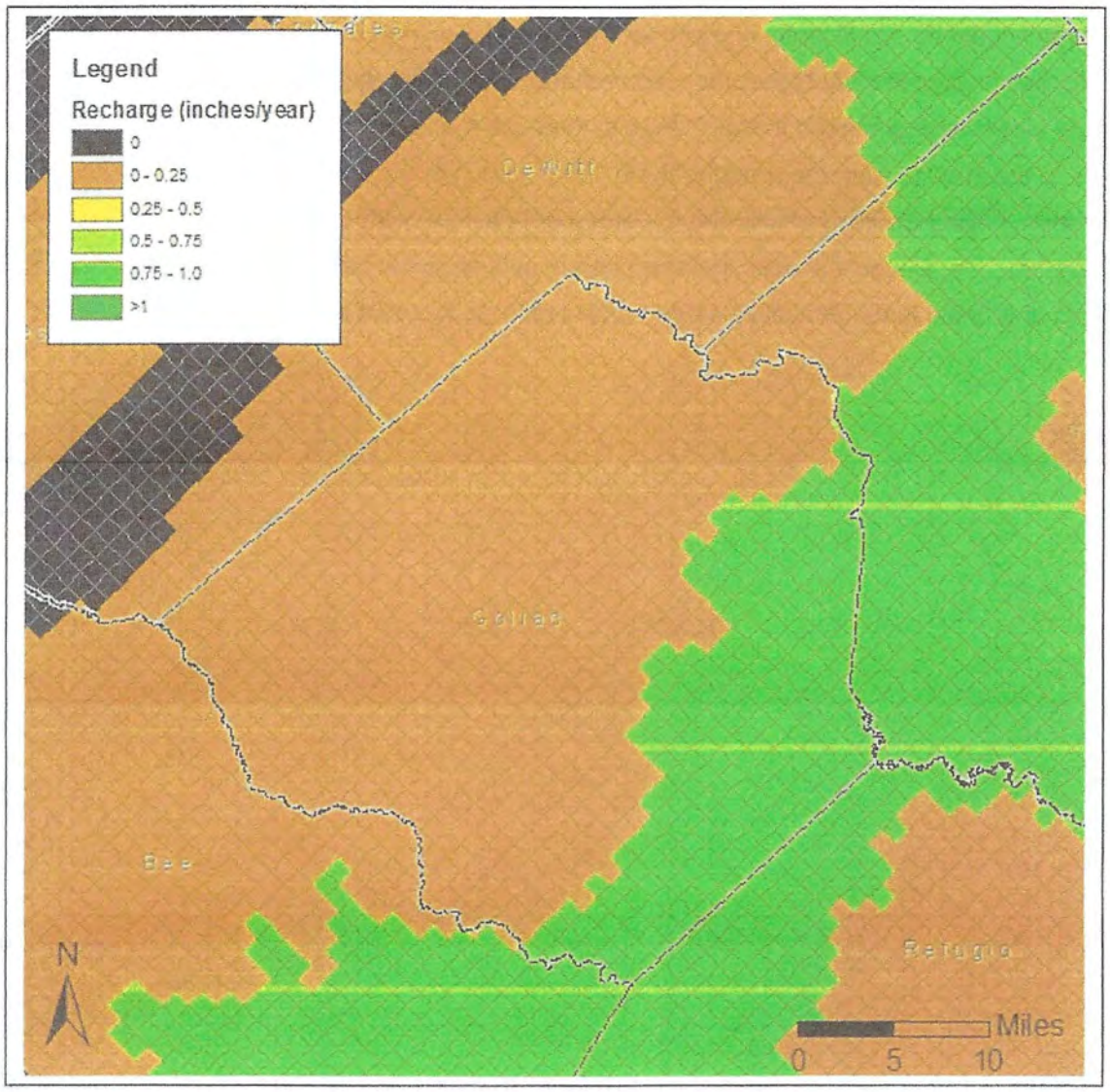


Figure 3. Recharge rates used for GMA 15 predictive simulations.

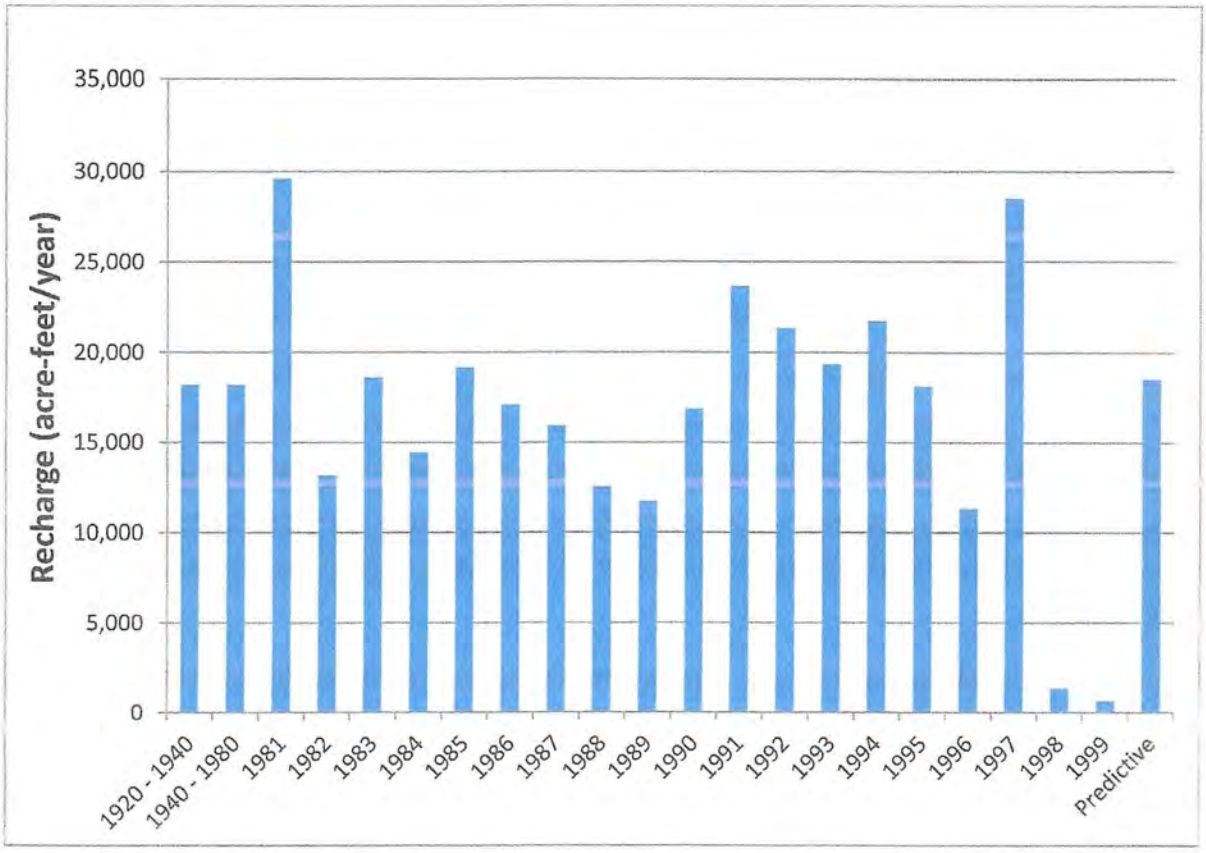


Figure 4. Total recharge applied to Goliad County in the historic and predictive GAM simulations.

d. Historic Groundwater Pumpage

Historic groundwater pumpage was reviewed for Goliad County. Data was obtained from the TWDB, the District, and GAM input files. The TWDB database provides an overview of water use and groundwater production within the county based on water use surveys conducted by the TWDB annually, but are based on the input and data received by the water use survey team at the TWDB and therefore are only as accurate as the reported values. Additional insight into the values provided by the TWDB are given by the data and input provided by the District. The pumpage estimates were also compared to the pumpage used in the GAM.

TWDB Estimates-TWDB estimates of groundwater pumpage for Goliad County from 1980 to 2015 are summarized in Table 3. This table indicates that since 1980, municipal and power pumpage within Goliad County has been fairly constant, irrigation and livestock pumpage has increased, and little to no groundwater production for industrial or mining purposes has occurred. Some of the TWDB reported data for Goliad County appears to be erroneous, as noted below:

- Municipal pumpage is fairly constant from 1980 to 2009 at reasonable values, but since 2009 the municipal water use reported by the TWDB appears to be too low.
- No groundwater production for industrial use was identified in Goliad County by the TWDB.
- Reported groundwater production for mining operations, which includes water used in support of oil and gas production, was reported to be minimal from 1980 to 2015. However, based on input from the District, oil and gas production and exploration has been conducted since the 1940s. Virtually all of the District monitor wells are capped oil and gas rig supply wells. The TWDB mining water use estimates appear to be low.
- A small but consistent amount of groundwater is reported for power production, apparently associated with the American National Power/Coleto Creek Power Plant, described below.
- TWDB groundwater production for irrigation use dramatically increased beginning in 2003. Based on input from the District, the estimates since 2003 are accurate, and estimates from 1980 to 2002 should be similar to these. The District notes that the TWDB only reports water use associated with projects that are reported under financial agriculture programs, and much of the agriculture in Goliad County is not included in these programs. The District notes that the higher numbers starting in 2003 accurately

represent use as reported by the District, and that they are aware of extensive historic use prior to 2003.

- TWDB estimates of groundwater production for livestock purposes dramatically increased since 2005. Based on input from the District, the estimates for the last 10 years are accurate, and estimates for the earlier period 1980 to 2004 should be similar to the recent values.

These pumpage estimation issues warrant additional investigation by the District.

In addition to the county-wide estimates, the TWDB also conducts water use surveys of significant water users across the state. Within Goliad County, several groundwater users have historic data available from the TWDB, including:

- *Municipal Users.* The TWDB has historic water use data from several municipal users in Goliad County, including the City of Goliad, the U.S. Naval Air Station in Goliad, and the Fannin Battle Ground State Park. Both the U.S. Naval Air Station and Fannin Battle Ground State Park have only sporadic, low volume uses reported in the 1980s and 1990s, and so they are not addressed further in this report.
- *Industrial and Power Users.* The TWDB has specific surveyed water use data from several industrial and power users, including American National Power, Coleto Creek Power LP, HNG Petrochemicals, Inc., Transcontinental Pipeline Co., and Uranium Energy Corp. However, the last three of these users reported only sporadic usage of less than 10 acre-feet/year, and so are not assessed further in this report.

Groundwater production by the City of Goliad from 1958 to 2015 is shown in Figure 5. This figure shows a slight increase in groundwater pumping during the 1970s to early 1980s, but in general it has remained fairly constant. The pumpage trend for the City of Goliad reflects the overall municipal pumpage trend for Goliad County from 1980 through 2015 noted above, and accounts for approximately 50 percent of the total municipal pumpage in the county. Groundwater production by American National Power/Coleto Creek Power LP is shown in Figure 6. This figure shows a fairly consistent amount of pumping since the 1970s.

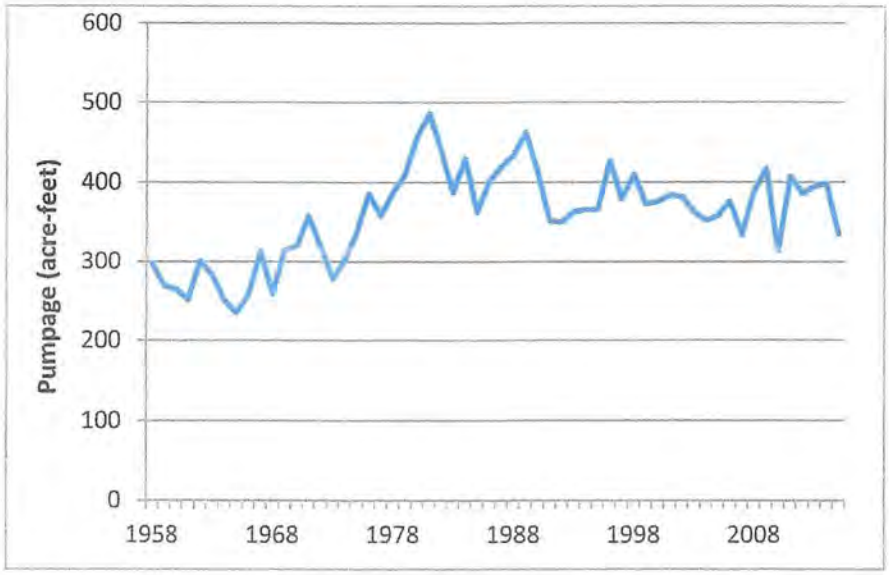


Figure 5. Estimated groundwater production from the Gulf Coast Aquifer by the City of Goliad.

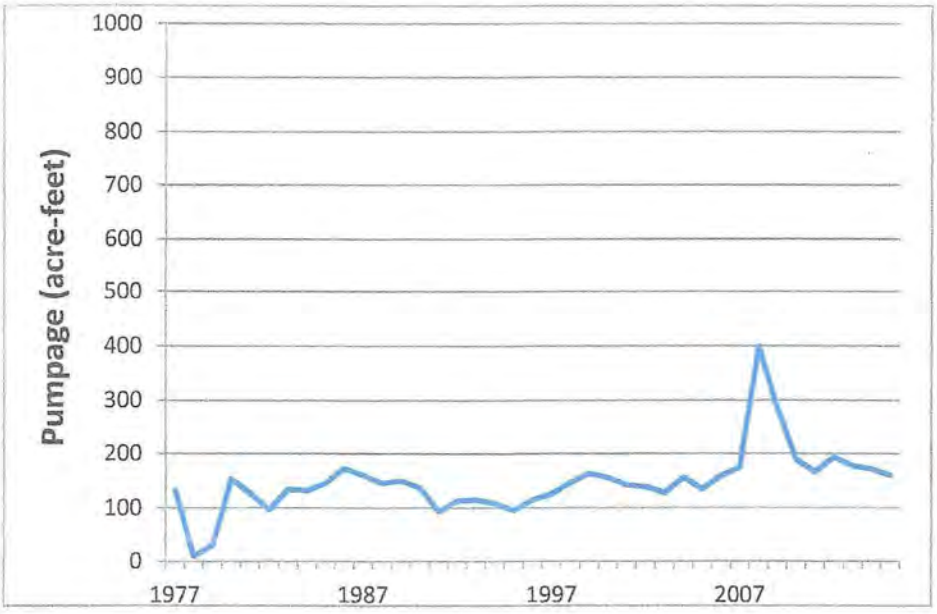


Figure 6. Estimated groundwater production from the Gulf Coast Aquifer by the American National Power/Coleto Creek Power LP.

GAM Pumpage

The GAM was evaluated to determine the historic pumpage used for calibration of the model, as well as the amount of pumpage used in the predictive simulations by GMA 15. Pumpage in Goliad County was only included in two of the four layers of the Gulf Coast Aquifer in the historic calibration inputs. These are model layer 1 (Chicot Aquifer) and model layer 2 (Evangeline Aquifer). The amount of pumpage used in the GAM calibration period of 1980 through 1999 for the Chicot and Evangeline Aquifers is shown in Figures 7 and 8, respectively, and the distribution of this pumpage within Goliad County in 1999 is shown in Figures 9 and 10, respectively.

As indicted in Figures 7 and 8, the GAM incorporates about 1,200 acre-feet/year of pumpage from 1980 through 1999, of which approximately 90 percent was from the Evangeline Aquifer. Combined, these pumping totals are similar to the TWDB estimates for total pumpage in Goliad County prior to 2000. However, this amount of pumping is significantly smaller than TWDB pumpage estimates for Goliad County since 2000. In addition, input from the District indicates that historic pumpage in the county prior to 2000 estimated by the TWDB is too low, which means that groundwater pumpage during the calibration period in the GAM is also too low.

Figure 9 shows the distribution of pumpage in the Chicot Aquifer used in the GAM. This figure indicates that the pumpage from the Chicot Aquifer is generally less than 2 acre-feet/year per model cell applied throughout the portion of the county where the Chicot Aquifer is present. Figure 10 shows the distribution of pumpage in the Evangeline Aquifer in 1999 used in the GAM. Figures 9 and 10 show that where the Chicot is present in Goliad County, the GAM generally does not have pumpage in the Evangeline Aquifer. The overall distribution of pumpage from the Evangeline Aquifer is also relatively low at less than 5 acre-feet/year per cell. There are two higher pumpage cells in the City of Goliad, presumably for the city pumping, and a single higher pumpage cell in the eastern part of the county near the town of Fannin and Coleto Creek Reservoir, which presumably represents pumpage from the American National Power /Coleto Creek Power LP.

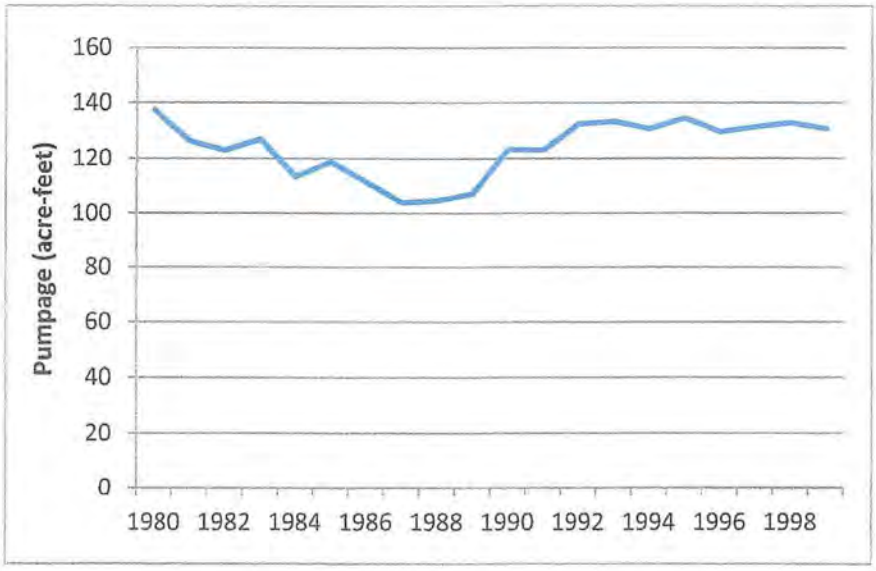


Figure 7. Historic groundwater production from the Chicot Aquifer (Layer 1) for 1980-1999 from the GAM.

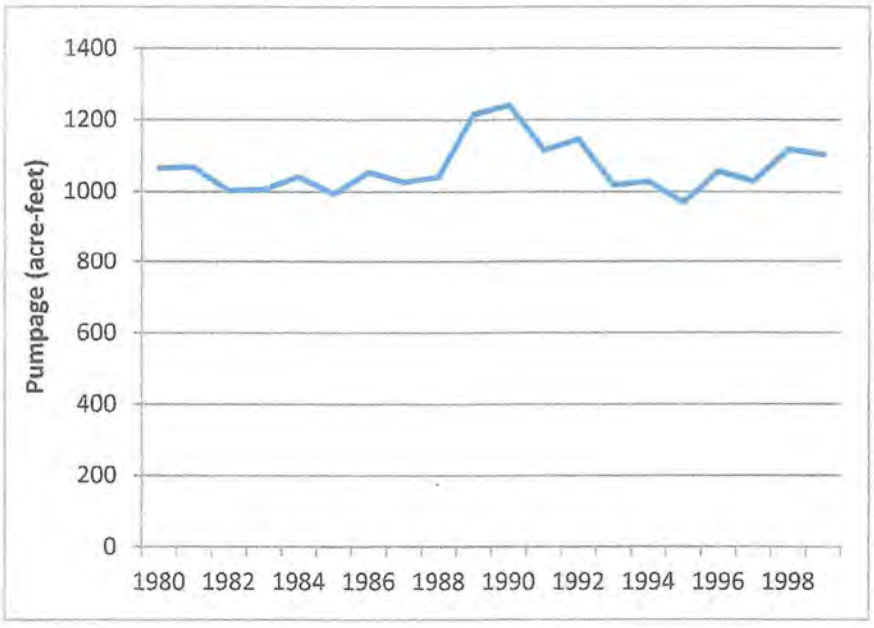


Figure 8. Historic groundwater production from the Evangeline Aquifer (Layer 2) for 1980-1999 from the GAM.

Predictive GMA 15 Pumpage

The predictive pumpage in Goliad County used by GMA 15 for joint groundwater planning was also evaluated. Figures 11 and 12 show both the historic and predictive pumpage used in the GAM for the Chicot and Evangeline aquifers, respectively. The historical calibration period is the period 1980 through 1999, and the predictive simulation period is 2000 to 2070. These figures show the significant increase in the pumpage used in the predictive portion of the simulation (after 1999) compared to the historic portion of the simulation (before 1999). Pumpage increases from approximately 100 acre-feet/year to 700 acre-feet/year in the Chicot Aquifer, and from approximately 1,000 acre-feet/year to over 10,000 acre-feet/year in the Evangeline Aquifer. As discussed above, pumpage in the historic portion of the model simulations appears to be significantly lower than the actual amount of historic pumpage based on input from the District. Pumpage used in the predictive portion of these simulations is also significantly higher than the TWDB estimated amount of pumpage that occurred in Goliad County from 2000-2015.

Goliad County GCD Permit and Production

Some permit and production data, as well as data on registered wells, was obtained from the District and reviewed. However, we were unable to determine with certainty from this data the number of active permits and registered wells in the District. The discussion below is based on our current understanding and interpretation of this dataset.

Based on the data DBS&A received, the District has 4,968.3 acre-feet/year of permitted pumpage. There are two types of permits: historic use permits and regular permitted pumpage. There are 54 historic use permits totaling 2,316.9 acre-feet/year and 62 regular permitted pumping permits totaling 2,651.4 acre-feet/year. Groundwater pumped under the historic use permits is unknown because historic use permit holders are not required to submit annual production totals. Reported production totals for the regular permitted pumpage have varied greatly, ranging from 78 to 805 acre-feet/year between 2005 and 2015.

Table 3. Estimated historic groundwater production from the Gulf Coast Aquifer in Goliad County from TWDB historic groundwater pumpage estimates.

Year	Municipal	Industrial	Mining	Power	Irrigation	Livestock	Total
1980	834	0	0	153	0	223	1,210
1984	876	0	540	132	23	110	1,681
1985	808	0	1	146	23	131	1,109
1986	836	0	1	173	26	105	1,141
1987	864	0	0	160	26	97	1,147
1988	892	0	0	145	21	85	1,143
1989	931	0	0	150	164	84	1,329
1990	915	0	0	136	205	87	1,343
1991	864	0	13	93	185	90	1,245
1992	861	0	13	113	185	121	1,293
1993	872	0	13	115	31	118	1,149
1994	858	0	13	108	59	118	1,156
1995	873	0	13	95	49	118	1,148
1996	957	0	13	115	53	87	1,225
1997	912	0	13	125	53	90	1,193
1998	936	0	13	140	53	103	1,245
1999	912	0	13	140	0	116	1,181
2000	799	0	0	156	147	92	1,194
2001	816	0	0	141	103	33	1,093
2002	819	0	0	138	251	32	1,240
2003	801	0	0	127	1,894	40	2,862
2004	768	0	0	2,154	1,585	40	4,547
2005	804	0	0	134	2,539	885	4,362
2006	854	0	0	1,197	2,176	1,045	5,272
2007	732	0	0	174	1,065	911	2,882
2008	834	0	0	399	2,257	802	4,292
2009	920	0	0	285	2,454	870	4,529
2010	563	0	0	189	1,937	774	3,463
2011	631	0	0	166	3,436	771	5,004
2012	580	0	0	193	2,884	638	4,295
2013	546	0	0	177	2,785	589	4,097
2014	516	0	0	171	2,770	587	4,044
2015	443	0	4	159	3,057	597	4,260

Source: Texas Water Development Board historic groundwater pumpage database at http://www.twdb.texas.gov/waterplanning/waterusesurvey/historical-pumpage.asp

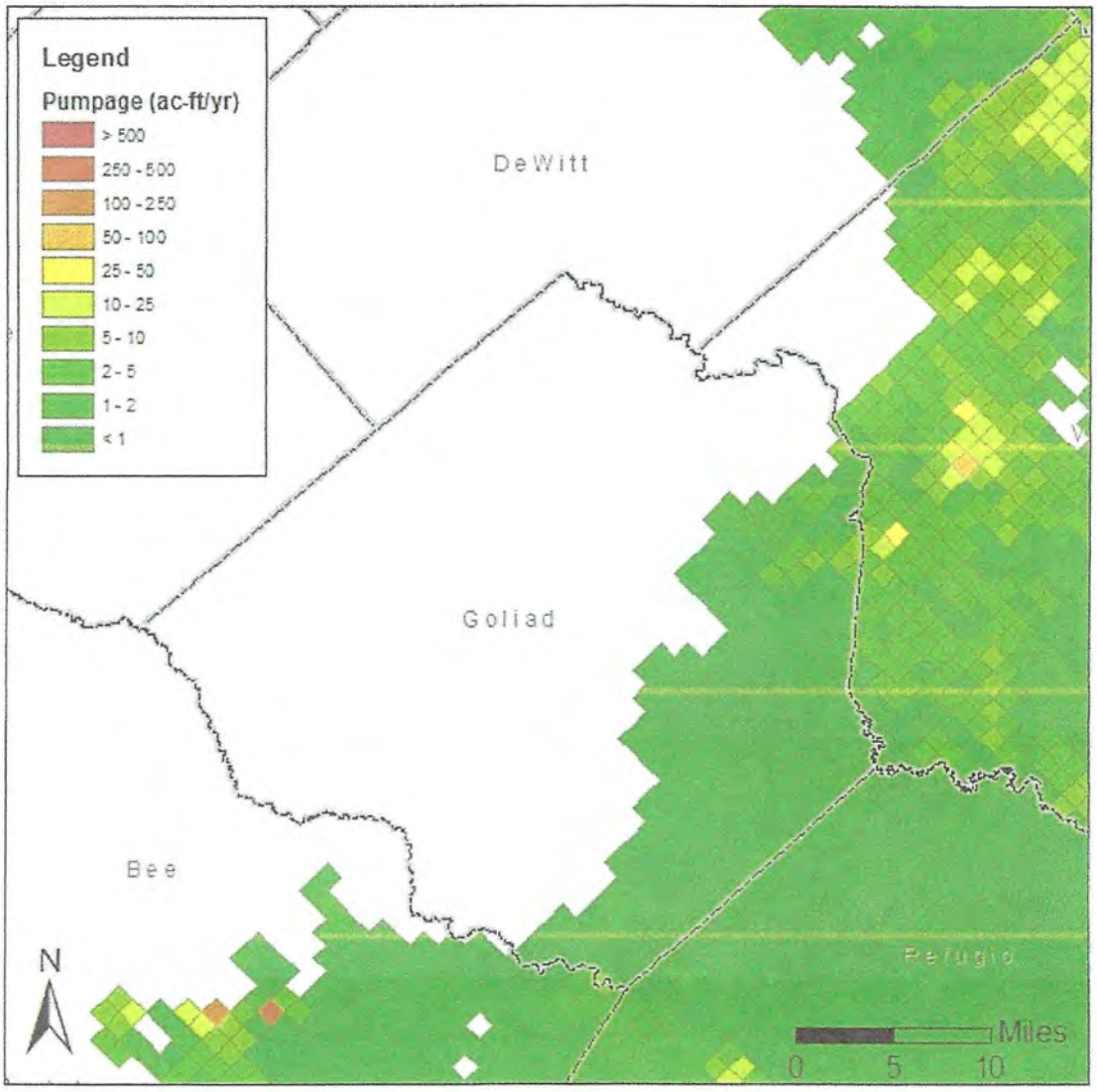


Figure 9. Distribution of historic groundwater production from the Chicot Aquifer (Layer 1) in 1999 from the GAM.

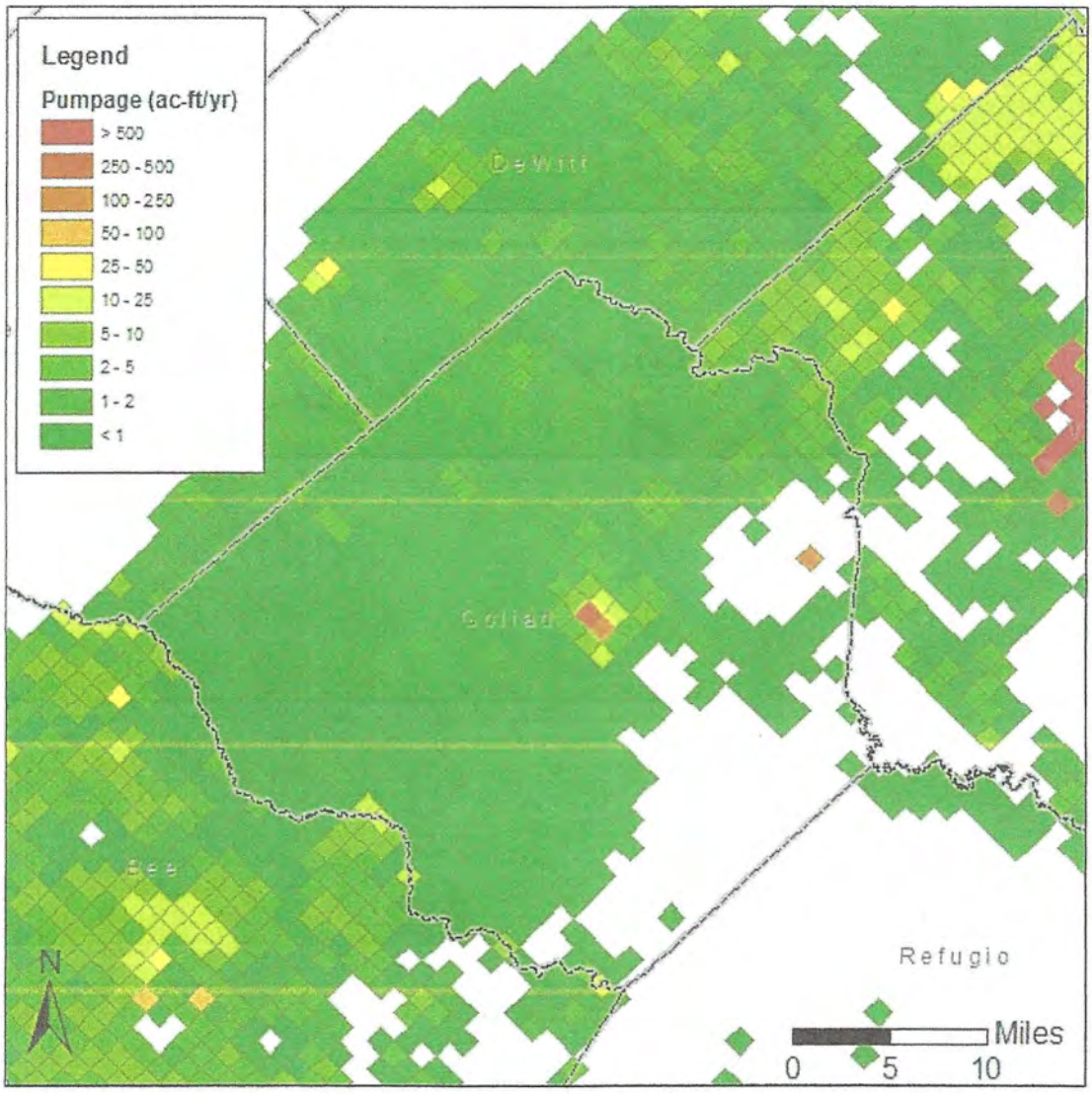


Figure 10. Distribution of historic groundwater production from the Evangeline Aquifer (Layer 2) in 1999 from the GAM.

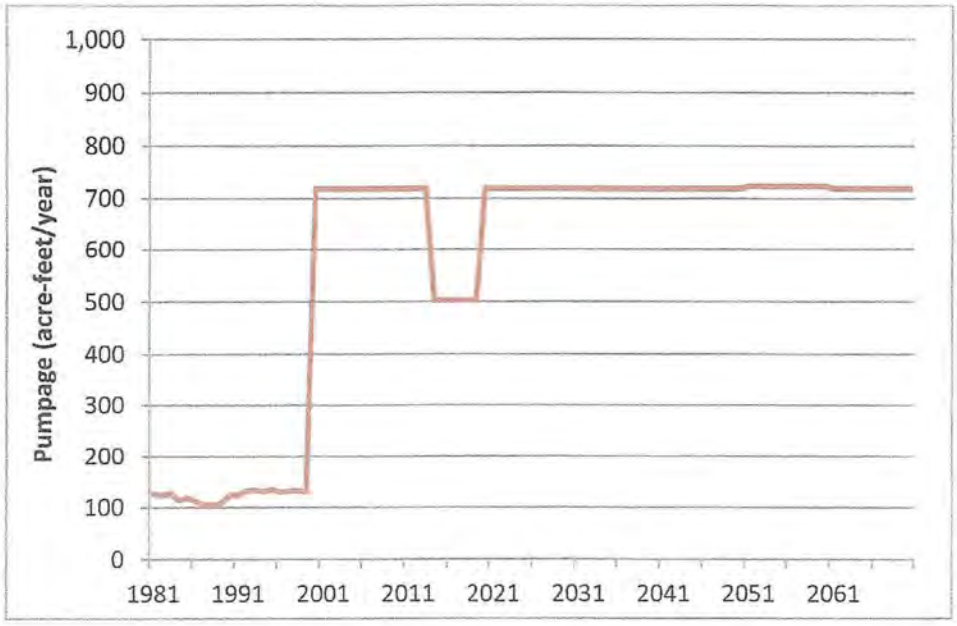


Figure 11. ***Goliad County pumpage in the historic calibration time period (1981-1999) and predictive time period (2000-70) for the Chicot Aquifer.***

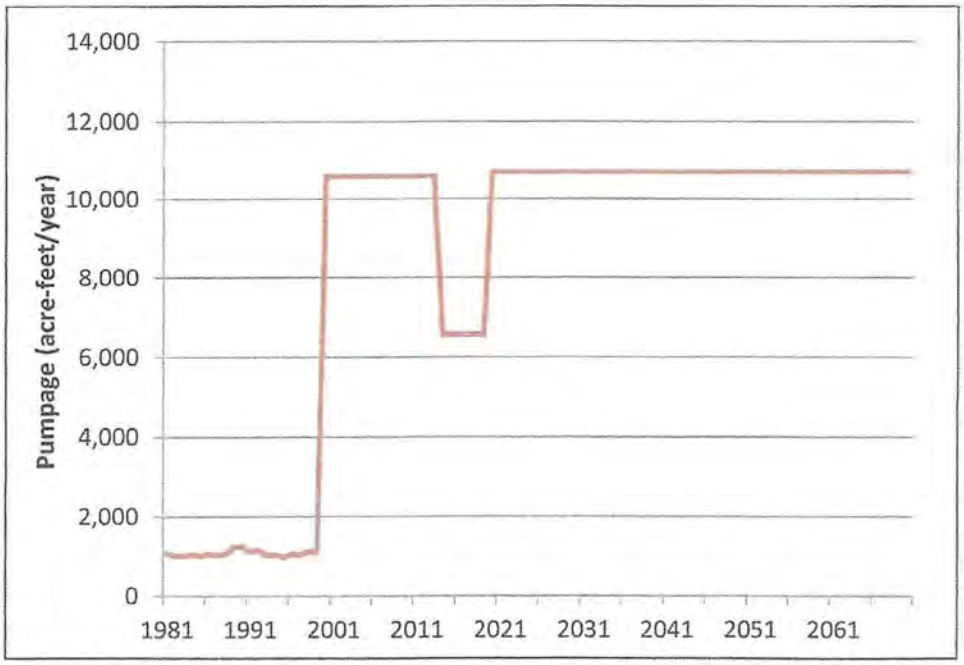


Figure 12. ***Goliad County pumpage in the historic calibration time period (1981-1999) and predictive time period (2000-70) for the Evangeline Aquifer.***

4. Summary and Conclusions

The District contracted DBS&A to conduct an initial evaluation of water levels, DFCs, recharge, and pumpage within Goliad County. The District has a water level monitoring network of 97 wells and has been collecting water level measurements since 2002-2003. Wells in the monitor well network were divided into groups to determine the nature and extent of the water-level changes in different parts of Goliad County. The observed rate of decline was determined to be different in different areas of the county, and ranged from 0.1 to 1.0 feet/year. In some areas the water levels have increased since the water level monitoring began. In addition, most areas within Goliad County that have multiple monitoring wells have at least one well that shows an increase in water levels, although most wells in the same area show a decline.

Water level declines in Goliad County may the due to the combination of pumpage and a decrease in recharge over time. The amount of decline observed in some wells, and the variable rates of declines observed in the wells (including some wells that exhibit increasing water levels) implies that pumpage is a significant factor in water levels changes that are observed in the monitoring well network.

The DFC for Goliad County is 10 feet of drawdown in the Gulf Coast Aquifer System from 2000 to 2069; the DFC does not refer to specific aquifer units. To provide for flexibility in monitoring and managing groundwater production, we suggest that the District evaluate each of the aquifer units within the Gulf Coast Aquifer System (the Chicot, Evangeline, and Jasper Aquifers) separately. Following this approach, the DFC for each of the individual aquifers would also be 10 feet of drawdown from 2000 to 2069.

Although the methodology for the assessment of DFC compliance has not been developed yet for the District, the drawdowns that have been observed in the Chicot, Evangeline, and Jasper Aquifers appear to be greater than the DFC, regardless of the DFC compliance methodology that may be chosen by the District. The exceedance of the DFCs is a concern due to the potential this may have in limiting future permits issued by the District.

Recommendations for expanding the monitoring well network are provided in Section 5. We believe that expansion of the monitoring well network is important to cover areas of the county where few or no monitoring wells currently exist. Options for assessing DFC compliance for the District depend on the potential expansion of the monitoring well network. We recommend that the District assess DFC compliance using the following approach:

1. Evaluate the Chicot and Evangeline aquifers separately, which requires sufficient monitor wells in each aquifer unit
2. Group monitor wells based on location to remove location bias where multiple wells are monitored in relatively localized regions.

Groundwater recharge values used in the GAM in Goliad County are similar to or the same as that used in adjacent counties and in other portions of the GAM, and the magnitude of recharge is consistent with values estimated in prior studies. Recharge rates used in the predictive simulations to approximate average recharge conditions are approximately 0.25 inches/year in the Evangeline Aquifer outcrop area, and 0.9 inches/year in the Chicot Aquifer outcrop area. Based on an average annual rainfall of 35 inches/year the recharge rates used in the GAM are 1 percent of average annual precipitation in the Evangeline Aquifer outcrop area and 2.5 percent of average annual precipitation in the Chicot Aquifer outcrop area.

An error was discovered in the recharge package used for the historical calibration period of the GAM that may impact calculated water level declines in predictive model runs. Recharge at the end of the calibration time period in the southern part of the model, including Goliad County, is much lower than it should be. This error may cause water levels at the end of the calibration simulation (which are used as starting water levels for predictive simulations) to be lower than they should be, which in turn may lower the calculated drawdowns at the end of each predictive simulation. This issue should be further evaluated by the District and corrected in future models and model runs.

An ecological model developed for Goliad County was assessed for insight into the recharge rates used in the GAM. However, we were unable to use information from this model to help quantifiably assess whether the recharge rates in the GAM are appropriate.

Historic pumpage for Goliad County from the TWDB, the District, and the GAM was reviewed. County-wide estimates from the TWDB prior to 2000 were approximately 1,000 to 1,500 acre-feet/year, most of which was for municipal use, with lesser amounts for mining, power, irrigation, and livestock uses. Based on input from the District these estimates of historic pumpage appear to be too low, and pumpage prior to 2000 should be similar to pumpage after 2000.

Pumpage used in the GAM calibration reflected the historic groundwater pumpage estimates in the TWDB database. Of this pumpage, 90 percent was from the Evangeline Aquifer and 10 percent from the Chicot Aquifer. Most of the pumpage from the Evangeline Aquifer and all of

the pumpage from the Chicot Aquifer in the historic pumpage dataset is evenly distributed at low rates across the part of the county where each aquifer is present, except for several model cells believed to represent City of Goliad and Coleto Creek Power LP.

In addition to county-wide estimates, the TWDB has data available from annual water use surveys that have been conducted. These data provide some additional information about groundwater production from the Gulf Coast Aquifer System in Goliad County, specifically that approximately half of the municipal pumpage is from the City of Goliad, which is the only significant municipal water supply source in the county, and that the only other current water user group of any significant size is Coleto Creek Power LP.

5. Recommendations

Our recommendations based on the results of this investigation are as follows:

- The DFC compliance methodology should monitor and evaluate the Chicot, Evangeline, and Jasper Aquifers separately. This will provide the District with flexibility in managing groundwater use within Goliad County.
- Because the official DFC is 10 feet of drawdown over 70 years for the entire Gulf Coast Aquifer System, we recommend assuming this means 10 feet of drawdown for each of the three aquifer units in the Gulf Coast Aquifer System.
- The assessment of DFC compliance should not be done using each well in the monitoring well network equally. Because of the spatial distribution of the wells, some of the wells should be grouped prior to calculating DFC compliance. This will eliminate bias that could be introduced into the calculations due to the locations of the wells.
- The monitoring well network should be expanded, attempting to identify and begin measuring wells in areas not already monitored. Although the DFC is an average water level decline over the entire District, water levels are currently monitored in only about half of the county. It would benefit the District to incorporate monitor wells away from the areas where large numbers of monitoring wells are already located, if possible, into the monitoring program.
- The District should organize and fully evaluate the permitted pumpage and production under both historic use and regular permits.
- The District should contact the TWDB about updating the estimates of historic pumpage based on the District's understanding of pumpage history and patterns within Goliad County. This includes the county-wide estimates of irrigation and livestock pumpage since 1980. . Historic pumpage estimates should also include reviewing pumpage for oil and gas supply within Goliad County.
- The District should review and compile all permits, both regular and historic use, issued by the District into a single dataset. Wells associated with permits should be identified, and as much information as possible should be gathered for each permitted well. The aquifer that each well/permit applies to should also be identified.

- The District should review and compile the information on all known wells in the District into a single dataset that includes well location, depth, aquifer the well is completed in, type of use and other factors.
- The District should review and compile all water quality sampling data that has been done by the District in the last 15 years. The information provided by the District indicates that hundreds of wells have been sampled, and this data should be compiled into a county-wide summary of groundwater quality conditions. Similar studies have been, or are being, conducted by other GCDs in the region, including Fayette County GCD and Pecan Valley GCD.
- The District should finalize a methodology for DFC compliance assessment. Completion of this task is dependent on the results and implementation of the above recommendations, especially the expansion of the water level monitoring network.
- The District should request that GMA 15 evaluate the impact of the erroneous recharge data used for Goliad County and surrounding areas in the model calibration. The District should also ensure that the erroneous recharge data used in the previous GAM calibration is corrected in the current revision of the GAM being conducted by the TWDB.

6. References

Baker, E.T., 1979- Stratigraphic and hydrogeologic framework of part of the coastal plain of Texas: Texas Water Development Board Report 236; July, 1979; 18 pp.

Chowdhury, A.H., S. Wade, R.E. Mace, and C. Ridgeway, 2004- Groundwater availability model of the Central Gulf Coast Aquifer System: Munerical Simulations through 1999; Texas Water Development Board Groundwater Availability Modeling Section Model Report; September 27, 2004; 114 pp.

Dale, O.C., E.A. Moulder, and T. Arnow, 1957- Ground-water resources of Goliad County, Texas; Texas Board of Water Engineers Bulletin 5711; September, 1957; 102 pp.

Goswami, R.R., 2017- GAM Run 16-025 MAG: Modeled available groundwater for the Gulf Coast Aquifer System in Groundwater Management Area 15; Texas Water Development Board Groundwater Availability Modeling Section GAM Run Report; March 22, 2017; 16 pp.

McLendon, T., J.D. Booker, C.L. Coldren, and C.R. Pappas, 2016- Development of an EDYS ecological model for Goliad County, Texas; report prepared for the San Antonio River Authority and Texas State Soil and Water Conservation Board; August, 2016; 243 pp.

Scanlon, B.R., A. Dutton, and M. Sophocleous, 2010- Groundwater recharge in Texas; special report prepared for the Texas Water Development Board; 2010; 84 pp.

Young, S.C., T. Budge, P.R. Knox, E. Baker, S. Hamlin, B. Galloway, and N. Deeds, 2010- Hydrostratigraphy of the Gulf Coast Aquifer from the Brazos River to the Rio Grande; report prepared fo rthe Texas Water Development Board; February, 2010; 213 pp.

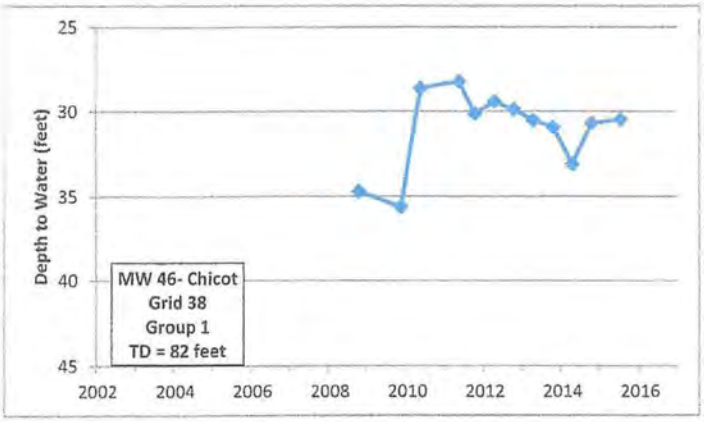
Young, S.C., 2016- Desired future conditions Explanatory Report for Groundwater Management Area 15; Consultant report prepared for Groundwater Management Area 15; June 14, 2016; 818 pp.

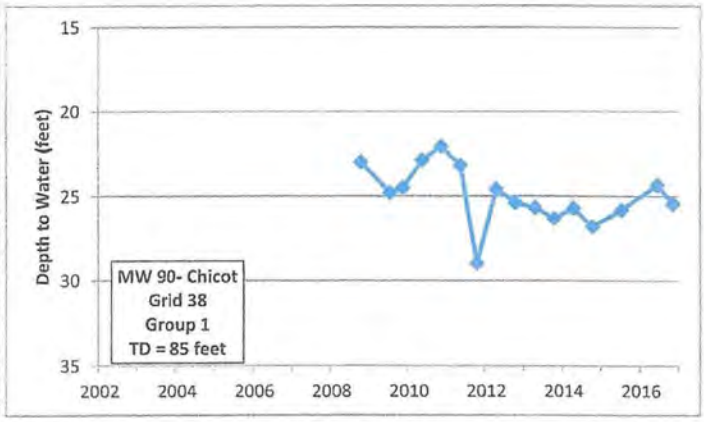
GMA 15 Reports- Various reports done as part of the joint groundwater planning process for Groundwater Management Area (GMA) 15, which includes Goliad County.

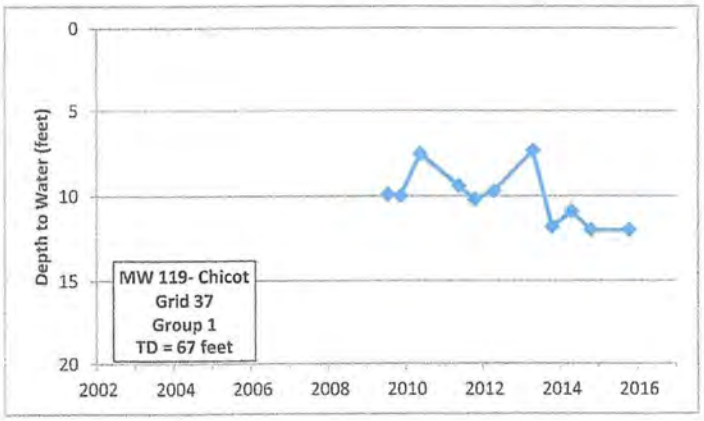
Appendix A

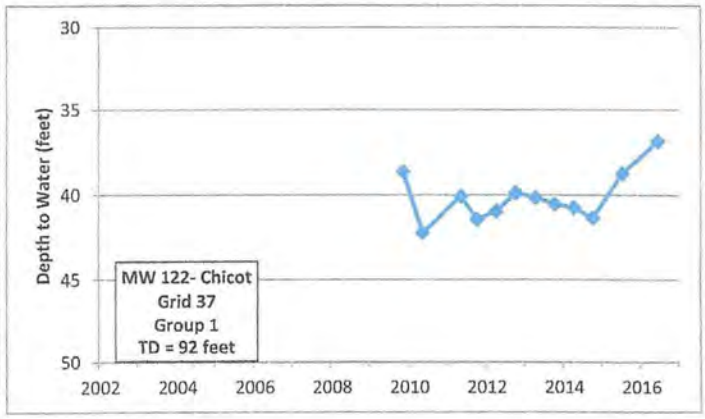
Hydrographs

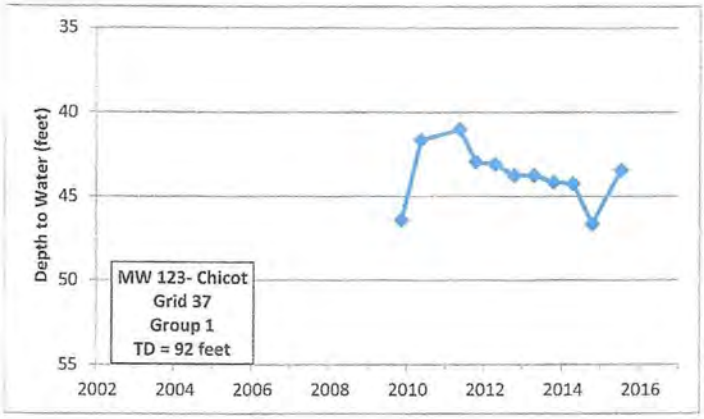
Group 1 Hydrographs

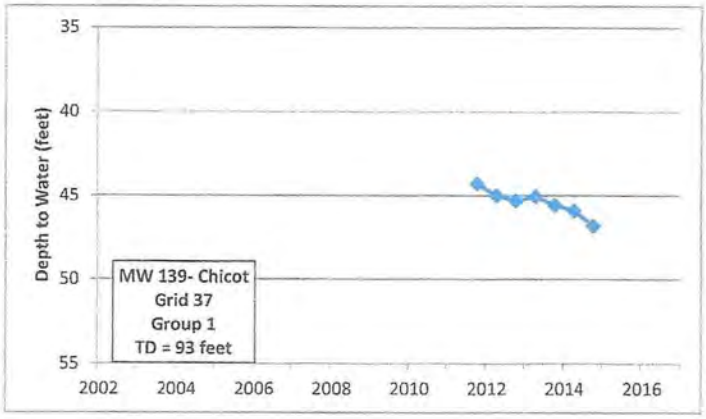

Depth to Water (feet)
25
30
35
40
45
2002
2004
2006
2008
2010
2012
2014
2016
MW 46- Chicot
Grid 38
Group 1
TD = 82 feet


Depth to Water (feet)
15
20
25
30
35
2002
2004
2006
2008
2010
2012
2014
2016
MW 90- Chicot
Grid 38
Group 1
TD = 85 feet

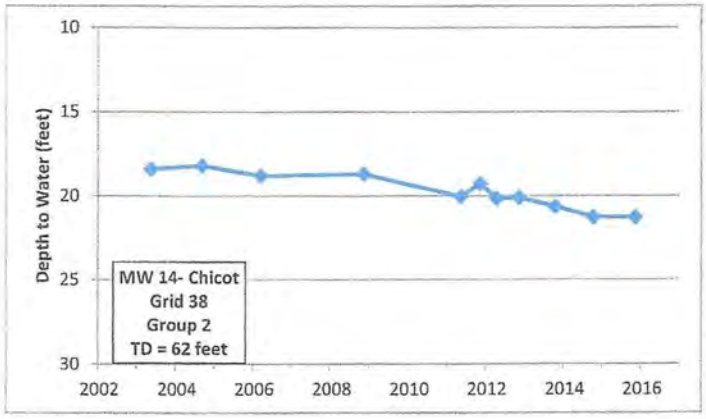

Depth to Water (feet)
0
5
10
15
20
2002
2004
2006
2008
2010
2012
2014
2016
MW 119- Chicot
Grid 37
Group 1
TD = 67 feet

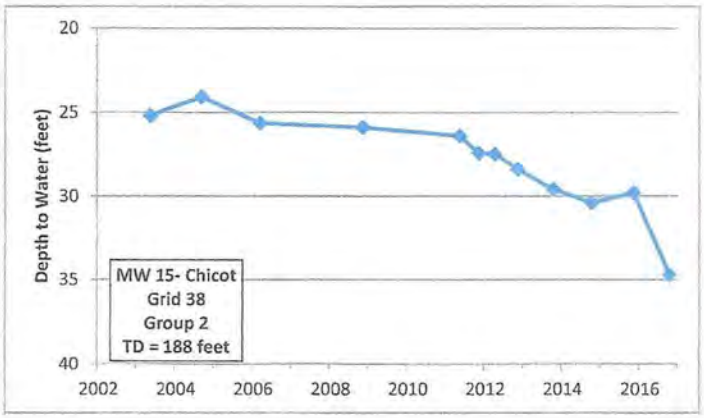

Depth to Water (feet)
30
35
40
45
50
2002
2004
2006
2008
2010
2012
2014
2016
MW 122- Chicot
Grid 37
Group 1
TD = 92 feet

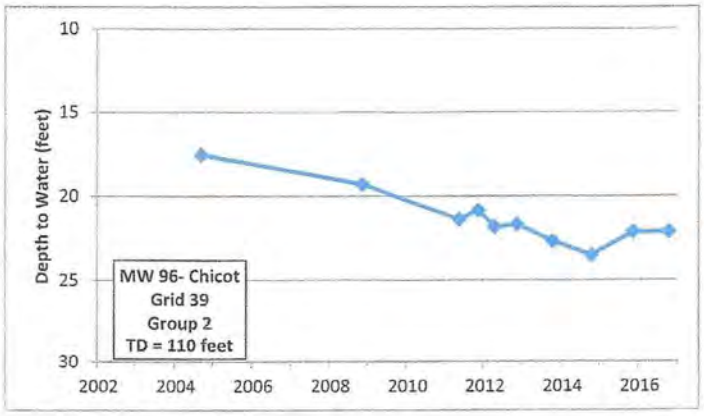

35
40
45
50
55
Depth to Water (feet)
MW 123- Chicot
Grid 37
Group 1
TD = 92 feet
2002
2004
2006
2008
2010
2012
2014
2016

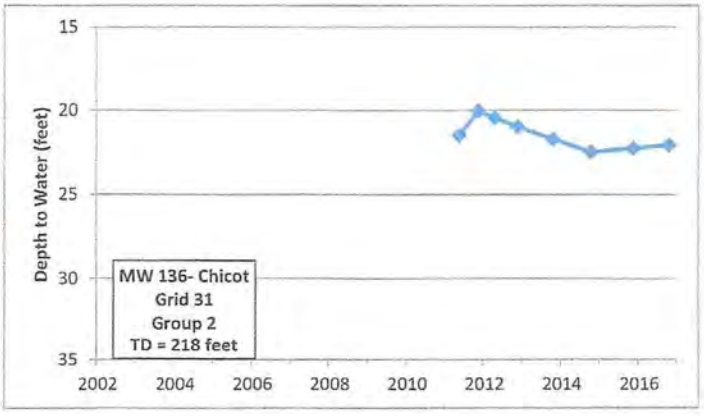

35
40
45
50
55
Depth to Water (feet)
MW 139- Chicot
Grid 37
Group 1
TD = 93 feet
2002
2004
2006
2008
2010
2012
2014
2016

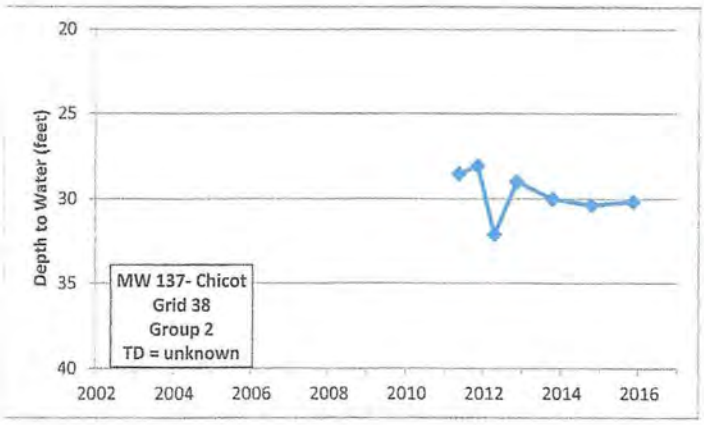
Group 2 Hydrographs

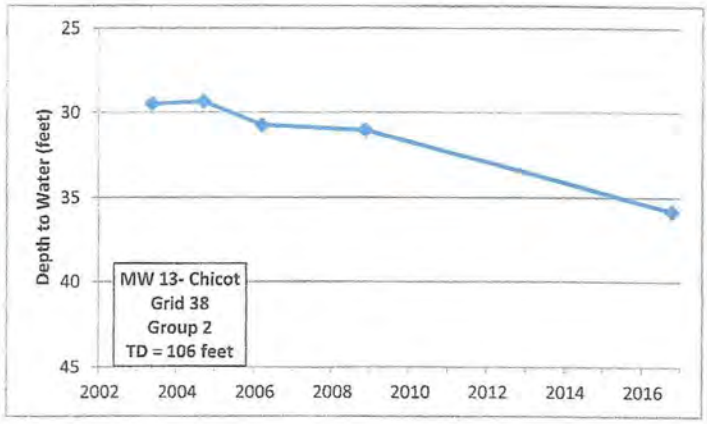

Depth to Water (feet)
10
15
20
25
30
2002
2004
2006
2008
2010
2012
2014
2016
MW 14- Chicot
Grid 38
Group 2
TD = 62 feet


Depth to Water (feet)
20
25
30
35
40
2002
2004
2006
2008
2010
2012
2014
2016
MW 15- Chicot
Grid 38
Group 2
TD = 188 feet

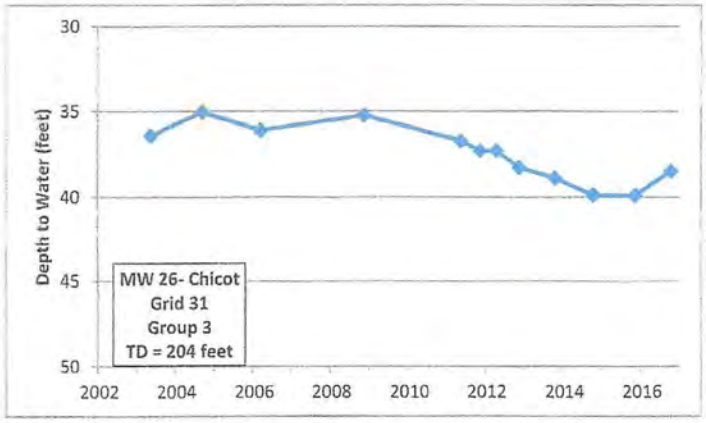

Depth to Water (feet)
10
15
20
25
30
2002
2004
2006
2008
2010
2012
2014
2016
MW 96- Chicot
Grid 39
Group 2
TD = 110 feet

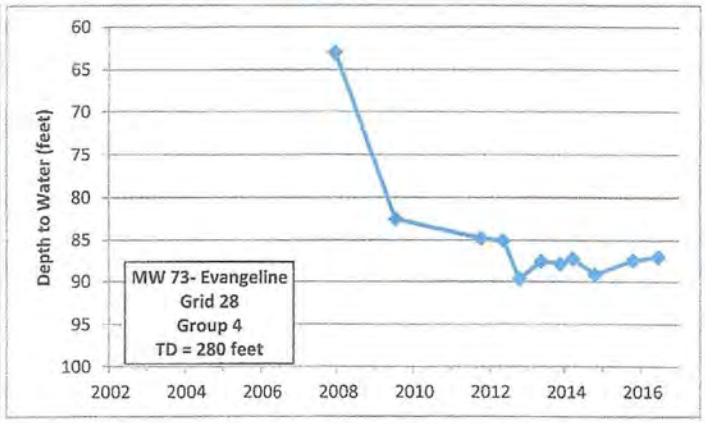

Depth to Water (feet)
15
20
25
30
35
2002
2004
2006
2008
2010
2012
2014
2016
MW 136- Chicot
Grid 31
Group 2
TD = 218 feet


20
25
30
35
40
Depth to Water (feet)
MW 137- Chicot
Grid 38
Group 2
TD = unknown
2002
2004
2006
2008
2010
2012
2014
2016

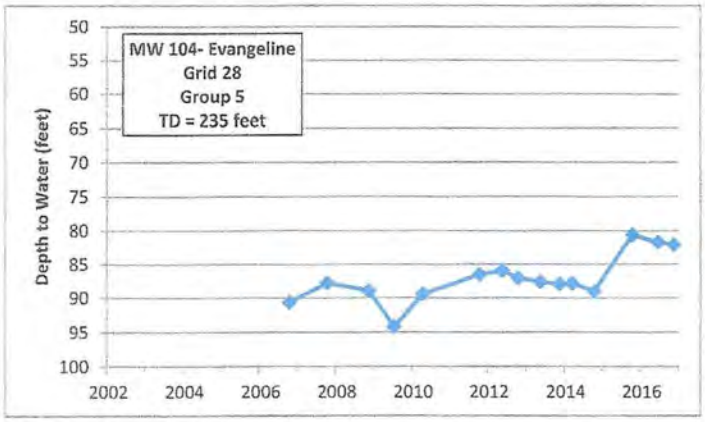

25
30
35
40
45
Depth to Water (feet)
MW 13- Chicot
Grid 38
Group 2
TD = 106 feet
2002
2004
2006
2008
2010
2012
2014
2016

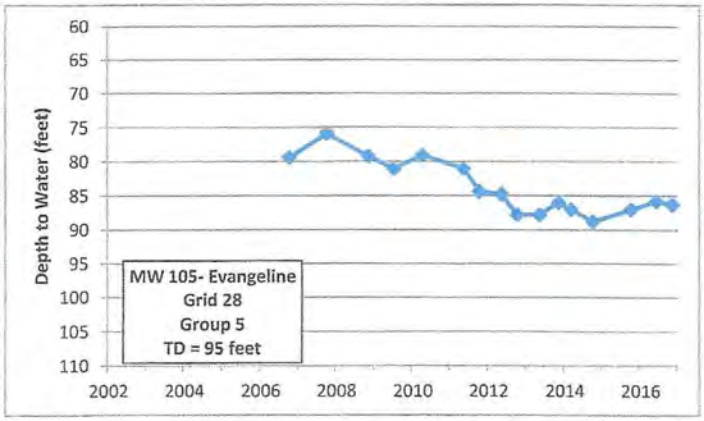
Groups 3 and 4 Hydrographs

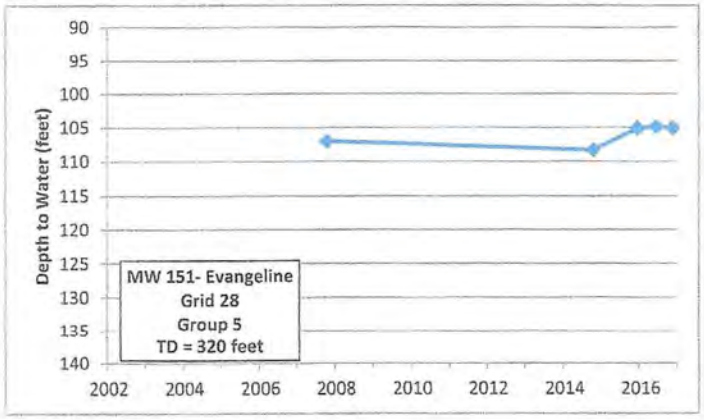

Depth to Water (feet)
30
35
40
45
50
2002
2004
2006
2008
2010
2012
2014
2016
MW 26- Chicot
Grid 31
Group 3
TD = 204 feet


Depth to Water (feet)
60
65
70
75
80
85
90
95
100
2002
2004
2006
2008
2010
2012
2014
2016
MW 73- Evangeline
Grid 28
Group 4
TD = 280 feet

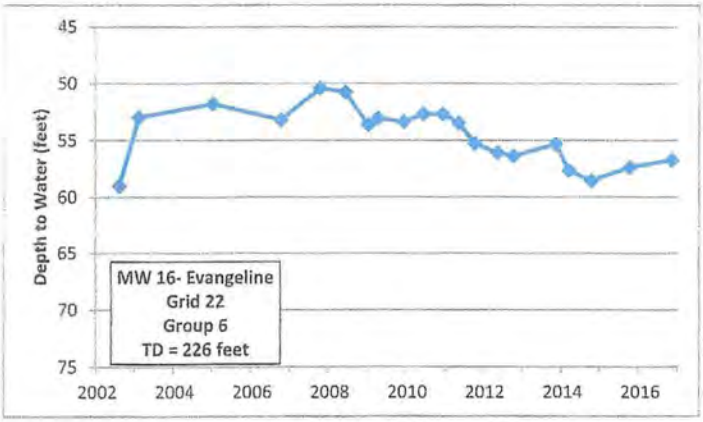
Group 5 Hydrographs

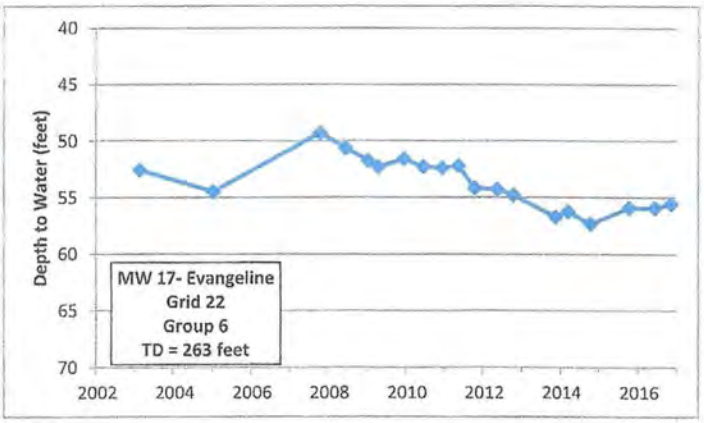

MW 104- Evangeline
Grid 28
Group 5
TD = 235 feet
Depth to Water (feet)
50
55
60
65
70
75
80
85
90
95
100
2002
2004
2006
2008
2010
2012
2014
2016

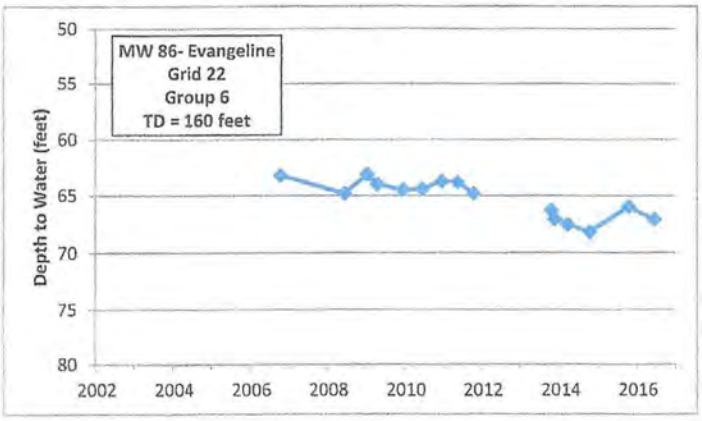

MW 105- Evangeline
Grid 28
Group 5
TD = 95 feet
Depth to Water (feet)
60
65
70
75
80
85
90
95
100
105
110
2002
2004
2006
2008
2010
2012
2014
2016


MW 151- Evangeline
Grid 28
Group 5
TD = 320 feet
Depth to Water (feet)
90
95
100
105
110
115
120
125
130
135
140
2002
2004
2006
2008
2010
2012
2014
2016

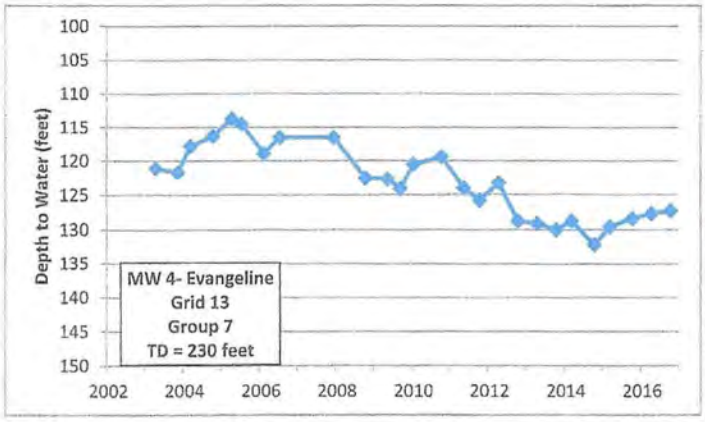
Group 6 Hydrographs

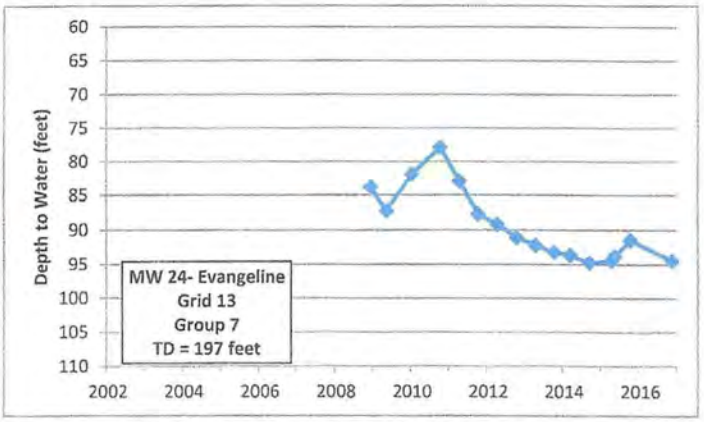

Depth to Water (feet)
45
50
55
60
65
70
75
2002
2004
2006
2008
2010
2012
2014
2016
MW 16- Evangeline
Grid 22
Group 6
TD = 226 feet

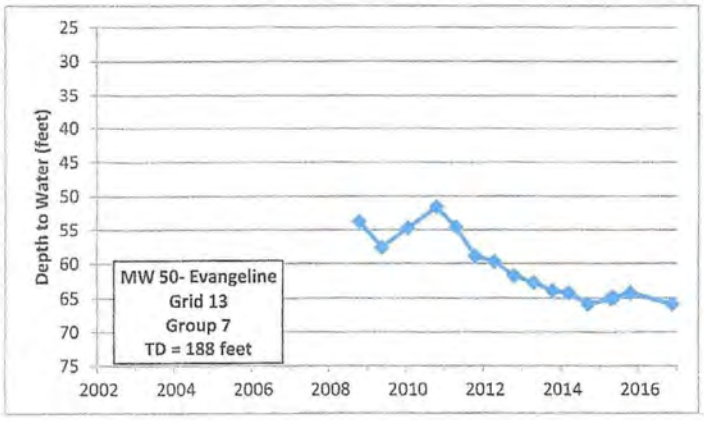

Depth to Water (feet)
40
45
50
55
60
65
70
2002
2004
2006
2008
2010
2012
2014
2016
MW 17- Evangeline
Grid 22
Group 6
TD = 263 feet

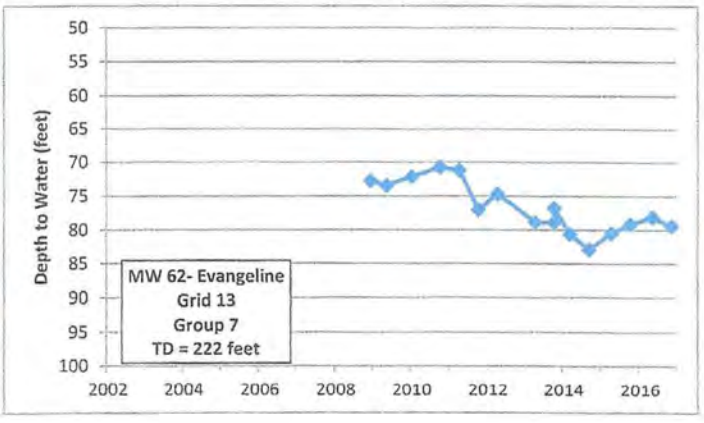

Depth to Water (feet)
50
55
60
65
70
75
80
2002
2004
2006
2008
2010
2012
2014
2016
MW 86- Evangeline
Grid 22
Group 6
TD = 160 feet

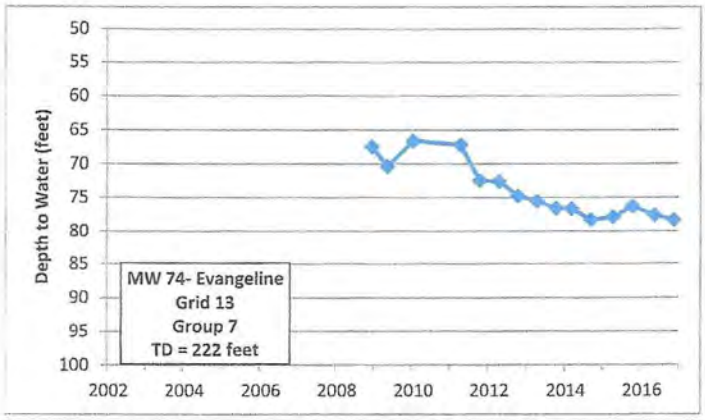
Group 7 Hydrographs

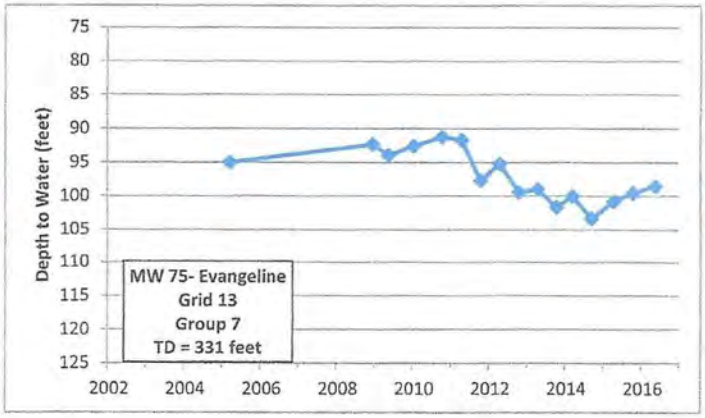

Depth to Water (feet)
100
105
110
115
120
125
130
135
140
145
150
2002
2004
2006
2008
2010
2012
2014
2016
MW 4- Evangeline
Grid 13
Group 7
TD = 230 feet

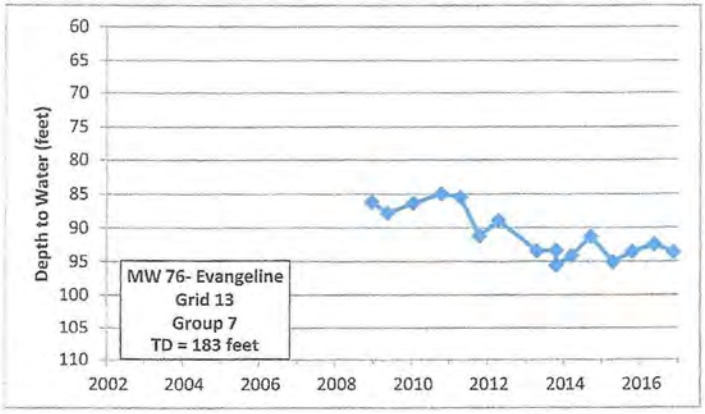

Depth to Water (feet)
60
65
70
75
80
85
90
95
100
105
110
2002
2004
2006
2008
2010
2012
2014
2016
MW 24- Evangeline
Grid 13
Group 7
TD = 197 feet

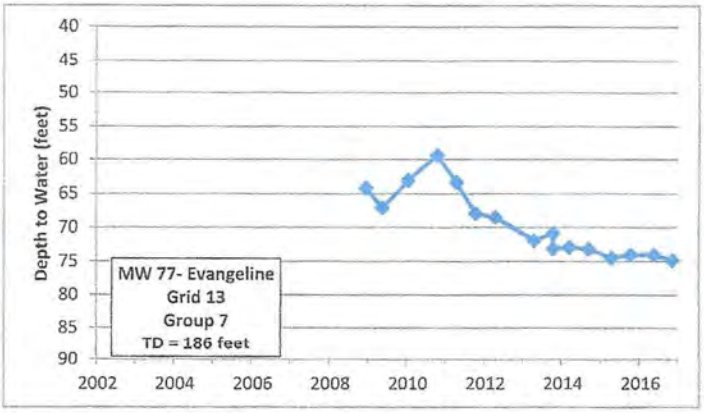

Depth to Water (feet)
25
30
35
40
45
50
55
60
65
70
75
2002
2004
2006
2008
2010
2012
2014
2016
MW 50- Evangeline
Grid 13
Group 7
TD = 188 feet

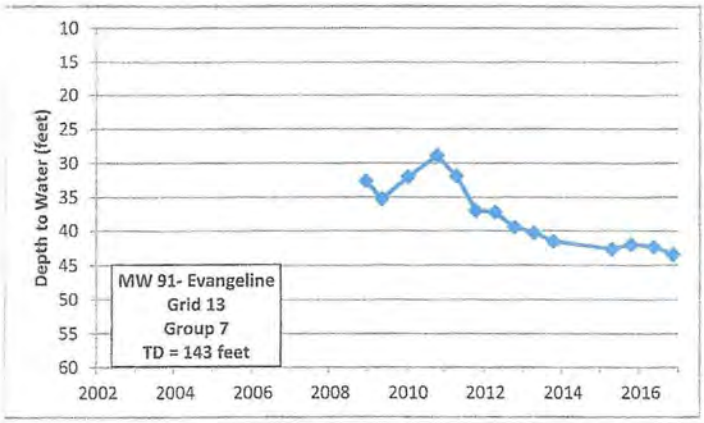

Depth to Water (feet)
50
55
60
65
70
75
80
85
90
95
100
2002
2004
2006
2008
2010
2012
2014
2016
MW 62- Evangeline
Grid 13
Group 7
TD = 222 feet

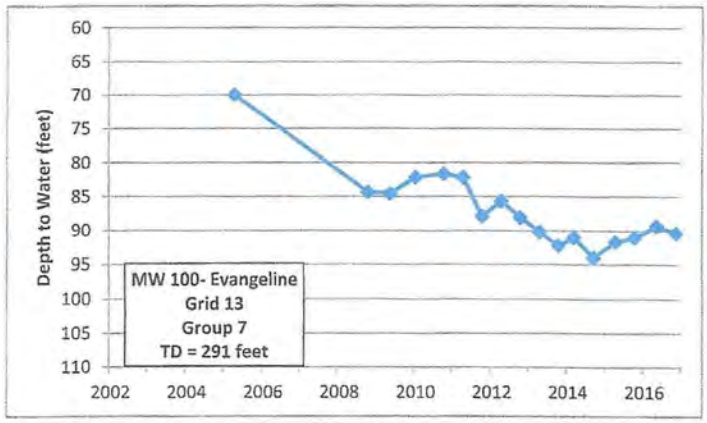

Depth to Water (feet)
50
55
60
65
70
75
80
85
90
95
100
2002
2004
2006
2008
2010
2012
2014
2016
MW 74- Evangeline
Grid 13
Group 7
TD = 222 feet

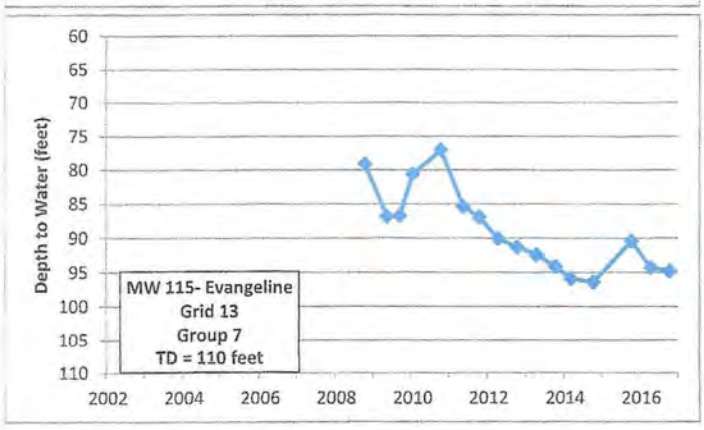

Depth to Water (feet)
75
80
85
90
95
100
105
110
115
120
125
2002
2004
2006
2008
2010
2012
2014
2016
MW 75- Evangeline
Grid 13
Group 7
TD = 331 feet

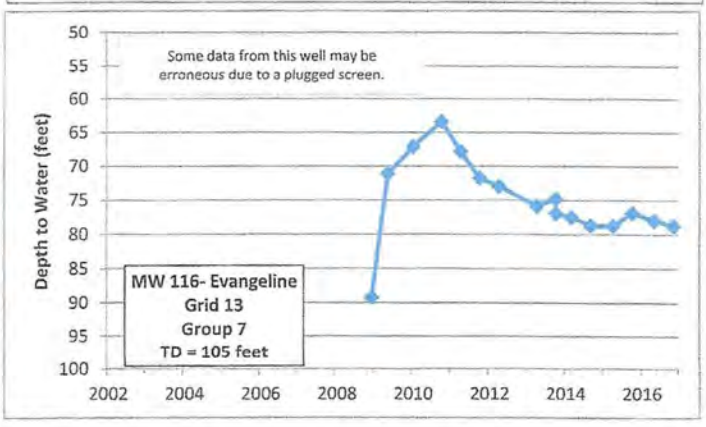

Depth to Water (feet)
60
65
70
75
80
85
90
95
100
105
110
2002
2004
2006
2008
2010
2012
2014
2016
MW 76- Evangeline
Grid 13
Group 7
TD = 183 feet

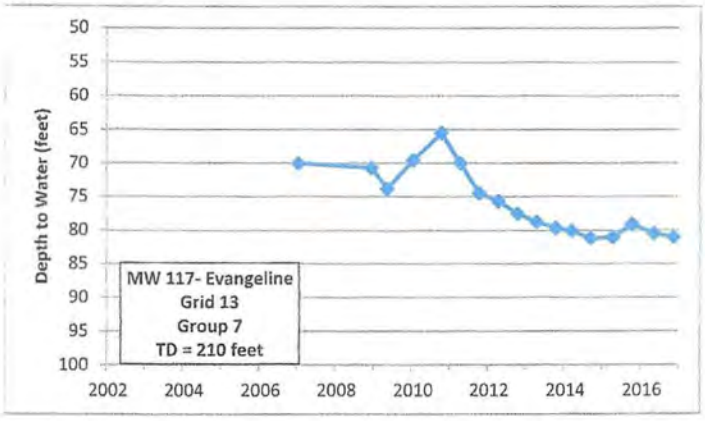

Depth to Water (feet)
40
45
50
55
60
65
70
75
80
85
90
2002
2004
2006
2008
2010
2012
2014
2016
MW 77- Evangeline
Grid 13
Group 7
TD = 186 feet


Depth to Water (feet)
10
15
20
25
30
35
40
45
50
55
60
2002
2004
2006
2008
2010
2012
2014
2016
MW 91- Evangeline
Grid 13
Group 7
TD = 143 feet

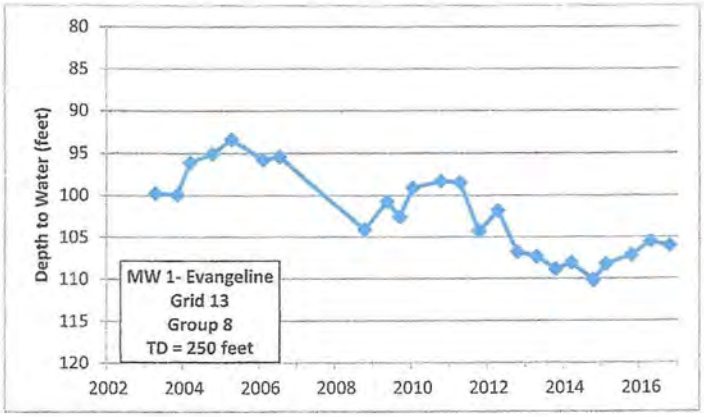

Depth to Water (feet)
60
65
70
75
80
85
90
95
100
105
110
2002
2004
2006
2008
2010
2012
2014
2016
MW 100- Evangeline
Grid 13
Group 7
TD = 291 feet

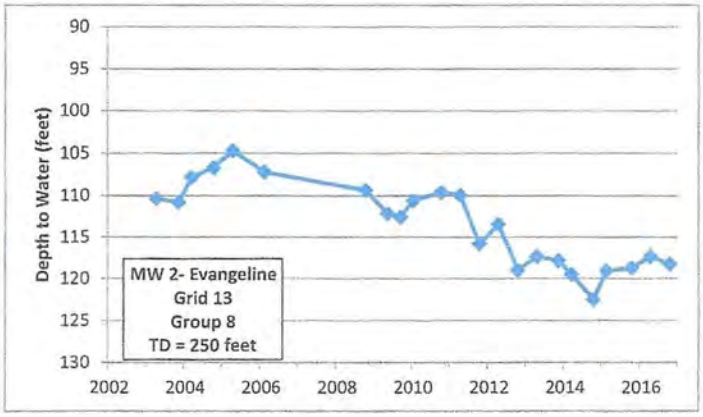

Depth to Water (feet)
60
65
70
75
80
85
90
95
100
105
110
2002
2004
2006
2008
2010
2012
2014
2016
MW 115- Evangeline
Grid 13
Group 7
TD = 110 feet

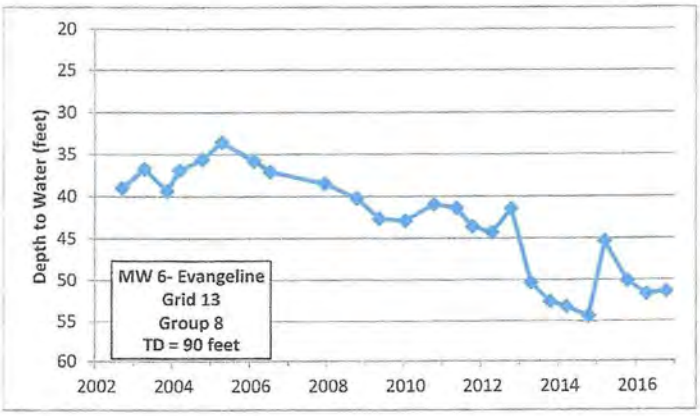

Depth to Water (feet)
50
55
60
65
70
75
80
85
90
95
100
2002
2004
2006
2008
2010
2012
2014
2016
Some data from this well may be erroneous due to a plugged screen.
MW 116- Evangeline
Grid 13
Group 7
TD = 105 feet

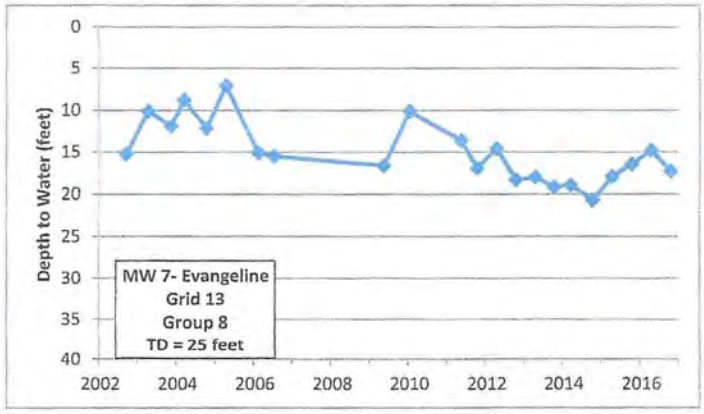

Depth to Water (feet)
50
55
60
65
70
75
80
85
90
95
100
2002
2004
2006
2008
2010
2012
2014
2016
MW 117- Evangeline
Grid 13
Group 7
TD = 210 feet

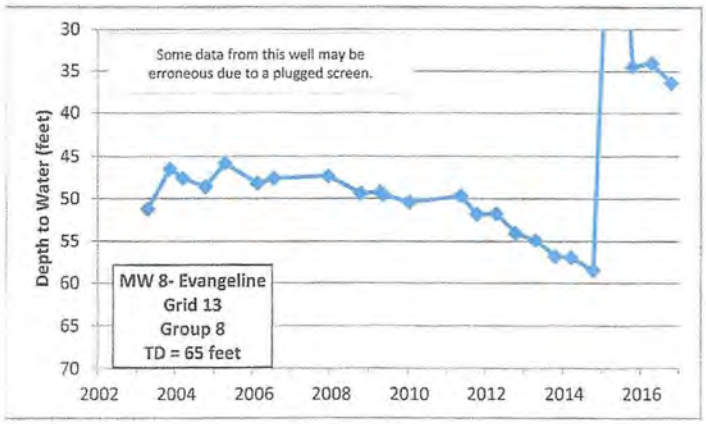
Group 8 Hydrographs

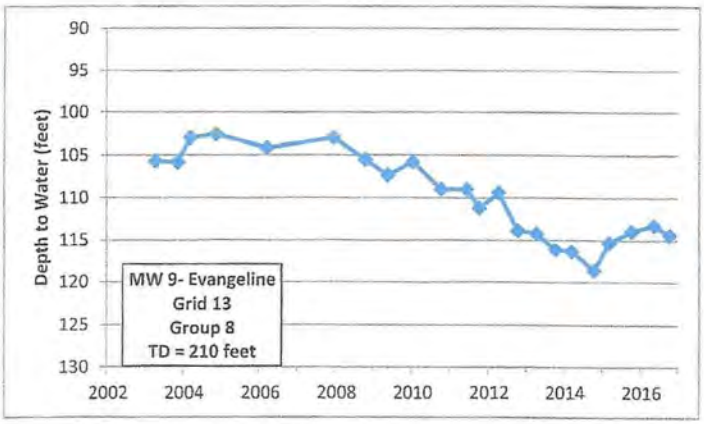

Depth to Water (feet)
80
85
90
95
100
105
110
115
120
2002
2004
2006
2008
2010
2012
2014
2016
MW 1- Evangeline
Grid 13
Group 8
TD = 250 feet

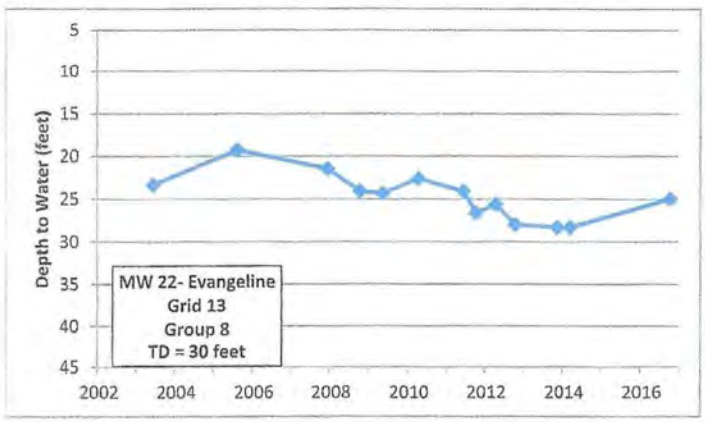

Depth to Water (feet)
90
95
100
105
110
115
120
125
130
2002
2004
2006
2008
2010
2012
2014
2016
MW 2- Evangeline
Grid 13
Group 8
TD = 250 feet

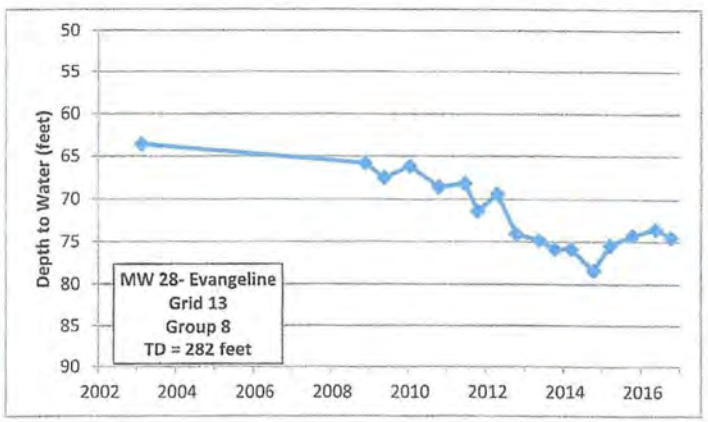

Depth to Water (feet)
20
25
30
35
40
45
50
55
60
2002
2004
2006
2008
2010
2012
2014
2016
MW 6- Evangeline
Grid 13
Group 8
TD = 90 feet

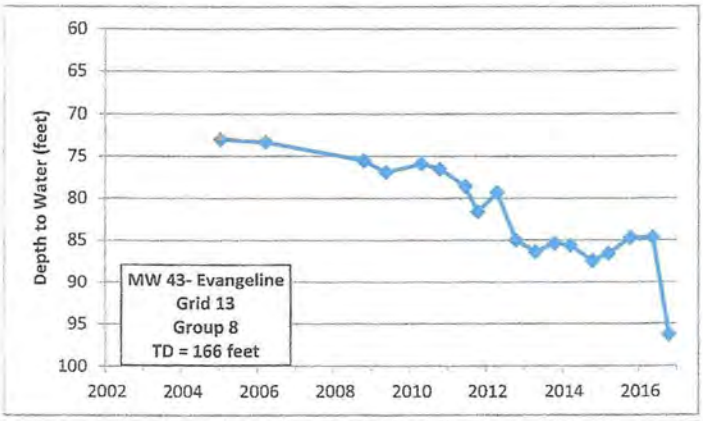

Depth to Water (feet)
0
5
10
15
20
25
30
35
40
2002
2004
2006
2008
2010
2012
2014
2016
MW 7- Evangeline
Grid 13
Group 8
TD = 25 feet

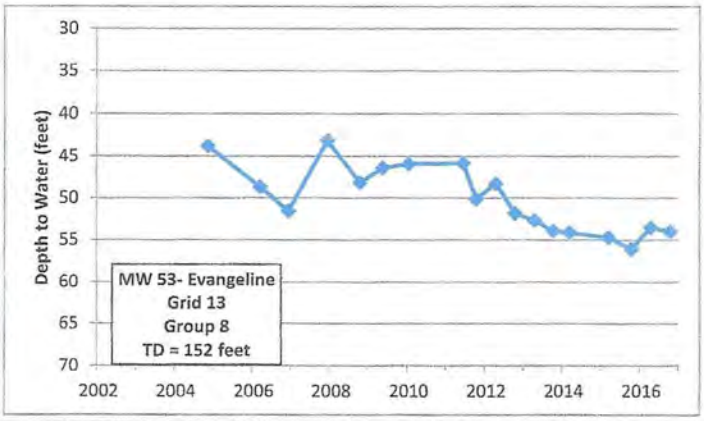

Some data from this well may be erroneous due to a plugged screen.
MW 8- Evangeline
Grid 13
Group 8
TD = 65 feet
Depth to Water (feet)
30
35
40
45
50
55
60
65
70
2002
2004
2006
2008
2010
2012
2014
2016

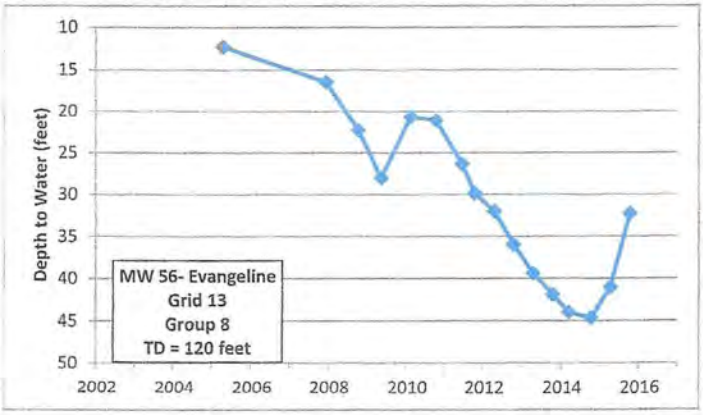

MW 9- Evangeline
Grid 13
Group 8
TD = 210 feet
Depth to Water (feet)
90
95
100
105
110
115
120
125
130
2002
2004
2006
2008
2010
2012
2014
2016

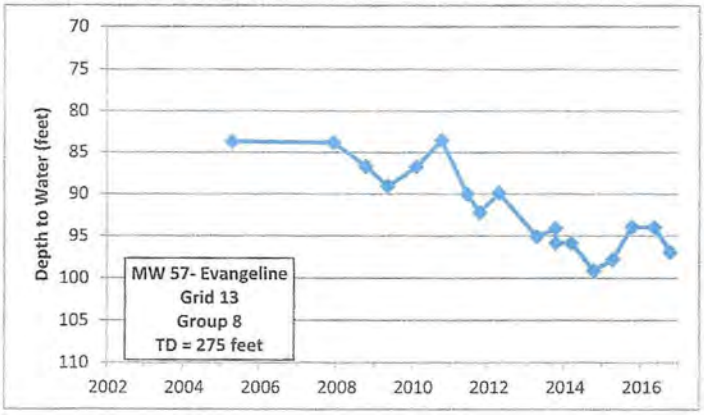

MW 22- Evangeline
Grid 13
Group 8
TD = 30 feet
Depth to Water (feet)
5
10
15
20
25
30
35
40
45
2002
2004
2006
2008
2010
2012
2014
2016

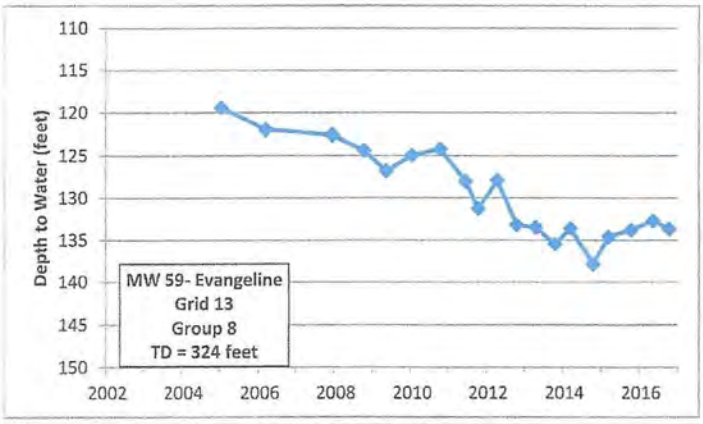

MW 28- Evangeline
Grid 13
Group 8
TD = 282 feet
Depth to Water (feet)
50
55
60
65
70
75
80
85
90
2002
2004
2006
2008
2010
2012
2014
2016

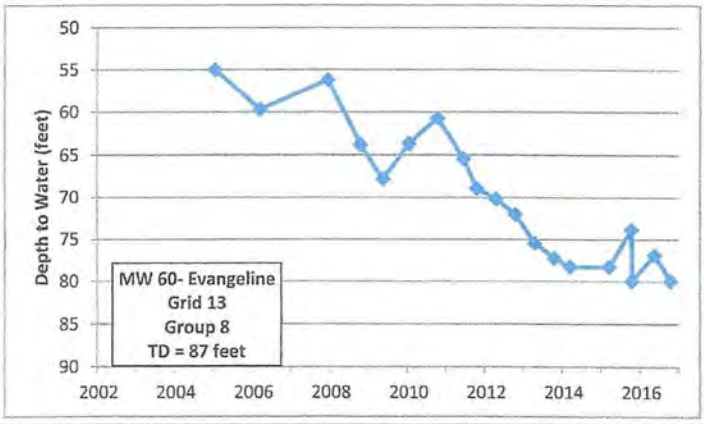

Depth to Water (feet)
60
65
70
75
80
85
90
95
100
2002
2004
2006
2008
2010
2012
2014
2016
MW 43- Evangeline
Grid 13
Group 8
TD = 166 feet

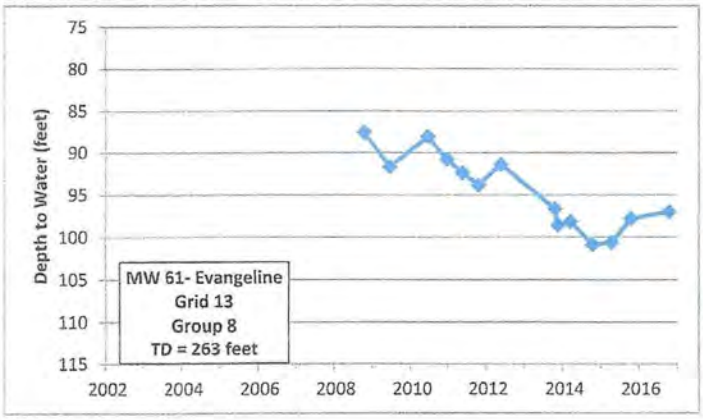

Depth to Water (feet)
30
35
40
45
50
55
60
65
70
2002
2004
2006
2008
2010
2012
2014
2016
MW 53- Evangeline
Grid 13
Group 8
TD = 152 feet

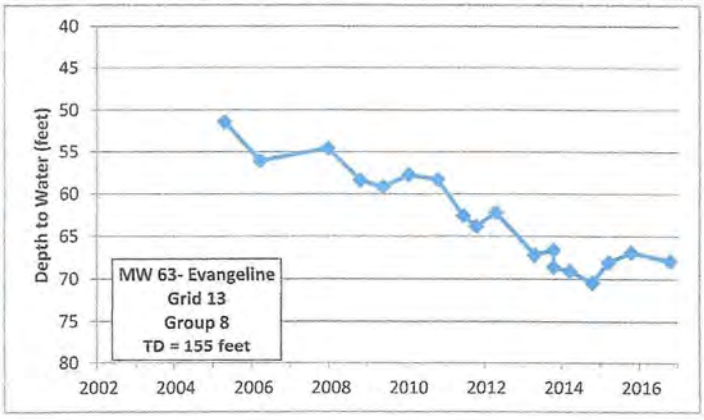

Depth to Water (feet)
10
15
20
25
30
35
40
45
50
2002
2004
2006
2008
2010
2012
2014
2016
MW 56- Evangeline
Grid 13
Group 8
TD = 120 feet

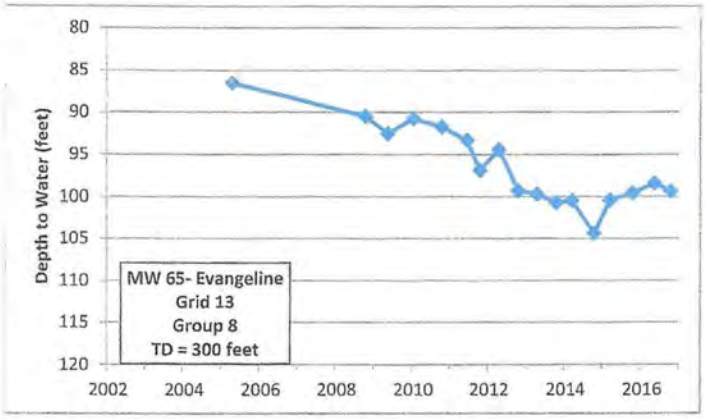

Depth to Water (feet)
70
75
80
85
90
95
100
105
110
2002
2004
2006
2008
2010
2012
2014
2016
MW 57- Evangeline
Grid 13
Group 8
TD = 275 feet

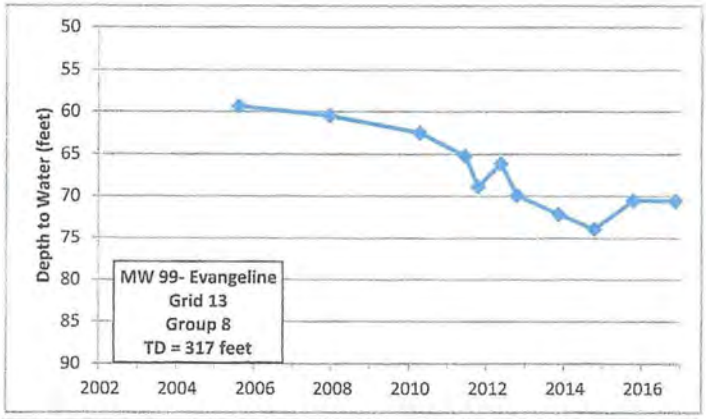

Depth to Water (feet)
110
115
120
125
130
135
140
145
150
2002
2004
2006
2008
2010
2012
2014
2016
MW 59- Evangeline
Grid 13
Group 8
TD = 324 feet

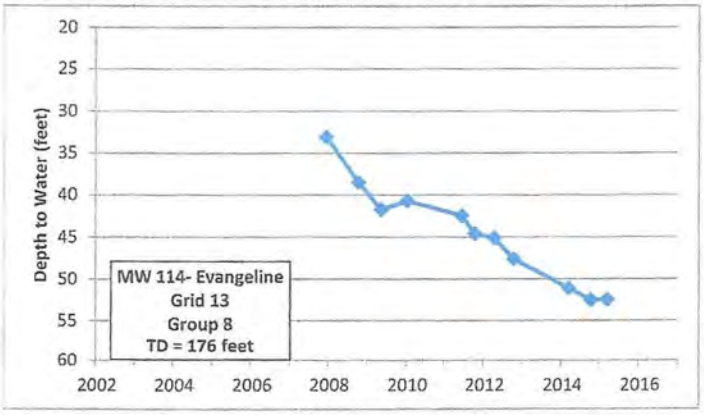

Depth to Water (feet)
50
55
60
65
70
75
80
85
90
2002
2004
2006
2008
2010
2012
2014
2016
MW 60- Evangeline
Grid 13
Group 8
TD = 87 feet

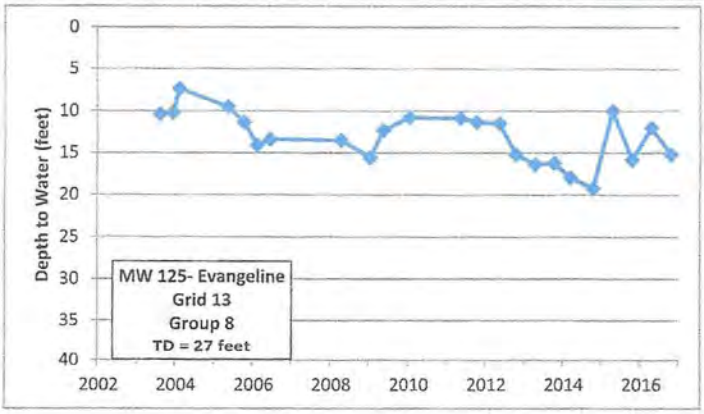

Depth to Water (feet)
75
80
85
90
95
100
105
110
115
2002
2004
2006
2008
2010
2012
2014
2016
MW 61- Evangeline
Grid 13
Group 8
TD = 263 feet


Depth to Water (feet)
40
45
50
55
60
65
70
75
80
2002
2004
2006
2008
2010
2012
2014
2016
MW 63- Evangeline
Grid 13
Group 8
TD = 155 feet

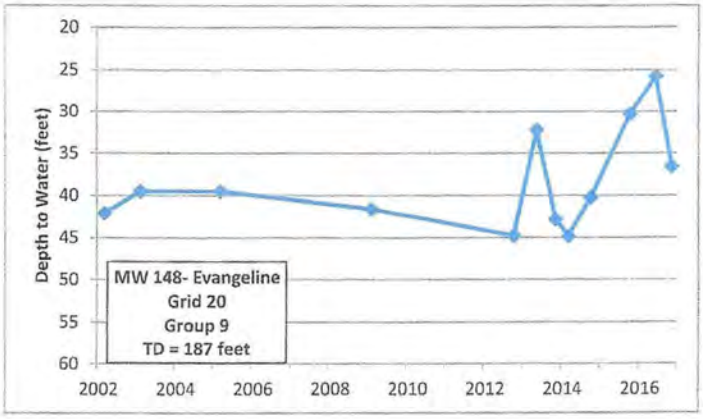

Depth to Water (feet)
80
85
90
95
100
105
110
115
120
2002
2004
2006
2008
2010
2012
2014
2016
MW 65- Evangeline
Grid 13
Group 8
TD = 300 feet

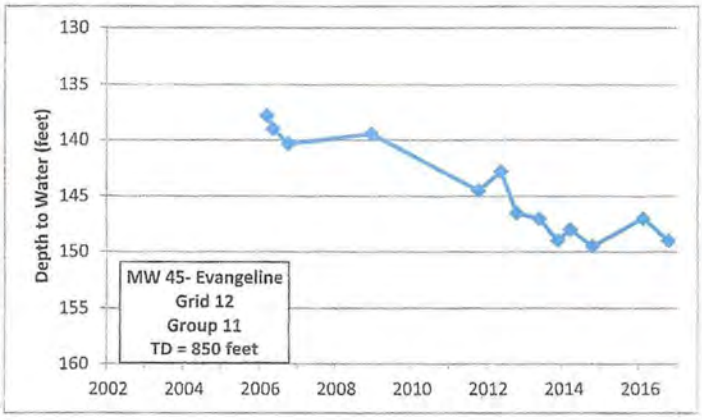

Depth to Water (feet)
50
55
60
65
70
75
80
85
90
2002
2004
2006
2008
2010
2012
2014
2016
MW 99- Evangeline
Grid 13
Group 8
TD = 317 feet


Depth to Water (feet)
20
25
30
35
40
45
50
55
60
2002
2004
2006
2008
2010
2012
2014
2016
MW 114- Evangeline
Grid 13
Group 8
TD = 176 feet

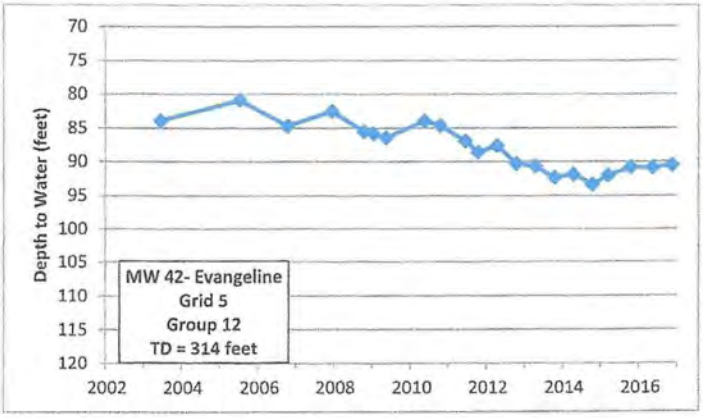

Depth to Water (feet)
0
5
10
15
20
25
30
35
40
2002
2004
2006
2008
2010
2012
2014
2016
MW 125- Evangeline
Grid 13
Group 8
TD = 27 feet

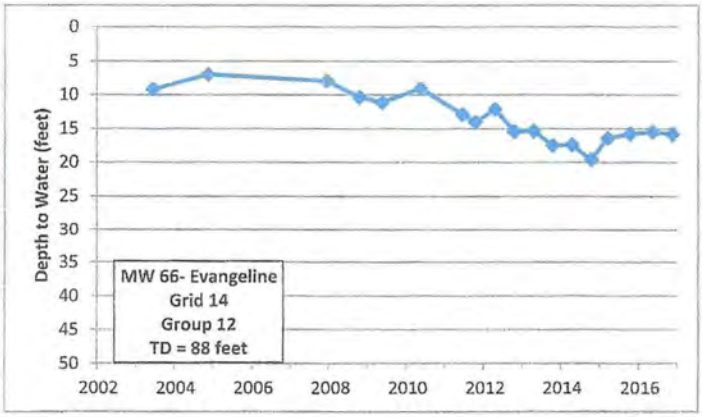
Groups 9 and 11 Hydrographs

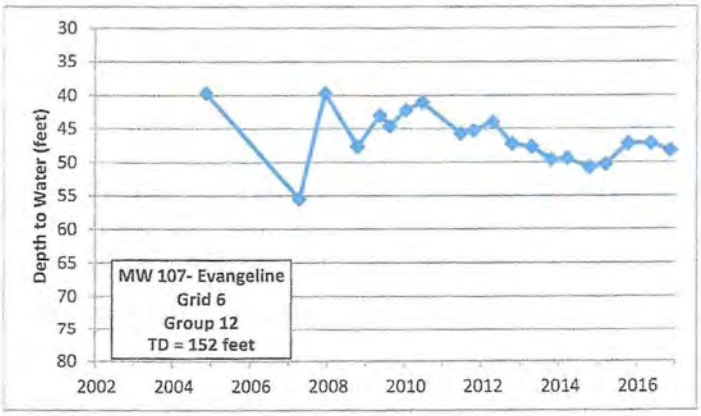

Depth to Water (feet)
20
25
30
35
40
45
50
55
60
2002
2004
2006
2008
2010
2012
2014
2016
MW 148- Evangeline
Grid 20
Group 9
TD = 187 feet

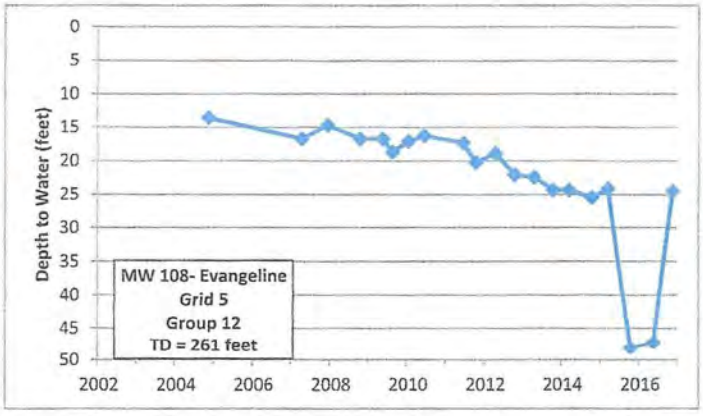

Depth to Water (feet)
130
135
140
145
150
155
160
2002
2004
2006
2008
2010
2012
2014
2016
MW 45- Evangeline
Grid 12
Group 11
TD = 850 feet

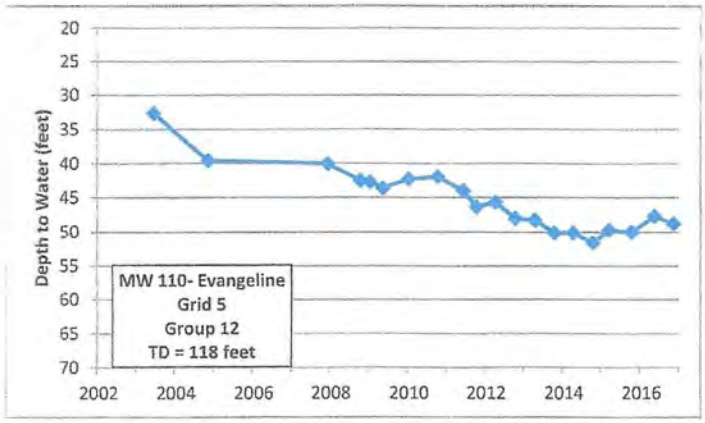
Group 12 Hydrographs

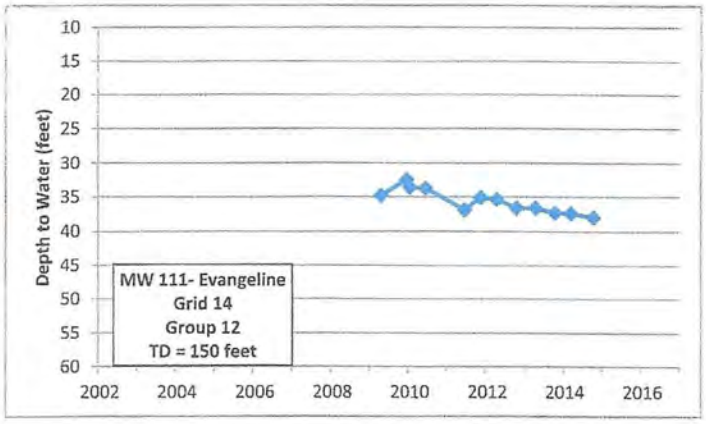

Depth to Water (feet)
70
75
80
85
90
95
100
105
110
115
120
2002
2004
2006
2008
2010
2012
2014
2016
MW 42- Evangeline
Grid 5
Group 12
TD = 314 feet

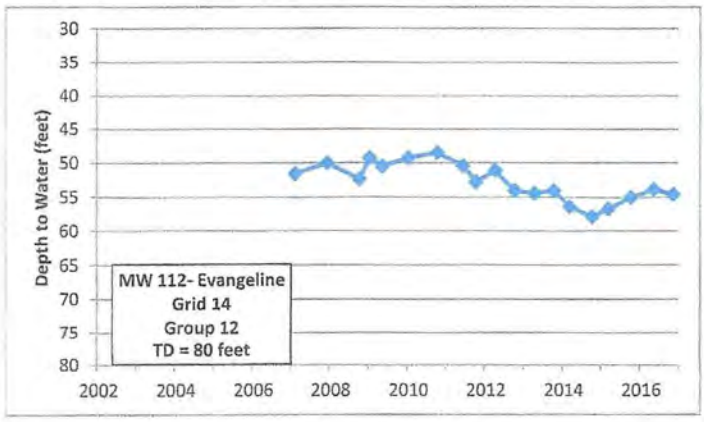

Depth to Water (feet)
0
5
10
15
20
25
30
35
40
45
50
2002
2004
2006
2008
2010
2012
2014
2016
MW 66- Evangeline
Grid 14
Group 12
TD = 88 feet

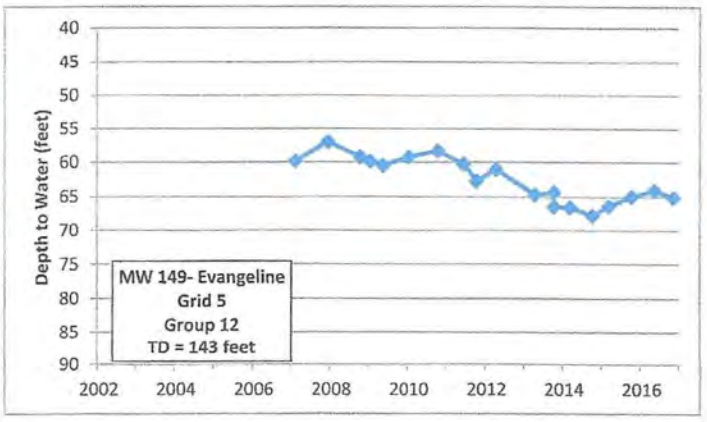

Depth to Water (feet)
30
35
40
45
50
55
60
65
70
75
80
2002
2004
2006
2008
2010
2012
2014
2016
MW 107- Evangeline
Grid 6
Group 12
TD = 152 feet


Depth to Water (feet)
0
5
10
15
20
25
30
35
40
45
50
2002
2004
2006
2008
2010
2012
2014
2016
MW 108- Evangeline
Grid 5
Group 12
TD = 261 feet

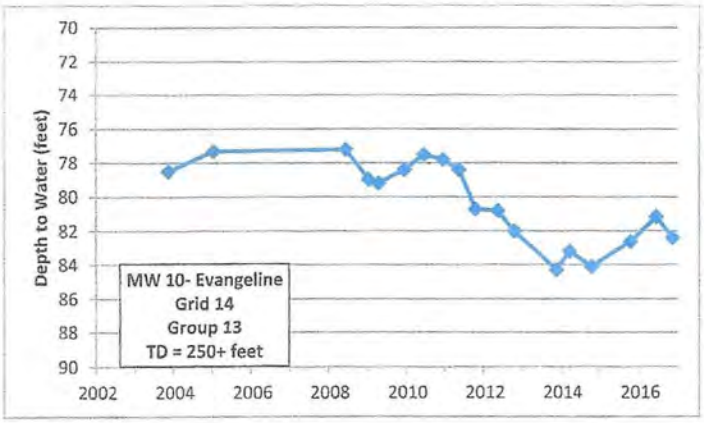

Depth to Water (feet)
20
25
30
35
40
45
50
55
60
65
70
2002
2004
2006
2008
2010
2012
2014
2016
MW 110- Evangeline
Grid 5
Group 12
TD = 118 feet

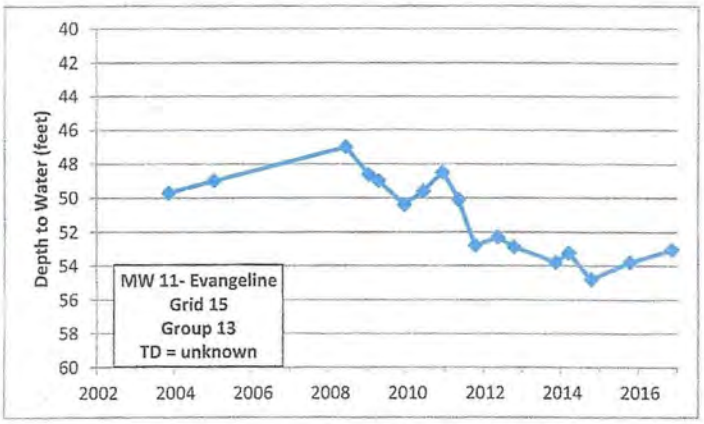

Depth to Water (feet)
10
15
20
25
30
35
40
45
50
55
60
2002
2004
2006
2008
2010
2012
2014
2016
MW 111- Evangeline
Grid 14
Group 12
TD = 150 feet

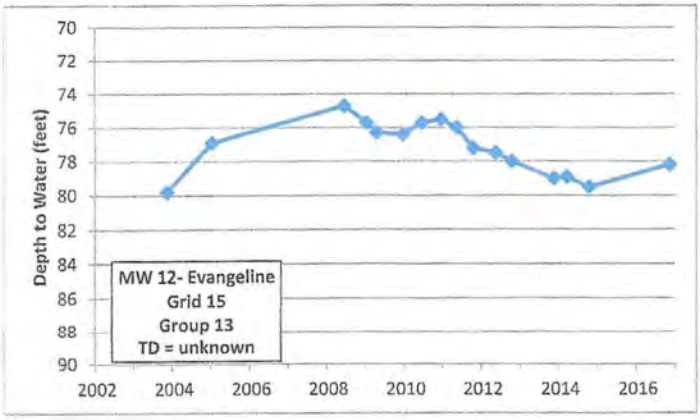

Depth to Water (feet)
30
35
40
45
50
55
60
65
70
75
80
2002
2004
2006
2008
2010
2012
2014
2016
MW 112- Evangeline
Grid 14
Group 12
TD = 80 feet

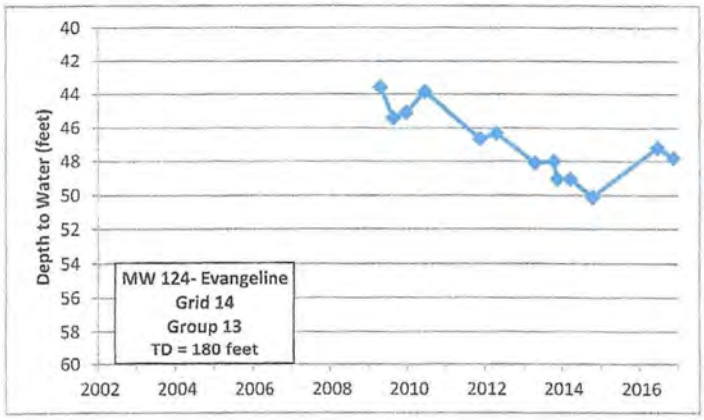

Depth to Water (feet)
40
45
50
55
60
65
70
75
80
85
90
2002
2004
2006
2008
2010
2012
2014
2016
MW 149- Evangeline
Grid 5
Group 12
TD = 143 feet

Group 13 Hydrographs

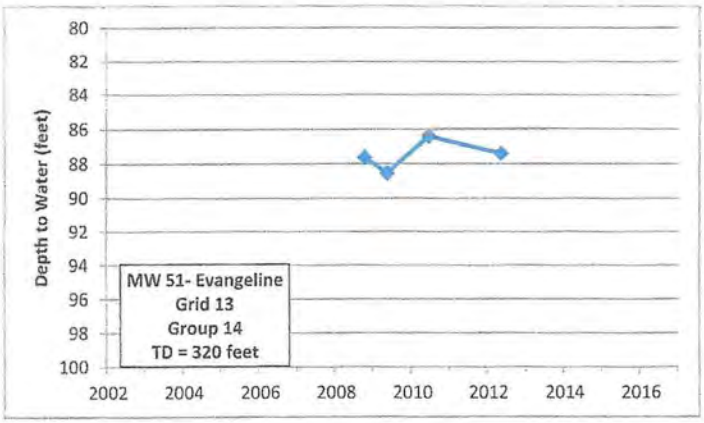

Depth to Water (feet)
70
72
74
76
78
80
82
84
86
88
90
2002
2004
2006
2008
2010
2012
2014
2016
MW 10- Evangeline
Grid 14
Group 13
TD = 250+ feet

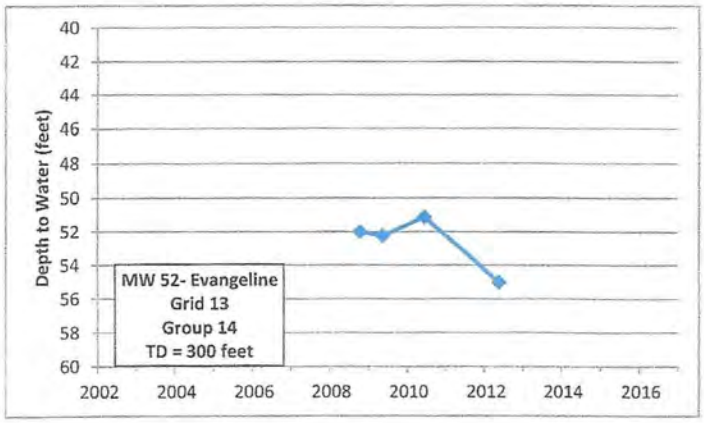

Depth to Water (feet)
40
42
44
46
48
50
52
54
56
58
60
2002
2004
2006
2008
2010
2012
2014
2016
MW 11- Evangeline
Grid 15
Group 13
TD = unknown


Depth to Water (feet)
70
72
74
76
78
80
82
84
86
88
90
2002
2004
2006
2008
2010
2012
2014
2016
MW 12- Evangeline
Grid 15
Group 13
TD = unknown


Depth to Water (feet)
40
42
44
46
48
50
52
54
56
58
60
2002
2004
2006
2008
2010
2012
2014
2016
MW 124- Evangeline
Grid 14
Group 13
TD = 180 feet

Group 14 Hydrographs


Depth to Water (feet)
80
82
84
86
88
90
92
94
96
98
100
2002
2004
2006
2008
2010
2012
2014
2016
MW 51- Evangeline
Grid 13
Group 14
TD = 320 feet

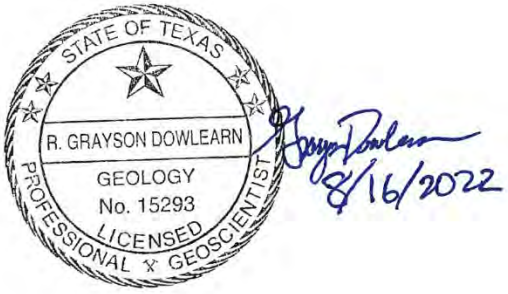

Depth to Water (feet)
40
42
44
46
48
50
52
54
56
58
60
2002
2004
2006
2008
2010
2012
2014
2016
MW 52- Evangeline
Grid 13
Group 14
TD = 300 feet

APPENDIX J

Gam Run 21-020 MAG: Modeled Available Groundwater

GAM Run 21-020 MAG: Modeled Available Groundwater for the Gulf Coast Aquifer System in Groundwater Management Area 15

Grayson Dowlearn, P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Section
512-475-1552
August 16, 2022



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GAM RUN 21-020 MAG: MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 15

Grayson Dowlearn, P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Section
512-475-1552
August 16, 2022

EXECUTIVE SUMMARY:

Groundwater Management Area 15 adopted the desired future conditions listed in Table 1 for the Gulf Coast Aquifer System on October 14, 2021. The Carrizo-Wilcox, Queen City, Sparta, and Yegua-Jackson aquifers were declared not relevant by Groundwater Management Area 15 for the purpose of joint planning. Groundwater Management Area 15 submitted model files as part of the Desired Future Conditions Explanatory Report for Groundwater Management Area 15 (Keester and others, 2021), which meet the desired future conditions adopted by the district representatives of Groundwater Management Area 15, to the Texas Water Development Board (TWDB) on December 13, 2021. The TWDB determined that the explanatory report and other materials submitted by the district representatives were administratively complete on April 22, 2022.

The modeled available groundwater values that meet the adopted desired future conditions for the Gulf Coast Aquifer System and its associated aquifers within Groundwater Management Area 15 are summarized by decade from 2020 to 2080 in Table 2 by groundwater conservation district and county. Figure 1 provides the groundwater conservation district and county boundaries within GMA 15. Table 3 provides modeled available groundwater values by decade from 2030 to 2080 summarized by county, regional water planning area, and river basin, for use in the regional water planning process. Figure 2 provides the county, regional water planning area, and river basin boundaries within Groundwater Management Area 15. Modeled available groundwater values fluctuate within Groundwater Management Area 15 over time, ranging from a maximum of 529,006 acre-feet per year in 2030 to a minimum of 522,307 acre-feet per year in 2040. The estimates were extracted from results of a model run using the groundwater availability model for the central portion of the Gulf Coast Aquifer System (Version 1.01; Chowdhury and others, 2004).

REQUESTOR:

Mr. Tim Andruss, Chair and Administrator of Groundwater Management Area 15.

DESCRIPTION OF REQUEST:

Mr. Tim Andruss provided the TWDB with the desired future conditions of the Gulf Coast Aquifer System on behalf of Groundwater Management Area (GMA) 15 in a letter dated December 10, 2021. Groundwater conservation district representatives in Groundwater Management Area 15 adopted desired future conditions for the Gulf Coast Aquifer System on October 14, 2021, as described in Resolution No. 2021-01 (Appendix 2 in Keester and others, 2021). The desired future conditions included in Table 1 are average water level drawdowns by county between January 2000 and December 2080 based on the predictive groundwater flow Scenario GMA15_2019_001_v1 (Keester and others, 2021). The predictive simulations were developed from the groundwater availability model for the Gulf Coast Aquifer System (Version 1.01; Chowdhury and others, 2004).

TABLE 1. DESIRED FUTURE CONDITIONS FOR EACH COUNTY WITHIN GROUNDWATER MANAGEMENT AREA 15 EXPRESSED AS AVERAGE DRAWDOWN BETWEEN JANUARY 2000 AND DECEMBER 2080 IN FEET SUBMITTED BY GROUNDWATER MANAGEMENT AREA 15. (ADAPTED FROM SUBMITTED RESOLUTION)

County	Aquifer	Desired future condition
Aransas	Gulf Coast Aquifer System	0
Bee	Gulf Coast Aquifer System	7
Calhoun	Gulf Coast Aquifer System	5
Colorado	Chicot and Evangeline	17
	Jasper	25
De Witt	Gulf Coast Aquifer System	17
Fayette	Gulf Coast Aquifer System	44
Goliad	Chicot	-4
	Evangeline	-2
	Burkeville	7
	Jasper	14
Jackson	Gulf Coast Aquifer System	15
Karnes	Gulf Coast Aquifer System	22
Lavaca	Gulf Coast Aquifer System	18
Matagorda	Chicot and Evangeline	11
Refugio	Gulf Coast Aquifer System	5
Victoria	Gulf Coast Aquifer System	5
Wharton	Chicot and Evangeline	15
Groundwater Management Area 15	Gulf Coast Aquifer System	13

After review of the explanatory report and model files, the TWDB was able to confirm that the submitted model files satisfactorily met the desired future conditions and did not require additional clarifications from Groundwater Management Area 15.

METHODS:

The TWDB ran the central portion of the Gulf Coast Aquifer System groundwater availability model (Version 1.01; Chowdhury and others, 2004) using the predictive model files submitted with the explanatory report (Keester and others, 2021) to calculate the drawdown and modeled available groundwater values for the Gulf Coast Aquifer System within Groundwater Management Area 15. The submitted predictive model files included the Scenario GMA15_2019_001_v1 (Keester and others, 2021) pumping file and the GAM Run 10-008 Addendum (Wade, 2010) model files extended to the year 2080. Drawdown was calculated for each county and model layer by first excluding model cells that went dry and model cells that fall outside of the official aquifer footprint, and then summing the drawdown (difference between the water levels from January 2000 [initial heads] to December 2080 [stress period 81]) in the remaining cells of each county and dividing by the number of model cells within that county. Drawdown values were compared to the desired future conditions and were determined to fall within the accepted tolerance for Groundwater Management Area 15.

Modeled available groundwater values were determined by extracting pumping rates by decade from the model results using ZONEBUDGET Version 3.01 (Harbaugh, 2009). Annual pumping rates by aquifer are presented from 2020 to 2080 by county and groundwater conservation district, subtotaled by groundwater conservation district, and summed for Groundwater Management Area 15 (Table 2). Annual pumping rates are also presented from 2030 to 2080 by county, river basin, and regional water planning area within Groundwater Management Area 15 for use in regional water planning (Table 3).

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 are required to consider modeled available groundwater, along with several other factors, when issuing permits in order to manage groundwater production to achieve the desired future condition(s). The other factors districts must consider include 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 groundwater availability model for the central portion of the Gulf Coast Aquifer System by Chowdhury and others (2004) was the base model for this analysis. See Chowdhury and others (2004) for assumptions and limitations of the historical calibrated model. Keester and others (2021) constructed a predictive

model simulation to extend the base model to 2080 for planning purposes. See Keester and others (2021) for assumptions of the predictive model simulation.

- The model has four layers representing the Chicot aquifer (Layer 1), the Evangeline aquifer (Layer 2), the Burkeville Confining Unit (Layer 3), and the Jasper aquifer and parts of the Catahoula Formation in direct hydrologic communication with the Jasper aquifer (Layer 4). Figures 3 to 6 show the extent of these active model layers within GMA 15.

- Pumping was not modeled in the Burkeville Confining Unit within Colorado, Matagorda, and Wharton counties and as such, this layer is excluded from the modeled available groundwater calculation in these counties.

- Pumping was not modeled in the Jasper aquifer within Matagorda and Wharton counties and as such this layer is excluded from the modeled available groundwater calculations in these counties.

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

- Pumping volumes are reduced to zero if a cell becomes dry during the predictive model run. For this reason, the modeled available groundwater values from the ZONEBUDGET output may not match the pumping values in the input well file.

- Drawdown averages and modeled available groundwater volumes were calculated based on the extent of the official TWDB aquifer boundary. The most recent TWDB model grid file dated June 26, 2020 (glfc_c_grid_poly062620.csv) was used to determine model cell entity assignment (county, groundwater management area, groundwater conservation district, river basin, regional water planning area).

- Drawdowns for cells that became dry during the simulation were excluded from the drawdown averages. Pumping in dry cells was excluded from the modeled available groundwater calculations.

- To be consistent with Groundwater Management Area 15's assumptions (see Keester and others, 2021), a tolerance of three feet was assumed when comparing desired future conditions to modeled drawdown results for all counties except Goliad County. Goliad County was given a tolerance of ±17 feet for the Chicot aquifer, ±36 feet for the Evangeline aquifer, ±14 feet for the Burkeville Confining Unit, and ±7 feet for the Jasper aquifer. Goliad County Groundwater Conservation District plans to monitor achievement of their desired future conditions within these tolerances because they rely more heavily on their extensive monitoring program rather than modeled results.

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

RESULTS:

The modeled available groundwater values for the Gulf Coast Aquifer System that achieve the desired future conditions adopted by Groundwater Management Area 15 fluctuate over time, ranging from 529,006 acre-feet per year in 2030 to 522,307 acre-feet per year in 2040. The modeled available groundwater values are summarized by groundwater conservation district and county in Table 2. Table 3 summarizes the modeled available groundwater values by county, river basin, and regional water planning area for use in the regional water planning process.

The Carrizo-Wilcox, Queen City, Sparta, and Yegua-Jackson aquifers were declared not relevant for the purpose of joint planning by Groundwater Management Area 15; therefore, modeled available groundwater values were not calculated for those aquifers.

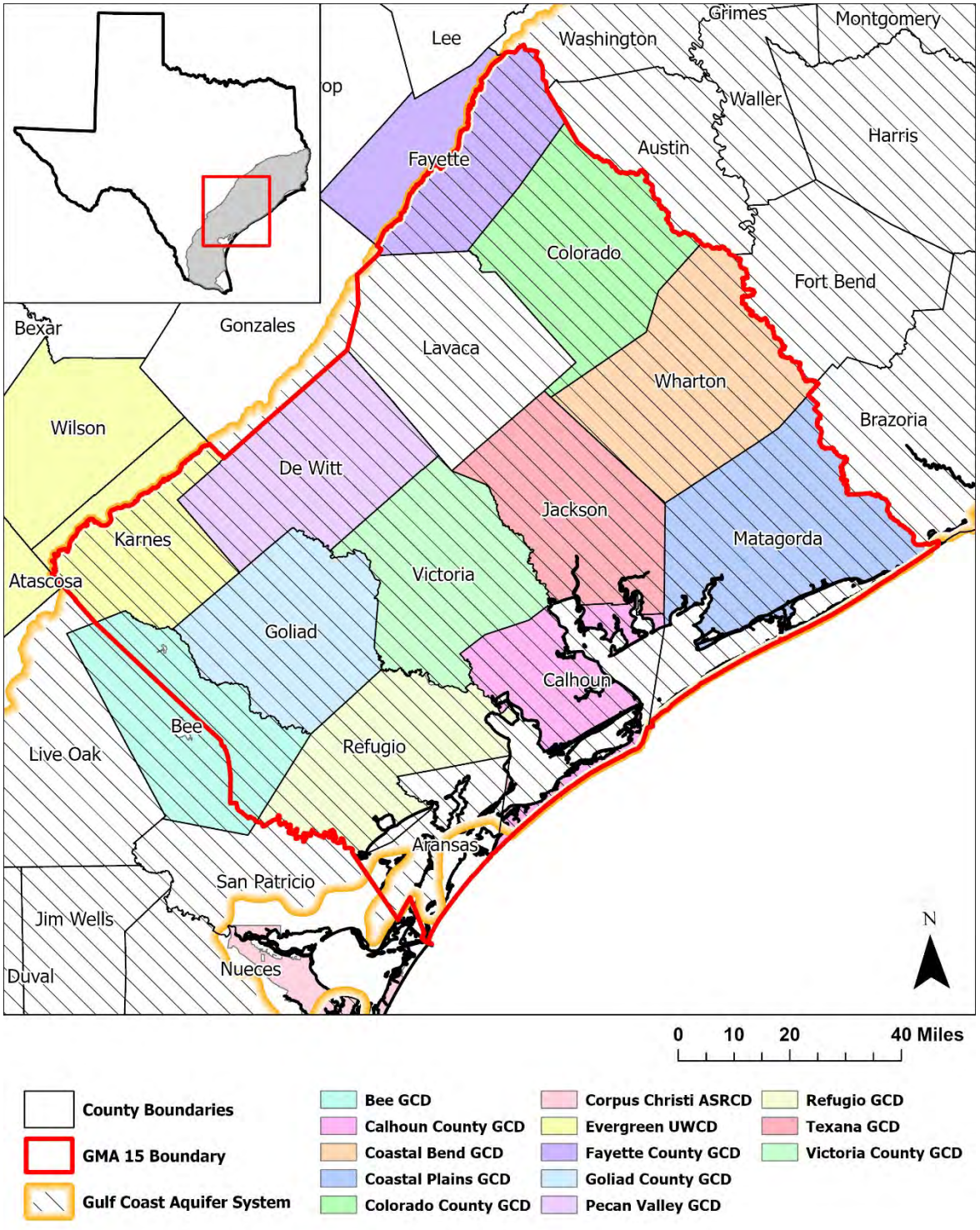

FIGURE 1. MAP SHOWING GROUNDWATER MANAGEMENT AREA (GMA) 15, GROUNDWATER CONSERVATION DISTRICTS (GCD), COUNTIES, AND THE EXTENT OF ACTIVE MODEL CELLS. (UWCD = UNDERGROUND WATER CONSERVATION DISTRICT)

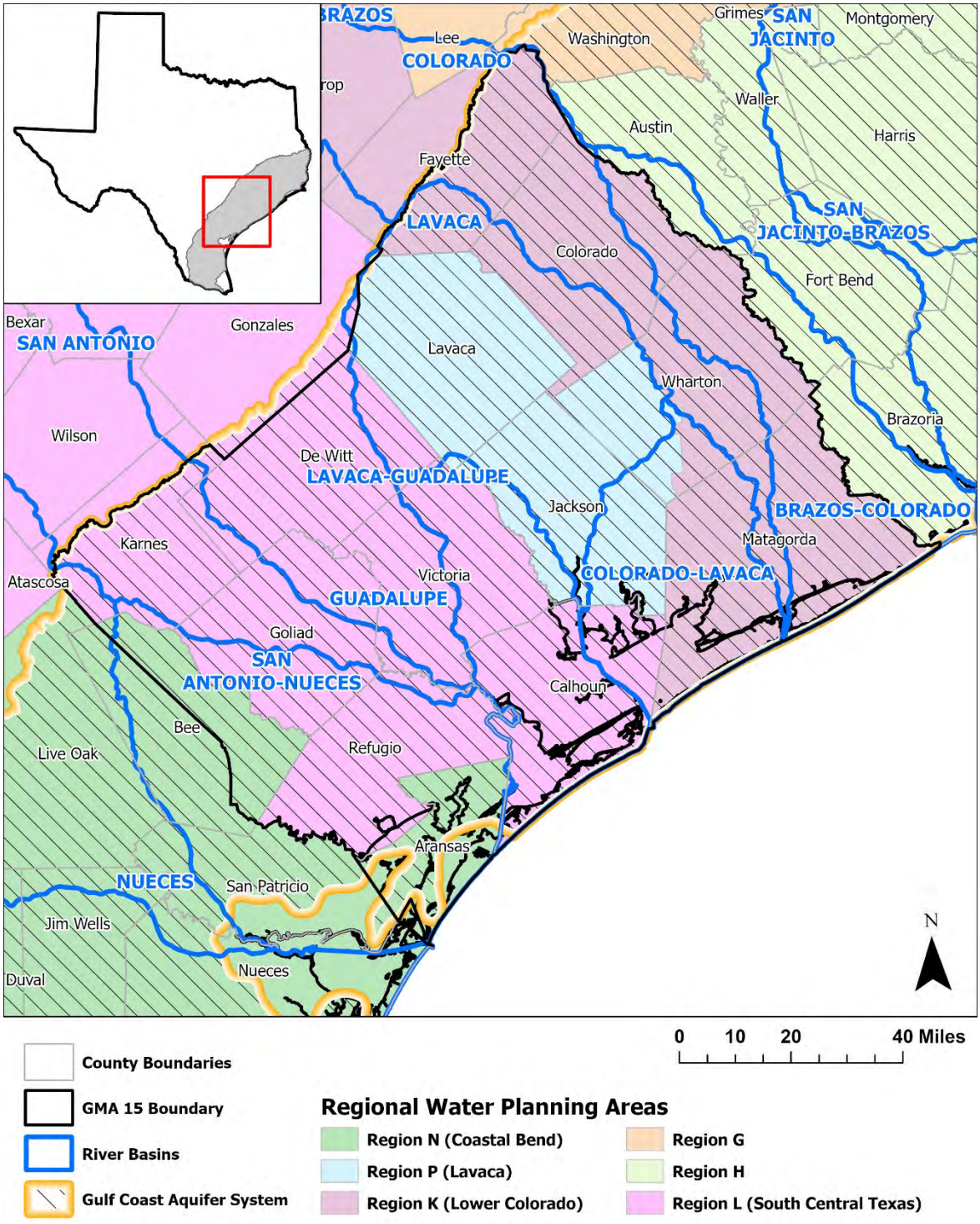

FIGURE 2. MAP SHOWING GROUNDWATER MANAGEMENT AREA (GMA) 15, REGIONAL WATER PLANNING AREAS, RIVER BASINS, COUNTIES, AND EXTENT OF ACTIVE MODEL CELLS.

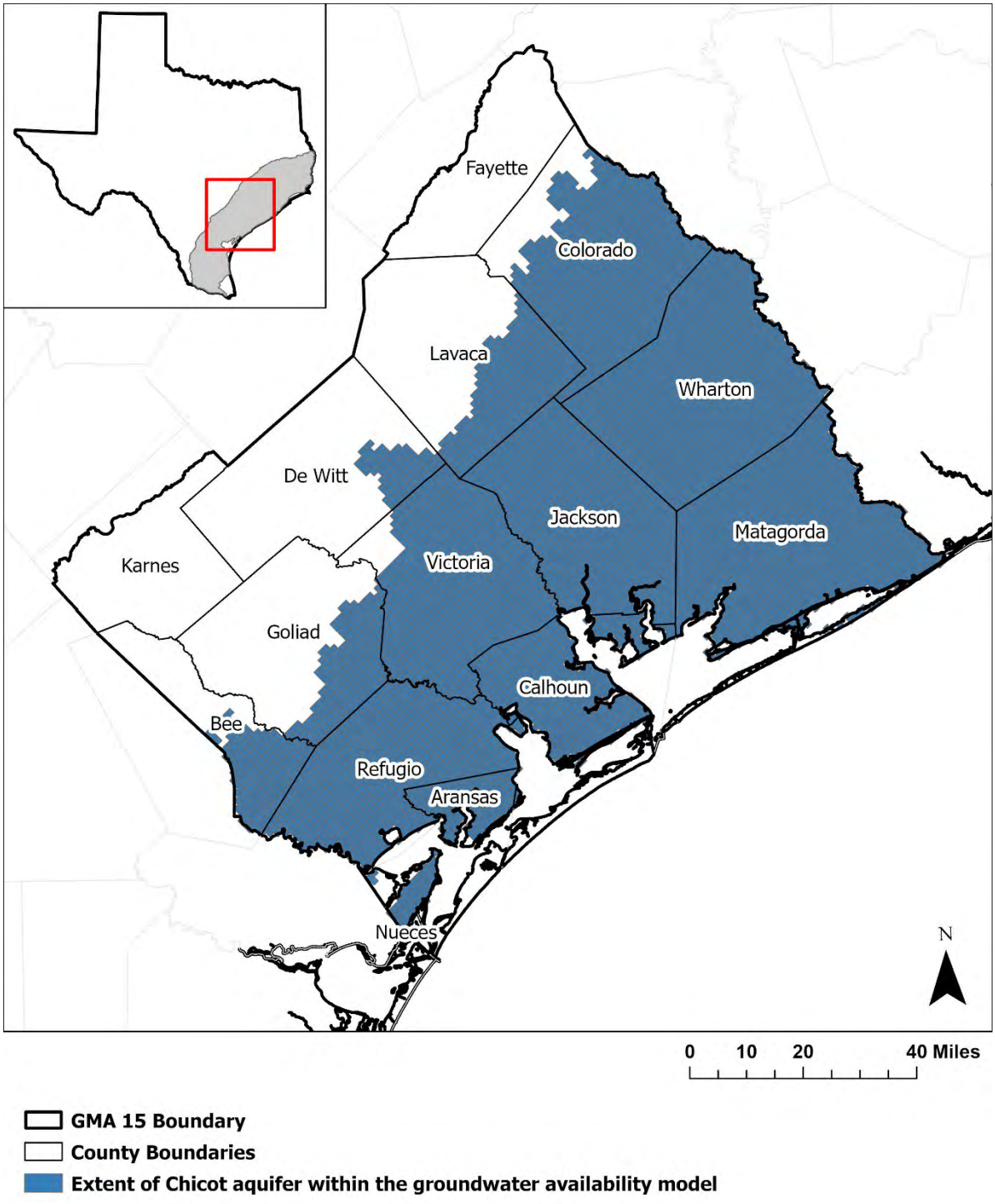

FIGURE 3. MAP SHOWING THE ACTIVE MODEL CELLS WITHIN GROUNDWATER MANAGEMENT AREA (GMA) 15 REPRESENTING THE CHICOT AQUIFER IN LAYER 1 OF THE CENTRAL GULF COAST AQUIFER SYSTEM GROUNDWATER AVAILABILITY MODEL.

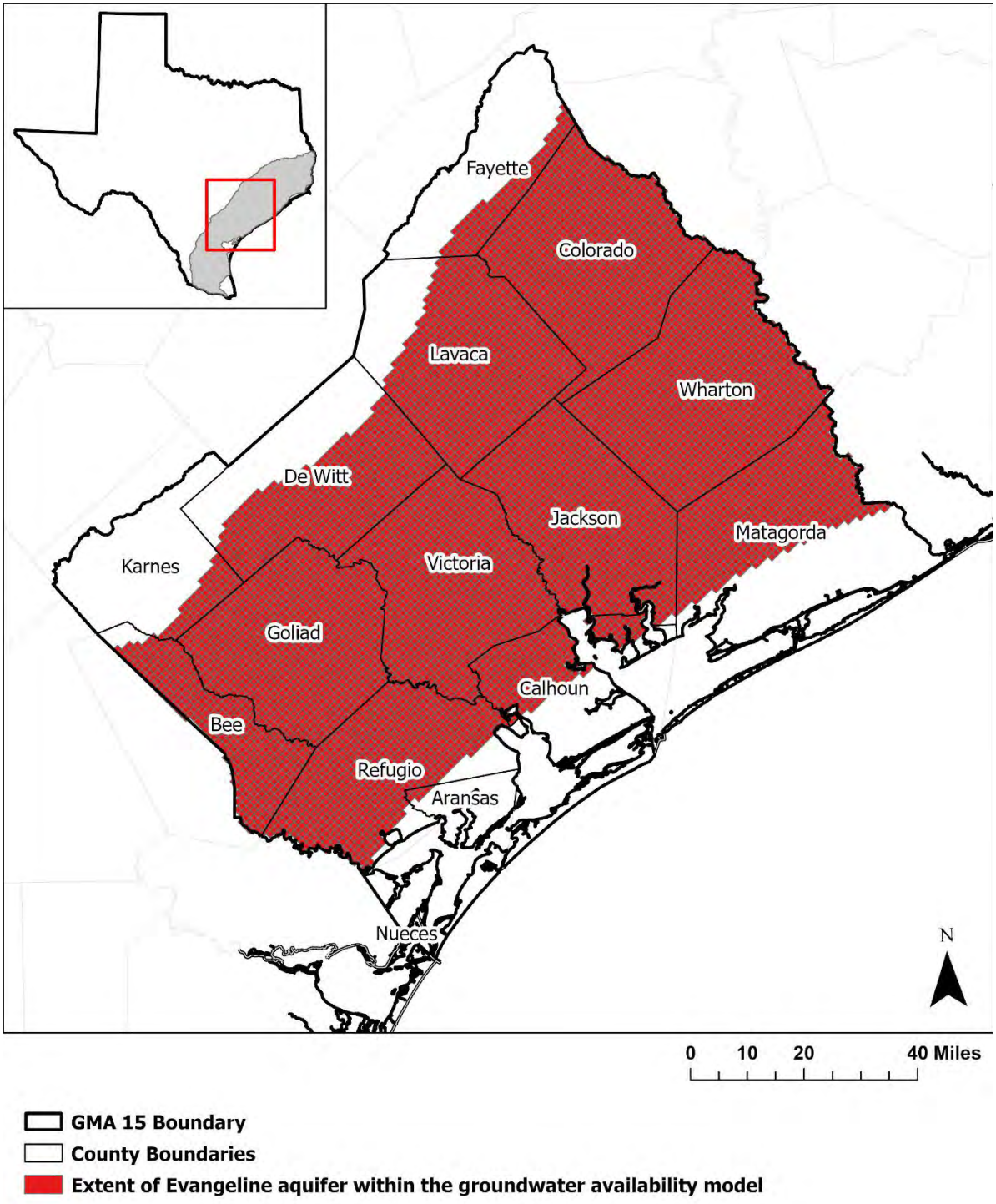

FIGURE 4. MAP SHOWING THE ACTIVE MODEL CELLS WITHIN GROUNDWATER MANAGEMENT AREA (GMA) 15 REPRESENTING THE EVANGELINE AQUIFER IN LAYER 2 OF THE CENTRAL GULF COAST AQUIFER SYSTEM GROUNDWATER AVAILABILITY MODEL.

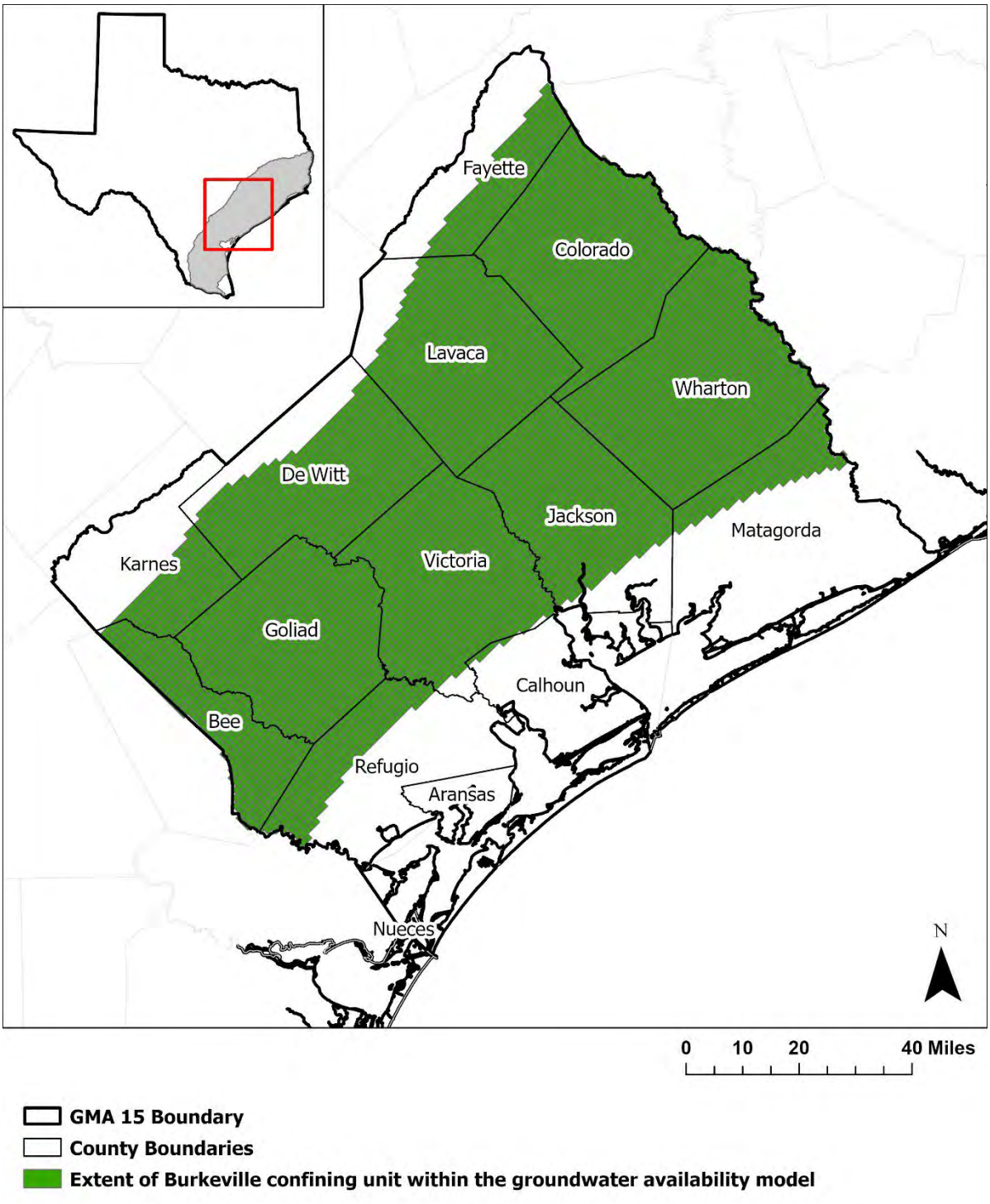

FIGURE 5. MAP SHOWING THE ACTIVE MODEL CELLS WITHIN GROUNDWATER MANAGEMENT AREA (GMA) 15 REPRESENTING THE BURKEVILLE CONFINING UNIT IN LAYER 3 OF THE CENTRAL GULF COAST AQUIFER SYSTEM GROUNDWATER AVAILABILITY MODEL.

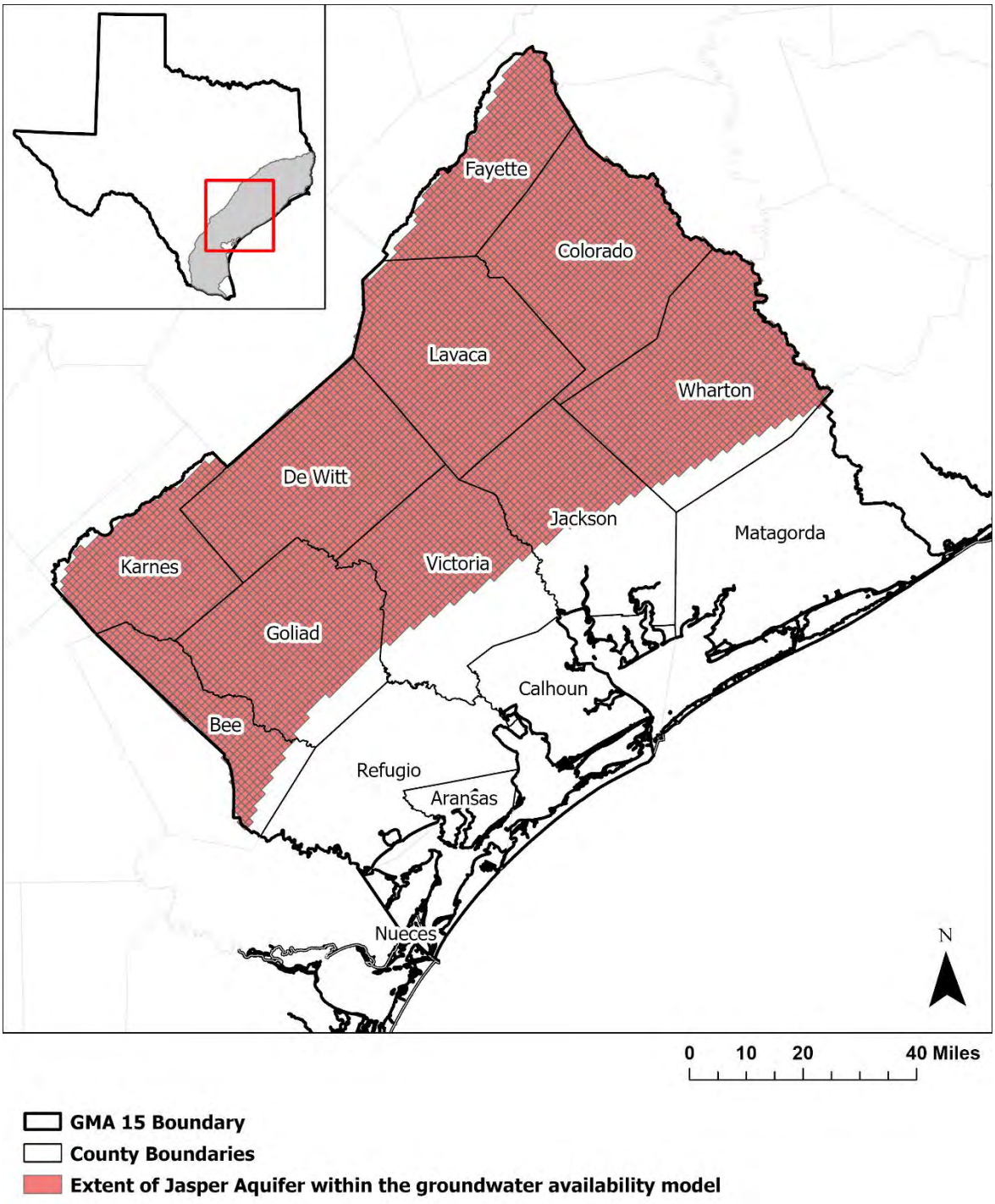

FIGURE 6. MAP SHOWING THE ACTIVE MODEL CELLS WITHIN GROUNDWATER MANAGEMENT AREA (GMA) 15 REPRESENTING THE JASPER AQUIFER AND CATAHOULA FORMATION IN DIRECT HYDROLOGIC CONNECTION WITH THE JASPER AQUIFER IN LAYER 4 OF THE CENTRAL GULF COAST AQUIFER SYSTEM GROUNDWATER AVAILABILITY MODEL.

TABLE 2. MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 15 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2080. VALUES ARE IN ACRE-FEET PER YEAR. (UWCD = UNDERGROUND WATER CONSERVATION DISTRICT; ND = NO DISTRICT))

Groundwater Conservation District	County	Portion of Gulf Coast Aquifer System	2020	2030	2040	2050	2060	2070	2080
Bee GCD	Bee	Total	8,017	8,018	8,020	8,000	8,002	8,003	7,989
Calhoun County GCD	Calhoun	Total	7,611	7,611	7,611	7,611	7,611	7,611	7,611
Coastal Bend GCD	Wharton	Chicot and Evangeline	181,446	181,446	181,446	181,446	181,446	181,446	181,446
Coastal Plains GCD	Matagorda	Chicot and Evangeline	38,892	38,892	38,892	38,892	38,892	38,892	38,892
Colorado County GCD	Colorado	Chicot and Evangeline	71,665	71,665	71,665	71,665	71,665	71,665	71,665
	Colorado	Jasper	918	918	918	918	918	918	918
Colorado County GCD Total	**Colorado**	**Total**	**72,583**	**72,583**	**72,583**	**72,583**	**72,583**	**72,583**	**72,583**
Evergreen UWCD	Karnes	Total	10,694	10,525	3,404	3,399	3,227	2,952	2,949
Fayette County GCD	Fayette	Total	7,168	7,394	7,683	8,011	8,387	8,660	8,590
Goliad County GCD	Goliad	Chicot	418	421	426	430	432	436	436
	Goliad	Evangeline	4,983	5,044	5,105	5,165	5,225	5,287	5,287
	Goliad	Burkeville	425	451	478	505	532	559	559
	Goliad	Jasper	250	338	427	515	602	690	690
Goliad County GCD Total	**Goliad**	**Total**	**6,076**	**6,254**	**6,436**	**6,615**	**6,791**	**6,972**	**6,972**
Pecan Valley GCD	DeWitt	Total	17,993	17,958	17,912	17,827	17,806	17,784	17,772
Refugio GCD	Refugio	Total	5,858	5,858	5,858	5,858	5,858	5,858	5,858
Texana GCD	Jackson	Total	90,571	90,571	90,571	90,571	90,571	90,571	90,571
Victoria County GCD	Victoria	Total	59,948	59,948	59,948	59,948	59,948	59,948	59,948
Total (GCDs)		**Total**	**506,857**	**507,058**	**500,364**	**500,761**	**501,122**	**501,280**	**501,181**

TABLE 2. CONTINUED: MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 15 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2080. VALUES ARE IN ACRE-FEET PER YEAR. (UWCD = UNDERGROUND WATER CONSERVATION DISTRICT; ND = NO DISTRICT))

Groundwater Conservation District	County	Portion of Gulf Coast Aquifer System	2020	2030	2040	2050	2060	2070	2080
ND Aransas	Aransas	Total	1,547	1,547	1,547	1,547	1,547	1,547	1,547
ND Bee	Bee	Total	9	9	9	9	9	9	9
ND Lavaca	Lavaca	Total	20,384	20,384	20,379	20,379	20,372	20,368	20,350
ND Refugio	Refugio	Total	8	8	8	8	8	8	8
No District-County Total		**Total**	**21,948**	**21,948**	**21,943**	**21,943**	**21,936**	**21,932**	**21,914**
GMA 15 Total		**Total**	**528,805**	**529,006**	**522,307**	**522,704**	**523,058**	**523,212**	**523,095**

TABLE 3. MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 15. RESULTS ARE SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE FROM 2030 TO 2080. VALUES ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Portion of Gulf Coast Aquifer System	2030	2040	2050	2060	2070	2080
Aransas	N	San Antonio-Nueces	Total	1,547	1,547	1,547	1,547	1,547	1,547
Bee	N	Nueces	Total	26	26	26	26	26	26
	N	San Antonio-Nueces	Total	8,001	8,003	7,983	7,985	7,986	7,972
Calhoun	L	Colorado-Lavaca	Total	5,221	5,221	5,221	5,221	5,221	5,221
	L	Guadalupe	Total	18	18	18	18	18	18
	L	Lavaca-Guadalupe	Total	2,365	2,365	2,365	2,365	2,365	2,365
	L	San Antonio-Nueces	Total	7	7	7	7	7	7
Colorado	K	Brazos-Colorado	Chicot and Evangeline	15,352	15,352	15,352	15,352	15,352	15,352
	K	Colorado	Chicot and Evangeline	20,079	20,079	20,079	20,079	20,079	20,079
	K	Lavaca	Chicot and Evangeline	36,234	36,234	36,234	36,234	36,234	36,234
	K	Brazos-Colorado	Jasper	49	49	49	49	49	49
	K	Colorado	Jasper	273	273	273	273	273	273
	K	Lavaca	Jasper	596	596	596	596	596	596
DeWitt	L	Guadalupe	Total	14,055	14,042	13,966	13,946	13,927	13,917
	L	Lavaca	Total	2,638	2,626	2,620	2,620	2,620	2,620
	L	Lavaca-Guadalupe	Total	298	298	298	298	298	298
	L	San Antonio	Total	967	946	943	942	939	937
Fayette	K	Brazos	Total	19	21	22	24	26	26
	K	Colorado	Total	4,894	5,041	5,196	5,370	5,406	5,392
	K	Lavaca	Total	2,481	2,621	2,793	2,993	3,228	3,172

TABLE 3. CONTINUED: MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 15. RESULTS ARE SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE FROM 2030 TO 2080. VALUES ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Portion of Gulf Coast Aquifer System	2030	2040	2050	2060	2070	2080
Goliad	L	Guadalupe	Chicot	10	11	11	11	11	11
	L	San Antonio	Chicot	136	137	139	140	141	141
	L	San Antonio-Nueces	Chicot	275	278	280	281	284	284
	L	Guadalupe	Evangeline	2,056	2,081	2,105	2,129	2,155	2,155
	L	San Antonio	Evangeline	2,660	2,692	2,724	2,755	2,788	2,788
	L	San Antonio-Nueces	Evangeline	328	332	336	341	344	344
	L	Guadalupe	Burkeville	0	0	0	0	0	0
	L	San Antonio	Burkeville	451	478	505	532	559	559
	L	San Antonio-Nueces	Burkeville	0	0	0	0	0	0
	L	Guadalupe	Jasper	0	1	1	1	1	1
	L	San Antonio	Jasper	338	426	514	601	689	689
	L	San Antonio-Nueces	Jasper	0	0	0	0	0	0
Jackson	P	Colorado-Lavaca	Total	28,157	28,157	28,157	28,157	28,157	28,157
	P	Lavaca	Total	49,484	49,484	49,484	49,484	49,484	49,484
	P	Lavaca-Guadalupe	Total	12,930	12,930	12,930	12,930	12,930	12,930
Karnes	L	Guadalupe	Total	18	18	18	18	18	18
	L	Nueces	Total	1,059	79	79	79	79	79
	L	San Antonio	Total	9,362	3,221	3,217	3,050	2,781	2,780
	L	San Antonio-Nueces	Total	86	86	85	80	74	72
Lavaca	P	Guadalupe	Total	41	41	41	41	41	41
	P	Lavaca	Total	19,942	19,937	19,937	19,930	19,926	19,908
	P	Lavaca-Guadalupe	Total	401	401	401	401	401	401
Matagorda	K	Brazos-Colorado	Chicot and Evangeline	15,321	15,321	15,321	15,321	15,321	15,321

TABLE 3. CONTINUED: MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 15. RESULTS ARE SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE FROM 2030 TO 2080. VALUES ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Portion of Gulf Coast Aquifer System	2030	2040	2050	2060	2070	2080
	K	Colorado	Chicot and Evangeline	3,219	3,219	3,219	3,219	3,219	3,219
	K	Colorado-Lavaca	Chicot and Evangeline	20,352	20,352	20,352	20,352	20,352	20,352
Refugio	L	San Antonio	Total	329	329	329	329	329	329
	L	San Antonio-Nueces	Total	5,537	5,537	5,537	5,537	5,537	5,537
Victoria	L	Guadalupe	Total	27,611	27,611	27,611	27,611	27,611	27,611
	L	Lavaca	Total	234	234	234	234	234	234
	L	Lavaca-Guadalupe	Total	30,421	30,421	30,421	30,421	30,421	30,421
	L	San Antonio	Total	1,682	1,682	1,682	1,682	1,682	1,682
Wharton	K	Brazos-Colorado	Chicot and Evangeline	50,560	50,560	50,560	50,560	50,560	50,560
	K	Colorado	Chicot and Evangeline	35,934	35,934	35,934	35,934	35,934	35,934
	K	Colorado-Lavaca	Chicot and Evangeline	16,207	16,207	16,207	16,207	16,207	16,207
	K	Lavaca	Chicot and Evangeline	579	579	579	579	579	579
	P	Colorado	Chicot and Evangeline	874	874	874	874	874	874
	P	Colorado-Lavaca	Chicot and Evangeline	14,100	14,100	14,100	14,100	14,100	14,100
	P	Lavaca	Chicot and Evangeline	63,193	63,193	63,193	63,193	63,193	63,193
GMA 15 Total				**529,007**	**522,308**	**522,705**	**523,059**	**523,213**	**523,096**

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:

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.

Harbaugh, A. W., 2009, Zonebudget Version 3.01, A computer program for computing sub-regional 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.

Keester, M., Danielson, V., Donnelly, A., 2021, GMA 15 2021 Joint Planning Desired Future Conditions Explanatory Report, 1047 p.

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.

Wade, S., 2010, GAM Run 10-008 Addendum: Texas Water Development Board, 8 p., https://www.twdb.texas.gov/groundwater/docs/GAMruns/GR10-08addendum.pdf

APPENDIX K

GMA 15 Resolution, Transmittal Letter and Explanatory Report

Victoria County Groundwater Conservation District

2805 N. Navarro St., Suite 210, Victoria, Texas 77901
Phone (361) 579-6863 | Fax (361) 579-0041 | www.vcgcd.org

May 4, 2021

RE: Desired Future Conditions Proposed for Adoption by Groundwater Management Area 15

The purpose of this letter is to distribute, by mail as required by 36.108(d-2) of the Texas Water Code, the desired future conditions (DFCs) proposed for adoption on April 8, 2021 by the representatives of Groundwater Management Area 15 (GMA 15), see attached. The draft explanatory report related to the proposed DFCs may be downloaded from the following links: http://bit.ly/GMA_15_3rd_Round or https://www.vcgcd.org/groundwater-management-area-15.html.

The public comment period, as required by 36.108(d-2) of the Texas Water Code, for the proposed DFCs begins with this transmittal letter. During the comment period, which must remain open for at least 90 days, each member district of GMA 15 is required to hold a public hearing on any proposed DFCs relevant to the district. In addition, each member district must "make available in its office a copy of the proposed desired future conditions and any supporting materials, such as the documentation of factors considered under Subsection (d) and groundwater availability model run results."

Finally, after the public comment period closes, each member district is required to compile a summary of relevant comments received, any suggested revisions to the proposed DFCs, and the basis for the revisions. Each district must submit its summary to GMA 15 for consideration at future meeting. The next meeting at which the summaries are anticipated to be reviewed and considered is planned for October 14, 2021.

If you have any questions regarding this matter, please contact me at your convenience.

Regards,

Tim Andruss
Groundwater Management Area 15 Chairman

Victoria County Groundwater Conservation District

2805 N. Navarro St., Suite 210, Victoria, Texas 77901
Phone (361) 579-6863 | Fax (361) 579-0041 | www.vcgcd.org

Proposed Desired Future Conditions for GMA 15
Date: April 8, 2021

The following Desired Future Conditions (DFCs) are proposed for adoption for GMA 15:

1) The Desired Future Condition for the counties in the groundwater management area (gma-specific DFC) shall not exceed an average drawdown of 13 feet for the Gulf Coast Aquifer System at December 2080; and
2) The Desired Future Conditions for each county within the groundwater management area (county-specific DFCs) shall not exceed the values specified in Table A at December 2080:

Table A. Desired Future Conditions for Counties of GMA 15 expressed as an Average Drawdown between January 2000 and December 2080.

Aransas County	0 feet of drawdown of the Gulf Coast Aquifer System.
Bee County	7 feet of drawdown of the Gulf Coast Aquifer System.
Calhoun County	5 feet of drawdown of the Gulf Coast Aquifer System.
Colorado County	17 feet of drawdown of the Chicot and Evangeline Aquifers; and 25 feet of drawdown of the Jasper Aquifer.
DeWitt County	17 feet of drawdown of the Gulf Coast Aquifer System.
Fayette County	44 feet of drawdown of the Gulf Coast Aquifer System.
Goliad County	4 feet of recovery of the Chicot Aquifer; 2 feet of recovery of the Evangeline Aquifer; 7 feet of drawdown of the Burkeville Aquifer; and 14 feet of drawdown of the Jasper Aquifer.
Jackson County	15 feet of drawdown of the Gulf Coast Aquifer System.
Karnes County	22 feet of drawdown of the Gulf Coast Aquifer System.
Lavaca County	18 feet of drawdown of the Gulf Coast Aquifer System.
Matagorda County	11 feet of drawdown of the Chicot and Evangeline Aquifers.
Refugio County	5 feet of drawdown of the Gulf Coast Aquifer System.
Victoria County	5 feet of drawdown of the Gulf Coast Aquifer System.
Wharton County	15 feet of drawdown of the Chicot and Evangeline Aquifers.

APPENDIX L

Administrative Items

Resolution

Goliad County Groundwater Conservation District

A resolution by the Board of Directors of the Goliad County Groundwater Conservation District adopting the "Goliad County Groundwater Conservation District Management Plan" which was adopted on August 7, 2023 and will remain in force until amended or July 2028.

Whereas, in compliance with the Texas Open Meetings Act, the agenda for the Goliad County Groundwater Conservation District meeting on August 7, 2023 was duly posted in the Goliad County Courthouse on Tuesday, August 2, 2023: and

Whereas, all legal requirements, and all other applicable laws have been complied with and fulfilled. And,

Now, Therefore Be It Resolved, that the Goliad County Groundwater Conservation District Management Plan in its final draft as presented to the Board of Directors on August 7, 2023, and it be effective until amended by the Board of Directors, with proper notice and posting or until July 2028 is hereby adopted by a motion made by Mr. Dohmann, followed by a second made by Mr. Graham. The vote was 6 in favor, 0 against, and 0 abstaining.

Wilfred Korth, President

Absent.
Ernest Alaniz, Director

Art Dohmann, Vice President

Reagan Sahadi, Director

Roy Rosin, Secretary

Terrell Graham, Director

Barbara Smith, Director

Notice of Hearing
Goliad County Groundwater Conservation District
Board of Directors

NOTICE OF PUBLIC HEARING
NOTICE IS GIVEN IN ACCORDANCE WITH CHAPTER 551, GOVERNMENT CODE (V.T.C.A.) TEXAS OPEN MEETING ACT, that the Goliad County Groundwater Conservation District Board of Directors will hold a meeting on Monday, August 7, 2023, at 5:00 p.m. at 118 S. Market St., Goliad, Texas

GCGCD meetings are recorded and the recordings are subject to open records requests. GCGCD meetings are conducted according to Robert's Rules of Order – latest revision.

Notice of Public Hearing – 2023 Management Plan

Pursuant to Chapter 36.1072 (e) and 36.101 (d) of the Texas Water Code, Notice is hereby given that the Goliad County Groundwater Conservation District will hold a public hearing on Monday, August 7, 2023 at 118 S. Market St., Goliad, TX. 77963 at 5:00 p.m. to hear public comments and consider adoption of the 2023 Management Plan for the District. This hearing is held to comply with the requirements that the District submit the Management Plan for approval to the public and Texas Water Development Board every five years. If you wish to view a copy of the Plan you can access the plan at www.goliadcogcd.org or a copy will be available for review at Goliad County Groundwater Conservation District office at 118 S. Market St., Goliad, Texas 77963, Monday – Friday between 8:00 a.m. and 5:00 p.m.

For information or comment please call Michelle Shelton, General Manager at 361-645-1716.

72 HOUR NOTICE

The Goliad County Groundwater Conservation District is committed to compliance with the Americans with Disabilities Act (ADA). Reasonable accommodations and equal opportunity for effective communications will be provided upon request. Please contact the District at 361-645-1716 at least 24 hours in advance if accommodation is needed.

CERTIFICATE OF POSTING
11:42 o'clock A M
AUG 03 2023
Vickie Quinn
County Clerk, Goliad County Texas
By:

GOLIAD COUNTY GROUNDWATER CONSERVATION DISTRICT
118 S. Market St., P.O. Box 562, Goliad, Texas 77963-0562
Telephone: (361) 645-1716 Facsimile: (361) 645-1772
website: www.goliadcogcd.org | email: gcgcd@goliadgcd.org

August 15, 2023

Suzanna Scott
General Manager
San Antonio River Authority
100 East Guenther Street
San Antonio, Texas 78204

Re: Goliad County Groundwater Conservation District

Dear Ms. Scott,

Goliad County Groundwater Conservation District adopted the District's 2023 Management Plan on August 7, 2023. Please find the enclosed copy of the Resolution and flash drive of the adopted Management Plan.

Pursuant to Chapter 36 Water Code, the District has sent a copy to Texas Water Development Board for review and approval.

If you have any questions, please feel free to contact me.

Sincerely,

Michelle Shelton
General Manager

:mls

Cc: Aransas County Groundwater Conservation District
Bee County Groundwater Conservation District
Calhoun County Groundwater Conservation District
City of Goliad

Coastal Bend Groundwater Conservation District
Coastal Plains Groundwater Conservation District
Colorado County Groundwater Conservation District
Corpus Christi ASR Conservation District
Evergreen Underground Water Conservation District
Fayette County Groundwater Conservation District
Goliad County Water Supply
Guadalupe-Blanco River Authority
Groundwater Management Area 15
Pecan Valley Groundwater Conservation District
Refugio County Groundwater Conservation District
South Central Texas Regional Planning Group
Texana Groundwater Conservation District
Victoria County Groundwater Conservation District