GROUNDWATER MANAGEMENT PLAN

FOR

BANDERA COUNTY RIVER AUTHORITY AND GROUNDWATER DISTRICT

PO BOX 177
440 FM 3240
BANDERA, TX 78003
(830) 796-7260

ADOPTED APRIL 8, 2010

AMENDED APRIL 11, 2013

AMENDED FEBRUARY 8, 2018

TABLE OF CONTENTS

TEXAS WATER CODE BACKGROUND

In 1917, an amendment to the Texas Constitution was added, Article XVI, Section 59 allowing for the creation of CONSERVATION AND DEVELOPMENT OF NATURAL RESOURCES; CONSERVATION AND RECLAMATION DISTRICTS. Through this amendment, all the various types of water districts were created. Underground water conservation districts, or groundwater conservation districts as they are currently called, have been authorized and created in Texas since 1949 by authority of Article III, Section 52, or Article XVI, Section 59, of the Texas Constitution. Each water district is given specific authorities listed in their enabling legislation, addressing the needs and functions necessary for the district's region. The different authorities are stated within different chapters of the Texas Water Code.

BANDERA COUNTY RIVER AUTHORITY

In 1971, the 62nd Texas Legislature created the Bandera County River Authority under House Bill 988. It was created as a conservation and reclamation district under and pursuant to Article XVI, Section 59, of the Texas Constitution. As defined by Article 8280-526, Vernon's Texas Civil Statutes, the River Authority encompassed all the territory contained in Bandera County except the territory included in the Bandera County Fresh Water Supply District No. 1 (Pebble Beach) and the Bandera County Water Control and Improvement District No. 1 (City of Bandera).

According to the provisions of the legislation, the Bandera County River Authority shall have and exercise and is hereby vested with, all of the rights, powers, privileges, authority and duties conferred and imposed by the general laws of this state now in force or hereafter enacted, applicable to water control and improvement districts created under authority of Article XVI, Section 59 of the Texas Constitution; but to the extent that the Provisions of any such general laws may be in conflict or inconsistent with the provisions of this Act, the provisions of this Act shall prevail. All such general laws are hereby adopted and incorporated by reference with the same effect as if incorporated in full in this Act.

SPRINGHILLS WATER MANAGEMENT DISTRICT

The Bandera County River Authority was a springboard for the creation of the joint surface and groundwater district. In 1985 the River Authority Board of Directors began working with state and local officials and concerned citizens to determine the most advantageous method to manage groundwater and surface water in Bandera County. After numerous public meetings, the decision was made to pursue legislation creating a joint surface and groundwater district in Bandera County. The result was the creation and confirmation of the Springhills Water Management District.

Springhills Water Management District was created under Senate Bill 1636. The District's enabling legislation, appearing as Act of June 17, 1989, Ch. 654, 1989, Tex. Gen. Laws 2155 (Vernon), granted the District the rights, powers, privileges, authority, functions, and duties provided by Chapters 50 and 52; and the rights, powers, purposes, authority, and functions of the Bandera County River Authority.

The legislation defines the District's boundaries as all the territory contained within Bandera County. The legislation further stipulates that the Board of Directors will be composed of nine (9) directors. The directors will be elected from commissioner precincts with one director at large.

The Springhills Water Management District continued the programs and activities initiated by the River Authority, and implemented the programs required of a groundwater conservation district.

BANDERA COUNTY RIVER AUTHORITY AND GROUNDWATER DISTRICT

On April 10, 2003, the TCEQ authorized changing the District's name to Bandera County River Authority and Groundwater District. The BCRAGD shall continue all programs and activities of Springhills Water Management. The District has the rights, powers, privileges, authority, functions and duties now provided by Chapter 36 of the Texas Water Code.

Also, the District is vested with, all rights, powers, privileges, authority and duties of the original Bandera County River Authority, conferred and imposed by the general laws of this state applicable to water control and improvement districts created under authority of Article XVI, Section 59 of the Texas Constitution.

TEXAS WATER CODE CHAPTERS

At the time of the Bandera County River Authority's conception, water control and improvement districts originally fell under Chapters 50, and 51.

Ch. 50 - *Provisions Generally Applicable to Districts,* an administrative chapter.

Ch. 51 - *Water Control and Improvement Districts,* specific authority granted to water control and improvement districts.

Major portions of these Chapters were repealed and replaced by Chapters 36 and 49, which were enacted in 1995 by the 74th Legislature. Chapter 36 is the chapter applicable to Bandera County River Authority and Groundwater District when the District utilizes its water control and improvement authority.

Ch. 49 - *Provisions Applicable to All Districts,* an administrative chapter applicable to any conservation and reclamation district unless superseded by another chapter of the Texas Water Code. (This chapter is applicable to Bandera County River Authority and Groundwater District only when the water control and improvement district powers are used.

The Bandera County River Authority and Groundwater District is a dual powers District, operating under Chapters 36, 49, and 51 of the State Water Code.

PURPOSE OF A DISTRICT

Texas Water Code, Chapter 51, Water Control and Improvement District 51.121.

Purposes of District (River Authority)

A water control and improvement district organized under the provisions of Article XVI, Section 59, of the Texas Constitution, may provide for:

(1) The control, storage, preservation, and distribution of its water and floodwater and the water of its rivers and streams for irrigation, power, and all other useful purposes;
(2) The reclamation and irrigation of its arid, semiarid, and other land which needs irrigation;
(3) The reclamation, drainage, conservation, and development of its forests, water, and hydroelectric power;
(4) The navigation of its coastal and inland water;
(5) The control, abatement, and change of any shortage or harmful excess of water;
(6) The protection, preservation, and restoration of the purity and sanitary condition of water within the state; and
(7) The preservation and conservation of all-natural resources of the state.

The purposes stated in Subsection (b) of this section may be accomplished by any practical means.

Texas Water Code, Chapter 36, Groundwater Conservation Districts 36.0015.

Purpose (Groundwater)

In order to provide for the conservation, preservation, protection, recharging, and prevention of waste of groundwater, and of groundwater reservoirs or their subdivisions, and to control subsidence caused by withdrawal of water from those groundwater reservoirs or their subdivisions, consistent with the objective of Section 59, Article XVI, Texas Constitution, groundwater conservation districts may be created as provided by this chapter. Groundwater conservation districts created as provided by this chapter are the state's preferred method of groundwater management.

ACTIVITIES OF THE DISTRICT

Since the original river authority and the groundwater district were formed, programs have been implemented to collect data from the aquifers and streams to better understand the groundwater and surface water in the county. Rules have been developed and adopted to regulate, record, and inspect drilling of water wells. The following list includes programs conducted by the District:

(1) The District registers and permits water wells. Each well is assigned a permit or registration number and is furnished with a brass well marker displaying the number, which must be placed in the well slab. The District conducts inspections before, during drilling, and after completion of the wells. The District strives to inspect 100% of completed wells upon receipt of completion paperwork submitted by the driller. The final inspection includes a comprehensive review of the well site, the completed well, the State well log, and the completion paperwork for compliance with State, local, and District rules, laws, and administrative codes. When possible, the District will also

measure and record the static water level and collect and analyze the water quality.

(2) The District samples surface water throughout the county to determine water quality. A water quality report is made to the local newspapers to advise the public of water conditions for recreational contact.

(3) The District has an established program to plug abandoned and deteriorated wells in the county. A budget is set each year to cover the cost of the plugging program.

(4) In addition to the administrative requirements of the District, programs are developed to distribute literature on water conservation and to inform the public on activities of the District. The District maintains a public education program that helps foster public awareness on groundwater and surface water conservation as well as drought and flood issues.

(5) The District's monitor well program constitutes measuring water levels and collecting water samples from designated wells twice a year. The District has wells that are dedicated to continuous monitoring. Instruments have been installed in these wells and are checked each calendar quarter.

(6) Rainfall data is collected daily by volunteers throughout the county. The volunteers send in the rainfall reports on a quarterly basis. The District utilizes USGS rain and river gages in both San Antonio (Medina River and Lake) and Nueces (Sabinal River) River Basins. The District also supports a USGS rainfall and groundwater monitor gage at the District's Edwards monitoring well in western Bandera County. The gages serve as a flood awareness tool for the citizens and government entities in Bandera County.

(7) The District investigates complaints relating to contaminants and spills from all sources of potential pollution such as petroleum, herbicides, illegal dumping, etc., to protect surface and groundwater quality, and all other natural resources within the District.

(8) The District maintains a lab for analysis of surface and groundwater samples. The lab serves the needs of District monitoring programs, newly drilled wells, and the public.

MANAGEMENT PLAN TIMELINE

This plan becomes effective upon approval by the Texas Water Development Board (TWDB) and adoption by Bandera County River Authority and Groundwater District's Board of Directors, and remains in effect until a revised plan is approved and adopted. The plan may be revised at any time, or after five years, when the plan will be reviewed to ensure that it is consistent with applicable Regional Water Plans and the State Water Plan.

LOCATION AND EXTENT

Bandera County lies in the south-central part of Texas, in the hill country region of the Edwards Plateau. The County has an aerial extent of 768 square miles, or 491,520 acres. The City of Bandera is the County seat and is centrally located at the intersection of State Highways 16 and 173. Kerr, Kendall, Bexar, Medina, Uvalde, and Real Counties bound the County, in a clockwise pattern. Bandera County River Authority and Groundwater District encompasses all of Bandera County.

MANAGEMENT OF GROUNDWATER SUPPLIES

The Bandera County River Authority and Groundwater District will aim to protect and preserve the County's water and natural resources for the State of Texas. The District is also tasked with

maintaining local accountability of the County's water resources to help safeguard the property rights of the citizens of Bandera County. An observation network has been established and maintained in order to study and observe changing storage conditions of groundwater supplies within the District. The District will make a regular assessment of water supply and groundwater storage conditions and will report those conditions annually to the Board and make a report available to the public. The District will cooperate with investigations of the groundwater resource within the District and will make the results of investigations available to the public upon adoption by the Board.

The relevant factors to be considered in determining the denial of a well permit or limit groundwater withdrawals will include:

(1) The purpose of the rules of the District;
(2) The equitable distribution of the resource;
(3) The economic hardship resulting from grant or denial of a permit or the terms prescribed by the permit;
(4) The landowner's rights to the water beneath his/her property, and any changes or restrictions to the right of capture laws of the State.

As part of its mission to protect the resource, the District may require reduction of groundwater withdrawals to prevent harming the aquifer. To achieve this purpose, the District may, at the Boards discretion, reduce or revoke any permits after notice and hearing. The determination to seek the amendment of a permit by the District will be based on aquifer conditions observed by the District. The District will enforce the terms and conditions of permits and the rules of the District by enjoining the permit holder in a court of competent jurisdiction as provided for in Texas Water Code, 36.102.

The District will employ all technical resources at its disposal to evaluate the resources available within the District and to determine the effectiveness of regulatory and conservation measures. A public or private user may appeal to the Board for discretion in enforcement of the provisions of the water supply deficit contingency plan on grounds of adverse economic hardship or unique local conditions. The exercise of said discretion by the Board shall not be construed as limiting the power of the Board.

TOPOGRAPHY AND DRAINAGE

Ashworth (1983) describes the topography within the District in the following statement: "The land surface in Bandera County is characterized by rough and rolling terrain. The nearly flat-lying, erosion-resistive limestone rocks forming the surface of the Edwards Plateau have been deeply incised into the less resistive, marly limestone rocks of the Glen Rose Formation."

The altitude of the land surface ranges from approximately 2,330 to 1,080 feet above mean sea level.

Bandera County contains parts of three major drainage basins. The Nueces River basin occupies approximately 25 percent of the County to the west and southwest, with drainage to the south. The San Antonio River basin occupies approximately 73 percent of the County; located from the north central, to the southeastern portion of the County, where the river has been dammed to form Medina Lake. Drainage from the San Antonio River basin is to the

southeast. The Guadalupe River basin occupies approximately 2 percent of the County as a small portion of the central northern section. The two major rivers in the County are the Sabinal River, located in the Nueces River basin, and the Medina River, located in the San Antonio River Basin. The larger rivers are dominantly effluent and form wide valleys. Two dominant types characterize the smaller creeks and streams: the perennial spring-fed streams and the intermittent creeks that only transport precipitation runoff.

Wermund (1974) describes three different terrains in Bandera County as: Along the "....., Sabinal Rivers, the terrain comprises both highly dissected divides and incised stream valleys. About the Medina and Guadalupe Rivers, most terrain lies in broad valleys and less occupies narrow divides."

GROUNDWATER RESOURCES OF BANDERA COUNTY

The Trinity Group aquifer underlies all of Bandera County, underlying the Edwards Plateau aquifer in the northwest portion of the County and extending south into Medina and Uvalde counties and east into Kendall and Bexar counties. The Trinity Group aquifer is the primary source of groundwater in Bandera County. This aquifer is divided into three groups: the Upper Trinity, Middle Trinity, and Lower Trinity. The Upper Trinity aquifer contains the Upper Glen Rose Limestone. The Middle Trinity aquifer contains the Lower Glen Rose Limestone, the Hensell Sand, and the Cow Creek Limestone. The Lower Trinity aquifer is composed of the Sligo Limestone and Hosston Sands. The Trinity Group aquifer yields groundwater from the Upper and Lower units of the Glen Rose Formation; and the Hensell, Cow Creek, Sligo, and Hosston members of the Travis Peak Formation of the Trinity Group of Cretaceous age. Downdip from the outcrop area, in the artesian pressure portion of the aquifer, groundwater production supplies water to all wells. Primary sources of recharge to the Trinity Group aquifer include the infiltration of precipitation on the outcrops to the north and northwest of Bandera County and infiltration of surface water from lakes and streams through vertical leakage from overlying formations. The Trinity Group aquifer primarily exists under water-table conditions along the outcrop and under artesian conditions downdip, where confining beds of limestone and shale bound the water-bearing units. Movement of shallow groundwater is primarily down gradient, from high to low elevations, and at right angles to the potentiometric surface contours, which denote the configuration of the water table. The overall groundwater movement is to the southeast with local movement away from groundwater highs, and along the surface drainage system, with groundwater lows that have developed as a result of production in large well fields.

Alluvial deposits are found in the flood plain of the major tributaries of streams, which make up the surface drainage system in the county. The alluvial deposits are highly permeable with a maximum thickness of approximately 50 feet and small areal extent. They yield only small amounts of good quality water. Due to the naturally occurring anhydrate and gypsum beds, the overall quality of groundwater obtained from the Upper Trinity aquifer, which contains the Upper Glen Rose formation, is of poor quality with small yield. The Middle Trinity aquifer, which contains the Lower Glen Rose Limestone, Hensell Sand, and Cow Creek Limestone formations, yields small to moderate amounts of water with a good to excellent water quality. The lower Trinity aquifer that contains the Sligo Limestone and Hosston Sand yields moderate to large quantities of water of good to excellent quality.

ANNUAL VOLUME OF GROUNDWATER USED IN BANDERA COUNTY

Technical District Information Required by Texas Administrative Code

Estimate of Modeled Available Groundwater in District Based on Desired Future Conditions

Texas Water Code§ 36.001 defines modeled available groundwater as "the amount of water that the executive administrator determines may be produced on an average annual basis to achieve a desired future condition established under Section 36.108". The joint planning process set forth in Texas Water Code § 36.108 must be collectively conducted by all groundwater conservation districts within the same GMA. The District is a member of GMA 9. GMA 9 adopted DFCs for the Edwards Group of the Edwards-Trinity (Plateau) and the Hill Country Aquifer, GAM Run 16-023 MAG, on April 18, 2016. The adopted DFCs were then forwarded to the TWDB for development of the MAG calculations.

GAM Run 16-023 MAG:	Please refer to Appendix A
Annual Amount of Recharge from Precipitation to the Groundwater Resources within the District.	Please refer to Appendix B
Annual Volume of Water that Discharges from the Aquifer to Springs and Surface Water Bodies.	Please refer to Appendix B
Estimate of the Annual Volume of Flow into the District, out of the District, and Between Aquifers in the District.	Please refer to Appendix B
Projected Total Demand for Water within the District.	Please refer to Appendix C
Water Supply Needs.	Please refer to Appendix C
Water Management Strategies.	Please refer to Appendix C
Projected Surface Water Supply.	Please refer to Appendix C
Amount of Groundwater Being Used within the District on an Annual Basis.	Please refer to Appendix C

MANAGEMENT OF GROUNDWATER SUPPLIES

The District will study, monitor, and manage the groundwater supplies within Bandera County. The District will continue the programs and activities presently being performed in the District.

The District will continue to manage and monitor the groundwater of Bandera County to provide the best use of the resources while protecting the rights of the public. The District will continue to monitor and collect data to better understand and manage the aquifers. The existing monitoring system will be improved and expanded as needed for the development of data and a report will be prepared annually and made available to the public.

The District has implemented a drought management plan to aid in groundwater conservation. This plan is based on the Palmer Index and is designed to reduce pumping during the different drought stages.

The District will strive to conserve the groundwater resources by encouraging municipal use of surface water supplies when available, and promote aquifer storage and recovery and aquifer recharge where practical. The District will encourage the use of rainwater harvesting to supplement water well usage in the county to conserve groundwater. The District will support brush control programs and other programs designed to control invasive species by providing public information and interacting with other governmental or organization groups that practice best management practices for water conservation.

ACTION, PROCEDURES, PERFORMANCE AND AVOIDANCE FOR PLAN IMPLEMENTATION

The District has adopted rules relating to the permitting of wells and the production of groundwater. The most recent adoption was March 15, 2013.The rules adopted by the District are pursuant to Texas Water Code Chapter 36 and the provisions of this plan. All rules will be adhered to and enforced. The promulgation and enforcement of the rules will be based on the best technical evidence available. A public hearing was held regarding the set of rules. You can find a copy of the rules here: http://www.bcragd.org/about/rules-regulations/

The District shall treat all citizens equitably. Citizens may appeal 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 will strive to implement the provisions of this plan and will utilize the provisions of this plan for determining the direction or priority for the District. Agreements entered into by the District and any additional planning efforts in which the District may participate will be consistent with the purposes of this plan. All activities of the District will be undertaken in cooperation and coordinated with the appropriate state, regional or local water management entities and in compliance with State and Regional Water Plans.

METHODOLOGY FOR TRACKING PROGRESS IN ACHIEVING MANAGEMENT GOALS

The District will use the following methodology to track its progress toward achieving its management goals:

The District's General Manager will present an annual report to the Board of Directors on District performance and progress in achieving management goals and objectives at the April Quarterly Board meeting following the end of the fiscal year.

GROUNDWATER MANAGEMENT GOALS

Management Goal 1

1.0.0 Manage groundwater to provide the most efficient use of groundwater resources.

1.1.1 Management Objective

Implement a program to develop data on the aquifers for better modeling of the aquifers.

1.1.2 Performance Standard

a. Collect pump test data from subdivision test wells after water availability studies are conducted.
b. Collect water level data from a minimum of 1O wells on a semi-annual basis.

1.2.1 Management Objective

Maintain a program of issuance of well permits for non-exempt wells and registrations for exempt wells.

1.2.2 Performance Standard

Maintain an ongoing program of issuance of well permits each year. Provide the number of permits issued each year and the number of registrations issued each year in an annual report to the Board of Directors.

Management Goal 2

2.0.0 Control and prevent the waste of groundwater.

2.1.1 Management Objective

Provide literature to the public on the efficient use of water and water saving devices in the home.

2.1.2 Performance Standard

a. Provide handouts with well permits and registrations to educate the public on water saving devices. The District will report the number of handouts with well permits and registrations in an annual report to the Board of Directors.
b. Coordinate a minimum of one public presentation per year. Provide the number of shows, demonstrations, events, or educational talks at which literature or information is provided to the public, in an annual report to the Board of Directors.

2.2.1 Management Objective

Promote public awareness about preventing the waste of water resources.

2.2.2 Performance Standard

Record the number of speaking appearances and/or shows, demonstrations or events at which literature or information is provided to the public on preventing the waste of water resources. The District will report the number of aforementioned events in the annual report to the Board of Directors.

Management Goal 3

3.0.0 Control and prevent subsidence.

The control and prevention of subsidence is not a concern of this District as the formations are carbonates and do not contain the water saturated clays which can cause subsidence if dewatered; therefore, this management goal is not applicable to the District.

Management Goal 4

4.0.0 Address conjunctive surface water management issues.

4.1.1 Management Objective

Make at least one annual evaluation of the groundwater resources and surface water quality in Bandera County and include the results of the evaluation in the annual report to the Board of Directors.

4.1.2 Performance Standard

a. Record the number of reports and evaluations provided to the Board of Directors on the groundwater resources and the surface water quality in the annual report.
b. Maintain at the District Office an annual report of District activities available to the public.

4.2.1 Management Objective

Each year the District will participate in the regional planning process by attending Region J Regional Planning Group meetings.

4.2.2 Performance Standard

The attendance of a district representative at any Region J Regional Planning Group will be noted in the annual report to the Board of Directors.

Management Goal 5

5.0.0 Address natural resource issues.

5.1.1 Management Objective

The District is an active participant in the TCEQ Clean Rivers Program. This program is the gold standard in Texas for monitoring the water quality in the State. The District also tests groundwater from newly drilled wells and existing wells. The District will investigate, or refer to the proper agency, any citizen's or District initiated complaint related to surface water, groundwater, or any natural resource within the District. These investigations are a valuable tool to help the District protect the natural resources in the County.

5.1.2 Performance Standard

The General Manager will report the number of nuisance complaints, Notice of Violations issued, natural resources investigations, surface water tests, and groundwater tests to the Board of Directors in an annual report.

Management Goal 6

6.0.0 Address drought conditions.

6.1.1 Management Objective

Record the Drought Severity Index each month and when drought conditions exist, post the drought stage and any appropriate drought restrictions at the District's office.

6.1.2 Performance Standard

In conjunction with the drought index, the General Manager may utilize flow rates from the Sabinal and Medina Rivers to determine appropriate drought stages. The General Manager shall post the drought stage and any appropriate drought restrictions at the District's office each month.

6.2.1 Management Objective

Evaluate groundwater availability each year by monitoring water levels of the aquifer from monitor wells within Bandera County.

6.2.2 Performance Standard

Record number of wells monitored each year in the annual report to the Board of Directors.

Management Goal 7

7.0.0 Address conservation

7.1.1 Management Objective

Promote public awareness of the need for water conservation.

7.1.2 Performance Standard

A minimum of one public water quality/conservation show, demonstration, event, or educational talk will be held each year. The number of events, shows, or talks should be reported in the annual report to the Board of Directors.

7.2.1 Management Objective

The District will contract with Nueces River Authority (NRA) or similar organizations to provide information on efficient use of groundwater to students in Bandera County.

7.2.2 Performance Standard

The General Manager will report the instances that educational conservation information was given to students in Bandera County in the annual report to the Board.

Management Goal 8

8.0.0 Address rainwater harvesting

8.1.1 Management Objective

The District will promote rainwater harvesting and provide advice, information, and literature regarding the benefits of rainwater harvesting.

8.1.2 Performance Standard

Provide Rainwater Harvesting material to the public in handouts. Each year provide rainwater harvesting information on at least one occasion by one of the following methods:

- article to local newspapers
- distribution of conservation literature handouts
- public presentation by District Staff
- information on District website
- District exhibit/display booth at a public event

Management Goal 9

9.0.0 Address recharge enhancement

The District does not currently have the financial resources to buy property and construct recharge structures; therefore, this goal is not applicable to the District at this time.

Management Goal 10

10.0.0 Address precipitation enhancement

Precipitation enhancement over Bandera County is financed by the Edward Aquifer Authority and operates from Pleasanton, Texas; therefore, this goal is not applicable to the District at this time.

Management Goal 11

11.0.0 Address brush control.

11.1.1 Management Objective

Provide to the public available information on brush control including riparian health, along with native and invasive plant species management.

11.1.2 Performance Standard

Each year provide brush control, including riparian health, along with native and invasive plant species management information on at least one occasion by one of the following methods and include it in an annual report to the Board of Directors:

- article to local newspapers
- distribution of conservation literature handouts
- public presentation by District Staff
- information on District website
- District exhibit/display booth at a public event

Management Goal 12

12.0.0 Addressing water quality.

12.1.1 Management Objective

Continue the existing program to monitor groundwater quality in the District.

12.1.2 Performance Standard

Continue to monitor water quality from wells in the monitoring system on a semi-annual basis, and from newly drilled wells when samples can be obtained. Report the number of samples obtained to the Board of Directors in an annual report.

12.2.1 Management Objective

Continue the existing program to monitor surface water quality in the District.

12.2.2 Performance Standard

Continue to monitor water quality from a minimum of 6 locations in the county from the Sabinal and Medina River basins on a quarterly basis. Report the number of samples obtained to the Board of Directors in an annual report.

Management Goal 13

13.0.0 Addressing in a Quantitative Manner the Desired Future Conditions.

13.1.1 Management Objective

To achieve the Desired Future Condition adopted by GMA 9
For the Edwards Group of the Edwards Trinity (Plateau) and the Hill Country Trinity Aquifer.

13.1.2 Performance Standard

Groundwater Management Area 9 has adopted a Desired Future Condition (DFC) for the Edwards Trinity Plateau and the Hill Country Trinity aquifer.

District rules do not allow permitted wells in the Edwards Trinity Plateau Aquifer. The District has established a monitor well in the Edwards Aquifer and is monitoring the water level and rainfall on a real-time basis. A comparison of the annual water level measurements and the cumulative water level trend to the adopted Desired Future Condition will be made annually. The water levels will be included in the District database and a discussion of the water level trend-Desired Future Condition comparison will be reported to the Board of Directors on an annual basis and documented in the annual report.

The District will notate the Hill Country Trinity Aquifer water level trends from the District's Monitor Wells in order to track the District's progress in complying with the average drawdown as stated in GAM Run 16-023 MAG for Bandera County. The General Manager will report annually to the District Board of Directors the progress of achieving the Desired Future Condition. The General Manager will complete an annual groundwater report that details groundwater production from non-exempt wells combined with exempt well pumping estimates supplied by the Texas Water Development Board. This report will be included in the annual report provided to the District's Board of Directors.

I, the undersigned, do hereby certify that this Management Plan was formally adopted by the District Board and will be effective on the date of signature.

Signed this 22 day of FEBRUARY, 2018.

Don Sloan

Don Sloan, President

Sworn to and subscribed to before me this 22 day of February, 2018.

NOTARY PUBLIC STATE OF TEXAS
NICOLE M. MCCOY
NOTARY PUBLIC
STATE OF TEXAS
My Comm. Expires 07-05-2019

Nicole M. McCoy

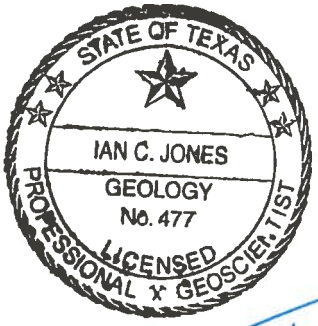
(Signature of Notary)

Nicole M. McCoy

(Printed Name of Notary)

GAM Run 16-023 MAG: Modeled Available Groundwater for the Aquifers in Groundwater Management Area 9

Ian C. Jones, Ph.D., P.G.
Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Section
(512) 463-6641
February 28, 2017



This page is intentionally left blank.

GAM RUN 16-023 MAG: MODELED AVAILABLE GROUNDWATER FOR THE AQUIFERS IN GROUNDWATER MANAGEMENT AREA 9

Ian C. Jones, Ph.D., P.G.
Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Section
(512) 463-6641
February 28, 2017

EXECUTIVE SUMMARY:

We have prepared estimates of the modeled available groundwater for the relevant aquifers of Groundwater Management Area 9—the Trinity, Edwards Group of the Edwards-Trinity (Plateau), Ellenburger-San Saba, and Hickory aquifers. The estimates are based on the desired future conditions for these aquifers adopted by the groundwater conservation districts in Groundwater Management Area 9 on April 28, 2016. The explanatory report and other materials submitted to the Texas Water Development Board (TWDB) were determined to be administratively complete on November 23, 2016.

The modeled available groundwater values are summarized by decade for the groundwater conservation districts (Tables 1, 3, 5, and 7) and for use in the regional water planning process (Tables 2, 4, 6, and 8). The modeled available groundwater estimates are 2,208 acre-feet per year in the Edwards Group of the Edwards-Trinity (Plateau) Aquifer, up to 75 acre-feet per year in the Ellenburger-San Saba Aquifer, 140 acre-feet per year in the Hickory Aquifer, and range from approximately 93,000 acre-feet per year in 2010 to about 90,500 acre-feet per year in 2060 in the Trinity Aquifer. Please note that the Trinity Aquifer includes both the Trinity Aquifer as defined by the TWDB and the Trinity Group of the Edwards-Trinity (Plateau) Aquifer. The modeled available groundwater estimates were extracted from results of model runs using the groundwater availability models for the Hill Country portion of the Trinity Aquifer version 2.01 (Jones and others, 2011), and the minor aquifers of the Llano Uplift Area (Shi and others, 2016).

REQUESTOR:

Mr. Ronald Fieseler, chair of Groundwater Management Area 9 districts.

DESCRIPTION OF REQUEST:

In a letter dated April 25, 2016, Mr. Ronald Fieseler provided the TWDB with the desired future conditions of the Trinity, Edwards Group of the Edwards-Trinity (Plateau), Ellenburger-San Saba, and Hickory aquifers in Groundwater Management Area 9. Mr.

Fieseler provided additional clarifications for baseline years for each desired future condition, areas not covered by the models, assumed climatic conditions, and spatial pumping distributions through emails to the TWDB on June 8, 2016, August 15, 2016 and September 9, 2016. Mr. Fieseler also clarified the water level drawdown for the Ellenburger-San Saba Aquifer in Kendall County in a letter dated October 19, 2016.

The final adopted desired future conditions for the aquifers in Groundwater Management Area 9 are:

- Trinity Aquifer *[Upper, Middle, and Lower undifferentiated]* - Allow for an increase in average drawdown of approximately 30 feet through 2060 (throughout GMA-9) consistent with "Scenario 6" in TWDB GAM Task 10-005.
- Edwards Group of Edwards-Trinity (Plateau) *[Aquifer]* in Kendall and Bandera counties - Allow for no net increase in average drawdown in Bandera and Kendall counties through 2070.
- Ellenburger-San Saba Aquifer in Kendall County - Allow for an increase in average drawdown of no less than 7 feet in Kendall County through 2070.
- Hickory Aquifer in Kendall County - Allow for an increase in average drawdown of no more than 7 Feet in Kendall County through 2070.

The Trinity Aquifer includes both the Trinity Aquifer as defined by the TWDB and the Trinity Group of the Edwards-Trinity (Plateau) Aquifer.

Additionally, districts in Groundwater Management Area 9 voted to declare that the following aquifers or parts of aquifers be classified as non-relevant for the purposes of joint planning:

- Edwards Group of the Edwards-Trinity (Plateau) Aquifer in Kerr and Blanco counties.
- Ellenburger-San Saba Aquifer in Blanco and Kerr counties.
- Hickory Aquifer in Blanco, Hays, Kerr, and Travis counties.
- Marble Falls Aquifer in Blanco County.
- Edwards (Balcones Fault Zone) Aquifer in Bexar, Comal, Hays, and Travis counties.

METHODS:

As defined in Chapter 36 of the Texas Water Code, "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.

The desired future condition for the Trinity Aquifer is identical to the one adopted in 2010 and the associated modeled available groundwater is based on a specific model run and scenario—Scenario 6 in GAM Task 10-005 (Hutchison, 2010) and GAM Task 10-050 (Hassan, 2012). Trinity Aquifer water-level drawdown is based on 2008 water levels.

For other relevant aquifers—the Edwards Group of the Edwards-Trinity (Plateau), Ellenburger-San Saba, and Hickory aquifers—the groundwater availability models for the Hill Country portion of the Trinity Aquifer version 2.01 (Jones and others, 2011), and the minor aquifers of the Llano Uplift Area (Shi and others, 2016) were used to simulate the desired future conditions outlined in the explanatory report (GMA 9 and others, 2016) and further clarified as noted in the previous section. Water level drawdown calculations were based on the water levels simulated in final years of the historical versions of the respective models. These final years are 1997 in the groundwater availability model for the Hill Country portion of the Trinity Aquifer and 2010 in the groundwater availability model for the minor aquifers of the Llano Uplift Area. The predictive model runs retain pumping rates from the historic period—1980 through 1997—except in the aquifer or area of interest. In those areas, pumping rates are varied such that they produce the desired future average water level drawdown conditions. Pumping rates were reported on 10-year intervals from 2010 through 2060 (for the Trinity Aquifer) and 2010 through 2070 (for all other relevant aquifers). The groundwater availability estimates for 2070 for the Trinity Aquifer will be determined by the regional water planning groups.

Water level drawdown averages were calculated for the relevant portions of each aquifer. Drawdown for model cells which became dry during the simulation (water level dropped below the base of the cell) were excluded from the averaging. Estimates of modeled available groundwater therefore decrease over time as continued simulated pumping predicts the development of dry model cells in areas of Hays, Kerr, and Travis counties. The calculated water-level drawdown averages were compared with the desired future conditions to verify that the pumping scenario achieved the desired future conditions.

Modeled available groundwater values for the Trinity Aquifer and the Edwards Group of the Edwards-Trinity (Plateau) Aquifer were determined by extracting pumping rates by decade from the model results using ZONEBUDGET Version 3.01 (Harbaugh, 2009). For the Ellenburger-San Saba and Hickory aquifers, modeled available groundwater values were determined by extracting pumping rates by decade from the model results using ZONBUDUSG Version 1.01 (Panday and others, 2013).

PARAMETERS AND ASSUMPTIONS:

Trinity and Edwards-Trinity (Plateau) Aquifers

We used the groundwater availability model (version 2.01) for the Hill Country portion of the Trinity Aquifer developed by Jones and others (2009) to determine modeled available groundwater in the Trinity Aquifer and the Edwards Group of the Edwards-Trinity (Plateau) Aquifer. See Jones and others (2009) for details on model construction, recharge, discharge, assumptions, and limitations. The parameters and assumptions for the groundwater availability model for the Hill Country portion of the Trinity Aquifer are described below:

- The model has four layers:
    - Layer 1 represents mostly the Edwards Group of the Edwards-Trinity (Plateau) Aquifer and larger portions of the Edwards Group not classified as an aquifer,
    - Layer 2 represents the Upper Trinity Aquifer,
    - Layer 3 represents the Middle Trinity Aquifer, and
    - Layer 4 represents the Lower Trinity Aquifer.
- The model was run with MODFLOW-96 (Harbaugh and McDonald, 1996).
- Parts of Bandera, Blanco, and Kerr counties are not included in the model and consequently are not included in the modeled available groundwater calculations.
- Drawdown for cells with water levels below the base elevation of the cell ("dry" cells) were excluded from calculation of average drawdown and the modeled available groundwater values.
- In separate model runs, modeled available groundwater was calculated for the Trinity Aquifer and the Edwards Group of the Edwards-Trinity (Plateau) Aquifer. The Trinity Aquifer is defined as the Trinity Group occurring within Groundwater Management Area 9, irrespective of whether it forms part of the Trinity Aquifer or Edwards-Trinity (Plateau) Aquifer.
- The results for the Trinity Aquifer presented in this report are based on Scenario 6 of GAM Task 10-005 (Hutchison, 2010). See Hutchison (2010) for a full description of the methods, assumptions, and results of the model simulations. Each scenario in GAM Task 10-005 consisted of a series of 387 separate 50-year

model simulations, each with a different recharge configuration. Though the pumping input to the model was the same for each of the 387 simulations, the pumping output differed depending on the occurrence of inactive (or dry) cells. Because the analysis was statistical any baseline year may be assumed, therefore average drawdown is based on 2008 conditions as noted in the Groundwater Management Area 9 explanatory report.

- The results for the Edwards Group of the Edwards-Trinity (Plateau) Aquifer are based on a single model run using historic pumping rates in all parts of the model area except the Edwards Group of Kendall and Bandera counties and average recharge from GAM Task 10-005. Recharge used in this model run represents the average recharge taken from the 387 simulations (Run 169) used in Trinity Aquifer model runs. Average drawdown was calculated based on the last historic stress period (1997).

Minor aquifers of the Llano Uplift Area

We used version 1.01 of the groundwater availability model for the minor aquifers in the Llano Uplift Area. See Shi and others (2016) for assumptions and limitations of the model. The parameters and assumptions for the groundwater availability model for the minor aquifers of the Llano Uplift Area are described below:

- The model contains eight layers:
  - Layer 1 (the Trinity Aquifer, Edwards-Trinity (Plateau) Aquifer, and younger alluvium deposits),
  - Layer 2 (confining units),
  - Layer 3 (the Marble Falls Aquifer and equivalent units),
  - Layer 4 (confining units),
  - Layer 5 (Ellenburger-San Saba Aquifer and equivalent units),
  - Layer 6 (confining units),
  - Layer 7 (the Hickory Aquifer and equivalent units), and
  - Layer 8 (Precambrian units).
- The model was run with MODFLOW-USG beta (development) version (Panday and others, 2013).

- Perennial rivers and reservoirs were simulated using the MODFLOW-USG river package. Springs were simulated using the MODFLOW-USG drain package.

- There is no historic pumping information available for the Ellenburger-San Saba and Hickory aquifers of Kendall County. Consequently, we used uniformly distributed pumping to simulate the desired future condition and determine the modeled available groundwater.

RESULTS:

The modeled available groundwater for the Trinity Aquifer that achieves the desired future conditions adopted by districts in Groundwater Management Area 9 decreases from 93,052 to 90,503 acre-feet per year between 2010 and 2060 (Tables 1 and 2). This decline is attributable to the occurrence of increasing numbers of dry model cells over time in parts of Hays, Kerr, and Travis counties. The modeled available groundwater for the Edwards Group of the Edwards-Trinity (Plateau), Ellenburger-San Saba, and Hickory aquifers are 2,208, 75, and 140 acre-feet per year, respectively (Tables 3 through 8). The modeled available groundwater for the respective aquifers has been summarized by aquifer, county, and groundwater conservation district (Tables 1, 3, 5, and 7). The modeled available groundwater is also summarized by county, regional water planning area, river basin, and aquifer for use in the regional water planning process (Tables 2, 4, 6, and 8).

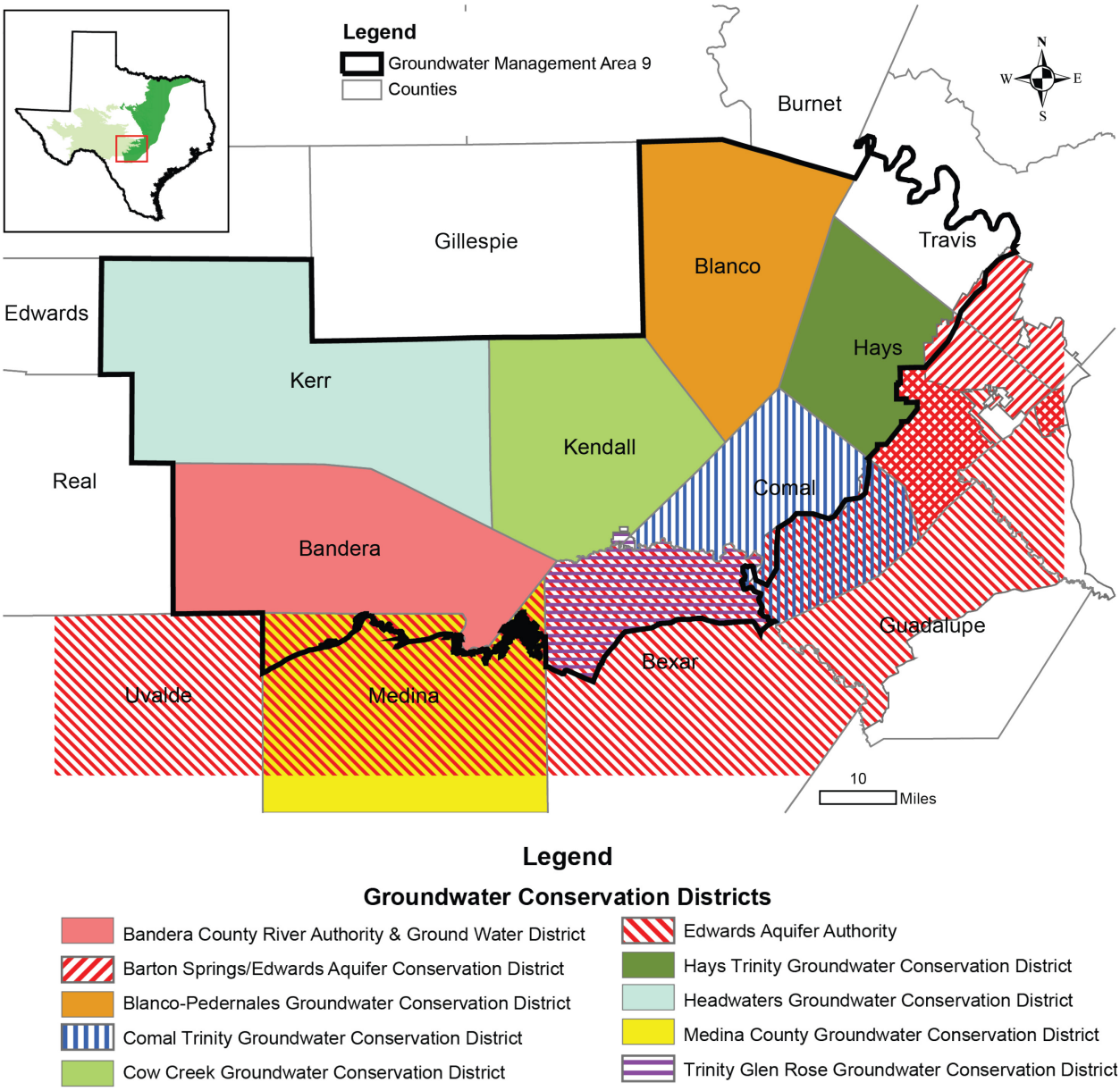


FIGURE 1. MAP SHOWING THE GROUNDWATER CONSERVATION DISTRICTS IN GROUNDWATER MANAGEMENT AREA 9. NOTE: THE BOUNDARIES OF THE EDWARDS AQUIFER AUTHORITY OVERLAP WITH THE MEDINA COUNTY, TRINITY GLEN ROSE, AND COMAL TRINITY GROUNDWATER CONSERVATION DISTRICTS AND THE BARTON SPRINGS/EDWARDS AQUIFER CONSERVATION DISTRICT.

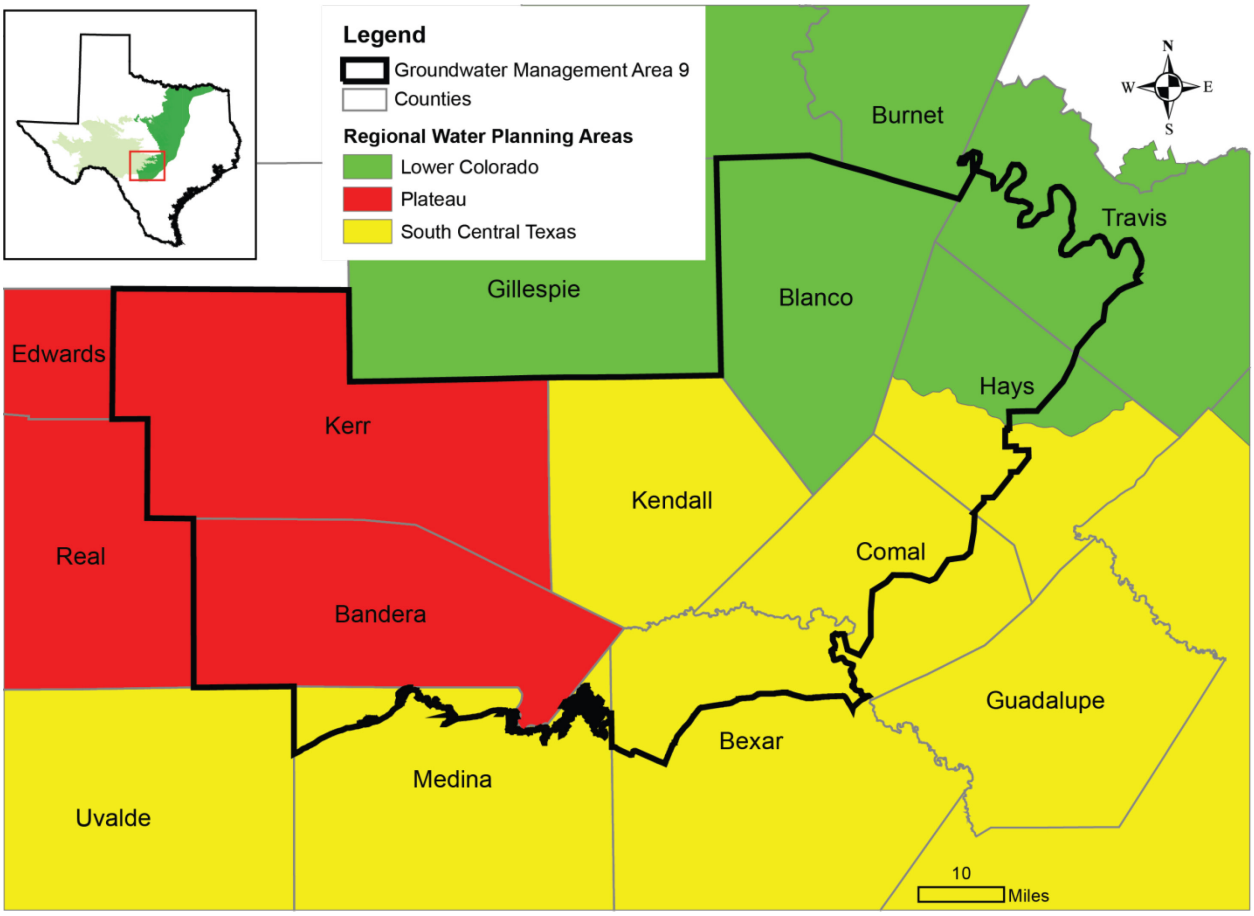


FIGURE 2. MAP SHOWING REGIONAL WATER PLANNING AREAS IN GROUNDWATER MANAGEMENT AREA 9.

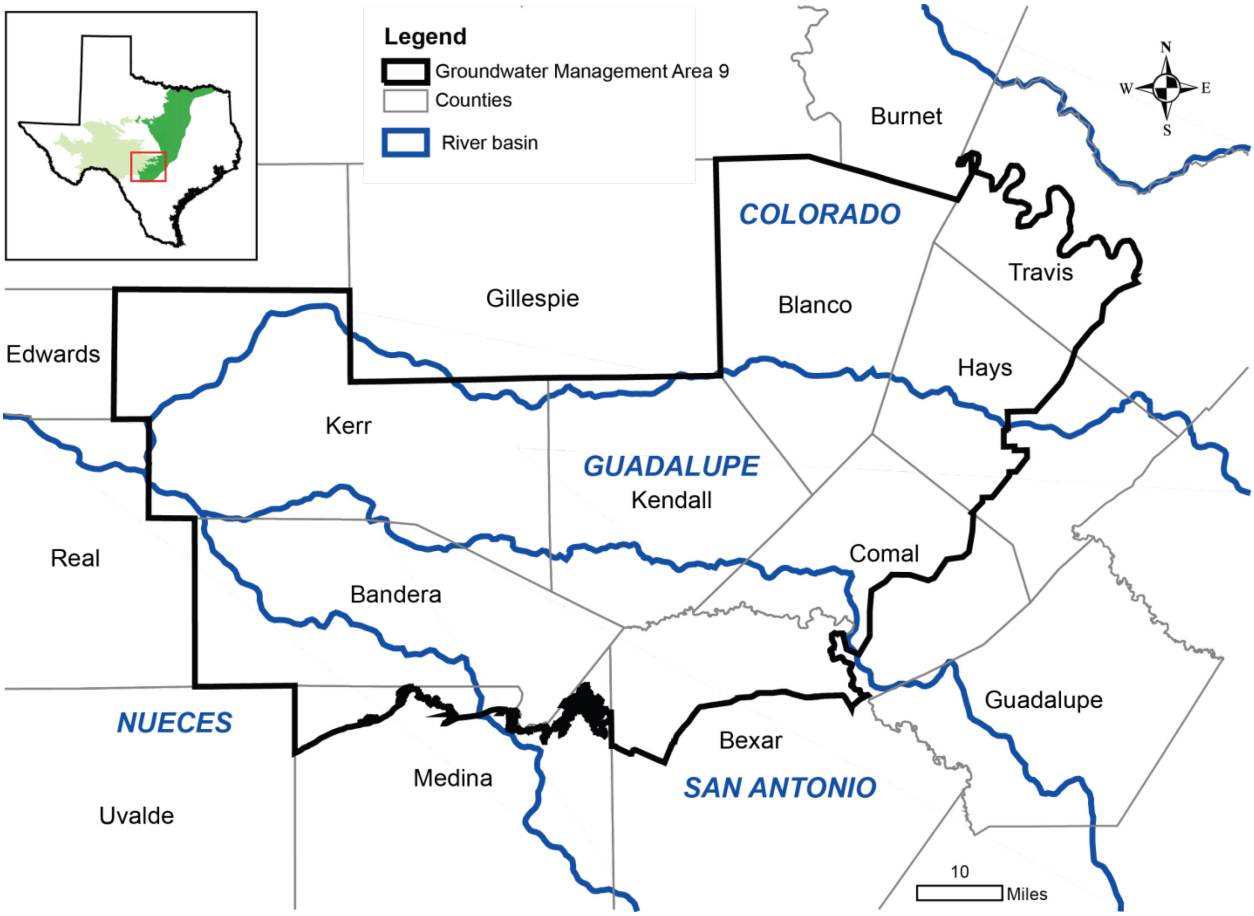


FIGURE 3. MAP SHOWING RIVER BASINS IN GROUNDWATER MANAGEMENT AREA 9. THESE INCLUDE PARTS OF THE COLORADO, GUADALUPE, SAN ANTONIO, AND NUECES RIVER BASINS.

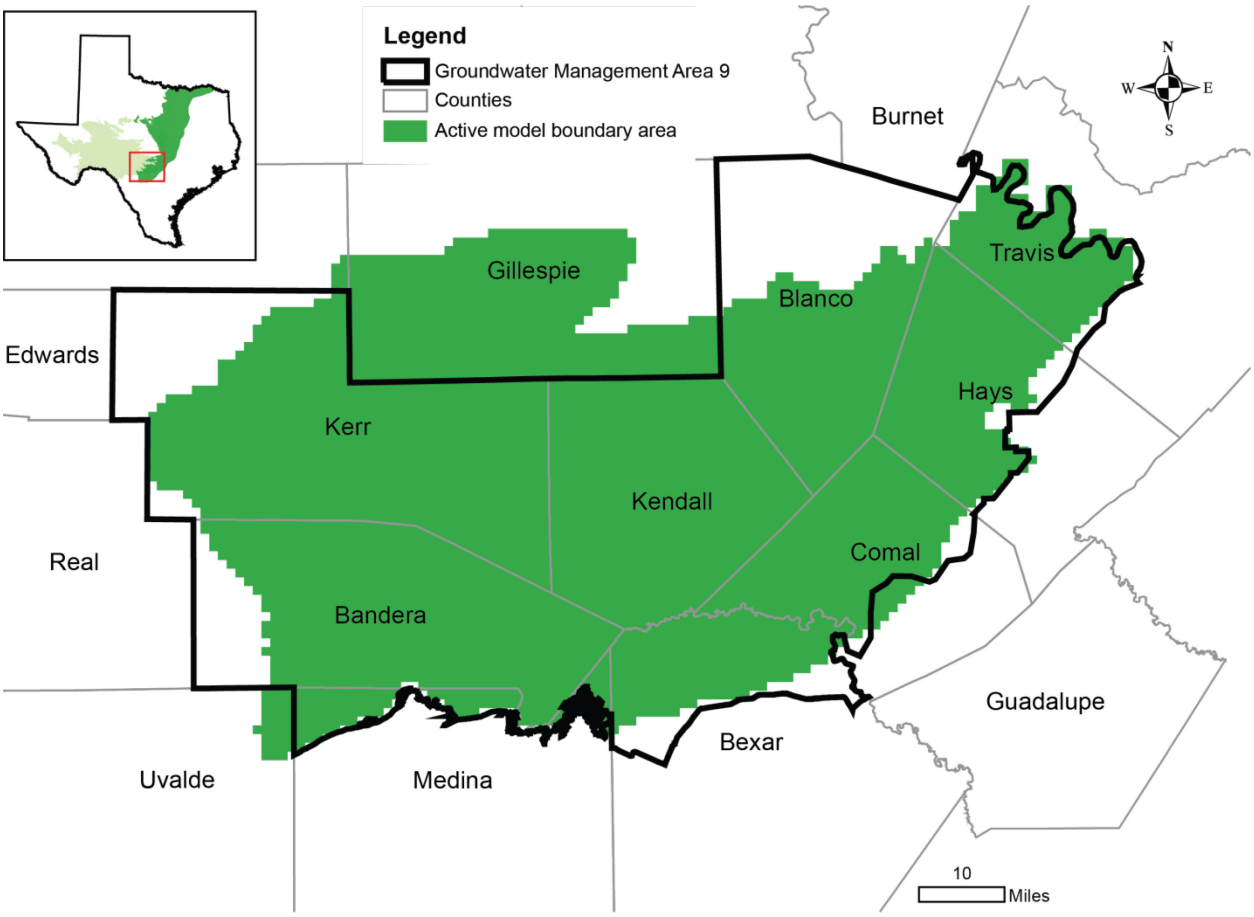


FIGURE 4. MAP SHOWING THE AREAS COVERED BY THE TRINITY AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE HILL COUNTRY PORTION OF THE TRINITY AQUIFER IN GROUNDWATER MANAGEMENT AREA 9.

TABLE 1. MODELED AVAILABLE GROUNDWATER FOR THE TRINITY AQUIFER IN GROUNDWATER MANAGEMENT AREA 9 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR.

District	County	Year					
		2010	2020	2030	2040	2050	2060
Bandera County River Authority & Groundwater District Total	Bandera	7,284	7,284	7,284	7,284	7,284	7,284
Barton Springs/Edwards Aquifer Conservation District Total	Hays	22	22	22	22	22	22
Blanco-Pedernales Groundwater Conservation District Total	Blanco	2,573	2,573	2,573	2,573	2,573	2,573
Comal Trinity Groundwater Conservation District Total	Comal	10,076	10,076	10,076	10,076	10,076	10,076
Cow Creek Groundwater Conservation District Total	Kendall	10,622	10,622	10,622	10,622	10,622	10,622
Hays Trinity Groundwater Conservation District Total	Hays	9,109	9,098	9,095	9,094	9,094	9,094
Headwaters Groundwater Conservation District Total	Kerr	16,435	14,918	14,845	14,556	14,239	14,223
Medina County Groundwater Conservation District Total	Medina	2,500	2,500	2,500	2,500	2,500	2,500

TABLE 1. CONTINUED.

District	County	Year					
		2010	2020	2030	2040	2050	2060
Trinity Glen Rose Groundwater Conservation District	Bexar	24,856	24,856	24,856	24,856	24,856	24,856
Trinity Glen Rose Groundwater Conservation District	Comal	138	138	138	138	138	138
Trinity Glen Rose Groundwater Conservation District	Kendall	517	517	517	517	517	517
Trinity Glen Rose Groundwater Conservation District Total		**25,511**	**25,511**	**25,511**	**25,511**	**25,511**	**25,511**
No district Total	**Travis**	**8,920**	**8,672**	**8,655**	**8,643**	**8,627**	**8,598**
GMA 9	**Total**	**93,052**	**91,276**	**91,183**	**90,881**	**90,548**	**90,503**

TABLE 2. MODELED AVAILABLE GROUNDWATER FOR THE TRINITY AQUIFER IN GROUNDWATER MANAGEMENT AREA 9 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Year					
			2010	2020	2030	2040	2050	2060
Bandera	J	Guadalupe	76	76	76	76	76	76
		Nueces	903	903	903	903	903	903
		San Antonio	6,305	6,305	6,305	6,305	6,305	6,305
		Total	**7,284**	**7,284**	**7,284**	**7,284**	**7,284**	**7,284**
Bexar	L	San Antonio	24,856	24,856	24,856	24,856	24,856	24,856
		Total	**24,856**	**24,856**	**24,856**	**24,856**	**24,856**	**24,856**
Blanco	K	Colorado	1,322	1,322	1,322	1,322	1,322	1,322
		Guadalupe	1,251	1,251	1,251	1,251	1,251	1,251
		Total	**2,573**	**2,573**	**2,573**	**2,573**	**2,573**	**2,573**
Comal	L	Guadalupe	6,906	6,906	6,906	6,906	6,906	6,906
		San Antonio	3,308	3,308	3,308	3,308	3,308	3,308
		Total	**10,214**	**10,214**	**10,214**	**10,214**	**10,214**	**10,214**

TABLE 2. CONTINUED.

County	RWPA	River Basin	Year					
			2010	2020	2030	2040	2050	2060
Hays	K	Colorado	4,721	4,710	4,707	4,706	4,706	4,706
	L	Guadalupe	4,410	4,410	4,410	4,410	4,410	4,410
		Total	**9,131**	**9,120**	**9,117**	**9,116**	**9,116**	**9,116**
Kendall	L	Colorado	135	135	135	135	135	135
		Guadalupe	6,028	6,028	6,028	6,028	6,028	6,028
		San Antonio	4,976	4,976	4,976	4,976	4,976	4,976
		Total	**11,139**	**11,139**	**11,139**	**11,139**	**11,139**	**11,139**
Kerr	J	Colorado	318	318	318	318	318	318
		Guadalupe	15,646	14,129	14,056	13,767	13,450	13,434
		San Antonio	471	471	471	471	471	471
		Total	**16,435**	**14,918**	**14,845**	**14,556**	**14,239**	**14,223**
Medina	L	Nueces	1,575	1,575	1,575	1,575	1,575	1,575
		San Antonio	925	925	925	925	925	925
		Total	**2,500**	**2,500**	**2,500**	**2,500**	**2,500**	**2,500**

TABLE 2. CONTINUED.

County	RWPA	River Basin	Year					
			2010	2020	2030	2040	2050	2060
Travis	K	**Colorado (Total)**	**8,920**	**8,672**	**8,655**	**8,643**	**8,627**	**8,598**
GMA 9			**93,052**	**91,276**	**91,183**	**90,881**	**90,548**	**90,503**

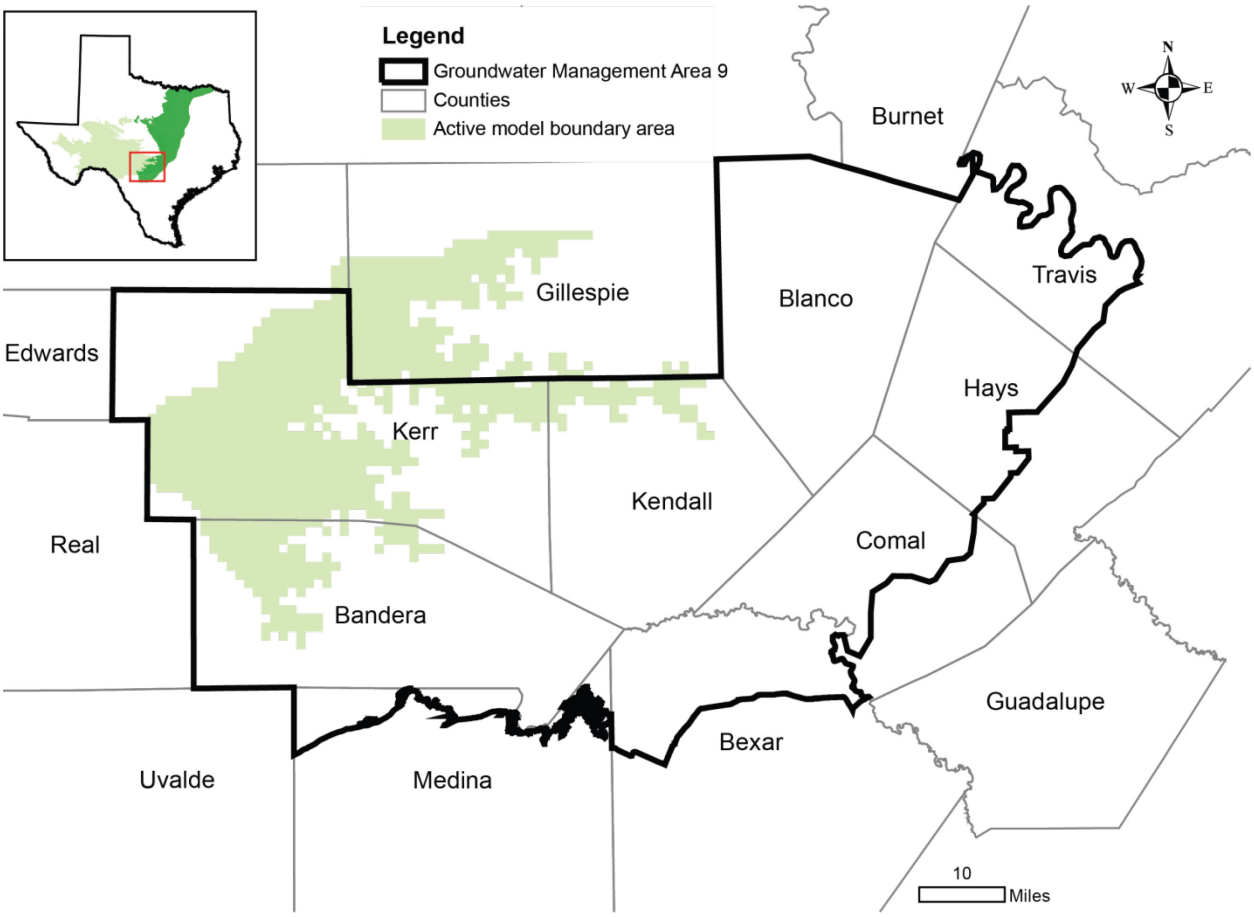


FIGURE 5. MAP SHOWING THE AREAS COVERED BY THE EDWARDS GROUP OF THE EDWARDS-TRINITY (PLATEAU) AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE HILL COUNTRY PORTION OF THE TRINITY AQUIFER IN GROUNDWATER MANAGEMENT AREA 9.

TABLE 3. MODELED AVAILABLE GROUNDWATER FOR THE EDWARDS GROUP OF THE EDWARDS-TRINITY (PLATEAU) AQUIFER IN GROUNDWATER MANAGEMENT AREA 9 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT AND COUNTY, FOR EACH DECADE BETWEEN 2010 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

District	County	Year						
		2010	2020	2030	2040	2050	2060	2070
Bandera County River Authority & Groundwater District Total	Bandera	2,009	2,009	2,009	2,009	2,009	2,009	2,009
Cow Creek Groundwater Conservation District Total	Kendall	199	199	199	199	199	199	199
Grand Total		2,208	2,208	2,208	2,208	2,208	2,208	2,208

TABLE 4. MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE EDWARDS GROUP OF THE EDWARDS-TRINITY (PLATEAU) AQUIFER IN GROUNDWATER MANAGEMENT AREA 9 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2010 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Year						
			2010	2020	2030	2040	2050	2060	2070
Bandera	Plateau (J)	Guadalupe	81	81	81	81	81	81	81
		Nueces	38	38	38	38	38	38	38
		San Antonio	1,890	1,890	1,890	1,890	1,890	1,890	1,890
		Total	**2,009**	**2,009**	**2,009**	**2,009**	**2,009**	**2,009**	**2,009**
Kendall	South Central Texas (L)	Colorado	69	69	69	69	69	69	69
		Guadalupe	130	130	130	130	130	130	130
		Total	**199**	**199**	**199**	**199**	**199**	**199**	**199**
Grand Total			**2,208**	**2,208**	**2,208**	**2,208**	**2,208**	**2,208**	**2,208**

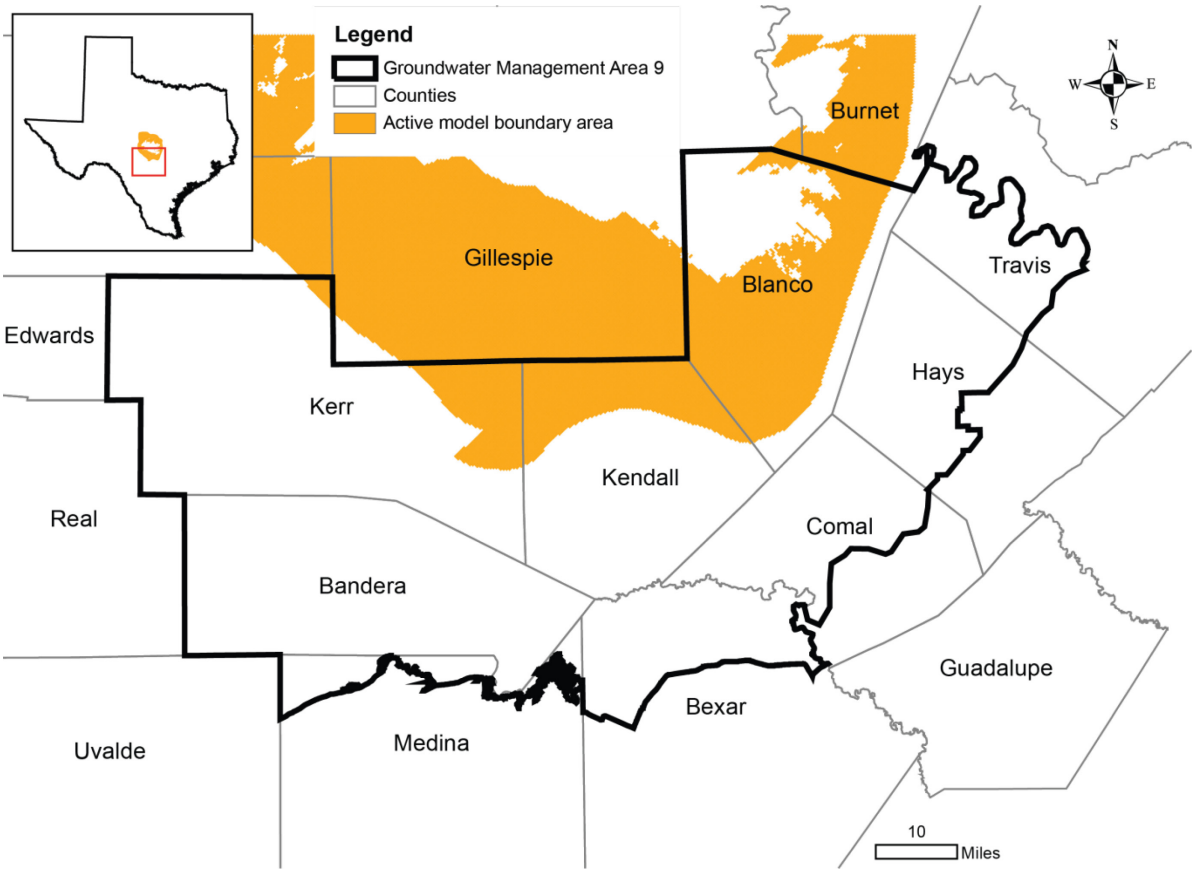


FIGURE 6. MAP SHOWING THE AREAS COVERED BY THE ELLENBURGER-SAN SABA AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE MINOR AQUIFERS OF THE LLANO UPLIFT AREA IN GROUNDWATER MANAGEMENT AREA 9.

TABLE 5. MODELED AVAILABLE GROUNDWATER FOR THE ELLENBURGER-SAN SABA AQUIFER IN GROUNDWATER MANAGEMENT AREA 9 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2010 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

District	County	Year						
		2010	2020	2030	2040	2050	2060	2070
Cow Creek Groundwater Conservation District Total	**Kendall**	**75**	**75**	**75**	**75**	**75**	**75**	**75**

TABLE 6. MODELED AVAILABLE GROUNDWATER FOR THE ELLENBURGER-SAN SABA AQUIFER IN GROUNDWATER MANAGEMENT AREA 9 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2010 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Year						
			2010	2020	2030	2040	2050	2060	2070
Kendall	South Central Texas (L)	Colorado	10	10	10	10	10	10	10
		Guadalupe	64	64	64	64	64	64	64
		Total	**75**	**75**	**75**	**75**	**75**	**75**	**75**

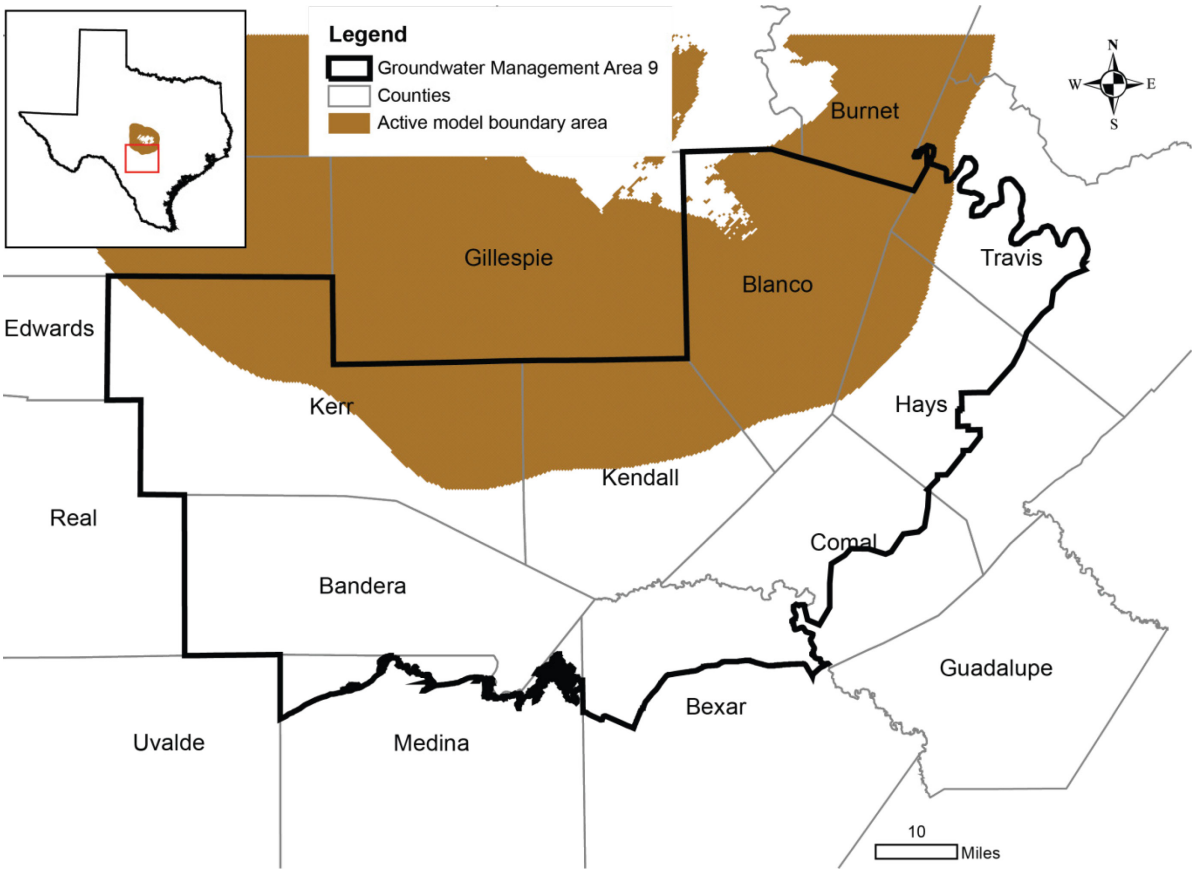


FIGURE 7. MAP SHOWING AREAS COVERED BY THE HICKORY AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE MINOR AQUIFERS OF THE LLANO UPLIFT AREA IN GROUNDWATER MANAGEMENT AREA 9.

TABLE 7. MODELED AVAILABLE GROUNDWATER FOR THE HICKORY AQUIFER IN GROUNDWATER MANAGEMENT AREA 9 SUMMARIZED BY DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2010 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

District	County	Year						
		2010	2020	2030	2040	2050	2060	2070
Cow Creek Groundwater Conservation District Total	**Kendall**	**140**	**140**	**140**	**140**	**140**	**140**	**140**

TABLE 8. MODELED AVAILABLE GROUNDWATER FOR THE HICKORY AQUIFER IN GROUNDWATER MANAGEMENT AREA 9 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2010 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

County	RPWA	River Basin	Year						
			2010	2020	2030	2040	2050	2060	2070
Kendall	South Central Texas (L)	Colorado	12	12	12	12	12	12	12
		Guadalupe	128	128	128	128	128	128	128
		Total	**140**	**140**	**140**	**140**	**140**	**140**	**140**

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.

Model "Dry" Cells

The predictive model run for this analysis results in water levels in some model cells dropping below the base elevation of the cell during the simulation. In terms of water level,

the cells have gone dry. However, as noted in the model assumptions the transmissivity of the cell remains constant and will produce water.

A total of 18 cells out of 23,805 active cells simulating the Trinity Aquifer cells go "dry" during the predictive period through 2060. These dry cells are located in western Travis County, central Hays County and Kerr County. These dry cells are associated either with areas of high pumping or thin parts of the Trinity Aquifer.

REFERENCES:

Groundwater Management Area 9 (GMA 9) Joint Planning Committee, Blanton and Associates, Inc., and LBG-Guyton Associates, 2016, Groundwater Management Area 9 explanatory report for desired future conditions: major and minor aquifers, April 2016, 189 p.

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

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

Hassan, M. M., 2012, GAM Run 10-050 MAG: Texas Water Development Board GAM Run Report 10-050, v. 2, 10 p.

Hutchison, W. R., 2010, GAM Task 10-005: Texas Water Development Board GAM Task Report 10-005, 13 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.

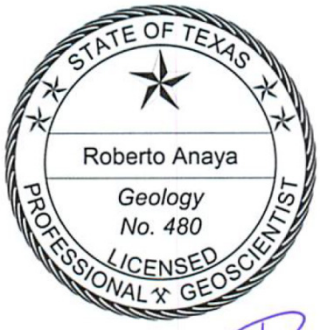
Panday, S., Langevin, C. D., Niswonger, R. G., Ibaraki, M., and Hughes, J. D., 2013, MODFLOW–USG version 1: An unstructured grid version of MODFLOW for simulating groundwater flow and tightly coupled processes using a control volume finite-difference formulation: U.S. Geological Survey Techniques and Methods, book 6, chap. A45, 66 p.

Shi, J., Boghici, R., Kohlrenken, W., and Hutchison, W., 2016, Numerical model report: minor aquifers of the Llano Uplift Region of Texas (Marble Falls, Ellenburger-San Saba, and Hickory): Texas Water Development Board published report, 400 p.

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

GAM RUN 17-004: BANDERA COUNTY RIVER AUTHORITY & GROUNDWATER DISTRICT GROUNDWATER MANAGEMENT PLAN

Roberto Anaya, P.G.
Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Department
512-463-6115
October 23, 2017



Robert Anaya
10/23/17

This page is intentionally blank.

GAM RUN 17-004: BANDERA COUNTY RIVER AUTHORITY & GROUNDWATER DISTRICT GROUNDWATER MANAGEMENT PLAN

Roberto Anaya, P.G.
Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Department
512-463-6115
October 23, 2017

EXECUTIVE SUMMARY:

Texas State Water Code, Section 36.1071, Subsection (h) (Texas Water Code, 2015), states that, in developing its groundwater management plan, a groundwater conservation district shall use groundwater availability modeling information provided by the Executive Administrator of the Texas Water Development Board (TWDB) in conjunction with any available site-specific information provided by the district for review and comment to the Executive Administrator.

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

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

The groundwater management plan for the Bandera County River Authority and Groundwater District should be adopted by the district on or before February 27, 2018,

and submitted to the Executive Administrator of the TWDB on or before March 29, 2018. The current management plan for the Bandera County River Authority and Groundwater District expires on May 28, 2018.

We used the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers version 1.01 (Anaya and Jones, 2009) to estimate the management plan information for the aquifers within the Bandera County River Authority and Groundwater District. This report replaces the results of GAM Run 12-009 (Jones, 2012). GAM Run 17-004 meets current standards set after the release of GAM Run 12-009 and includes updated information for the Edwards-Trinity (Plateau) Aquifer groundwater availability model grid attributes. Tables 1 and 2 summarize the groundwater availability model data required by statute and Figures 1 and 2 show the area of the model from which the values in the tables were extracted. If, after review of the figures, the Bandera County River Authority and Groundwater District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the TWDB at your earliest convenience.

METHODS:

In accordance with the provisions of the Texas State Water Code, Section 36.1071, Subsection (h), the groundwater availability model mentioned above was used to estimate information for the Bandera County River Authority and Groundwater District management plan. Water budgets were extracted for the historical model periods for the Edwards-Trinity (Plateau) Aquifer and the Hill Country portion of the Trinity Aquifer (1980 through 1999) using ZONEBUDGET Version 3.01 (Harbaugh, 2009). The average annual water budget values for recharge, surface-water outflow, inflow to the district, and outflow from the district for the aquifers within the district are summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Edwards-Trinity (Plateau) Aquifer

- We used version 1.01 of the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers. See Anaya and Jones (2009) for assumptions and limitations of the model.

- The groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers contains 2 layers: Layer 1 (the Edwards Group and equivalent limestone hydrostratigraphic units of the Edwards-Trinity (Plateau) Aquifer System, and layer 2 (comprised of the undifferentiated Trinity Group hydrostratigraphic units of the Edwards-Trinity (Plateau) Aquifer System). The two layers were

lumped for calculating water budget flows in the Edwards-Trinity (Plateau) Aquifer System within the district.

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

Trinity Aquifer

- We used version 1.01 of the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers. See Anaya and Jones (2009) for assumptions and limitations of the model.
- The groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers contains 2 layers. However, only layer 2 (comprised of the undifferentiated Trinity Group hydrostratigraphic units) was used for calculating water budget flows in the Hill Country portion of the Trinity Aquifer within the district.
- We used the groundwater availability model for the Edwards-Trinity (Plateau) instead of the groundwater availability model for the Hill Country portion of the Trinity Aquifer because the Edwards-Trinity (Plateau) Aquifer model covers the entire geographical areas of district. Both groundwater availability models are aligned with different model grid orientations which prevent combining the results from each without double accounting or omitting important water budget information.
- The model was run with MODFLOW-96 (Harbaugh and others, 1996).

RESULTS:

A groundwater budget summarizes the amount of water entering and leaving the aquifers according to the groundwater availability model. Selected groundwater budget components listed below were extracted from the groundwater availability model results for the Edwards-Trinity (Plateau) and Trinity aquifers located within Bandera County River Authority and Groundwater District and averaged over the historical calibration periods, as shown in Tables 1 and 2.

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

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

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

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

The information needed for the district's management plan is summarized in Tables 1 and 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.

TABLE 1. SUMMARIZED INFORMATION FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER FOR BANDERA COUNTY RIVER AUTHORITY AND GROUNDWATER DISTRICT GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Edwards-Trinity (Plateau) Aquifer	7,596
Estimated annual volume of water that discharges from the aquifer to springs and any surface-water body including lakes, streams, and rivers	Edwards-Trinity (Plateau) Aquifer	4,141
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	8,538
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	4,033
Estimated net annual volume of flow between each aquifer in the district	From the Edwards-Trinity (Plateau) Aquifer to the Trinity Aquifer	12,910

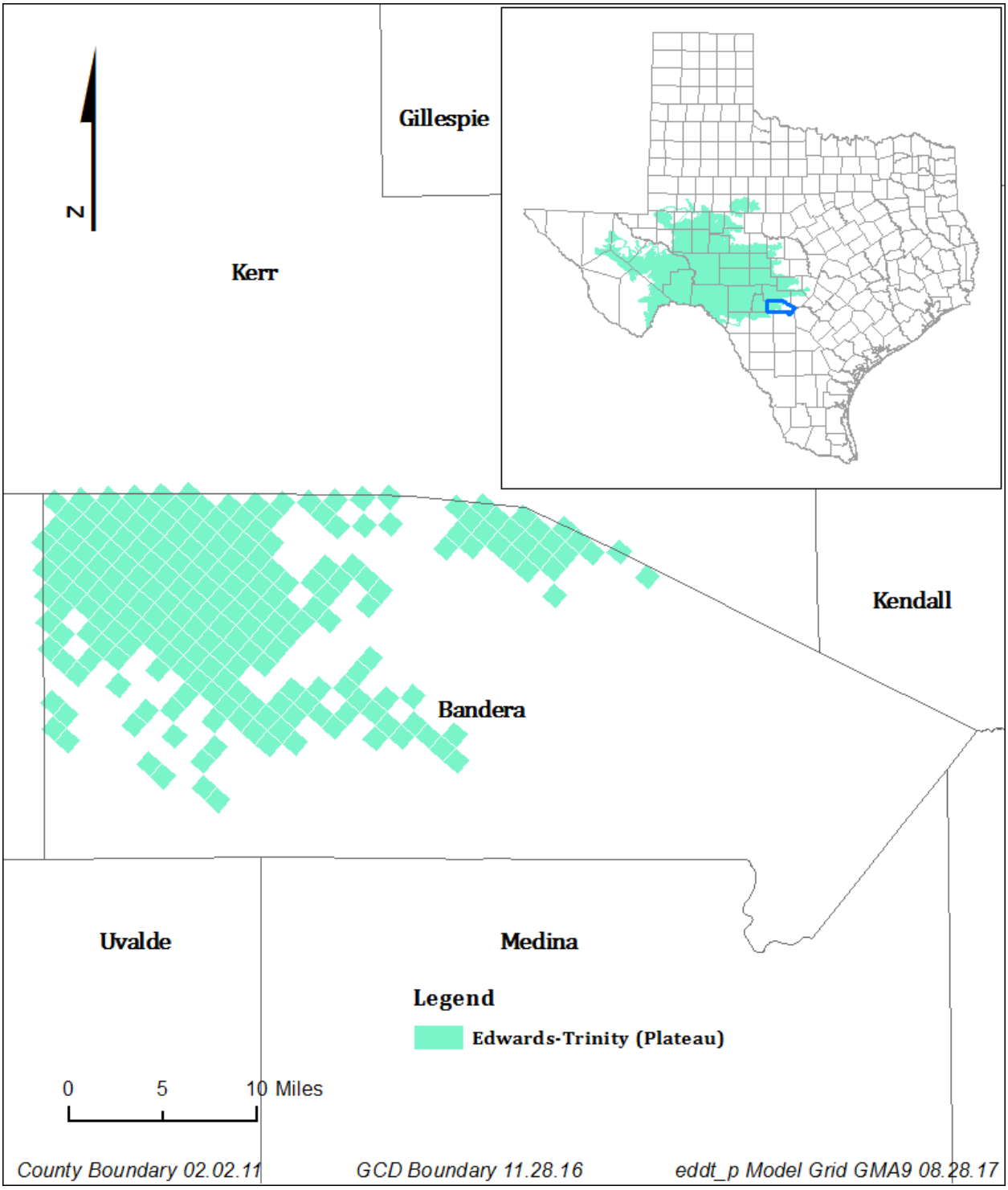


FIGURE 1. AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AND PECOS VALLEY AQUIFERS FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE EDWARDS-TRINITY (PLATEAU) AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 2. SUMMARIZED INFORMATION FOR THE TRINITY AQUIFER FOR BANDERA COUNTY RIVER AUTHORITY AND GROUNDWATER DISTRICT GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Trinity Aquifer	47,239
Estimated annual volume of water that discharges from the aquifer to springs and any surface-water body including lakes, streams, and rivers	Trinity Aquifer	32,750
Estimated annual volume of flow into the district within each aquifer in the district	Trinity Aquifer	9,561
Estimated annual volume of flow out of the district within each aquifer in the district	Trinity Aquifer	31,028
Estimated net annual volume of flow between each aquifer in the district	From the Edwards-Trinity (Plateau) Aquifer to the Trinity Aquifer	12,910

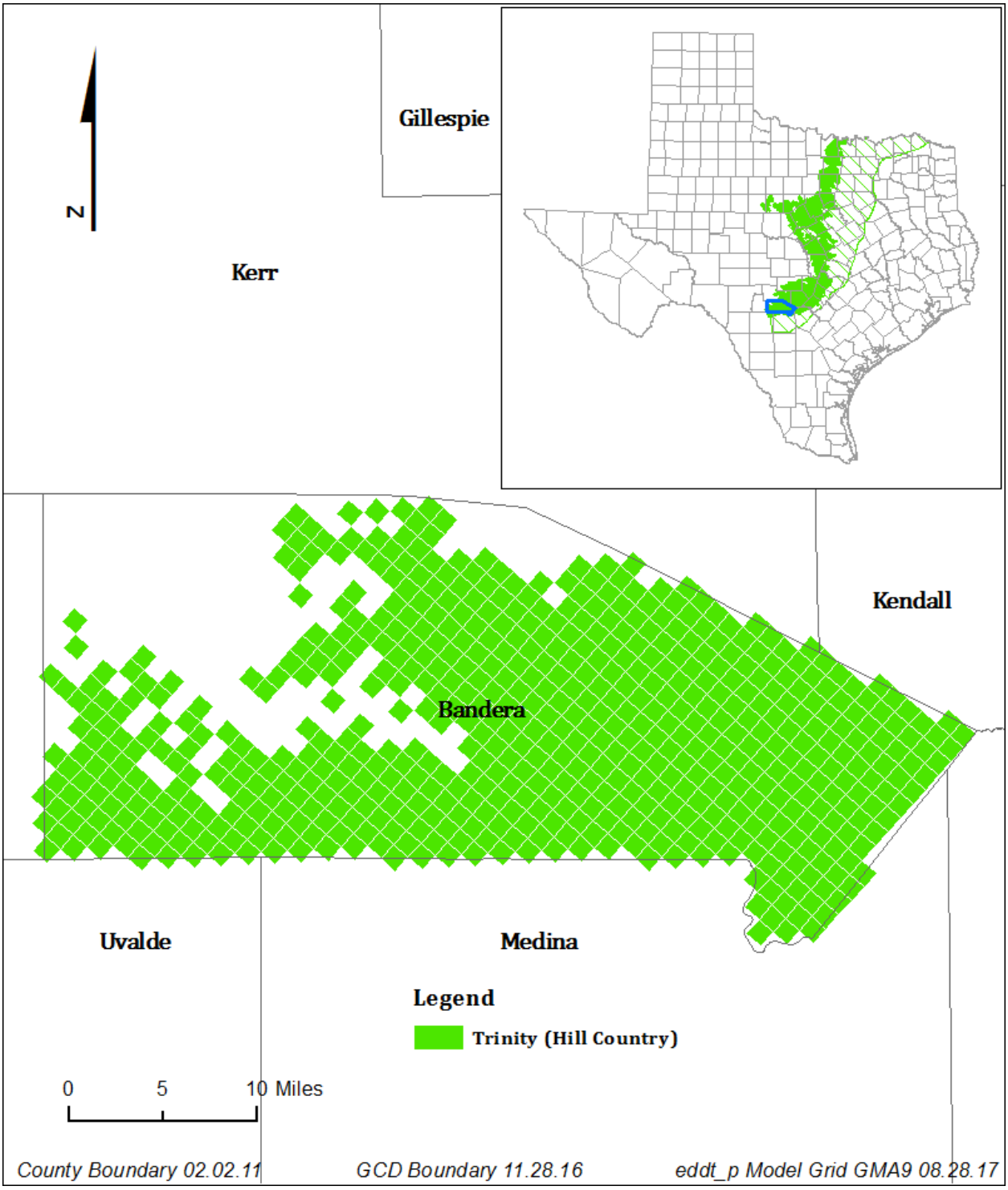


FIGURE 2. AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AND PECOS VALLEY AQUIFERS FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE TRINITY AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

LIMITATIONS:

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

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

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

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

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

REFERENCES:

Anaya, R., and Jones, I., 2009, Groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers of Texas: Texas Water Development Board, Report 373, 103 p.

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

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

Jones, I., 2012, GAM Run 12-009: Bandera County River Authority and Groundwater District 1 Management Plan, 12 p., http://www.twdb.texas.gov/groundwater/docs/GAMruns/GR12-009.pdf.

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.

Estimated Historical Water Use And 2017 State Water Plan Datasets:

Bandera County River Authority and Groundwater District

by Stephen Allen
Texas Water Development Board
Groundwater Division
Groundwater Technical Assistance Section
stephen.allen@twdb.texas.gov
(512) 463-7317
November 7, 2017

GROUNDWATER MANAGEMENT PLAN DATA:

This package of water data reports (part 1 of a 2-part package of information) is being provided to groundwater conservation districts to help them meet the requirements for approval of their five-year groundwater management plan. Each report in the package addresses a specific numbered requirement in the Texas Water Development Board's groundwater management plan checklist. The checklist can be viewed and downloaded from this web address:

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

The five reports included in this part are:

1. Estimated Historical Water Use (checklist item 2)

   from the TWDB Historical Water Use Survey (WUS)
2. Projected Surface Water Supplies (checklist item 6)
3. Projected Water Demands (checklist item 7)
4. Projected Water Supply Needs (checklist item 8)
5. Projected Water Management Strategies (checklist item 9)

   from the 2017 Texas State Water Plan (SWP)

Part 2 of the 2-part package is the groundwater availability model (GAM) report for the District (checklist items 3 through 5). The District should have received, or will receive, this report from the Groundwater Availability Modeling Section. Questions about the GAM can be directed to Dr. Shirley Wade, shirley.wade@twdb.texas.gov, (512) 936-0883.

DISCLAIMER:

The data presented in this report represents the most up-to-date WUS and 2017 SWP data available as of 11/7/2017. Although it does not happen frequently, either of these datasets are subject to change pending the availability of more accurate WUS data or an amendment to the 2017 SWP. District personnel must review these datasets and correct any discrepancies in order to ensure approval of their groundwater management plan.

The WUS dataset can be verified at this web address:

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

The 2017 SWP dataset can be verified by contacting Sabrina Anderson (sabrina.anderson@twdb.texas.gov or 512-936-0886).

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

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

Groundwater and surface water historical use estimates are currently unavailable for calendar year 2016. TWDB staff anticipates the calculation and posting of these estimates at a later date.

BANDERA COUNTY

All values are in acre-feet

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2015	GW	2,097	0	0	0	578	163	2,838
	SW	0	0	0	0	16	54	70
2014	GW	2,226	0	0	0	797	162	3,185
	SW	0	0	0	0	34	54	88
2013	GW	2,540	0	0	0	778	149	3,467
	SW	0	0	0	0	15	50	65
2012	GW	2,696	0	0	0	824	154	3,674
	SW	0	0	0	0	0	51	51
2011	GW	2,849	0	0	0	1,396	224	4,469
	SW	0	0	0	0	1	73	74
2010	GW	2,600	0	0	0	887	224	3,711
	SW	0	0	0	0	0	73	73
2009	GW	2,590	0	0	0	888	196	3,674
	SW	0	0	0	0	0	66	66
2008	GW	2,658	0	0	0	374	184	3,216
	SW	0	0	0	0	0	61	61
2007	GW	2,421	0	0	0	365	209	2,995
	SW	0	0	0	0	0	70	70
2006	GW	2,780	0	0	0	284	197	3,261
	SW	0	0	0	0	0	66	66
2005	GW	2,542	0	0	0	246	197	2,985
	SW	106	0	0	0	5	66	177
2004	GW	2,352	0	0	0	266	114	2,732
	SW	106	0	0	0	5	139	250
2003	GW	2,446	0	0	0	161	108	2,715
	SW	107	0	0	0	8	133	248
2002	GW	2,372	0	0	0	263	125	2,760
	SW	182	0	0	0	224	153	559
2001	GW	2,365	0	0	0	263	141	2,769
	SW	95	0	0	0	224	173	492
2000	GW	2,358	0	0	0	325	252	2,935
	SW	101	0	0	0	278	63	442

Projected Surface Water Supplies
TWDB 2017 State Water Plan Data

BANDERA COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	Source Name	2020	2030	2040	2050	2060	2070
J	COUNTY-OTHER, BANDERA	NUECES	NUECES RUN-OF-RIVER	2	2	2	2	2	2
J	COUNTY-OTHER, BANDERA	SAN ANTONIO	SAN ANTONIO RUN-OF-RIVER	0	0	0	0	0	0
J	IRRIGATION, BANDERA	NUECES	NUECES RUN-OF-RIVER	25	25	25	25	25	25
J	IRRIGATION, BANDERA	SAN ANTONIO	SAN ANTONIO RUN-OF-RIVER	0	0	0	0	0	0
J	LIVESTOCK, BANDERA	SAN ANTONIO	SAN ANTONIO OTHER LOCAL SUPPLY	74	74	74	74	74	74
	Sum of Projected Surface Water Supplies (acre-feet)			**101**	**101**	**101**	**101**	**101**	**101**

Projected Water Demands
TWDB 2017 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.

BANDERA COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
J	BANDERA	SAN ANTONIO	191	214	225	231	234	236
J	COUNTY-OTHER, BANDERA	GUADALUPE	16	18	19	19	19	19
J	COUNTY-OTHER, BANDERA	NUECES	143	159	168	171	173	174
J	COUNTY-OTHER, BANDERA	SAN ANTONIO	2,334	2,597	2,731	2,778	2,817	2,840
J	IRRIGATION, BANDERA	NUECES	86	86	86	86	86	86
J	IRRIGATION, BANDERA	SAN ANTONIO	346	346	346	346	346	346
J	LIVESTOCK, BANDERA	GUADALUPE	13	13	13	13	13	13
J	LIVESTOCK, BANDERA	NUECES	58	58	58	58	58	58
J	LIVESTOCK, BANDERA	SAN ANTONIO	226	226	226	226	226	226
	Sum of Projected Water Demands (acre-feet)		**3,413**	**3,717**	**3,872**	**3,928**	**3,972**	**3,998**

Projected Water Supply Needs
TWDB 2017 State Water Plan Data

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

BANDERA COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
J	BANDERA	SAN ANTONIO	469	446	435	429	426	424
J	COUNTY-OTHER, BANDERA	GUADALUPE	4	2	1	1	1	1
J	COUNTY-OTHER, BANDERA	NUECES	7	-9	-18	-21	-23	-24
J	COUNTY-OTHER, BANDERA	SAN ANTONIO	37	-226	-360	-407	-446	-469
J	IRRIGATION, BANDERA	NUECES	400	400	400	400	400	400
J	IRRIGATION, BANDERA	SAN ANTONIO	-129	-129	-129	-129	-129	-129
J	LIVESTOCK, BANDERA	GUADALUPE	-12	-12	-12	-12	-12	-12
J	LIVESTOCK, BANDERA	NUECES	14	14	14	14	14	14
J	LIVESTOCK, BANDERA	SAN ANTONIO	-1	-1	-1	-1	-1	-1
	Sum of Projected Water Supply Needs (acre-feet)		**-142**	**-377**	**-520**	**-570**	**-611**	**-635**

Projected Water Management Strategies
TWDB 2017 State Water Plan Data

BANDERA COUNTY

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

Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
BANDERA, SAN ANTONIO (J)							
CITY OF BANDERA - ADDITIONAL GROUNDWATER WELL AND NECESSARY PIPELINE	TRINITY AQUIFER [BANDERA]	323	323	323	323	323	323
CITY OF BANDERA - ADDITIONAL MIDDLE TRINITY WELLS WITHIN CITY	TRINITY AQUIFER [BANDERA]	161	161	161	161	161	161
CITY OF BANDERA - PROMOTE, DESIGN AND INSTALL RAINWATER HARVESTING SYSTEMS	DEMAND REDUCTION [BANDERA]	1	1	1	1	1	1
CITY OF BANDERA - REUSE TREATED WASTEWATER EFFLUENT FOR IRRIGATION USE	DIRECT REUSE [BANDERA]	310	310	310	310	310	310
		795	**795**	**795**	**795**	**795**	**795**
COUNTY-OTHER, BANDERA, GUADALUPE (J)							
DROUGHT MANAGEMENT (BCRAGD)	DEMAND REDUCTION [BANDERA]	0	0	0	0	0	0
		0	**0**	**0**	**0**	**0**	**0**
COUNTY-OTHER, BANDERA, NUECES (J)							
BCRAGD - VEGETATIVE MANAGEMENT	SAN ANTONIO RUN-OF-RIVER [BANDERA]	0	0	0	0	0	0
DROUGHT MANAGEMENT (BCRAGD)	DEMAND REDUCTION [BANDERA]	29	32	34	34	35	35
		29	**32**	**34**	**34**	**35**	**35**
COUNTY-OTHER, BANDERA, SAN ANTONIO (J)							
BANDERA CO. FWSD #1 - ADDITIONAL WELL FOR PEBBLE BEACH SUBDIVISION	TRINITY AQUIFER [BANDERA]	161	161	161	161	161	161
BANDERA COUNTY FWSD #1 - WATER LOSS AUDIT AND MAIN-LINE REPAIR	DEMAND REDUCTION [BANDERA]	1	1	1	1	1	1
BANDERA RIVER RANCH #1 - WATER LOSS AUDIT AND MAIN-LINE REPAIR	DEMAND REDUCTION [BANDERA]	1	1	1	1	1	1
BCRAGD - ADDITIONAL WELLS TO HELP MEDINA LAKE AREA	TRINITY AQUIFER [BANDERA]	27	27	27	27	27	27
BCRAGD - ADDITIONAL WELLS TO PROVIDE EMERGENCY SUPPLY TO VFD	TRINITY AQUIFER [BANDERA]	189	189	189	189	189	189
BCRAGD - VEGETATIVE MANAGEMENT	SAN ANTONIO RUN-OF-RIVER [BANDERA]	0	0	0	0	0	0
DROUGHT MANAGEMENT (BCRAGD)	DEMAND REDUCTION [BANDERA]	467	519	546	556	563	568
MEDINA WSC - WATER LOSS AUDIT AND MAIN-LINE REPAIR	DEMAND REDUCTION [BANDERA]	1	1	1	1	1	1
		847	**899**	**926**	**936**	**943**	**948**

IRRIGATION, BANDERA, SAN ANTONIO (J)							
BANDERA COUNTY IRRIGATION - ADDITIONAL GROUNDWATER WELLS	TRINITY AQUIFER [BANDERA]	130	130	130	130	130	130
		130	**130**	**130**	**130**	**130**	**130**
LIVESTOCK, BANDERA, GUADALUPE (J)							
BANDERA COUNTY LIVESTOCK - ADDITIONAL GROUNDWATER WELL	EDWARDS-TRINITY-PLATEAU AQUIFER [BANDERA]	15	15	15	15	15	15
		15	**15**	**15**	**15**	**15**	**15**
LIVESTOCK, BANDERA, SAN ANTONIO (J)							
BANDERA COUNTY LIVESTOCK - ADDITIONAL GROUNDWATER WELL	EDWARDS-TRINITY-PLATEAU AQUIFER [BANDERA]	5	5	5	5	5	5
		5	**5**	**5**	**5**	**5**	**5**
Sum of Projected Water Management Strategies (acre-feet)		**1,821**	**1,876**	**1,905**	**1,915**	**1,923**	**1,928**