GROUNDWATER MANAGEMENT PLAN

FOR

BANDERA COUNTY RIVER AUTHORITY AND GROUNDWATER DISTRICT

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ADOPTED APRIL 8, 2010

AMENDED APRIL 11, 2013

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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 of 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 created with specific authorities, listed in their enabling legislation, which address the needs and functions necessary for the district's region. The different authorities are stated in the 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 of 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. Beginning with the reorganization of the River Authority Board of Directors in 1985, the 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 of 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 all of 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 continues all the programs and activities of Springhills Water Management. The District has all of 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 of the 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 slab. The District conducts inspections before, during drilling, and after completion of the wells. Upon submission of the completion paperwork by the driller, the district inspects 100% of the completed wells. This well inspection includes a comprehension 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. Also, when possible, the static level measurement of the water level is recorded and a water sample is collected and analyzed.
2. The District samples surface water throughout the county to determine water quality. A water quality report is made to the local newspapers in order 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. An aquifer model is used for a demonstration in schools and at school related events. The District maintains a public education program that helps foster public awareness on groundwater and surface water issues and conservation.
5. The District's monitor well program includes a program of measuring water levels and collecting water samples from designated wells twice a year. The District has also been able to find some wells that could be dedicated to continuous monitoring. Instruments have been installed in these wells and are checked and/or downloaded each calendar quarter.
6. Rainfall data is collected on a daily basis by volunteers scattered across the county. These volunteers send in the rainfall reports on a quarterly basis. The District supports a USGS rain and river gage on the Medina River in Medina, Texas. Also, the District supports a USGS rainfall and groundwater monitor gage at the District's Edwards monitoring well in western Bandera County. This data is used to study rainfall and its possible impact on the recharge of the aquifer. Also, the gages can serve as a flood awareness 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., as a means to protect surface, groundwater quality, and natural resources within the District.
8. The District maintains a lab for public analysis of surface water and groundwater. This lab also analysis groundwater samples from newly drilled wells in Bandera County.

TIME PERIOD FOR THIS PLAN

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 anytime, or after five years, when the plan will be reviewed to insure 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 areal extent of 768 square miles, or 491,520 acres. The County seat, the city of Bandera, 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 District will continue to manage the supply of groundwater within the District in order to conserve the resource while seeking to maintain the economic viability of all resource user groups, public and private. In consideration of the economic and cultural activities occurring within the District, the District will identify and engage in such activities and practices that, if implemented, would result in a reduction of groundwater use. 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 making a determination to deny 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.

In pursuit of the District's mission of protecting the resource, the District may require reduction of groundwater withdrawals to amounts that will not cause harm to 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 or 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 as:

> "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.

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."

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.

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) on August 26, 2010. DFC's were adopted also on August 26, 1010 for the Hill Country Trinity Aquifer, as stated in GAM Run 10-005. The adopted DFCs were then forwarded to the TWDB for development of the MAG calculations.
A summary of the desired future conditions and the modeled available groundwater are summarized below.

GAM Task 10-005 & GAM Task 10-031: Supplement for DFC.	Please refer to Appendix A

GAM Run 10-049 MAG Report Version 2, for Modeled Available Groundwater for the Edwards Group of the Edwards-Trinity (Plateau).	Please refer to Appendix B

GAM Run 10-050 MAG Report Version 2, for Modeled Available Groundwater For the Trinity Aquifer.	Please refer to Appendix C

Amount of Groundwater Being Used within the District on an Annual Basis.	Please refer to Appendix D

Annual Amount of Recharge From Precipitation to the Groundwater Resources within the District.	Please refer to Appendix E

Annual Volume of Water that Discharges from the Aquifer to Springs and Surface Water Bodies.	Please refer to Appendix E

Estimate of the Annual Volume of Flow into the District, out of the District, and Between Aquifers in the District.	Please refer to Appendix E

Projected Surface Water Supply within the District.	Please refer to Appendix D

Projected Total Demand for Water within the District.	Please refer to Appendix D

Water Supply Needs.	Please refer to Appendix D

Water Management Strategies.	Please refer to Appendix D

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 in order 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 pumpage of the aquifer 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 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 with the most recent set adopted March 15, 2013 relating to the permitting of wells and the production of groundwater. 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.

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 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 second Quarterly Board meeting following the end of the fiscal year.

GROUNDWATER MANAGEMENT GOALS

Management Goal 1

1.0.0 Manage groundwater in order 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 10 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 once at the first of each month and when drought conditions exist, implement the Drought Management Plan.

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 announce and record the Drought index at the first of each month and implement the appropriate stage of the Drought Management Plan when necessary.

6.2.1 Management Objective
Evaluate groundwater availability each year by monitoring water levels of the aquifer from at least 6 monitor wells with continuous recorders within Bandera County.

6.2.2 Performance Standard
Record number of wells recording daily water levels and number of wells analyzed 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 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
Provide literature on designing and operating a rainwater harvesting system to the public.

8.1.2 Performance Standard
Provide Rainwater Harvesting material to the public in handouts. Publish a minimum of one newspaper article annually on the benefits of Rainwater Harvesting. Report annually to the Board of Directors the number of publications provided and other educational talks by the District.

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 or published reports on the benefits of brush and control to 100 percent of written public requests.

11.1.2 Performance Standard

Report the number of requests received for brush control information, and the number of times brush control information was provided, in an annual report to the Board of Directors.

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 10 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 Task 10-005 Scenario 6 for Bandera County. The General Manager will report annually to the District Board of Directors and GMA 9 committee 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 ___ day of ______________, 2013.

______________________________	Attest: ____________________
Don Sloan, President	Jerry Sides, Secretary

Sworn to and subscribed to before me this ___ day of _______________, 2013.

____
(Signature of Notary)

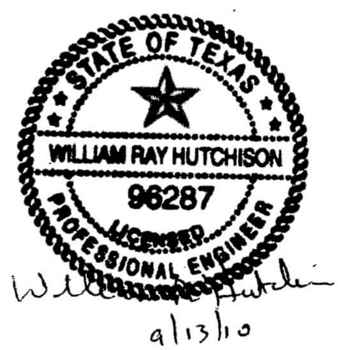
____
(Printed Name of Notary)

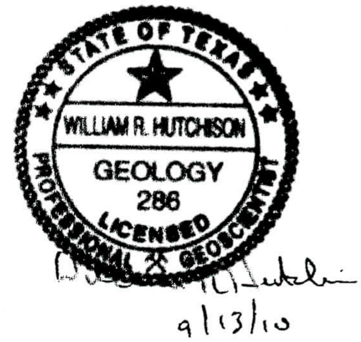
APPENDIX A

GAM Task 10-005

by **William R. Hutchison, Ph.D, P.E., P.G.**
Texas Water Development Board
Groundwater Resources Division
(512) 463-5067
September 3, 2010

The seal appearing on this document was authorized by William R. Hutchison, P.E. 96287, P.G. 286 on September 3, 2010.





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EXECUTIVE SUMMARY

This report presents results of a GAM Task that was requested at the May 10, 2010 Groundwater Management Area 9 meeting in Kerrville. This task represents an expansion of the GAM run requested by Groundwater Management Area 9 (Chowdhury, 2010) and the supplement of that GAM run request (Hutchison, 2010), both of which were discussed at the May 10, 2010 Groundwater Management Area 9 meeting.

The simulations completed as part of this task include seven pumping scenarios of the Trinity Aquifer that range from zero pumping to about twice current pumping. Each scenario included running 387 50-year simulations. The 387 50-year simulations were developed based on tree-ring precipitation estimates from 1537 to 1972 for the Edwards Plateau (Cleaveland, 2006). The results were used to evaluate the relationships between pumping versus drawdown, spring and base flow and outflow across the Balcones Fault Zone.

Results from the Task were summarized Groundwater Management Area-wide, by county, and by three areas designated by Mr. Ron Fieseler, General Manager of the Blanco-Pedernales Groundwater Conservation District. Because each scenario consisted of 387 50-year simulations, the results can also be expressed in terms of minimum, average, and maximum, as well as values that are exceeded 5 percent of the time and values that are exceeded 95 percent of the time.

ORIGIN OF TASK:

During the course of the May 10, 2010 Groundwater Management Area 9 meeting, there was consensus to complete these 50-year simulations to provide additional information to the groundwater conservation districts in Groundwater Management Area 9

DESCRIPTION OF TASK:

The simulations completed as part of this task include seven pumping scenarios of the Trinity Aquifer that range from zero pumping to about twice current pumping. Each scenario included running 387 50-year simulations. The 387 50-year simulations were developed based on tree-ring precipitation estimates from 1537 to 1972 for the Edwards Plateau (Cleaveland, 2006). The results were used to evaluate the relationships between pumping versus drawdown, spring and base flow and outflow across the Balcones Fault Zone.

METHODS:

The original request (Chowdhury, 2010) included model runs that included predictive simulations using the Hill Country portion of the Trinity Aquifer model to assess the effects of drought and increased pumping on water levels, baseflow, and flow across the Balcones Fault Zone. The requested runs consisted of 50-year simulations, some with 50 years of average recharge, and some with 43 years of average recharge followed by 7 years of drought-of-record conditions. The runs also included various combinations of pumping at 2008 levels, one and a half times the 2008 pumping levels, and one and a half times 2008 pumping levels which were reduced to 2008 pumping levels during droughts.

The supplement (Hutchison, 2010) included seven separate scenarios. Three of the scenarios assumed constant pumping (i.e. no drought reduction), and four scenarios assumed a 33 percent pumping reduction during drought years. Each scenario included 430 7-year simulations based on tree-ring precipitation estimates from 1537 to 1972 for the Edwards Plateau (Cleaveland, 2006).

These simulations involve varying recharge based on the Cleaveland (2006) tree-ring dataset, but include 387 50-years simulations, as detailed below.

Precipitation and Recharge

The 50-year running average of the tree-ring precipitation is presented in Figure 1. Note that the precipitation for the 50-year period ending in 1593 is about 96 percent of average, and represents the driest 50 year period in the record. Aside from the generally dry conditions in the late 1500s and early 1600s, there are three other relatively dry periods in the early 1800s, the early 1900s, and the most recent period that ended in 1972 (at the end of the record).

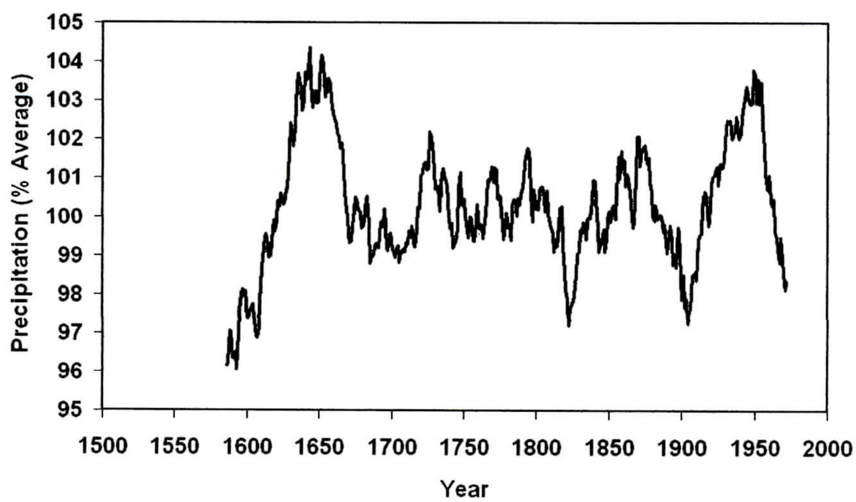

Figure 1. 50-year running average precipitation in the Edwards Plateau region of Texas based on tree-ring data (data from Cleaveland, 2006).

These tree-ring precipitation data were used to develop 387 separate recharge input files based on the relationship between precipitation and recharge during the model calibration period as shown in Figure 2.

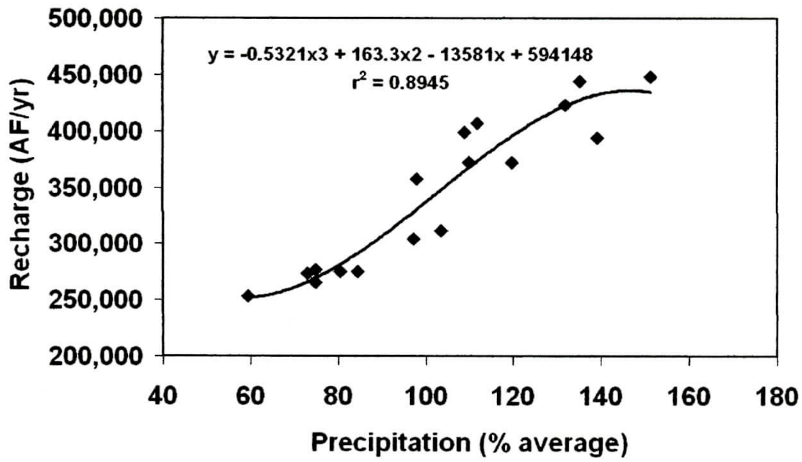

Figure 2. Precipitation versus recharge in Hill Country model from 1981 to 1997

Pumping

Pumping in the original request was based on 2008 pumping, and in some runs, was increased to one-and-a-half times the 2008 pumping. As reported in the main report (Chowdhury, 2010) 2008 pumping totaled 61,248 acre-feet per year. One-and-a-half times 2008 pumping totaled 89,921 acre-feet per year. Pumping scenarios in the supplemental runs (Hutchison, 2010) were based on an analysis of 2008 pumping and 2007 State Water Plan groundwater availability estimates. Pumping ranged from about 64,000 acre-feet per year to about 119,000 acre-feet per year.

For this Task, seven pumping scenarios were developed. The groundwater districts in Groundwater Management Area 9 updated their estimates of 2008 pumping, as detailed in Table 1. Total 2008 pumping is about 60,000 acre-feet per year.

The seven scenarios were based on varying the 2008 pumping as follows (all pumping amounts are from the Trinity Aquifer and are approximate):

- Scenario 1 = 0 acre-feet per year
- Scenario 2 = 20,000 acre-feet per year
- Scenario 3 = 40,000 acre-feet per year
- Scenario 4 = 60,000 acre-feet per year (2008 conditions)
- Scenario 5 = 80,000 acre-feet per year
- Scenario 6 = 100,000 acre-feet per year
- Scenario 7 = 120,000 acre-feet per year

Table 2. Estimated 2008 Pumping as Provided by Groundwater Conservation Districts in Groundwater Management Area 9

County	Edwards Group of the Edwards-Trinity (Plateau) Aquifer	Upper Trinity Aquifer	Middle Trinity Aquifer	Lower Trinity Aquifer	Total Pumping (County)
Bandera	631	288	3567	515	**5,000**
Bexar	0	693	14110	197	**15,000**
Blanco	0	77	1,477	0	**1,554**
Comal	0	398	5,788	0	**6,186**
Hays	0	416	4,800	449	**5,665**
Kendall	315	300	6,060	325	**7,000**
Kerr	1,035	213	6,263	5,534	**13,045**
Medina	0	0	500	1000	**1,500**
Travis	0	551	4,967	0	**5,518**
Total pumping (aquifer)	**1,981**	**2,936**	**47,532**	**8,020**	**60,468**

PARAMETERS AND ASSUMPTIONS:

- As in the requested runs and the supplemental runs, the recently updated groundwater availability model (version 2.01) for the Hill Country portion of the Trinity Aquifer developed by Jones and others (2009) was used for these simulations (see Mace and others (2000) and Jones and others (2009) for details on model construction, recharge, discharge, assumptions, and limitations of the model).

- The model has four layers: layer 1 represents the Edwards Group of the Edwards-Trinity (Plateau) Aquifer, layer 2 represents the Upper Trinity Aquifer, layer 3 represents the Middle Trinity Aquifer, and layer 4 represents the Lower Trinity Aquifer.

- The rivers, streams, and springs were simulated in the model using MODFLOW's Drain package. MODFLOW's Drain package was also used to simulate spring discharge along bedding contacts of the Edwards Group (Plateau) and the Upper

Trinity Aquifer in the northwestern parts of the model area. This resulted in the assignment of numerous drain cells along this outcrop contact.

- Seven different pumping scenarios were used as described above

- 387 recharge input files were developed as described above.

- Each simulation consisted of 50 stress periods. Initial conditions were assumed to be equivalent to 2008 conditions.

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

RESULTS:

Similar to the supplemental runs (Hutchison, 2010), results from this Task focused on drawdown impacts, impacts to spring and base flow, and impacts to outflow across the Balcones Fault Zone. Results are summarized Groundwater Management Area-wide and by county. In addition, results are presented for three areas within Groundwater Management Area 9 as designated by Mr. Ron Fieseler, General Manager of the Blanco-Pedernales Groundwater Conservation District. These areas are defined as follows:

- Area 1 – Comal, Hays and Travis Counties
- Area 2 – Bexar and Medina Counties
- Area 3 – Bandera, Blanco, Kendall and Kerr Counties

Because each scenario consisted of 387 50-year simulations, the results can also be expressed in terms of minimum, average, and maximum, as well as values that are exceeded 5 percent of the time and values that are exceeded 95 percent of the time.

All drawdown results are expressed as drawdown from 2008 initial conditions at the end of the simulation (50 years). All flow data (spring flow, baseflow, outflow across the Balcones Fault Zone) are calculated using the results from each year of the 387 50-year simulations.

Summary tables of all results (for all of Groundwater Management Area 9, by the portions of the counties located within the model, and by area) are presented in Appendix A.

Figure 3 summarizes the relationship between Groundwater Management Area 9 pumping and overall Trinity Aquifer drawdown after 50 years (averaged over the entire Groundwater Management Area) for all seven pumping scenarios. For purposes of this analysis, overall Trinity Aquifer drawdown includes the Trinity Aquifer and the Trinity portion of the Edwards-Trinity (Plateau) Aquifer.

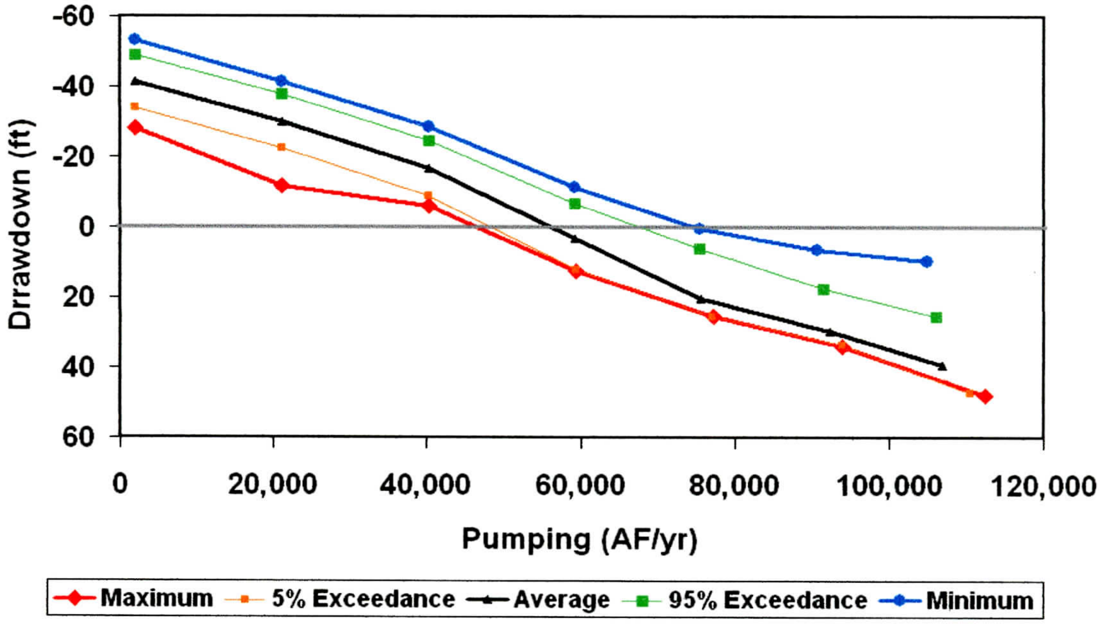

Figure 3. Pumping versus overall Trinity Aquifer drawdown after 50 years for all scenarios for Groundwater Management Area 9

Note that, as expected, increases in pumping result in increases in drawdown. The nature of these simulations provides an opportunity to evaluate drawdown in terms of the minimum value (out of all 387 simulations), 95 percent exceedance value (drawdown that is exceeded 95 percent of the time based on the 387 simulations), the average drawdown (out of all 387 simulations), 5 percent exceedance value (drawdown that is exceeded 5 percent of the time based on the 387 simulations), and the maximum value (out of all 387 simulations).

When pumping is about 60,000 acre-feet per year (the estimated 2008 pumping), average drawdown is near zero, which is expected since this pumping represents no change from 2008 conditions. However, it ranges from 12 feet of drawdown (representative of when a 50-year period ends in dry conditions) to about 12 feet of recovery (representative of when a 50-year period ends in wet conditions).

When pumping is about 1.5 times current pumping (92,000 acre-feet per year), average drawdown is about 29 feet after 50 years, with a range of between 6 to 33 feet depending on conditions at the end of the 50-year period.

Figure 4 summarizes the relationship between pumping and spring and base flow (averaged over the entire Groundwater Management Area) for all seven scenarios.

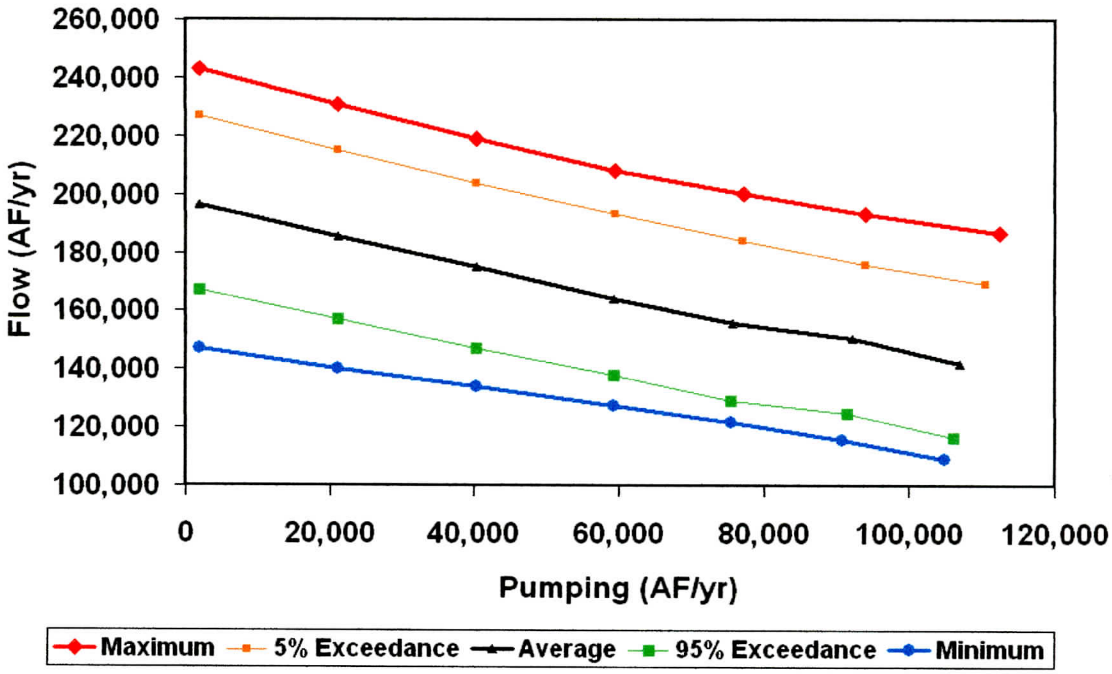

Figure 4. Pumping versus spring and base flow for all scenarios for Groundwater Management Area 9

As expected, pumping increases result in reductions in spring and base flow as the pumping captures this water prior to its discharge. It can be seen that, based on average values, 2008 pumping rates (approximately 60,000 acre-feet per year) result in an average spring and base flow of about 164,000 acre-feet per year. Zero pumping would result in a spring and base flow of about 197,000 acre-feet per year. Thus the impact of pumping 60,000 acre-feet per year includes a reduction in spring and base flow of about 33,000 acre-feet per year. If pumping were increased to 92,000 acre-feet per year (about 1.5 times the 2008 pumping rate), spring and base flow would be reduced, on average, to about 150,000 acre-feet per year. Thus an increase in pumping from 2008 levels of about 32,000 acre-feet per year would result in a reduction of 14,000 acre-feet per year in spring and base flow.

Figure 5 summarizes the relationship between pumping and outflow across the Balcones Fault Zone (averaged over the entire Groundwater Management Area) for all seven scenarios. As expected, pumping increases result in reductions in outflow across the Balcones Fault Zone as the pumping captures this water prior to its discharge. It can be seen that, based on average values, 2008 pumping rates result in an average outflow of 62,000 acre-feet per year. Zero pumping would result in a spring and base flow of about 81,000 acre-feet per year. Thus, the impact of pumping 60,000 acre-feet per year includes a reduction in Balcones Fault Zone outflow of about 19,000 acre-feet per year. If pumping were increased to 92,000 acre-feet per year (about 1.5 times the 2008 pumping rate), Balcones Fault Zone outflow would be reduced, on average, to about

50,000 acre-feet per year. Thus an increase in pumping from 2008 levels of about 32,000 acre-feet would result in a reduction of about 12,000 acre-feet per year in Balcones Fault Zone outflow.

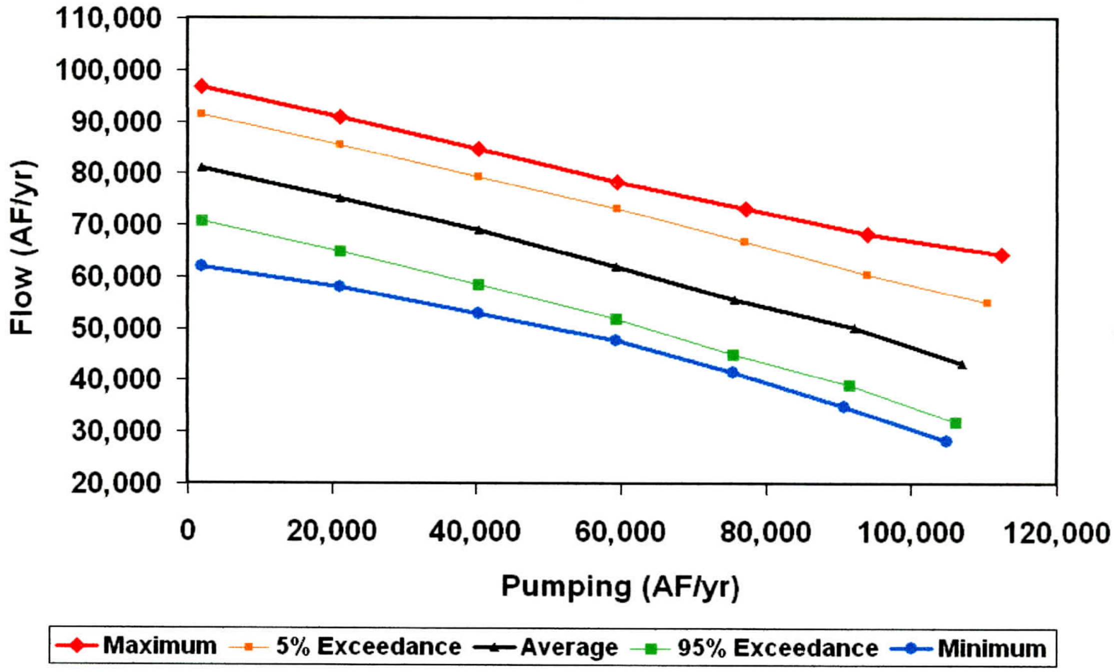

Figure 5. Pumping versus outflow across the Balcones Fault Zone for all scenarios for Groundwater Management Area 9

Figures 6, 7 and 8 summarize pumping versus the average Groundwater Management Area 9 drawdown in the upper, middle and lower Trinity Aquifer, respectively. Note that increases in pumping have less impact in the Upper Trinity Aquifer drawdown, presumably due to the buffering effect of surface water and the smaller amount of pumping in this aquifer compared with the Middle and Lower Trinity units.

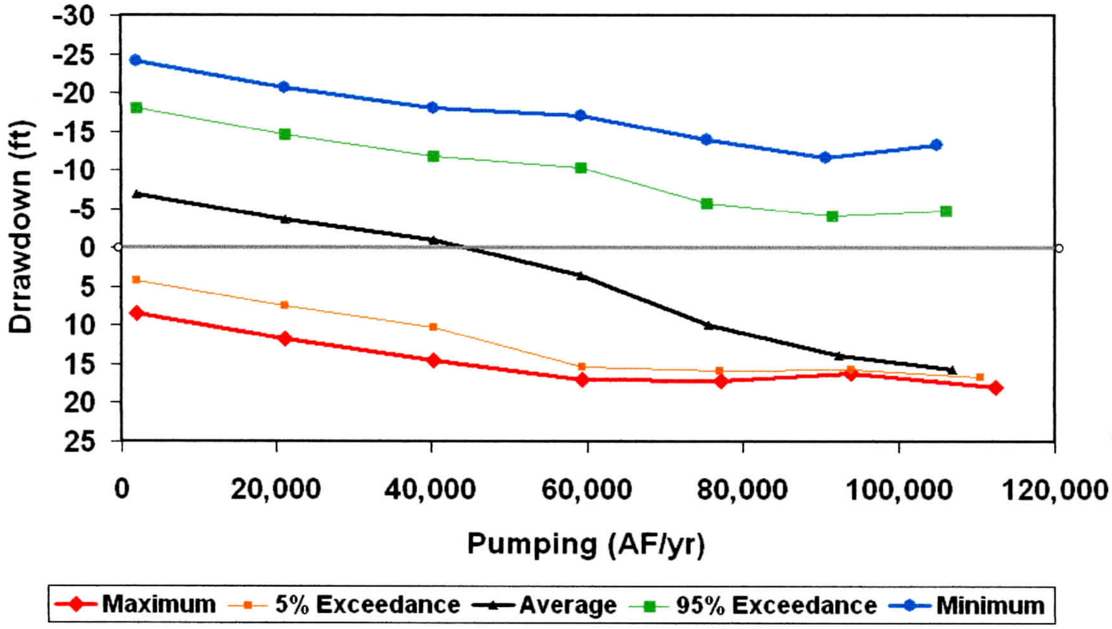

Figure 6. Pumping versus drawdown after 50 years in the Upper Trinity Aquifer for all scenarios for Groundwater Management Area 9

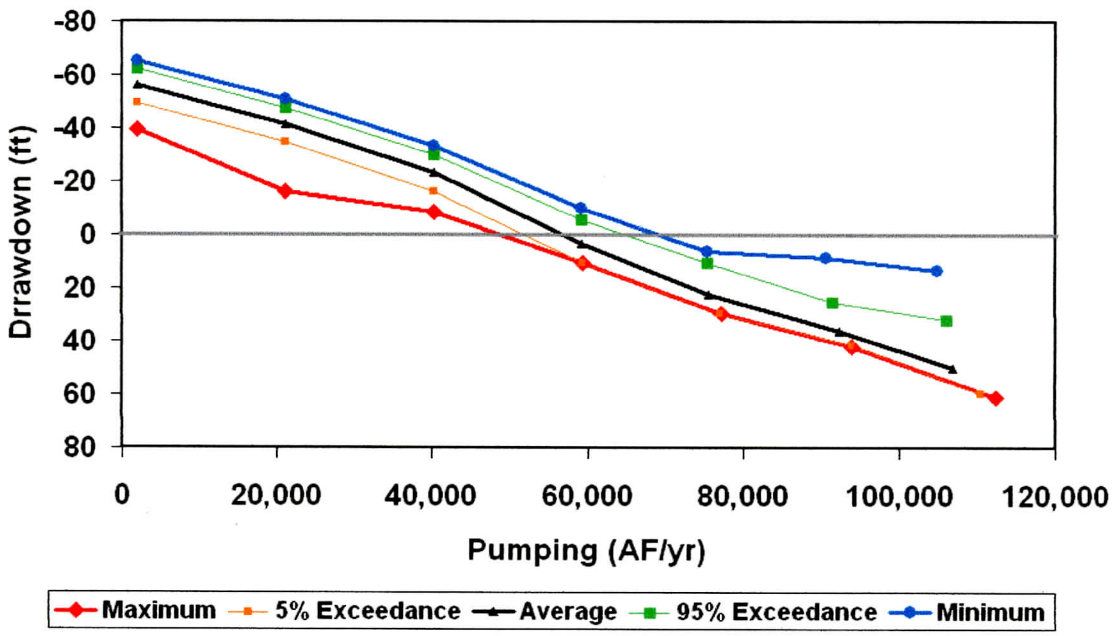

Figure 7. Pumping versus drawdown after 50 years in the Middle Trinity Aquifer for all scenarios for Groundwater Management Area 9

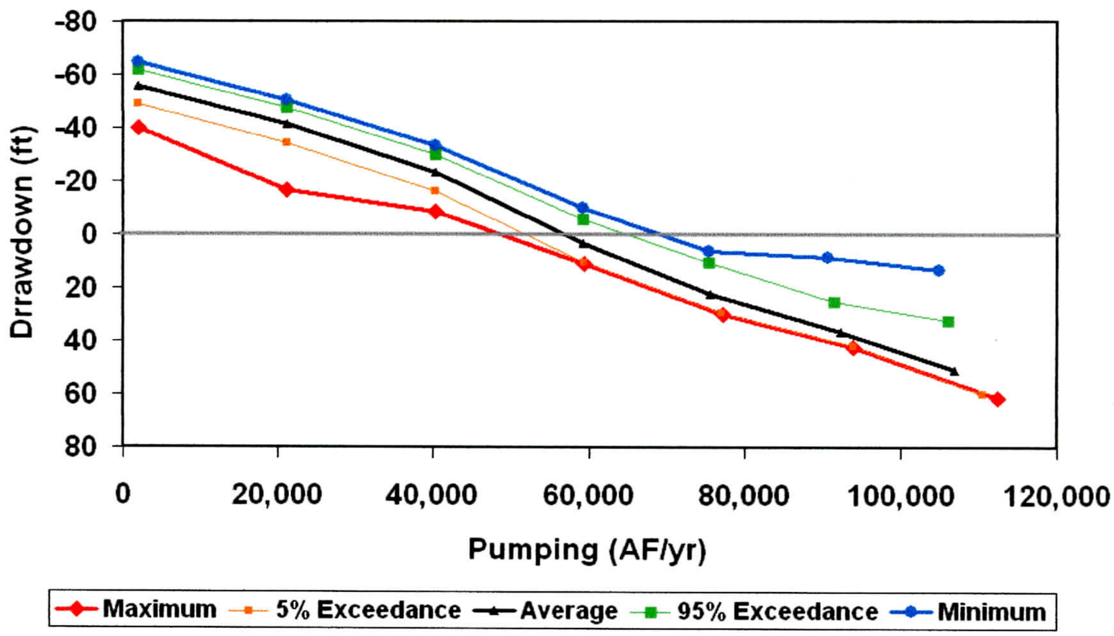

Figure 10. Pumping versus drawdown after 50 years in the Lower Trinity Aquifer for all scenarios for Groundwater Management Area 9

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Appendix A
Results Summary:
GMA 9
Bandera County
Bexar County
Blanco County
Comal County
Hays County
Kendall County
Kerr County
Medina County
Travis County
Area 1 (Comal, Hays, Travis Counties)
Area 2 (Bexar and Medina Counties)
Area 3 (Bandera, Blanco, Kendall and Kerr Counties)

GMA 9

Component	Case	Scenario 1	2	3	4	5	6	7
Pumping (AF/yr)	Minimum	1,969	21,117	40,270	59,344	75,424	90,727	104,940
	Exceeded 95% of years	1,969	21,117	40,270	59,344	75,524	91,479	106,022
	Average	1,969	21,117	40,270	59,344	75,624	92,261	106,982
	Exceeded 5% of years	1,969	21,117	40,270	59,418	77,094	94,042	110,485
	Maximum	1,969	21,117	40,270	59,418	77,193	94,042	112,454
Spring and River Base Flow (AF/yr)	Minimum	147,208	140,310	133,845	127,663	121,697	115,641	109,250
	Exceeded 95% of years	166,965	156,950	147,187	137,975	129,301	125,017	116,465
	Average	196,565	185,496	174,835	164,295	155,854	150,359	141,829
	Exceeded 5% of years	226,855	215,184	203,683	193,362	184,292	175,822	169,517
	Maximum	242,887	230,903	218,873	208,311	200,390	193,276	186,668
Outflow Across the Balcones Fault Zone (AF/yr)	Minimum	61,911	58,009	52,906	47,691	41,702	34,904	28,372
	Exceeded 95% of years	70,712	64,824	58,595	51,782	45,097	39,036	32,054
	Average	81,036	75,275	69,101	62,023	55,633	50,163	43,208
	Exceeded 5% of years	91,297	85,499	79,377	73,150	66,955	60,524	54,981
	Maximum	96,699	90,900	84,783	78,421	73,289	68,380	64,497
Overall Trinity Drawdown after 50 Years (ft)	Minimum	-53.1	-41.6	-28.6	-11.6	0.4	6.4	9.8
	Exceeded 95% of years	-49.1	-37.8	-24.5	-6.9	6.0	17.6	25.4
	Average	-41.6	-30.1	-16.9	3.2	20.2	29.8	39.4
	Exceeded 5% of years	-33.8	-22.4	-8.8	12.0	25.4	33.7	47.0
	Maximum	-28.1	-11.8	-6.1	12.5	25.5	34.0	48.0
Edwards Group Drawdown after 50 Years (ft)	Minimum	-8.1	-8.1	-8.1	-8.1	-6.5	-6.1	-6.5
	Exceeded 95% of years	-6.2	-6.1	-6.1	-5.9	-4.8	-4.4	-4.7
	Average	-3.0	-3.0	-3.1	-2.1	0.2	0.5	0.2
	Exceeded 5% of years	0.2	0.2	0.2	0.7	3.5	2.5	3.4
	Maximum	1.7	1.3	1.7	3.3	3.9	3.4	3.9
Upper Trinity Drawdown after 50 Years(ft)	Minimum	-24.1	-20.7	-18.0	-17.0	-14.0	-11.6	-13.3
	Exceeded 95% of years	-18.0	-14.6	-11.8	-10.4	-5.7	-4.1	-4.8
	Average	-7.0	-3.7	-1.0	3.6	9.9	13.9	15.6
	Exceeded 5% of years	4.2	7.5	10.2	15.4	15.8	15.6	16.6
	Maximum	8.4	11.8	14.5	16.9	17.2	16.2	18.0
Middle Trinity Drawdown after 50 Years(ft)	Minimum	-65.1	-50.8	-33.4	-9.9	6.3	8.5	13.2
	Exceeded 95% of years	-62.2	-47.7	-29.9	-5.9	10.5	25.0	31.9
	Average	-56.0	-41.3	-23.4	3.1	22.4	36.4	50.2
	Exceeded 5% of years	-49.5	-34.6	-16.4	10.5	29.4	41.6	59.5
	Maximum	-39.5	-16.3	-8.6	10.7	29.6	42.0	60.9
Lower Trinity Drawdown after 50 Years (ft)	Minimum	-64.8	-50.6	-33.4	-10.0	6.3	8.7	13.5
	Exceeded 95% of years	-61.9	-47.5	-29.9	-5.9	10.6	25.4	32.5
	Average	-55.7	-41.2	-23.4	3.1	22.6	36.7	50.8
	Exceeded 5% of years	-49.2	-34.4	-16.4	10.6	29.5	42.0	60.0
	Maximum	-40.0	-16.6	-8.8	10.8	29.8	42.3	61.5

Bandera County

Component	Case	Scenario						
		1	2	3	4	5	6	7
Pumping (AF/yr)	Minimum	625	2,082	3,540	4,996	6,452	7,910	9,349
	Exceeded 95% of years	625	2,082	3,540	4,996	6,452	7,910	9,361
	Average	625	2,082	3,540	4,996	6,452	7,910	9,367
	Exceeded 5% of years	625	2,082	3,540	4,996	6,452	7,910	9,367
	Maximum	625	2,082	3,540	4,996	6,452	7,910	9,367
Spring and River Base Flow (AF/yr)	Minimum	30,247	29,115	28,013	26,929	25,691	24,868	23,201
	Exceeded 95% of years	35,570	33,352	31,201	28,948	27,337	26,502	25,120
	Average	40,975	38,469	35,883	33,402	31,735	30,620	29,204
	Exceeded 5% of years	46,187	43,494	40,716	38,187	36,489	34,773	33,648
	Maximum	48,851	46,055	43,093	40,337	39,037	37,946	36,910
Outflow Across the Balcones Fault Zone (AF/yr)	Minimum	1,217	1,081	887	673	323	5	-445
	Exceeded 95% of years	1,763	1,505	1,197	819	499	165	-225
	Average	2,148	1,856	1,531	1,122	823	535	169
	Exceeded 5% of years	2,457	2,168	1,838	1,443	1,154	924	681
	Maximum	2,622	2,336	2,006	1,611	1,413	1,259	1,125
Overall Trinity Drawdown after 50 Years (ft)	Minimum	-48.9	-39.2	-26.7	-8.0	5.5	4.5	6.7
	Exceeded 95% of years	-46.5	-36.4	-23.6	-4.2	8.8	18.6	21.6
	Average	-41.2	-31.1	-18.2	3.2	18.7	29.3	42.7
	Exceeded 5% of years	-35.9	-25.5	-12.3	9.7	24.4	34.6	51.1
	Maximum	-25.0	-8.0	-3.9	9.9	24.6	35.0	52.7
Edwards Group Drawdown after 50 Years (ft)	Minimum	-7.1	-7.1	-7.1	-7.1	-5.9	-5.4	-5.9
	Exceeded 95% of years	-5.5	-5.4	-5.4	-5.2	-4.2	-3.7	-3.9
	Average	-2.5	-2.5	-2.5	-1.5	0.6	0.8	0.6
	Exceeded 5% of years	0.5	0.5	0.5	0.9	3.1	2.4	3.0
	Maximum	1.8	1.4	1.8	3.1	3.3	3.1	3.3
Upper Trinity Drawdown after 50 Years(ft)	Minimum	-20.7	-18.2	-15.9	-15.3	-12.6	-10.6	-12.1
	Exceeded 95% of years	-15.3	-12.7	-10.4	-9.1	-5.2	-3.8	-4.5
	Average	-5.5	-3.0	-0.8	3.5	13.7	12.6	14.2
	Exceeded 5% of years	4.6	7.1	9.6	14.2	14.5	14.1	15.1
	Maximum	8.3	11.0	13.5	15.6	15.8	14.7	16.3
Middle Trinity Drawdown after 50 Years(ft)	Minimum	-62.2	-49.3	-32.2	-5.3	11.0	6.2	9.2
	Exceeded 95% of years	-60.8	-47.4	-29.9	-2.5	13.9	21.2	25.6
	Average	-57.6	-43.9	-26.1	3.3	21.3	37.8	58.3
	Exceeded 5% of years	-54.1	-40.2	-21.8	7.7	29.1	44.6	67.6
	Maximum	-36.8	-11.6	-5.9	8.9	29.5	45.1	70.1
Lower Trinity Drawdown after 50 Years (ft)	Minimum	-62.2	-49.3	-32.2	-5.3	11.0	6.2	9.2
	Exceeded 95% of years	-60.8	-47.4	-29.9	-2.5	13.9	21.2	25.6
	Average	-57.6	-43.9	-26.1	3.3	21.3	37.8	58.3
	Exceeded 5% of years	-54.2	-40.2	-21.8	7.7	29.1	44.6	67.7
	Maximum	-36.8	-11.6	-5.9	8.9	29.5	45.1	70.1

Bexar County

Component	Case	Scenario						
		1	2	3	4	5	6	7
Pumping (AF/yr)	Minimum	0	4,970	9,943	14,913	19,884	24,856	29,246
	Exceeded 95% of years	0	4,970	9,943	14,913	19,884	24,856	29,358
	Average	0	4,970	9,943	14,913	19,884	24,856	29,589
	Exceeded 5% of years	0	4,970	9,943	14,913	19,884	24,856	29,827
	Maximum	0	4,970	9,943	14,913	19,884	24,856	29,827
Spring and River Base Flow (AF/yr)	Minimum	9,527	9,466	9,405	9,344	9,284	9,225	9,167
	Exceeded 95% of years	9,790	9,730	9,671	9,596	9,519	9,455	9,392
	Average	10,647	10,581	10,515	10,444	10,340	10,319	10,233
	Exceeded 5% of years	11,492	11,424	11,365	11,301	11,224	11,104	11,092
	Maximum	11,867	11,798	11,730	11,665	11,600	11,536	11,471
Outflow Across the Balcones Fault Zone (AF/yr)	Minimum	33,298	31,221	28,595	25,917	23,139	20,183	17,228
	Exceeded 95% of years	36,683	34,038	31,225	28,227	25,103	22,220	19,009
	Average	42,130	39,459	36,714	33,626	30,583	28,131	24,650
	Exceeded 5% of years	47,585	44,946	42,210	39,560	36,613	33,455	30,948
	Maximum	50,232	47,632	44,964	42,271	39,633	37,091	34,721
Overall Trinity Drawdown after 50 Years (ft)	Minimum	-69.2	-56.9	-44.3	-31.0	-13.3	4.7	14.6
	Exceeded 95% of years	-59.9	-47.5	-34.5	-20.2	0.1	16.3	29.2
	Average	-43.7	-31.2	-18.2	1.5	33.7	46.0	62.9
	Exceeded 5% of years	-27.0	-13.9	-0.4	20.6	35.2	49.4	64.2
	Maximum	-20.8	-7.6	6.1	22.8	36.1	49.4	64.4
Edwards Group Drawdown after 50 Years (ft)	Minimum	NA	NA	NA	NA	NA	NA	NA
	Exceeded 95% of years	NA	NA	NA	NA	NA	NA	NA
	Average	NA	NA	NA	NA	NA	NA	NA
	Exceeded 5% of years	NA	NA	NA	NA	NA	NA	NA
	Maximum	NA	NA	NA	NA	NA	NA	NA
Upper Trinity Drawdown after 50 Years(ft)	Minimum	-24.5	-23.7	-22.9	-22.1	-17.7	-15.9	-16.1
	Exceeded 95% of years	-17.9	-16.5	-15.7	-14.0	-9.2	-6.2	-6.9
	Average	-4.2	-3.4	-2.7	3.4	16.0	15.1	17.4
	Exceeded 5% of years	10.7	11.5	12.3	17.2	18.0	17.5	19.5
	Maximum	14.8	15.6	16.4	17.6	18.3	17.7	19.8
Middle Trinity Drawdown after 50 Years(ft)	Minimum	-87.6	-70.6	-53.0	-34.7	-11.6	13.1	27.1
	Exceeded 95% of years	-77.0	-60.0	-42.4	-21.9	3.9	25.6	44.5
	Average	-60.1	-43.0	-24.6	0.7	40.6	58.6	81.1
	Exceeded 5% of years	-42.3	-24.3	-5.5	22.1	42.3	62.5	82.6
	Maximum	-35.4	-17.1	1.9	24.9	43.4	62.6	82.8
Lower Trinity Drawdown after 50 Years (ft)	Minimum	-87.5	-70.5	-53.0	-34.7	-11.6	13.1	27.1
	Exceeded 95% of years	-76.9	-59.9	-42.3	-21.9	3.9	25.5	44.5
	Average	-60.0	-42.9	-24.6	0.7	40.6	58.6	81.5
	Exceeded 5% of years	-42.3	-24.3	-5.5	22.1	42.3	62.5	83.0
	Maximum	-35.3	-17.1	1.9	24.9	43.4	62.6	83.2

Blanco County

Component	Case	Scenario 1	2	3	4	5	6	7
Pumping (AF/yr)	Minimum	0	515	1,029	1,544	2,059	2,573	3,088
	Exceeded 95% of years	0	515	1,029	1,544	2,059	2,573	3,088
	Average	0	515	1,029	1,544	2,059	2,573	3,088
	Exceeded 5% of years	0	515	1,029	1,544	2,059	2,573	3,088
	Maximum	0	515	1,029	1,544	2,059	2,573	3,088
Spring and River Base Flow (AF/yr)	Minimum	13,690	13,313	12,942	12,594	12,221	11,845	11,411
	Exceeded 95% of years	15,263	14,849	14,353	13,847	13,187	12,913	12,310
	Average	18,762	18,259	17,710	17,092	16,489	16,312	15,606
	Exceeded 5% of years	22,508	21,879	21,285	20,783	20,208	19,556	19,181
	Maximum	24,353	23,748	23,128	22,617	22,122	21,702	21,319
Outflow Across the Balcones Fault Zone (AF/yr)	Minimum	NA	NA	NA	NA	NA	NA	NA
	Exceeded 95% of years	NA	NA	NA	NA	NA	NA	NA
	Average	NA	NA	NA	NA	NA	NA	NA
	Exceeded 5% of years	NA	NA	NA	NA	NA	NA	NA
	Maximum	NA	NA	NA	NA	NA	NA	NA
Overall Trinity Drawdown after 50 Years (ft)	Minimum	-23.0	-19.9	-16.6	-13.1	-7.9	-1.4	-0.4
	Exceeded 95% of years	-18.1	-14.9	-11.6	-7.4	-0.2	4.1	7.4
	Average	-9.4	-6.1	-2.7	4.0	16.7	19.2	23.6
	Exceeded 5% of years	-0.1	3.0	6.7	13.3	18.5	21.0	27.1
	Maximum	2.9	6.2	9.6	14.8	18.5	22.1	27.2
Edwards Group Drawdown after 50 Years (ft)	Minimum	NA	NA	NA	NA	NA	NA	NA
	Exceeded 95% of years	NA	NA	NA	NA	NA	NA	NA
	Average	NA	NA	NA	NA	NA	NA	NA
	Exceeded 5% of years	NA	NA	NA	NA	NA	NA	NA
	Maximum	NA	NA	NA	NA	NA	NA	NA
Upper Trinity Drawdown after 50 Years(ft)	Minimum	-19.7	-19.1	-18.6	-18.1	-14.3	-12.6	-13.5
	Exceeded 95% of years	-13.2	-12.5	-11.9	-10.5	-6.2	-4.0	-5.4
	Average	-1.0	-0.5	-0.1	4.9	16.0	14.8	16.2
	Exceeded 5% of years	12.1	12.6	13.0	17.3	17.6	16.7	18.1
	Maximum	16.0	16.5	16.9	17.8	18.0	16.9	18.4
Middle Trinity Drawdown after 50 Years(ft)	Minimum	-24.1	-20.1	-15.9	-11.3	-5.6	2.7	4.4
	Exceeded 95% of years	-20.1	-16.0	-11.7	-6.4	1.5	7.0	11.6
	Average	-12.6	-8.2	-3.6	3.5	16.7	20.6	26.0
	Exceeded 5% of years	-4.3	0.2	5.0	11.8	19.6	23.4	31.4
	Maximum	-1.8	2.7	7.5	13.7	19.7	24.5	31.4
Lower Trinity Drawdown after 50 Years (ft)	Minimum	-24.4	-20.3	-16.0	-11.4	-5.5	2.9	4.6
	Exceeded 95% of years	-20.4	-16.1	-11.8	-6.4	1.6	7.2	11.8
	Average	-12.7	-8.3	-3.6	3.6	16.8	20.7	26.2
	Exceeded 5% of years	-4.5	0.1	4.9	11.8	19.6	23.4	31.3
	Maximum	-2.0	2.6	7.4	13.7	19.6	24.4	31.3

Comal County

Component	Case	Scenario						
		1	2	3	4	5	6	7
Pumping (AF/yr)	Minimum	0	2,042	4,086	6,128	8,170	10,214	11,924
	Exceeded 95% of years	0	2,042	4,086	6,128	8,170	10,214	12,068
	Average	0	2,042	4,086	6,128	8,170	10,214	12,225
	Exceeded 5% of years	0	2,042	4,086	6,128	8,170	10,214	12,256
	Maximum	0	2,042	4,086	6,128	8,170	10,214	12,256
Spring and River Base Flow (AF/yr)	Minimum	5,309	3,693	1,918	124	-1,730	-3,623	-5,496
	Exceeded 95% of years	8,017	5,663	3,509	1,592	-576	-2,387	-4,498
	Average	12,794	10,322	7,883	5,319	3,114	1,477	-823
	Exceeded 5% of years	17,638	15,165	12,669	10,228	7,669	5,079	3,287
	Maximum	19,973	17,503	15,001	12,558	10,192	8,010	6,277
Outflow Across the Balcones Fault Zone (AF/yr)	Minimum	33,808	32,833	31,781	30,711	29,604	28,442	27,279
	Exceeded 95% of years	35,331	34,298	33,261	32,094	30,871	29,689	28,480
	Average	39,283	38,316	37,292	36,131	34,913	33,948	32,577
	Exceeded 5% of years	43,101	42,124	41,128	40,215	39,082	37,888	36,897
	Maximum	44,814	43,864	42,898	41,927	40,960	40,011	39,046
Overall Trinity Drawdown after 50 Years (ft)	Minimum	-27.8	-23.6	-19.4	-15.0	-7.9	-1.3	2.3
	Exceeded 95% of years	-22.8	-18.6	-14.3	-9.2	-0.7	5.9	10.8
	Average	-14.2	-10.1	-5.3	2.9	19.2	23.9	31.1
	Exceeded 5% of years	-4.9	-0.3	4.6	14.4	20.3	25.7	31.9
	Maximum	-1.7	3.1	8.5	15.2	20.7	25.7	32.0
Edwards Group Drawdown after 50 Years (ft)	Minimum	NA	NA	NA	NA	NA	NA	NA
	Exceeded 95% of years	NA	NA	NA	NA	NA	NA	NA
	Average	NA	NA	NA	NA	NA	NA	NA
	Exceeded 5% of years	NA	NA	NA	NA	NA	NA	NA
	Maximum	NA	NA	NA	NA	NA	NA	NA
Upper Trinity Drawdown after 50 Years(ft)	Minimum	-21.8	-21.1	-20.5	-19.9	-16.0	-14.3	-14.8
	Exceeded 95% of years	-14.8	-14.0	-13.5	-11.9	-7.5	-4.2	-5.2
	Average	-1.4	-0.9	-0.3	5.4	16.4	15.4	17.5
	Exceeded 5% of years	12.6	13.1	13.7	17.9	18.5	17.9	19.6
	Maximum	16.3	16.8	17.4	17.9	18.5	17.9	19.6
Middle Trinity Drawdown after 50 Years(ft)	Minimum	-29.1	-24.2	-19.1	-13.9	-6.3	1.6	5.9
	Exceeded 95% of years	-24.6	-19.6	-14.6	-8.7	0.6	8.4	14.3
	Average	-17.0	-11.9	-6.4	2.4	19.8	25.5	33.7
	Exceeded 5% of years	-8.9	-3.2	2.8	13.6	20.7	27.5	34.3
	Maximum	-5.7	0.1	6.6	14.7	21.2	27.5	34.4
Lower Trinity Drawdown after 50 Years (ft)	Minimum	-29.1	-24.2	-19.1	-13.9	-6.3	1.6	6.0
	Exceeded 95% of years	-24.7	-19.7	-14.6	-8.7	0.6	8.4	14.4
	Average	-17.0	-11.9	-6.4	2.4	19.7	25.5	34.3
	Exceeded 5% of years	-9.0	-3.2	2.8	13.6	20.7	27.5	35.1
	Maximum	-5.7	0.1	6.5	14.7	21.2	27.5	35.3

Hays County

Component	Case	Scenario						
		1	2	3	4	5	6	7
Pumping (AF/yr)	Minimum	0	1,826	3,652	5,478	7,304	9,115	10,486
	Exceeded 95% of years	0	1,826	3,652	5,478	7,304	9,115	10,492
	Average	0	1,826	3,652	5,478	7,304	9,115	10,938
	Exceeded 5% of years	0	1,826	3,652	5,478	7,304	9,130	10,956
	Maximum	0	1,826	3,652	5,478	7,304	9,130	10,956
Spring and River Base Flow (AF/yr)	Minimum	17,976	17,239	16,474	15,709	14,913	14,104	13,345
	Exceeded 95% of years	18,900	18,203	17,417	16,552	15,690	14,938	14,154
	Average	21,917	21,133	20,364	19,599	18,694	18,025	17,140
	Exceeded 5% of years	25,016	24,230	23,451	22,686	21,850	20,971	20,286
	Maximum	26,427	25,620	24,832	24,080	23,346	22,630	21,854
Outflow Across the Balcones Fault Zone (AF/yr)	Minimum	5,832	5,290	4,623	3,894	3,046	2,155	1,418
	Exceeded 95% of years	6,889	6,029	5,235	4,355	3,371	2,600	1,838
	Average	8,252	7,409	6,557	5,668	4,774	3,995	3,179
	Exceeded 5% of years	9,628	8,772	7,907	7,105	6,214	5,335	4,665
	Maximum	10,263	9,405	8,542	7,743	7,039	6,509	5,978
Overall Trinity Drawdown after 50 Years (ft)	Minimum	-21.5	-16.8	-12.1	-7.3	-1.3	5.4	6.6
	Exceeded 95% of years	-18.3	-13.6	-8.8	-3.5	3.9	9.2	12.2
	Average	-12.5	-7.7	-3.0	4.0	15.1	19.2	23.5
	Exceeded 5% of years	-6.6	-1.9	3.2	10.2	15.9	20.3	24.5
	Maximum	-4.7	0.2	5.2	10.9	15.9	20.8	24.6
Edwards Group Drawdown after 50 Years (ft)	Minimum	NA	NA	NA	NA	NA	NA	NA
	Exceeded 95% of years	NA	NA	NA	NA	NA	NA	NA
	Average	NA	NA	NA	NA	NA	NA	NA
	Exceeded 5% of years	NA	NA	NA	NA	NA	NA	NA
	Maximum	NA	NA	NA	NA	NA	NA	NA
Upper Trinity Drawdown after 50 Years(ft)	Minimum	-12.0	-11.7	-11.3	-11.0	-8.2	-7.3	-7.8
	Exceeded 95% of years	-8.0	-7.1	-6.7	-5.8	-2.9	-1.1	-2.2
	Average	0.5	0.9	1.2	4.8	12.2	11.4	12.7
	Exceeded 5% of years	9.4	9.7	10.1	13.0	13.4	12.9	14.0
	Maximum	12.0	12.3	12.7	13.1	13.5	13.0	14.1
Middle Trinity Drawdown after 50 Years(ft)	Minimum	-25.4	-19.0	-12.6	-6.0	1.5	8.2	11.8
	Exceeded 95% of years	-22.8	-16.3	-9.7	-2.9	6.2	13.5	17.4
	Average	-17.9	-11.4	-4.7	3.7	16.0	22.4	27.5
	Exceeded 5% of years	-12.7	-6.1	0.9	9.1	17.6	23.8	29.2
	Maximum	-11.1	-4.3	2.6	10.0	17.6	24.3	29.4
Lower Trinity Drawdown after 50 Years (ft)	Minimum	-25.4	-19.0	-12.6	-6.0	1.5	8.2	11.8
	Exceeded 95% of years	-22.8	-16.3	-9.7	-2.9	6.2	13.5	17.5
	Average	-17.9	-11.4	-4.7	3.7	16.0	22.4	27.7
	Exceeded 5% of years	-12.7	-6.1	0.9	9.1	17.6	23.8	29.5
	Maximum	-11.1	-4.4	2.6	10.0	17.6	24.4	29.6

Kendall County

Component	Case	Scenario						
		1	2	3	4	5	6	7
Pumping (AF/yr)	Minimum	310	2,539	4,766	6,994	9,223	11,450	13,678
	Exceeded 95% of years	310	2,539	4,766	6,994	9,223	11,450	13,678
	Average	310	2,539	4,766	6,994	9,223	11,450	13,678
	Exceeded 5% of years	310	2,539	4,766	6,994	9,223	11,450	13,678
	Maximum	310	2,539	4,766	6,994	9,223	11,450	13,678
Spring and River Base Flow (AF/yr)	Minimum	25,159	23,558	22,071	20,736	19,214	17,848	15,899
	Exceeded 95% of years	29,988	27,651	25,150	22,814	20,790	19,421	17,739
	Average	36,424	33,737	31,034	28,183	26,184	24,753	22,688
	Exceeded 5% of years	43,318	40,422	37,390	34,466	32,253	30,160	28,629
	Maximum	47,156	44,178	40,989	38,030	36,010	34,442	32,978
Outflow Across the Balcones Fault Zone (AF/yr)	Minimum	NA	NA	NA	NA	NA	NA	NA
	Exceeded 95% of years	NA	NA	NA	NA	NA	NA	NA
	Average	NA	NA	NA	NA	NA	NA	NA
	Exceeded 5% of years	NA	NA	NA	NA	NA	NA	NA
	Maximum	NA	NA	NA	NA	NA	NA	NA
Overall Trinity Drawdown after 50 Years (ft)	Minimum	-41.3	-35.0	-28.0	-20.0	-11.5	-0.2	2.7
	Exceeded 95% of years	-34.5	-27.9	-21.1	-12.9	-0.9	7.7	13.5
	Average	-22.0	-15.7	-8.6	3.4	23.5	28.6	36.8
	Exceeded 5% of years	-9.1	-2.8	4.4	17.1	26.6	31.7	41.9
	Maximum	-5.0	1.5	8.6	19.6	26.6	32.5	42.0
Edwards Group Drawdown after 50 Years (ft)	Minimum	-3.5	-3.5	-3.5	-3.5	-3.1	-2.3	-3.1
	Exceeded 95% of years	-2.3	-2.3	-2.3	-2.3	-1.4	-1.1	-1.2
	Average	-0.3	-0.4	-0.3	0.2	2.1	2.0	2.0
	Exceeded 5% of years	1.7	1.7	1.7	2.1	2.7	2.3	2.7
	Maximum	2.3	2.3	2.3	2.7	2.7	2.7	2.7
Upper Trinity Drawdown after 50 Years(ft)	Minimum	-45.0	-42.8	-41.0	-39.5	-32.9	-27.1	-31.4
	Exceeded 95% of years	-30.6	-28.3	-26.5	-24.3	-14.9	-11.5	-12.6
	Average	-7.1	-5.2	-3.7	5.2	29.1	26.3	30.3
	Exceeded 5% of years	17.9	19.4	21.0	30.4	31.1	30.3	32.4
	Maximum	26.1	28.0	29.4	33.3	33.9	31.0	34.9
Middle Trinity Drawdown after 50 Years(ft)	Minimum	-40.2	-32.3	-23.9	-14.1	-4.3	7.4	11.1
	Exceeded 95% of years	-35.6	-27.8	-19.2	-8.8	3.7	13.6	22.5
	Average	-27.0	-19.1	-10.4	3.1	21.3	29.3	38.8
	Exceeded 5% of years	-18.2	-10.0	-0.8	12.5	25.6	32.8	45.7
	Maximum	-15.3	-7.0	2.2	14.9	25.6	33.3	45.8
Lower Trinity Drawdown after 50 Years (ft)	Minimum	-40.1	-32.3	-23.9	-14.2	-4.3	7.4	11.2
	Exceeded 95% of years	-35.5	-27.8	-19.3	-8.8	3.7	13.7	22.5
	Average	-26.9	-19.0	-10.4	3.0	21.3	29.4	39.0
	Exceeded 5% of years	-18.1	-9.9	-0.8	12.6	25.6	32.9	45.8
	Maximum	-15.2	-6.9	2.2	15.0	25.6	33.4	45.9

Kerr County

Component	Case	Scenario 1	2	3	4	5	6	7
Pumping (AF/yr)	Minimum	1,033	5,030	9,029	13,026	14,180	14,594	15,656
	Exceeded 95% of years	1,033	5,030	9,029	13,026	14,180	15,170	16,614
	Average	1,033	5,030	9,029	13,026	14,180	15,952	16,614
	Exceeded 5% of years	1,033	5,030	9,029	13,026	15,650	17,468	18,935
	Maximum	1,033	5,030	9,029	13,026	15,650	17,468	20,755
Spring and River Base Flow (AF/yr)	Minimum	31,354	31,284	31,168	31,102	31,097	31,127	31,040
	Exceeded 95% of years	34,569	33,772	33,361	33,242	33,121	33,421	33,125
	Average	39,213	38,159	37,582	37,349	37,351	37,559	37,294
	Exceeded 5% of years	44,116	42,936	42,155	42,132	41,972	41,641	41,844
	Maximum	46,635	45,388	44,438	44,272	44,256	44,225	44,193
Outflow Across the Balcones Fault Zone (AF/yr)	Minimum	NA	NA	NA	NA	NA	NA	NA
	Exceeded 95% of years	NA	NA	NA	NA	NA	NA	NA
	Average	NA	NA	NA	NA	NA	NA	NA
	Exceeded 5% of years	NA	NA	NA	NA	NA	NA	NA
	Maximum	NA	NA	NA	NA	NA	NA	NA
Overall Trinity Drawdown after 50 Years (ft)	Minimum	-103.0	-78.8	-49.0	-9.0	11.6	5.6	9.8
	Exceeded 95% of years	-100.1	-75.4	-45.2	-5.2	13.4	21.0	25.1
	Average	-94.7	-70.2	-40.1	2.7	21.3	39.2	58.5
	Exceeded 5% of years	-89.1	-64.4	-33.8	7.9	33.1	46.6	69.2
	Maximum	-57.2	-18.5	-9.8	11.5	33.6	47.5	72.0
Edwards Group Drawdown after 50 Years (ft)	Minimum	-9.0	-9.0	-9.0	-9.0	-7.1	-6.9	-7.1
	Exceeded 95% of years	-7.0	-6.9	-6.9	-6.6	-5.4	-5.2	-5.3
	Average	-3.5	-3.5	-3.6	-2.5	-0.2	0.2	-0.2
	Exceeded 5% of years	0.1	0.1	0.1	0.4	3.7	2.6	3.5
	Maximum	1.6	1.1	1.6	3.4	4.2	3.6	4.2
Upper Trinity Drawdown after 50 Years(ft)	Minimum	-27.3	-19.0	-12.5	-10.5	-9.1	-7.2	-8.7
	Exceeded 95% of years	-23.7	-15.4	-9.1	-6.9	-4.6	-3.7	-3.8
	Average	-17.0	-9.0	-2.8	0.7	6.9	6.7	7.1
	Exceeded 5% of years	-10.3	-2.2	3.7	6.9	9.4	8.3	9.6
	Maximum	-3.1	-0.1	5.9	9.4	9.7	9.5	10.1
Middle Trinity Drawdown after 50 Years(ft)	Minimum	-142.2	-109.5	-67.6	-8.1	13.2	8.3	14.4
	Exceeded 95% of years	-139.9	-106.3	-64.5	-4.8	21.0	27.6	34.1
	Average	-135.1	-101.8	-59.4	3.6	29.1	56.8	86.6
	Exceeded 5% of years	-130.1	-96.1	-52.1	9.5	45.1	66.4	99.8
	Maximum	-84.1	-27.0	-14.1	16.9	45.8	68.1	103.5
Lower Trinity Drawdown after 50 Years (ft)	Minimum	-142.7	-110.4	-68.5	-8.2	13.8	8.6	15.0
	Exceeded 95% of years	-140.2	-107.2	-65.4	-4.8	21.3	28.5	35.5
	Average	-135.6	-102.8	-60.2	3.8	29.7	58.2	88.8
	Exceeded 5% of years	-130.7	-97.1	-53.0	9.7	46.0	68.0	102.4
	Maximum	-86.7	-28.3	-14.8	17.2	46.7	69.8	106.3

Medina County

Component	Case	Scenario						
		1	2	3	4	5	6	7
Pumping (AF/yr)	Minimum	0	500	1,000	1,500	2,000	2,500	3,000
	Exceeded 95% of years	0	500	1,000	1,500	2,000	2,500	3,000
	Average	0	500	1,000	1,500	2,000	2,500	3,000
	Exceeded 5% of years	0	500	1,000	1,500	2,000	2,500	3,000
	Maximum	0	500	1,000	1,500	2,000	2,500	3,000
Spring and River Base Flow (AF/yr)	Minimum	4,991	4,985	4,978	4,971	4,965	4,955	4,943
	Exceeded 95% of years	5,112	5,096	5,083	5,070	5,056	5,049	5,037
	Average	5,463	5,443	5,428	5,413	5,398	5,395	5,378
	Exceeded 5% of years	5,810	5,789	5,773	5,776	5,750	5,734	5,729
	Maximum	5,961	5,940	5,922	5,911	5,904	5,896	5,889
Outflow Across the Balcones Fault Zone (AF/yr)	Minimum	10,930	9,947	8,705	7,361	5,365	3,375	915
	Exceeded 95% of years	14,040	12,286	10,422	8,214	6,305	4,318	2,065
	Average	16,304	14,499	12,538	10,236	8,380	6,647	4,483
	Exceeded 5% of years	18,400	16,589	14,611	12,344	10,570	8,903	7,233
	Maximum	19,533	17,731	15,726	13,475	12,099	10,924	9,948
Overall Trinity Drawdown after 50 Years (ft)	Minimum	-24.2	-18.9	-12.7	-4.9	1.6	5.0	7.4
	Exceeded 95% of years	-22.4	-17.0	-10.9	-2.9	4.3	10.7	15.4
	Average	-18.9	-13.6	-7.4	1.6	10.8	16.1	22.1
	Exceeded 5% of years	-15.3	-9.9	-3.8	5.7	12.4	17.9	25.0
	Maximum	-13.7	-6.8	-2.5	5.8	12.4	17.9	25.4
Edwards Group Drawdown after 50 Years (ft)	Minimum	NA	NA	NA	NA	NA	NA	NA
	Exceeded 95% of years	NA	NA	NA	NA	NA	NA	NA
	Average	NA	NA	NA	NA	NA	NA	NA
	Exceeded 5% of years	NA	NA	NA	NA	NA	NA	NA
	Maximum	NA	NA	NA	NA	NA	NA	NA
Upper Trinity Drawdown after 50 Years(ft)	Minimum	-8.2	-8.0	-7.8	-7.5	-6.0	-5.3	-5.7
	Exceeded 95% of years	-5.5	-5.2	-4.9	-4.4	-2.6	-1.7	-2.2
	Average	-0.5	-0.3	-0.1	2.0	6.8	6.4	7.0
	Exceeded 5% of years	5.0	5.2	5.4	7.3	7.5	7.2	7.9
	Maximum	6.6	6.9	7.1	7.6	7.7	7.2	7.9
Middle Trinity Drawdown after 50 Years(ft)	Minimum	-32.5	-24.6	-15.7	-4.1	5.4	7.3	10.9
	Exceeded 95% of years	-31.1	-23.2	-14.1	-2.4	7.5	16.0	20.8
	Average	-28.4	-20.4	-11.3	1.5	12.8	21.0	30.3
	Exceeded 5% of years	-25.5	-17.5	-8.3	4.8	15.3	23.5	34.2
	Maximum	-21.4	-10.4	-5.4	4.9	15.4	23.8	34.8
Lower Trinity Drawdown after 50 Years (ft)	Minimum	-32.6	-24.7	-15.7	-4.1	5.5	7.3	10.9
	Exceeded 95% of years	-31.2	-23.3	-14.2	-2.4	7.5	16.1	20.9
	Average	-28.5	-20.5	-11.3	1.5	12.8	21.1	30.4
	Exceeded 5% of years	-25.6	-17.5	-8.3	4.8	15.4	23.6	34.3
	Maximum	-21.4	-10.5	-5.4	4.9	15.4	23.9	34.9

Travis County

Component	Case	Scenario 1	2	3	4	5	6	7
Pumping (AF/yr)	Minimum	0	1,814	3,629	5,368	6,958	8,521	9,405
	Exceeded 95% of years	0	1,814	3,629	5,368	7,058	8,521	9,561
	Average	0	1,814	3,629	5,368	7,158	8,697	9,692
	Exceeded 5% of years	0	1,814	3,629	5,443	7,158	8,947	10,437
	Maximum	0	1,814	3,629	5,443	7,257	8,947	10,736
Spring and River Base Flow (AF/yr)	Minimum	13,039	12,019	10,762	9,511	8,171	6,895	5,915
	Exceeded 95% of years	14,452	12,938	11,495	10,032	8,549	7,343	6,337
	Average	16,216	14,699	13,180	11,666	10,197	9,050	7,959
	Exceeded 5% of years	18,024	16,480	14,936	13,469	12,022	10,687	9,792
	Maximum	18,883	17,348	15,798	14,389	13,230	12,312	11,359
Outflow Across the Balcones Fault Zone (AF/yr)	Minimum	1,565	1,377	1,132	855	521	171	-147
	Exceeded 95% of years	1,966	1,643	1,314	973	613	290	-28
	Average	2,341	2,006	1,672	1,321	980	670	341
	Exceeded 5% of years	2,717	2,377	2,034	1,700	1,384	1,057	777
	Maximum	2,914	2,571	2,226	1,917	1,695	1,510	1,324
Overall Trinity Drawdown after 50 Years (ft)	Minimum	-24.8	-18.4	-11.7	-5.1	2.9	11.1	12.5
	Exceeded 95% of years	-21.3	-14.8	-8.1	-1.0	8.9	16.6	19.1
	Average	-15.2	-8.6	-1.9	6.9	20.7	27.6	31.5
	Exceeded 5% of years	-9.0	-2.6	4.4	13.4	22.0	28.8	32.9
	Maximum	-7.1	-0.6	6.3	13.9	22.0	29.4	33.4
Edwards Group Drawdown after 50 Years (ft)	Minimum	NA	NA	NA	NA	NA	NA	NA
	Exceeded 95% of years	NA	NA	NA	NA	NA	NA	NA
	Average	NA	NA	NA	NA	NA	NA	NA
	Exceeded 5% of years	NA	NA	NA	NA	NA	NA	NA
	Maximum	NA	NA	NA	NA	NA	NA	NA
Upper Trinity Drawdown after 50 Years(ft)	Minimum	-14.2	-12.6	-11.0	-9.5	-4.3	-0.1	-3.8
	Exceeded 95% of years	-6.6	-5.0	-3.4	-1.3	4.9	8.0	6.4
	Average	5.9	7.4	8.9	14.8	28.0	28.2	29.4
	Exceeded 5% of years	18.7	20.3	21.8	28.1	29.3	29.7	31.0
	Maximum	23.5	25.1	26.7	28.3	29.6	30.8	32.9
Middle Trinity Drawdown after 50 Years(ft)	Minimum	-28.7	-20.6	-12.2	-3.8	5.7	11.3	16.1
	Exceeded 95% of years	-26.6	-18.3	-9.8	-1.1	9.7	19.8	23.3
	Average	-22.8	-14.5	-5.9	4.1	17.8	27.6	31.5
	Exceeded 5% of years	-18.9	-10.6	-1.8	8.1	19.8	29.0	33.5
	Maximum	-17.8	-9.4	-0.6	8.7	19.8	29.5	33.8
Lower Trinity Drawdown after 50 Years (ft)	Minimum	-28.9	-20.7	-12.3	-3.9	5.4	11.4	16.1
	Exceeded 95% of years	-26.8	-18.5	-9.9	-1.3	9.6	19.4	23.3
	Average	-23.0	-14.6	-5.9	4.0	17.8	27.6	32.5
	Exceeded 5% of years	-19.0	-10.6	-1.7	8.2	19.9	29.0	34.8
	Maximum	-17.9	-9.4	-0.5	8.8	19.9	29.5	35.3

Area 1 (Comal, Hays and Travis Counties)

Component	Case	Scenario 1	2	3	4	5	6	7
Pumping (AF/yr)	Minimum	0	5,682	11,367	16,974	22,432	27,850	31,828
	Exceeded 95% of years	0	5,682	11,367	16,974	22,532	27,850	32,131
	Average	0	5,682	11,367	16,974	22,632	28,026	32,855
	Exceeded 5% of years	0	5,682	11,367	17,049	22,632	28,291	33,649
	Maximum	0	5,682	11,367	17,049	22,731	28,291	33,948
Spring and River Base Flow (AF/yr)	Minimum	36,382	33,020	29,161	25,397	21,452	17,392	13,798
	Exceeded 95% of years	41,415	36,777	32,250	28,088	23,579	19,904	15,872
	Average	50,919	46,177	41,514	36,563	32,043	28,588	24,313
	Exceeded 5% of years	60,615	55,827	51,004	46,460	41,599	36,704	33,352
	Maximum	65,283	60,471	55,624	51,000	46,618	42,766	39,484
Outflow Across the Balcones Fault Zone (AF/yr)	Minimum	41,232	39,579	37,536	35,479	33,228	30,775	28,578
	Exceeded 95% of years	44,158	41,949	39,692	37,286	34,837	32,611	30,270
	Average	49,847	47,750	45,517	43,107	40,642	38,643	36,144
	Exceeded 5% of years	55,375	53,220	51,036	48,980	46,694	44,199	42,358
	Maximum	57,991	55,840	53,666	51,582	49,641	47,778	46,271
Overall Trinity Drawdown after 50 Years (ft)	Minimum	-24.5	-19.6	-14.5	-9.4	-2.6	4.8	6.5
	Exceeded 95% of years	-20.4	-15.4	-10.4	-4.7	3.6	10.0	13.4
	Average	-13.6	-8.8	-3.6	4.3	18.0	23.0	28.1
	Exceeded 5% of years	-6.7	-1.4	4.1	12.5	18.6	24.3	29.0
	Maximum	-4.3	1.0	6.6	13.1	18.6	24.5	29.3
Edwards Group Drawdown after 50 Years (ft)	Minimum	NA	NA	NA	NA	NA	NA	NA
	Exceeded 95% of years	NA	NA	NA	NA	NA	NA	NA
	Average	NA	NA	NA	NA	NA	NA	NA
	Exceeded 5% of years	NA	NA	NA	NA	NA	NA	NA
	Maximum	NA	NA	NA	NA	NA	NA	NA
Upper Trinity Drawdown after 50 Years(ft)	Minimum	-15.1	-14.4	-13.6	-12.9	-9.0	-7.2	-8.3
	Exceeded 95% of years	-9.7	-8.3	-7.5	-6.0	-1.9	0.7	-0.8
	Average	1.4	2.1	2.9	7.7	17.6	17.0	18.6
	Exceeded 5% of years	12.8	13.5	14.2	18.4	19.0	18.7	20.0
	Maximum	16.2	16.9	17.7	18.5	19.2	19.0	20.6
Middle Trinity Drawdown after 50 Years(ft)	Minimum	-27.5	-21.2	-14.8	-8.3	-0.4	8.7	11.4
	Exceeded 95% of years	-24.4	-18.0	-11.5	-4.6	5.1	13.1	18.0
	Average	-18.7	-12.3	-5.6	3.3	17.9	24.7	30.8
	Exceeded 5% of years	-12.8	-6.2	0.8	10.5	19.0	26.1	32.1
	Maximum	-10.9	-4.2	3.0	11.4	19.0	26.7	32.1
Lower Trinity Drawdown after 50 Years (ft)	Minimum	-27.6	-21.3	-14.8	-8.3	-0.5	8.6	11.4
	Exceeded 95% of years	-24.5	-18.1	-11.6	-4.6	5.1	13.0	18.2
	Average	-18.8	-12.4	-5.7	3.3	18.0	24.8	31.4
	Exceeded 5% of years	-12.9	-6.3	0.8	10.5	19.0	26.1	32.7
	Maximum	-11.0	-4.2	3.0	11.4	19.0	26.7	32.8

Area 2 (Medina and Bexar Counties)

Component	Case	Scenario						
		1	2	3	4	5	6	7
Pumping (AF/yr)	Minimum	0	5,470	10,943	16,413	21,884	27,356	32,246
	Exceeded 95% of years	0	5,470	10,943	16,413	21,884	27,356	32,358
	Average	0	5,470	10,943	16,413	21,884	27,356	32,589
	Exceeded 5% of years	0	5,470	10,943	16,413	21,884	27,356	32,827
	Maximum	0	5,470	10,943	16,413	21,884	27,356	32,827
Spring and River Base Flow (AF/yr)	Minimum	14,518	14,451	14,383	14,315	14,249	14,183	14,119
	Exceeded 95% of years	14,893	14,824	14,752	14,649	14,574	14,501	14,429
	Average	16,113	16,027	15,946	15,865	15,737	15,718	15,612
	Exceeded 5% of years	17,305	17,216	17,134	17,078	16,977	16,841	16,825
	Maximum	17,828	17,738	17,652	17,576	17,504	17,432	17,360
Outflow Across the Balcones Fault Zone (AF/yr)	Minimum	44,228	41,198	37,300	33,278	28,805	23,593	18,313
	Exceeded 95% of years	50,933	46,428	41,743	36,416	31,309	26,651	21,169
	Average	58,350	53,918	49,236	43,765	38,878	34,722	29,275
	Exceeded 5% of years	65,785	61,372	56,704	51,861	47,188	42,165	37,851
	Maximum	69,765	65,363	60,690	55,746	51,732	47,886	44,669
Overall Trinity Drawdown after 50 Years (ft)	Minimum	-54.3	-44.3	-33.8	-22.4	-8.4	6.1	14.5
	Exceeded 95% of years	-47.5	-37.2	-26.6	-14.1	1.5	14.4	25.1
	Average	-35.6	-25.4	-14.6	1.6	26.2	36.3	49.2
	Exceeded 5% of years	-23.1	-12.6	-1.6	15.6	27.4	38.9	50.8
	Maximum	-18.6	-8.0	3.2	17.1	27.4	39.0	51.1
Edwards Group Drawdown after 50 Years (ft)	Minimum	NA	NA	NA	NA	NA	NA	NA
	Exceeded 95% of years	NA	NA	NA	NA	NA	NA	NA
	Average	NA	NA	NA	NA	NA	NA	NA
	Exceeded 5% of years	NA	NA	NA	NA	NA	NA	NA
	Maximum	NA	NA	NA	NA	NA	NA	NA
Upper Trinity Drawdown after 50 Years(ft)	Minimum	-18.6	-18.0	-17.4	-16.8	-13.3	-12.0	-12.2
	Exceeded 95% of years	-13.4	-12.4	-11.8	-10.4	-6.8	-4.5	-5.2
	Average	-2.9	-2.3	-1.8	2.9	12.6	11.9	13.7
	Exceeded 5% of years	8.6	9.2	9.8	13.6	14.2	13.7	15.2
	Maximum	11.8	12.4	13.0	13.9	14.4	13.9	15.5
Middle Trinity Drawdown after 50 Years(ft)	Minimum	-70.2	-56.0	-41.1	-24.8	-6.2	14.0	26.3
	Exceeded 95% of years	-62.6	-48.3	-33.5	-15.8	5.2	23.1	38.9
	Average	-50.2	-35.8	-20.5	0.9	31.9	46.9	64.4
	Exceeded 5% of years	-37.1	-22.4	-6.4	16.5	33.4	50.1	67.0
	Maximum	-32.1	-17.1	-1.1	18.6	33.5	50.2	67.3
Lower Trinity Drawdown after 50 Years (ft)	Minimum	-70.1	-56.0	-41.1	-24.8	-6.2	14.0	26.4
	Exceeded 95% of years	-62.6	-48.3	-33.4	-15.8	5.2	23.1	39.0
	Average	-50.2	-35.8	-20.5	0.9	31.9	46.9	65.0
	Exceeded 5% of years	-37.1	-22.3	-6.4	16.5	33.4	50.1	67.6
	Maximum	-32.0	-17.1	-1.1	18.6	33.5	50.2	67.8

Area 3 (Bandera, Blanco, Kendall and Kerr Counties)

Component	Case	Scenario						
		1	2	3	4	5	6	7
Pumping (AF/yr)	Minimum	1,968	10,166	18,364	26,560	31,914	36,527	41,771
	Exceeded 95% of years	1,968	10,166	18,364	26,560	31,914	37,103	42,741
	Average	1,968	10,166	18,364	26,560	31,914	37,885	42,747
	Exceeded 5% of years	1,968	10,166	18,364	26,560	33,384	39,401	45,068
	Maximum	1,968	10,166	18,364	26,560	33,384	39,401	46,888
Spring and River Base Flow (AF/yr)	Minimum	100,461	97,270	94,255	91,435	88,684	86,241	82,052
	Exceeded 95% of years	115,607	109,855	104,205	98,851	94,460	92,528	88,258
	Average	135,508	128,712	122,144	116,054	111,785	109,241	104,792
	Exceeded 5% of years	155,874	148,542	141,290	135,155	130,583	126,108	122,824
	Maximum	166,200	158,564	150,900	144,514	140,649	137,187	134,241
Outflow Across the Balcones Fault Zone (AF/yr)	Minimum	1,217	1,081	887	673	323	5	-445
	Exceeded 95% of years	1,763	1,505	1,197	819	499	165	-225
	Average	2,148	1,856	1,531	1,122	823	535	169
	Exceeded 5% of years	2,457	2,168	1,838	1,443	1,154	924	681
	Maximum	2,622	2,336	2,006	1,611	1,413	1,259	1,125
Overall Trinity Drawdown after 50 Years (ft)	Minimum	-62.3	-49.1	-33.1	-11.4	2.5	5.0	7.9
	Exceeded 95% of years	-58.8	-45.4	-29.0	-6.8	7.1	19.6	24.6
	Average	-51.5	-38.0	-21.7	3.2	20.0	31.1	42.6
	Exceeded 5% of years	-43.9	-30.4	-13.8	11.2	27.3	36.3	52.2
	Maximum	-32.7	-11.9	-6.3	11.6	27.5	36.6	53.7
Edwards Group Drawdown after 50 Years (ft)	Minimum	-8.1	-8.1	-8.1	-8.1	-6.5	-6.1	-6.5
	Exceeded 95% of years	-6.2	-6.1	-6.1	-5.9	-4.8	-4.4	-4.7
	Average	-3.0	-3.0	-3.1	-2.1	0.2	0.5	0.2
	Exceeded 5% of years	0.2	0.2	0.2	0.7	3.5	2.5	3.4
	Maximum	1.7	1.3	1.7	3.3	3.9	3.4	3.9
Upper Trinity Drawdown after 50 Years(ft)	Minimum	-27.3	-22.8	-19.3	-18.2	-15.5	-12.8	-14.8
	Exceeded 95% of years	-21.3	-16.8	-13.2	-10.9	-6.9	-5.2	-5.9
	Average	-9.8	-5.5	-2.1	2.8	14.4	13.2	15.0
	Exceeded 5% of years	1.8	5.9	9.8	14.9	15.5	15.1	16.0
	Maximum	5.8	10.4	13.9	16.9	17.2	15.8	17.7
Middle Trinity Drawdown after 50 Years(ft)	Minimum	-77.6	-60.7	-39.3	-9.1	9.7	7.0	11.1
	Exceeded 95% of years	-74.9	-57.6	-35.9	-4.9	13.0	24.4	29.1
	Average	-69.4	-51.8	-29.9	3.2	22.5	38.9	56.7
	Exceeded 5% of years	-63.6	-45.7	-23.5	9.6	32.2	45.8	67.3
	Maximum	-46.0	-16.4	-8.6	10.6	32.6	46.3	69.5
Lower Trinity Drawdown after 50 Years (ft)	Minimum	-78.1	-61.2	-39.8	-9.1	10.0	7.2	11.4
	Exceeded 95% of years	-75.4	-58.2	-36.4	-4.9	13.2	24.8	29.8
	Average	-69.9	-52.4	-30.4	3.3	22.8	39.6	57.9
	Exceeded 5% of years	-64.2	-46.3	-24.0	9.7	32.6	46.7	68.7
	Maximum	-47.1	-16.9	-8.9	10.7	33.0	47.1	70.9

GAM Task 10-031:
Supplement to GAM Task 10-005

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DESCRIPTION OF TASK:

This report presents additional results associated with the analysis described in GAM Task 10-005. The simulations used as part of this task include four of the seven pumping scenarios (GAM Task 10-005) of the Trinity Aquifer that range from current estimated pumping representing 2008 to about twice the estimated 2008 level of pumping. Each scenario included running 387 50-year simulations. The 387 50-year simulations were developed based on tree-ring precipitation estimates from 1537 to 1972 for the Edwards Plateau (Cleaveland, 2006). The results were used to evaluate averaged water budgets per county and to develop contour maps of average drawdown in water levels for each scenario.

METHODS:

The seven pumping scenarios in GAM Task 10-005 (Hutchison, 2010) ranged from no pumping in the Trinity Aquifer (Scenario 1), to 2008 levels of pumping (about 60,000 acre-feet in Scenario 4) to about twice the pumping experienced in 2008 (about 120,000 acre-feet in Scenario 7) as summarized below:.

- Scenario 1 = 0 acre-feet per year
- Scenario 2 = 20,000 acre-feet per year
- Scenario 3 = 40,000 acre-feet per year
- Scenario 4 = 60,000 acre-feet per year (2008 conditions)
- Scenario 5 = 80,000 acre-feet per year
- Scenario 6 = 100,000 acre-feet per year
- Scenario 7 = 120,000 acre-feet per year

Table 1 summarizes the estimated pumping by county and by aquifer in 2008. These estimates were provided by groundwater conservation districts in Groundwater Management Area 9.

Table 1. Estimated 2008 pumping as provided by the groundwater conservation districts in Groundwater Management Area 9

County	Edwards Group of the Edwards-Trinity (Plateau) Aquifer	Upper Trinity Aquifer	Middle Trinity Aquifer	Lower Trinity Aquifer	Total Pumping (County)
Bandera	631	288	3567	515	**5,000**
Bexar	0	693	14110	197	**15,000**
Blanco	0	77	1,477	0	**1,554**
Comal	0	398	5,788	0	**6,186**
Hays	0	416	4,800	449	**5,665**
Kendall	315	300	6,060	325	**7,000**
Kerr	1,035	213	6,263	5,534	**13,045**
Medina	0	0	500	1000	**1,500**
Travis	0	551	4,967	0	**5,518**
Total pumping (aquifer)	**1,981**	**2,936**	**47,532**	**8,020**	**60,468**

PARAMETERS AND ASSUMPTIONS:

- See GAM Task 10-005 (Hutchison, 2010) for additional information of the assumptions used for recharge, starting conditions, and pumping for the 387 50 year simulations.
- The recently updated Hill Country portion of the Trinity Aquifer developed by Jones and others (2009) was used for these simulations. See Mace and others (2000) and Jones and others (2009) for details on model construction, recharge distribution, discharge, assumptions, and limitations of the model.
- Pumping scenarios 4, 5, 6, and 7 were used as described above
- The model has four layers: layer 1 represents the Edwards Group of the Edwards-Trinity (Plateau) Aquifer, layer 2 represents the Upper Trinity Aquifer, layer 3 represents the Middle Trinity Aquifer, and layer 4 represents the Lower Trinity Aquifer.
- The rivers, streams, and springs were simulated in the model using MODFLOW's Drain package. MODFLOW's Drain package was also used to simulate spring discharge along bedding contacts of the Edwards Group (Plateau) and the Upper

Trinity Aquifer in the northwestern parts of the model area. This resulted in the assignment of numerous drain cells along this outcrop contact.

- The model was run with MODFLOW-96 (Harbaugh and McDonald, 1996).
- Drawdowns were calculated by subtracting the final;water levels at the end of the 50 year simulations from the 2008 initial conditions..

RESULTS:

Summary tables of all groundwater budget results (by county and aquifer are presented in Appendix A. Because each scenario consisted of 387 50-year simulations, the groundwater budget results are expressed in terms of average of all 387 simulations for each scenario.

Figures 1 through 4 show the contour maps of the average drawdown for the Trinity Aquifer within Groundwater Management Area 9. In scenario 4 the drawdown is a maximum of about 14.5 feet to a minimum of 3.3 feet water rise in elevation compared to 2008 starting water level elevations. In scenario 5, 6 and 7 the drawdown ranges from:

- zero feet to 54.6 feet,
- zero feet to 74.0 feet, and
- zero feet to 87.9 feet respectively.

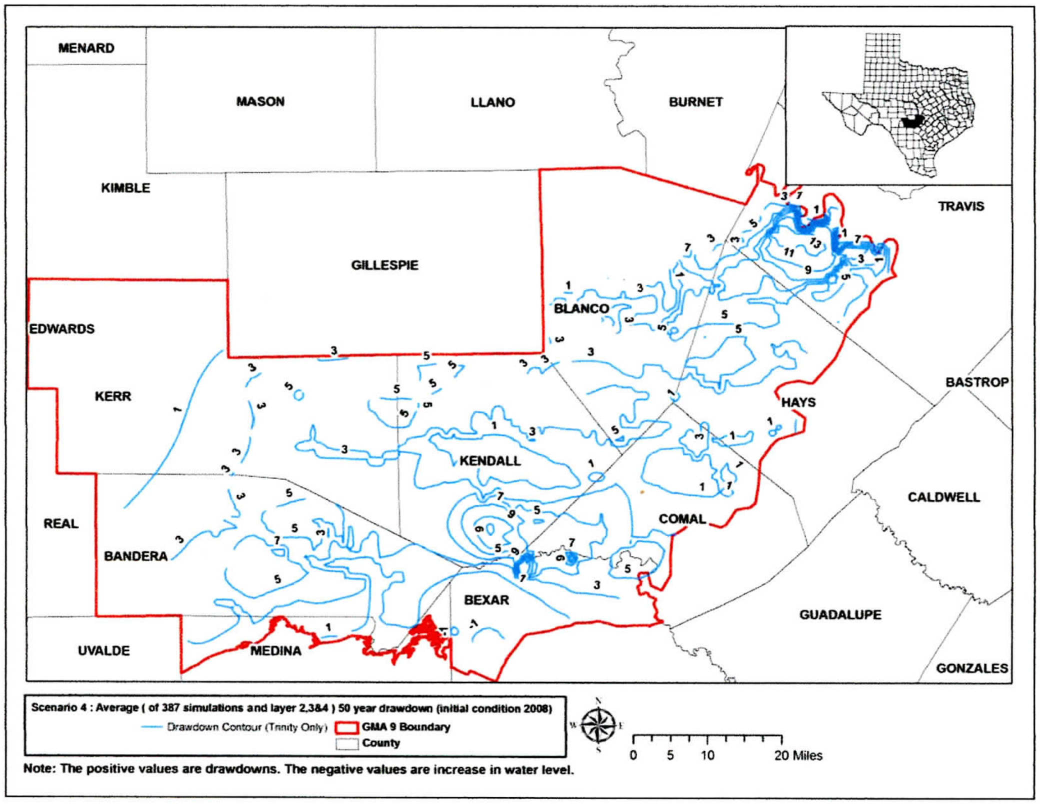

Figure 13: Average water level drawdown contour map for scenario 4 for Groundwater Management Area (GMA) 9 using 2008 water levels for the calculation.

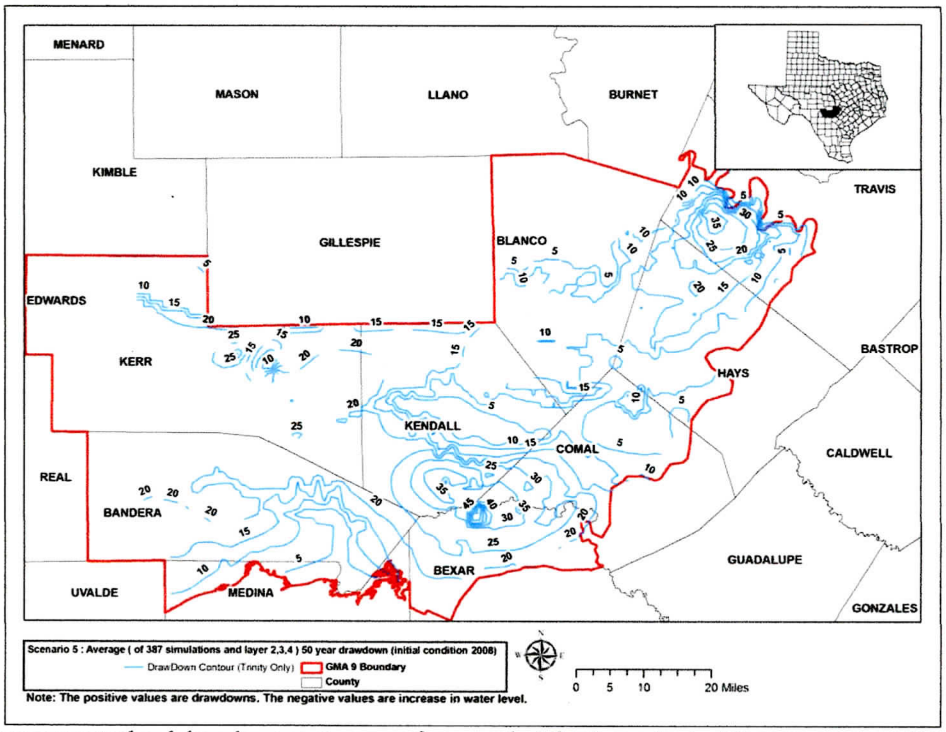

Figure 14: Average water level drawdown contour map for scenario 5 for Groundwater Management Area (GMA) 9 using 2008 water levels for the calculation.

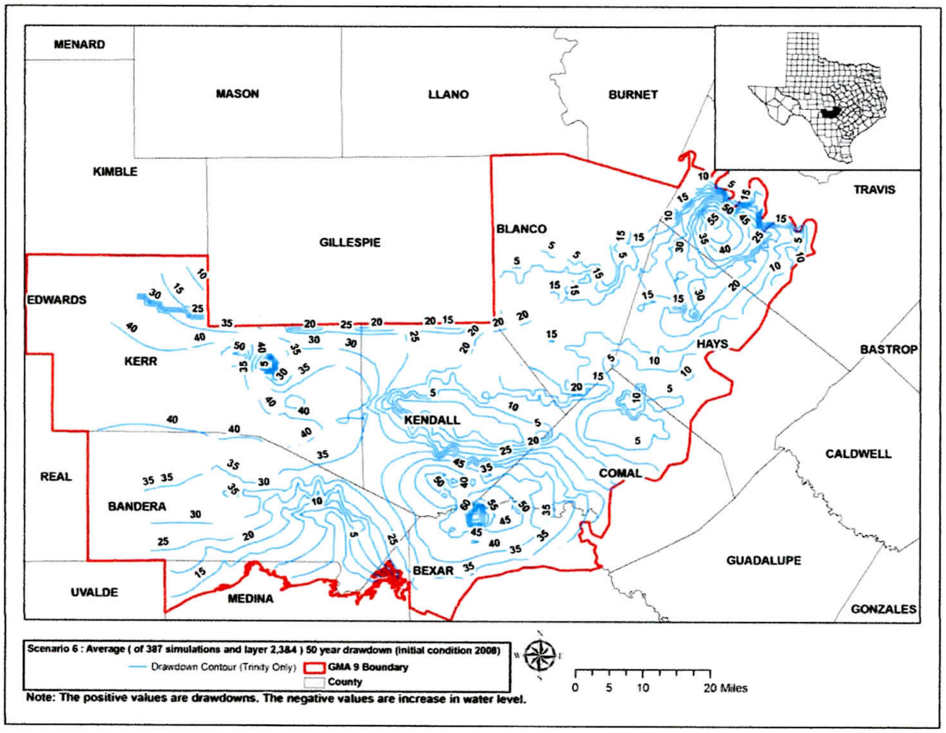

Figure 15: Average water level drawdown contour map for scenario 6 for Groundwater Management Area (GMA) 9 using 2008 water levels for the calculation.

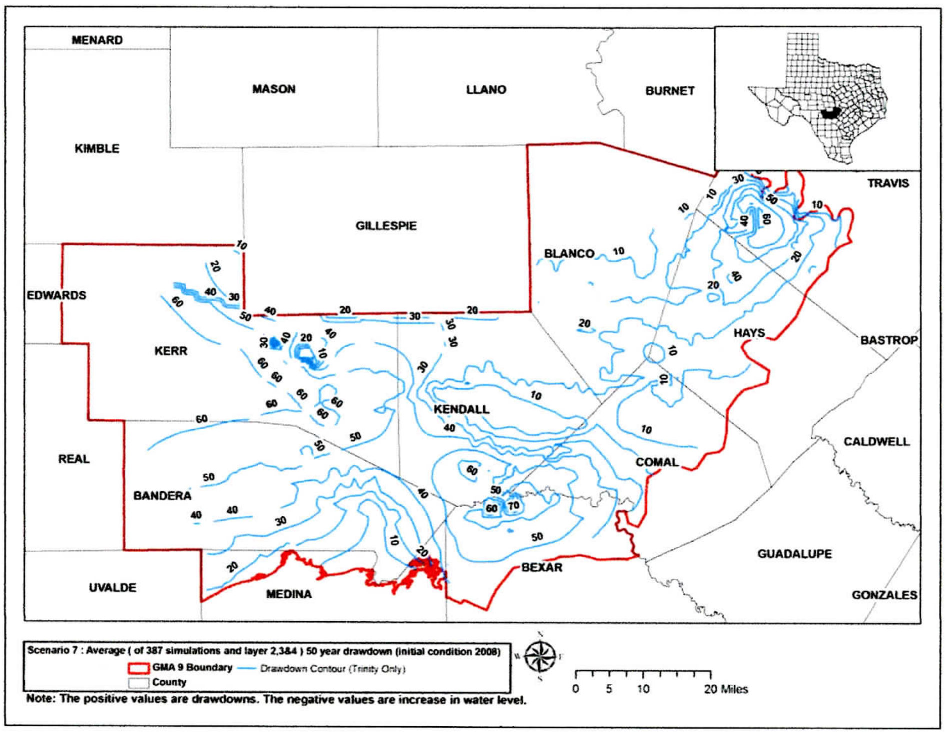

Figure 16: Average water level drawdown contour map for scenario 7 for Groundwater Management Area (GMA) 9 using 2008 water levels for the calculation.

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Appendix A
Water budgets per county for:

Bandera County
Bexar County
Blanco County
Comal County
Hays County
Kendall County
Kerr County
Medina County
Travis County

Table: Bandera County (Edward Aquifer. 2008 to 2060)				
INFLOW	Scen 4	Scen 5	Scen 6	Scen 7
RECHARGE FROM PRECIPITATION	9,604	9,460	9,435	9,405
INFLOW FROM KERR COUNTY	3,422	3,392	3,386	3,383
TOTAL INFLOW	13,026	12,852	12,821	12,788
OUTFLOW				
PUMPING	626	626	626	626
OUTFLOW TO SURFACE WATER	11,678	11,568	11,560	11,535
OUTFLOW TO TRINITY AQUIFER	707	704	704	703
TOTAL OUTFLOW	13,011	12,898	12,890	12,864
TOTAL INFLOW- TOTAL OUTFLOW	15	-46	-69	-76
STORAGE CHANGE	15	-45	-68	-75
MODEL ERROR	0	-1	-1	-1

Table: Bandera County (Trinity Aquifer. 2008 to 2060)				
INFLOW	Scen 4	Scen 5	Scen 6	Scen 7
RECHARGE FROM PRECIPITATION	31,787	31,310	31,227	31,129
INFLOW FROM KENDALL COUNTY	5,686	5,391	5,165	4,906
INFLOW FROM KERR COUNTY	7,415	6,655	6,070	5,459
INFLOW FROM EDWARD AQUIFER	707	704	704	703
TOTAL INFLOW	45,595	44,060	43,166	42,197
OUTFLOW				
PUMPING	4,373	5,831	7,290	8,746
OUTFLOW TO SURFACE WATER	21,680	19,892	18,672	17,436
OUTFLOW TO EDWARD AQUIFER (BALCONES FALT ZONE)	1,118	807	543	217
OUTFLOW TO OTHER AREA	470	381	324	237
OUTFLOW TO BEXAR COUNTY	1,742	1,754	1,775	1,779
OUTFLOW TO MEDINA COUNTY	16,295	15,870	15,579	15,033
TOTAL OUTFLOW	45,678	44,535	44,183	43,448
TOTAL INFLOW- TOTAL OUTFLOW	-83	-475	-1,017	-1,251
STORAGE CHANGE	-82	-475	-1,018	-1,251
MODEL ERROR	-1	0	1	0

Table: Bexar County (Trinity Aquifer. 2008 to 2060)				
INFLOW	Scen 4	Scen 5	Scen 6	Scen 7
RECHARGE FROM PRECIPITATION	41,294	40,673	40,566	40,439
INFLOW FROM BANDERA COUNTY	1,742	1,754	1,775	1,779
INFLOW FROM COMAL COUNTY	10,621	11,273	11,896	12,446
INFLOW FROM KENDALL COUNTY	10,392	10,086	9,844	9,480
INFLOW FROM MEDINA COUNTY	4,831	5,788	6,688	7,583
TOTAL INFLOW	68,880	69,574	70,769	71,727
OUTFLOW				
PUMPING	14,922	19,897	24,872	29,682
OUTFLOW TO SURFACE WATER	10,412	10,285	10,214	10,139
OUTFLOW TO EDWARD AQUIFER (BALCONES FALT ZONE)	33,705	30,389	27,484	24,436
OUTFLOW TO OTHER AREA	9,878	9,216	8,638	8,028
TOTAL OUTFLOW	68,917	69,787	71,208	72,285
TOTAL INFLOW- TOTAL OUTFLOW	-37	-213	-439	-558
STORAGE CHANGE	-37	-209	-434	-554
MODEL ERROR	0	-4	-5	-4

Table: Blanco County (Trinity Aquifer. 2008 to 2060)				
INFLOW	Scen 4	Scen 5	Scen 6	Scen 7
RECHARGE FROM PRECIPITATION	23,316	22,966	22,906	22,834
INFLOW FROM OTHER AREA	1,796	1,761	1,731	1,696
INFLOW FROM KENDALL COUNTY	2,738	2,704	2,690	2,670
TOTAL INFLOW	27,850	27,431	27,327	27,200
OUTFLOW				
PUMPING	1,545	2,060	2,575	3,090
OUTFLOW TO SURFACE WATER	17,127	16,380	15,928	15,419
OUTFLOW TO COMAL COUNTY	3,799	3,683	3,597	3,487
OUTFLOW TO HAYS COUNTY	5,434	5,482	5,532	5,558
TOTAL OUTFLOW	27,905	27,605	27,632	27,554
TOTAL INFLOW- TOTAL OUTFLOW	-55	-174	-305	-354
STORAGE CHANGE	-46	-164	-297	-344
MODEL ERROR	-9	-10	-8	-10

Table: Comal County (Trinity Aquifer. 2008 to 2060)				
INFLOW	Scen 4	Scen 5	Scen 6	Scen 7
RECHARGE FROM PRECIPITATION	39,793	39,195	39,092	38,969
INFLOW FROM SURFACE WATER	0	0	0	959
INFLOW FROM BLANCO COUNTY	3,799	3,683	3,597	3,487
INFLOW FROM KENDALL COUNTY	7,799	7,823	7,855	7,822
TOTAL INFLOW	51,391	50,701	50,544	51,237
OUTFLOW				
PUMPING	5,716	7,622	9,527	11,380
OUTFLOW TO SURFACE WATER	5,492	3,044	1,055	0
OUTFLOW TO EDWARD AQUIFER (BALCONES FALT ZONE)	15,384	14,796	14,315	13,803
OUTFLOW TO OTHER AREA	8,208	8,202	8,232	8,254
OUTFLOW TO BEXAR COUNTY	10,621	11,273	11,896	12,446
OUTFLOW TO HAYS COUNTY	6,016	5,958	5,890	5,809
TOTAL OUTFLOW	51,437	50,895	50,915	51,692
TOTAL INFLOW- TOTAL OUTFLOW	-46	-194	-371	-455
STORAGE CHANGE	-47	-192	-370	-452
MODEL ERROR	1	-2	-1	-3

Table: Hays County (Trinity Aquifer. 2008 to 2060)				
INFLOW	Scen 4	Scen 5	Scen 6	Scen 7
RECHARGE FROM PRECIPITATION	24,363	23,997	23,934	23,859
INFLOW FROM BLANCO COUNTY	5,434	5,482	5,532	5,558
INFLOW FROM COMAL COUNTY	6,016	5,958	5,890	5,809
TOTAL INFLOW	35,813	35,437	35,356	35,226
OUTFLOW				
PUMPING	5,397	7,196	8,985	10,620
OUTFLOW TO SURFACE WATER	19,490	18,462	17,658	16,837
OUTFLOW TO EDWARD AQUIFER (BALCONES FALT ZONE)	2,610	1,782	1,073	412
OUTFLOW TO OTHER AREA	2,417	2,330	2,252	2,180
OUTFLOW TO TRAVIS COUNTY	5,951	5,863	5,770	5,624
TOTAL OUTFLOW	35,865	35,633	35,738	35,673
TOTAL INFLOW- TOTAL OUTFLOW	-52	-196	-382	-447
STORAGE CHANGE	-51	-195	-382	-447
MODEL ERROR	-1	-1	0	0

Table: Kendall County (Edwards Aquifer. 2008 to 2060)				
INFLOW	Scen 4	Scen 5	Scen 6	Scen 7
RECHARGE FROM PRECIPITATION	5,446	5,364	5,350	5,333
INFLOW FROM KERR COUNTY	101	101	101	101
TOTAL INFLOW	5,547	5,465	5,451	5,434
OUTFLOW				
PUMPING	311	311	311	311
OUTFLOW TO SURFACE WATER	4,879	4,833	4,838	4,820
OUTFLOW TO OTHER AREA	217	216	216	215
OUTFLOW TO TRINITY AQUIFER	153	153	153	152
TOTAL OUTFLOW	5,560	5,513	5,518	5,498
TOTAL INFLOW- TOTAL OUTFLOW	-13	-48	-67	-64
STORAGE CHANGE	-13	-47	-66	-65
MODEL ERROR	0	-1	-1	1

Table: Kendall County (Trinity Aquifer. 2008 to 2060)				
INFLOW	Scen 4	Scen 5	Scen 6	Scen 7
RECHARGE FROM PRECIPITATION	52,346	51,559	51,424	51,262
INFLOW FROM OTHER AREA	4,087	4,048	4,034	4,009
INFLOW FROM KERR COUNTY	3	0	0	0
INFLOW FROM EDWARD AQUIFER	153	153	153	152
TOTAL INFLOW	56,589	55,760	55,611	55,423
OUTFLOW				
PUMPING	6,688	8,919	11,147	13,376
OUTFLOW TO SURFACE WATER	23,405	21,129	19,477	17,704
OUTFLOW TO BANDERA COUNTY	5,686	5,391	5,165	4,906
OUTFLOW TO BEXAR COUNTY	10,392	10,086	9,844	9,480
OUTFLOW TO BLANCO COUNTY	2,738	2,704	2,690	2,670
OUTFLOW TO COMAL COUNTY	7,799	7,823	7,855	7,822
OUTFLOW TO KERR COUNTY	0	223	404	619
TOTAL OUTFLOW	56,708	56,275	56,582	56,577
TOTAL INFLOW- TOTAL OUTFLOW	-119	-515	-971	-1,154
STORAGE CHANGE	-118	-511	-971	-1,153
MODEL ERROR	-1	-4	0	-1

Table: Kerr County (Edward Aquifer. 2008 to 2060)				
INFLOW	Scen 4	Scen 5	Scen 6	Scen 7
RECHARGE FROM PRECIPITATION	35,483	34,950	34,858	34,748
INFLOW FROM OTHER AREA	973	969	971	968
TOTAL INFLOW	36,456	35,919	35,829	35,716
OUTFLOW				
PUMPING	1,034	1,034	1,034	1,034
OUTFLOW TO SURFACE WATER	26,268	26,040	26,036	25,977
OUTFLOW TO BANDERA COUNTY	3,422	3,392	3,386	3,383
OUTFLOW TO KENDALL COUNTY	101	101	101	101
OUTFLOW TO TRINITY AQUIFER	5,494	5,473	5,470	5,466
TOTAL OUTFLOW	36,319	36,040	36,027	35,961
TOTAL INFLOW- TOTAL OUTFLOW	137	-121	-198	-245
STORAGE CHANGE	137	-121	-198	-245
MODEL ERROR	0	0	0	0

Table: Kerr County (Trinity Aquifer. 2008 to 2060)				
INFLOW	Scen 4	Scen 5	Scen 6	Scen 7
RECHARGE FROM PRECIPITATION	16,952	16,697	16,653	16,601
INFLOW FROM OTHER AREA	7,962	7,905	7,923	7,827
INFLOW FROM KENDALL COUNTY	0	223	404	619
INFLOW FROM EDWARD AQUIFER	5,494	5,473	5,470	5,466
TOTAL INFLOW	30,408	30,298	30,450	30,513
OUTFLOW				
PUMPING	12,001	13,544	15,302	16,428
OUTFLOW TO SURFACE WATER	11,063	10,863	10,826	10,746
OUTFLOW TO BANDERA COUNTY	7,415	6,655	6,070	5,459
OUTFLOW TO KENDALL COUNTY	3	0	0	0
TOTAL OUTFLOW	30,482	31,062	32,198	32,633
TOTAL INFLOW- TOTAL OUTFLOW	-74	-764	-1,748	-2,120
STORAGE CHANGE	-74	-762	-1,748	-2,118
MODEL ERROR	0	-2	0	-2

Table: Medina County (Trinity Aquifer. 2008 to 2060)				
INFLOW	Scen 4	Scen 5	Scen 6	Scen 7
RECHARGE FROM PRECIPITATION	6,084	5,993	5,977	5,958
INFLOW FROM BANDERA COUNTY	16,295	15,870	15,579	15,033
TOTAL INFLOW	22,379	21,863	21,556	20,991
OUTFLOW				
PUMPING	1,405	1,873	2,341	2,810
OUTFLOW TO SURFACE WATER	6,275	6,243	6,232	6,217
OUTFLOW TO EDWARD AQUIFER (BALCONES FALT ZONE)	7,998	6,486	5,185	3,619
OUTFLOW TO OTHER AREA	1,874	1,503	1,175	844
OUTFLOW TO BEXAR COUNTY	4,831	5,788	6,688	7,583
TOTAL OUTFLOW	22,383	21,893	21,621	21,073
TOTAL INFLOW- TOTAL OUTFLOW	-4	-30	-65	-82
STORAGE CHANGE	-6	-31	-66	-84
MODEL ERROR	2	1	1	2

Table: Travis County (Trinity Aquifer. 2008 to 2060)				
INFLOW	Scen 4	Scen 5	Scen 6	Scen 7
RECHARGE FROM PRECIPITATION	11,194	11,026	10,997	10,963
INFLOW FROM HAYS COUNTY	5,951	5,863	5,770	5,624
TOTAL INFLOW	17,145	16,889	16,767	16,587
OUTFLOW				
PUMPING	5,375	7,120	8,714	9,890
OUTFLOW TO SURFACE WATER	7,419	6,466	5,748	5,201
OUTFLOW TO EDWARD AQUIFER (BALCONES FALT ZONE)	1,327	969	657	354
OUTFLOW TO OTHER AREA	3,079	2,513	2,001	1,547
TOTAL OUTFLOW	17,200	17,068	17,120	16,992
TOTAL INFLOW- TOTAL OUTFLOW	-55	-179	-353	-405
STORAGE CHANGE	-43	-166	-341	-393
MODEL ERROR	-12	-13	-12	-12

APPENDIX B

GAM Run 10-049 MAG Version 2

By Mohammad Masud Hassan, P.E.

Edited by Marius Jigmond to reflect statutory
changes effective September 1, 2011

Updated to version 2 by Wade Oliver and Radu Boghici to reflect refined
modeled available groundwater estimates

Texas Water Development Board
Groundwater Availability Modeling Section
(512) 463-8499
March 28, 2012

STATE OF TEXAS
CYNTHIA K. RIDGEWAY
GEOLOGY
No. 471
LICENSED
PROFESSIONAL GEOSCIENTIST

Cynthia K. Ridgeway is the Manager of the Groundwater Availability Modeling Section and is responsible for oversight of work performed by employees under her direct supervision. The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G. 471 on March 28, 2012

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EXECUTIVE SUMMARY:

The modeled available groundwater for the Edwards Group of the Edwards-Trinity (Plateau) Aquifer as a result of the desired future condition adopted by the members of Groundwater Management Area 9 is approximately 1,001 acre-feet per year between 2010 and 2060. This is shown divided by county, regional water planning area, and river basin in Table 1 for use in the regional water planning process. Modeled available groundwater is summarized by county, regional water planning area, river basin, and groundwater conservation district in tables 2 through 5. The estimates were extracted from the previous Groundwater Availability Model Run 08-90mag (Chowdhury, 2009), which meets the desired future condition adopted by the members of Groundwater Management Area 9.

The first version of this report showed modeled available groundwater for Bandera, Kendall, and Kerr counties based on the pumping assumed in the groundwater availability model simulation. However, Groundwater Management Area 9 declared Kerr County "not relevant" for joint planning purposes. Since modeled available groundwater only applies to areas with a specified desired future condition, we updated this report to only depict modeled available groundwater in Kendall and Bandera counties.

REQUESTOR:

Mr. Ronald G. Fieseler of the Blanco Pedernales Groundwater Conservation District on behalf of Groundwater Management Area 9

DESCRIPTION OF REQUEST:

In a letter dated August 26, 2010 and received August 30, 2010, Mr. Ronald G. Fieseler provided the Texas Water Development Board (TWDB) with the desired future condition of the Edwards Group of Edwards-Trinity (Plateau) Aquifer adopted by the members of Groundwater Management Area 9. As described in Resolution #072610-01, the desired future condition for the Edwards Group of the Edwards-Trinity (Plateau) Aquifer in Groundwater Management Area 9 is:

"[...] Allow for no net increase in average drawdown in the Edwards Group of the Edward-Trinity (Plateau) Aquifer in Kendall and Bandera [c]ounties.

In addition, GMA 9 declared the Edward Group of the Edward-Trinity (Plateau) to be "Not Relevant" in Kerr and Blanco [c]ounties"

In response to receiving the adopted desired future condition, the Texas Water Development Board has estimated the modeled available groundwater for the Edwards Group of the Edwards-Trinity (Plateau) Aquifer for Kendall and Bandera counties.

METHODS:

The Texas Water Development Board previously completed Groundwater Availability Model (GAM) Run 08-90mag (Chowdhury, 2009) containing "managed available groundwater" information based on the desired future conditions adopted on August 28, 2008 by the groundwater conservation districts in Groundwater Management Area 9. Subsequent to the release of GAM Run 08-90mag, the desired future conditions for the Edwards Group of the Edwards-Trinity (Plateau) Aquifer were petitioned, and presented to the Texas Water Development Board at a special meeting on January 21, 2010. At that meeting, the Board found that the adopted desired future condition of zero drawdown was not reasonable. The Board further recommended that the desired future condition in Kerr County be 9 feet of drawdown and that the Edwards Group of the Edwards-Trinity (Plateau) Aquifer be found not relevant in Bandera and Kendall counties. The Board's recommended desired future condition was discussed at a meeting for Groundwater Management Area 9 on February 22, 2010, and a public hearing was held during that same meeting. At their July 26, 2010, meeting, the districts adopted new desired future conditions for the Edwards Group of the Edwards-Trinity (Plateau) Aquifer. In Bandera and Kendall counties, the new desired future condition is the same as the original desired future condition: zero drawdown. Because no changes were made to the desired future condition in Bandera and Kendall counties, the results in the GAM Run 08-90mag report were still applicable to the "new" desired future condition.

The location of Groundwater Management Area 9, the Edwards Group of the Edwards-Trinity (Plateau) Aquifer, and the groundwater availability model cells that represent the aquifer are shown in Figure 1. The pumping was divided by county, regional water planning area, river basin, and groundwater conservation district (Figure 2).

PARAMETERS AND ASSUMPTIONS:

The parameters and assumptions for the model run using the groundwater availability model for the Hill Country portion of the Trinity Aquifer, which contains a portion representing the Edwards Group of the Edwards-Trinity (Plateau) Aquifer, are described below:

- Version 1.03 of the groundwater availability model for the Hill Country portion of the Trinity Aquifer developed by Mace and others (2000) was used for this analysis. See Mace and others (2000) for details on model construction, recharge, discharge, assumptions and limitations of the model.
- The model has three layers: layer 1 represents the Edwards Group, layer 2 represents the Upper Trinity Aquifer, and layer 3 represents the Middle Trinity Aquifer.
- The model has a total of 79 stress periods with 2 stress periods representing pre-development conditions, 24 monthly stress periods for representing transient conditions (1996 to 1997), and 53 predictive annual stress periods (2008 to 2060).
- The root-mean squared error of the model (a measure of the difference between simulated and measured water levels) is approximately 56 feet. This represents 5 percent of the range of measured water levels across the model area.
- We assigned the baseline pumping to the first predictive stress period in the model to represent 2008 pumping conditions based on the assumption that the aquifers in the area recharge rapidly and groundwater movement is fast enough to quickly bring about a dynamic equilibrium. Comparisons of water level changes in selected hydrographs in the

predictive period suggest that the aquifer attains a dynamic equilibrium within a year (Chowdhury, 2009).

- Average recharge was used throughout the predictive period for this model run. Average recharge in the model was estimated for normal climatic conditions by using the average precipitation for the period 1960 to 1990 and the recharge coefficients estimated from baseflow analyses for each model cell (Mace and others, 2000).
- The model was run in Processing MODFLOW for Windows (version 5.3; Chiang and Kinzelbach, 1998).

Modeled Available Groundwater and Permitting

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. This is distinct from "managed available groundwater," shown in the draft version of this report dated January 31, 2011, which was a permitting value and accounted for the estimated use of the aquifer exempt from permitting. This change was made to reflect changes in statute by the 82nd Texas Legislature, effective September 1, 2011.

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 estimated amount of pumping exempt from permitting, which the Texas Water Development Board is now required to develop after soliciting input from applicable groundwater conservation districts, will be provided in a separate report.

RESULTS:

The modeled available groundwater for the Edwards Group of the Edward-Trinity (Plateau) Aquifer consistent as a result of the desired future condition adopted by the members of Groundwater Management Area 9 is approximately 1,001 acre-feet per year between 2010 and 2060. This is subdivided by county, regional water planning area, and river basin as shown in Table 1. The modeled available groundwater is also summarized by county, regional water planning area, river basin, and groundwater conservation district as shown in tables 2, 3, 4, and 5, respectively.

LIMITATIONS:

The groundwater model used in developing estimates of modeled available groundwater is the best available scientific tool that can be used to estimate the pumping that will achieve the desired future conditions. Although the groundwater model used in this analysis is the best available scientific tool for this purpose, it, like all models, has limitations. 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 develop estimates of modeled available groundwater is the need to make assumptions about the location in the aquifer where future pumping will occur. As actual pumping changes in the future, it will be necessary to evaluate the amount of that pumping as well as its location in the context of the assumptions associated with this analysis. Evaluating the amount and location of future pumping is as important as evaluating the changes in groundwater levels, spring flows, and other metrics that describe the condition of the groundwater resources in the area that relate to the adopted desired future condition(s).

Given these limitations, users of this information are cautioned that the modeled available groundwater numbers should not be considered a definitive, permanent description of the amount of groundwater that can be pumped to meet the adopted desired future condition. 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 future groundwater pumping as well as whether or not they are achieving their desired future conditions. Because of the limitations of the model and the assumptions in this analysis, it is important that the groundwater conservation districts work with the TWDB to refine the modeled available groundwater numbers given the reality of how the aquifer responds to the actual amount and location of pumping now and in the future.

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Mace, R.E., Chowdhury, A.H., Anaya, R., and Way, S-C., 2000, Groundwater availability of the Trinity Aquifer, Hill Country Area, Texas—Numerical simulations through 2050: Texas Water Development Board Report 353, 119 p.

Table 1. Modeled available groundwater for the Edwards Group of Edwards-Trinity (Plateau) Aquifer in Groundwater Management Area 9. Results are in acre-feet per year and are divided by county, regional water planning area, and river basin.

County	Regional Water Planning Area	River Basin	Year					
			2010	2020	2030	2040	2050	2060
Bandera	J	Guadalupe	21	21	21	21	21	21
		Nueces	101	101	101	101	101	101
		San Antonio	561	561	561	561	561	561
Kendall	L	Colorado	46	46	46	46	46	46
		Guadalupe	103	103	103	103	103	103
		San Antonio	169	169	169	169	169	169
Total			**1,001**	**1,001**	**1,001**	**1,001**	**1,001**	**1,001**

Table 2. Modeled available groundwater for the Edwards Group of Edwards-Trinity (Plateau) Aquifer in Groundwater Management Area 9. Results are in acre-feet per year and are summarized by county.

County	Year					
	2010	2020	2030	2040	2050	2060
Bandera	683	683	683	683	683	683
Kendall	318	318	318	318	318	318
Total	**1,001**	**1,001**	**1,001**	**1,001**	**1,001**	**1,001**

Table 3. Modeled available groundwater for the Edwards Group of Edwards-Trinity (Plateau) Aquifer in Groundwater Management Area 9. Results are in acre-feet per year and are summarized by regional water planning area.

Regional Water Planning Area	Year					
	2010	2020	2030	2040	2050	2060
J	683	683	683	683	683	683
L	318	318	318	318	318	318
Total	**1,001**	**1,001**	**1,001**	**1,001**	**1,001**	**1,001**

Table 4: Modeled available groundwater for the Edwards Group of Edwards-Trinity (Plateau) Aquifer in Groundwater Management Area 9. Results are in acre-feet per year and summarized by river basin.

River Basin	Year					
	2010	2020	2030	2040	2050	2060
Colorado	46	46	46	46	46	46
Guadalupe	124	124	124	124	124	124
Nueces	101	101	101	101	101	101
San Antonio	730	730	730	730	730	730
Total	**1,001**	**1,001**	**1,001**	**1,001**	**1,001**	**1,001**

Table 5: Modeled available groundwater for the Edwards Group of Edwards-Trinity (Plateau) Aquifer in Groundwater Management Area 9. Results are in acre-feet per year and summarized by groundwater conservation district (GCD). RA refers to River Authority. GWD refers to Groundwater District.

Groundwater Conservation District	Year					
	2010	2020	2030	2040	2050	2060
Bandera County RA & GWD	683	683	683	683	683	683
Cow Creek GCD	318	318	318	318	318	318
Total	**1,001**	**1,001**	**1,001**	**1,001**	**1,001**	**1,001**

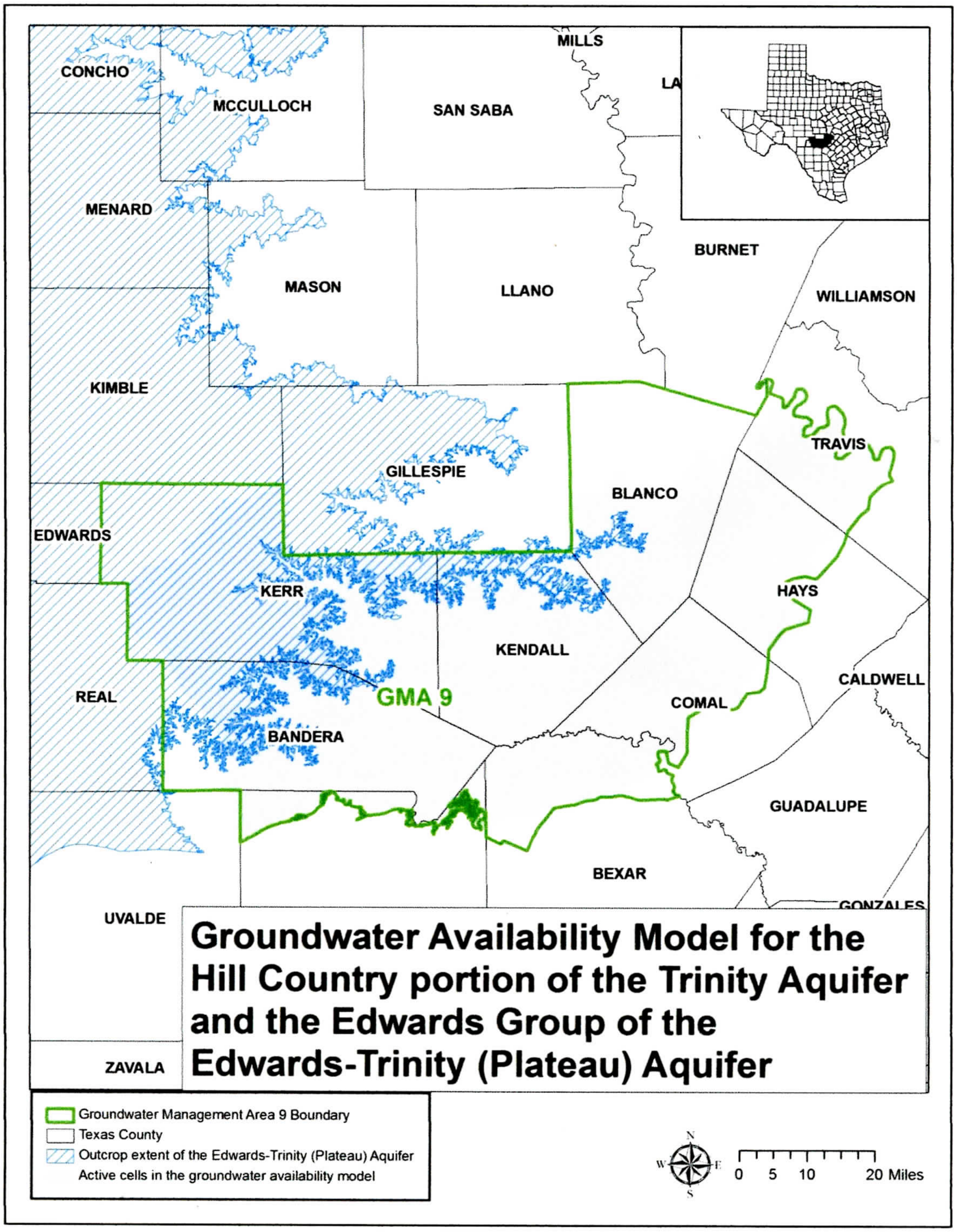


Figure 1: Map showing the areas covered by the groundwater availability model for the Hill Country portion of the Trinity Aquifer, which also contains the Edwards group of the Edwards-Trinity (Plateau) Aquifer.

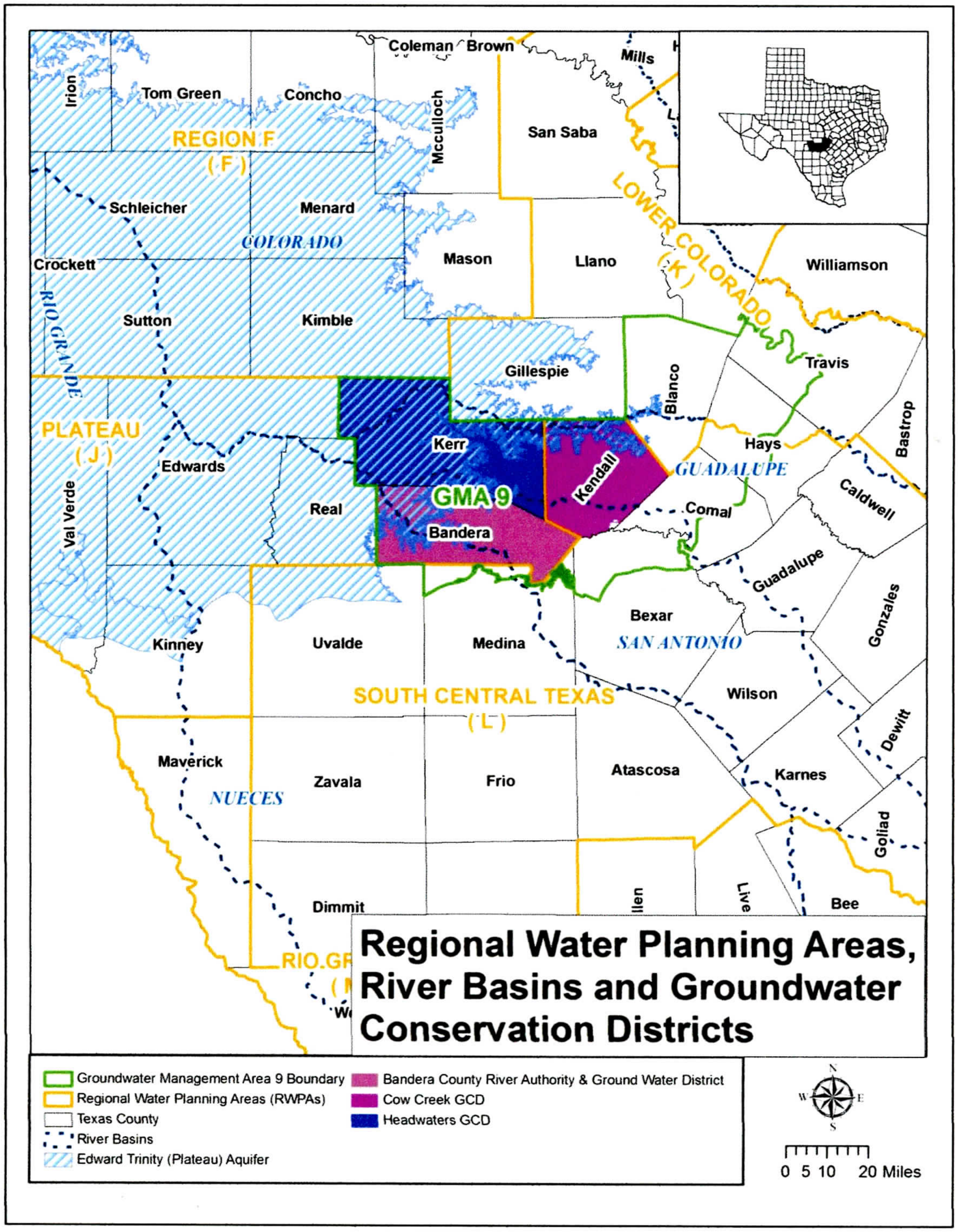


Figure 2: Map showing regional water planning areas (RWPAs), groundwater conservation districts (GCDs), counties, and river basins in Groundwater Management Area 9.

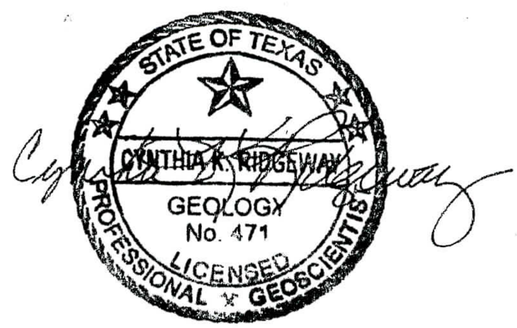
APPENDIX C

GAM Run 10-050 MAG version 2

By Mohammad Masud Hassan, P.E.

Edited and finalized by Radu Boghici to reflect statutory changes effective September 1, 2011

Texas Water Development Board
Groundwater Availability Modeling Section
(512) 463-5808
March 30, 2012



Cynthia K. Ridgeway, the Manager of the Groundwater Availability Modeling Section is responsible for oversight of work performed by employees under her direct supervision. The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G. 471 on March 30, 2012

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EXECUTIVE SUMMARY:

The modeled available groundwater for the Trinity Aquifer as a result of the desired future condition adopted by the members of Groundwater Management Area 9 declines from approximately 93,000 acre-feet per year to approximately 90,500 acre-feet per year between 2010 and 2060. This is shown divided by county, regional water planning area, and river basin in Table 1 for use in the regional water planning process. Modeled available groundwater is summarized by county, regional water planning area, river basin, and groundwater conservation district in tables 2 though 5. The estimates were extracted from Scenario 6 of Groundwater Availability Modeling Task 10-005 (Hutchison, 2010), which meets the desired future condition adopted by the members of Groundwater Management Area 9.

REQUESTOR:

Mr. Ronald G. Fieseler of the Blanco Pedernales Groundwater Conservation District on behalf of Groundwater Management Area 9

DESCRIPTION OF REQUEST:

In a letter dated August 26, 2010 and received August 30, 2010, Mr. Ronald G. Fieseler provided the Texas Water Development Board (TWDB) with the desired future condition of the Trinity Aquifer adopted by the members of Groundwater Management Area 9. The desired future condition for the Trinity Aquifer in Groundwater Management Area 9, as described in Resolution No. 07-26-10-1, is:

"Hill Country Trinity Aquifer - allow for an increase in average drawdown of approximately 30 feet through 2060 consistent with "Scenario 6" in TWDB Draft GAM Task 10-005"

The TWDB has used this adopted desired future condition to estimate the modeled available groundwater for the Trinity Aquifer for each groundwater conservation district within Groundwater Management Area 9.

METHODS:

The TWDB previously completed several predictive groundwater availability model simulations of the Trinity Aquifer to assist the members of Groundwater Management Area 9 in developing a desired future condition. The location of Groundwater Management Area 9, the Trinity Aquifer, and the groundwater availability model cells that represent the aquifer are shown in Figure 1. As stated in Resolution No. 07-26-10-1, the management area considered Groundwater Availability Modeling (GAM) Task 10-005 (Hutchison, 2010) when developing a desired future condition for the Trinity Aquifer. Since the desired future condition above is met in Scenario 6 of GAM Task 10-005, the modeled available groundwater for Groundwater Management Area 9 presented here was taken directly from that simulation. Please note that in GAM Task 10-005 the pumping was presented as an average of all years (2010 to 2060). We have reported this pumping by decade in the results shown in tables 1-5. The modeled available groundwater was then divided by county, regional water planning area, river basin, and groundwater conservation district (Figure 2).

PARAMETERS AND ASSUMPTIONS:

The parameters and assumptions for the model run using the groundwater availability model for the Trinity Aquifer are described below:

- The results 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.
- The recently updated groundwater availability model (version 2.01) for the Hill Country portion of the Trinity Aquifer developed by Jones and others (2009) was used for the simulations in GAM Task 10-005. See Mace and others (2000) and Jones and others (2009) for details on model construction, recharge, discharge, assumptions, and limitations.
- The model has four layers: Layer 1 represents the Edwards Group of the Edwards-Trinity (Plateau) Aquifer, Layer 2 represents the Upper Trinity Aquifer, Layer 3 represents the Middle Trinity Aquifer, and Layer 4 represents the Lower Trinity Aquifer. 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. The results below represent the average pumping for the year shown among the simulations comprising Scenario 6 in Hutchison (2010).

Modeled Available Groundwater and Permitting

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. This is distinct from "managed available groundwater", shown in the draft version of this report dated December 1, 2010, which was a permitting value, and accounted for the estimated use of the aquifer exempt from permitting.

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 the 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 estimated amount of pumping exempt from permitting, which the Texas Water Development Board is now required to develop after soliciting input from applicable groundwater conservation districts, will be provided in a separate report.

RESULTS:

The modeled available groundwater for the Trinity Aquifer in Groundwater Management Area 9 consistent with the desired future condition decreases from 93,052 acre-feet per year in 2010 to 90,503 acre-feet per year in 2060. The modeled available groundwater has been divided by county, regional water planning area, and river basin for each decade between 2010 and 2060 for use in the regional water planning process (Table 1).

The modeled available groundwater is also summarized by county, regional water planning area, river basin, and groundwater conservation district as shown in tables 2, 3, 4, and 5, respectively. In Table 5, note that modeled available groundwater is totaled for both groundwater conservation district areas and areas without groundwater conservation districts.

REFERENCES:

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

Jones, I.C., Anaya, R. and Wade, S., 2009, Groundwater Availability Model for the Hill Country portion of the Trinity Aquifer System, Texas, Texas Water Development Board unpublished report,193 p.

Mace, R.E., Chowdhury, A.H., Anaya, R., and Way, S-C., 2000, Groundwater availability of the Trinity Aquifer, Hill Country Area, Texas—Numerical simulations through 2050: Texas Water Development Board Report 353, 119 p.

TABLE 1. MODELED AVAILABLE GROUNDWATER FOR THE TRINITY AQUIFER IN GROUNDWATER MANAGEMENT AREA 9 DIVIDED BY COUNTY, REGIONAL WATER PLANNING AREA, AND RIVER BASIN. RESULTS ARE IN ACRE-FEET PER YEAR.

County	Regional Water Planning Area	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
Bexar	L	San Antonio	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
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
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
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
Kerr	J	Colorado	318	318	318	318	318	318
		Guadalupe	15,646	14,129	14,056	13,767	13,450	13,434
		Nueces	0	0	0	0	0	0
		San Antonio	471	471	471	471	471	471
Medina	L	Nueces	1,575	1,575	1,575	1,575	1,575	1,575
		San Antonio	925	925	925	925	925	925
Travis	K	Colorado	8,920	8,672	8,655	8,643	8,627	8,598
Total			**93,052**	**91,276**	**91,183**	**90,881**	**90,548**	**90,503**

TABLE 2: MODELED AVAILABLE GROUNDWATER FOR THE TRINITY AQUIFER SUMMARIZED BY COUNTY IN GROUNDWATER MANAGEMENT AREA 9 FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR.

County	Year					
	2010	2020	2030	2040	2050	2060
Bandera	7,284	7,284	7,284	7,284	7,284	7,284
Bexar	24,856	24,856	24,856	24,856	24,856	24,856
Blanco	2,573	2,573	2,573	2,573	2,573	2,573
Comal	10,214	10,214	10,214	10,214	10,214	10,214
Hays	9,131	9,120	9,117	9,116	9,116	9,116
Kendall	11,139	11,139	11,139	11,139	11,139	11,139
Kerr	16,435	14,918	14,845	14,556	14,239	14,223
Medina	2,500	2,500	2,500	2,500	2,500	2,500
Travis	8,920	8,672	8,655	8,643	8,627	8,598
Total	**93,052**	**91,276**	**91,183**	**90,881**	**90,548**	**90,503**

TABLE 3: MODELED AVAILABLE GROUNDWATER FOR THE TRINITY AQUIFER SUMMARIZED BY REGIONAL WATER PLANNING AREA IN GROUNDWATER MANAGEMENT AREA 9 FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR.

Regional Water Planning Area	Year					
	2010	2020	2030	2040	2050	2060
J	23,719	22,202	22,129	21,840	21,523	21,507
K	16,214	15,955	15,935	15,922	15,906	15,877
L	53,119	53,119	53,119	53,119	53,119	53,119
Total	**93,052**	**91,276**	**91,183**	**90,881**	**90,548**	**90,503**

TABLE 4: MODELED AVAILABLE GROUNDWATER FOR THE TRINITY AQUIFER SUMMARIZED BY RIVER BASIN IN GROUNDWATER MANAGEMENT AREA 9 FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR.

River Basin	Year					
	2010	2020	2030	2040	2050	2060
Colorado	15,416	15,157	15,137	15,124	15,108	15,079
Guadalupe	34,317	32,800	32,727	32,438	32,121	32,105
Nueces	2,478	2,478	2,478	2,478	2,478	2,478
San Antonio	40,841	40,841	40,841	40,841	40,841	40,841
Total	**93,052**	**91,276**	**91,183**	**90,881**	**90,548**	**90,503**

TABLE 5: MODELED AVAILABLE GROUNDWATER FOR THE TRINITY AQUIFER SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) IN GROUNDWATER MANAGEMENT AREA 9 FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR. RA REFERS TO RIVER AUTHORITY. GWD REFERS TO GROUNDWATER DISTRICT.

Groundwater Conservation District	**Year**					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Bandera County RA & GWD	7,284	7,284	7,284	7,284	7,284	7,284
Blanco-Pedernales GCD	2,573	2,573	2,573	2,573	2,573	2,573
Cow Creek GCD	10,622	10,622	10,622	10,622	10,622	10,622
Hays Trinity GCD	9,109	9,098	9,095	9,094	9,094	9,094
Headwaters GCD	16,435	14,918	14,845	14,556	14,239	14,223
Medina County GCD	2,500	2,500	2,500	2,500	2,500	2,500
Trinity Glen Rose GCD	25,511	25,511	25,511	25,511	25,511	25,511
Total (district areas)	**74,034**	**72,506**	**72,430**	**72,140**	**71,823**	**71,807**
No District	19,018	18,770	18,753	18,741	18,725	18,696
Total (including non-district areas)	**93,052**	**91,276**	**91,183**	**90,881**	**90,548**	**90,503**

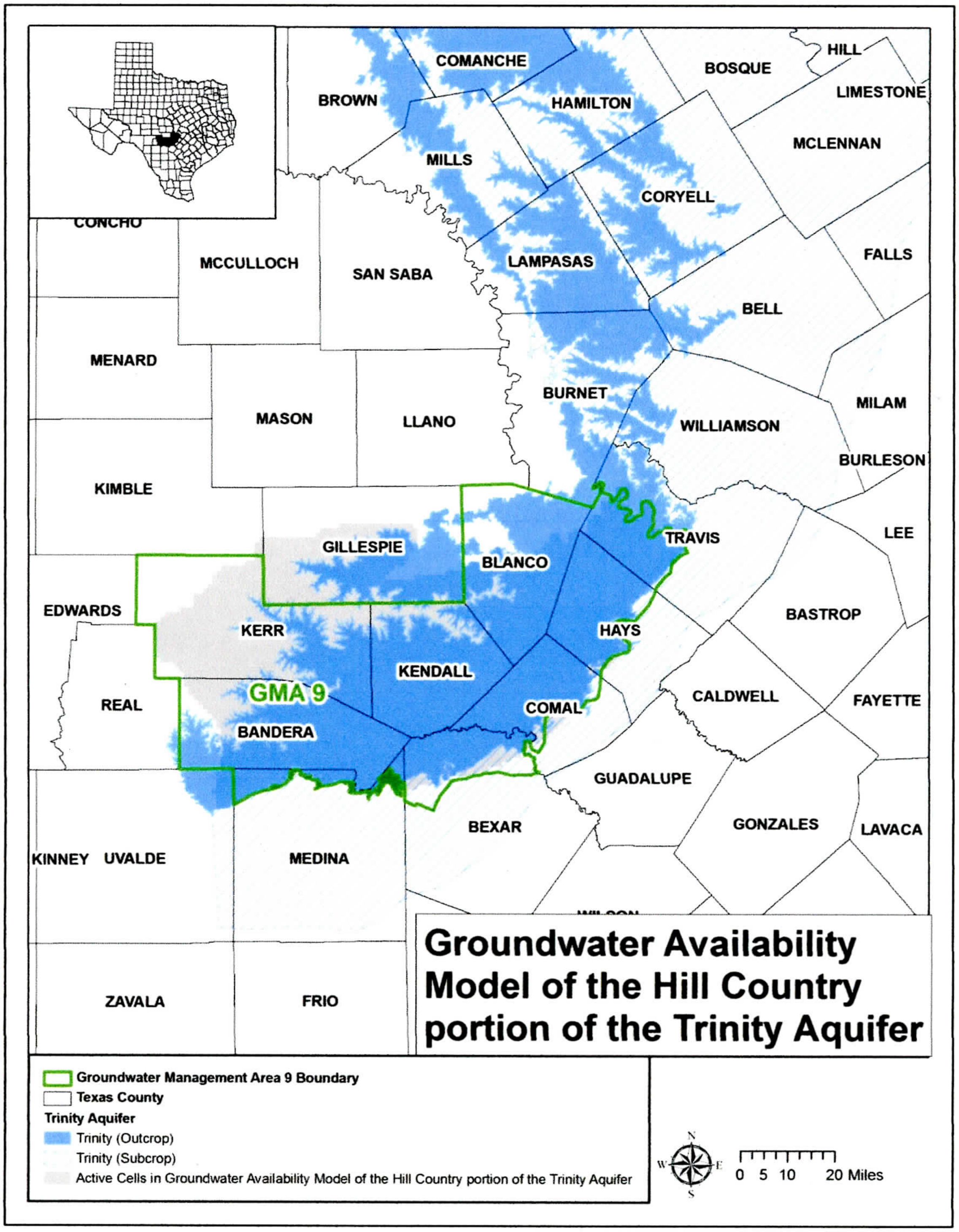

Figure 1: Map showing the areas covered by the groundwater availability model for the Trinity Aquifer.

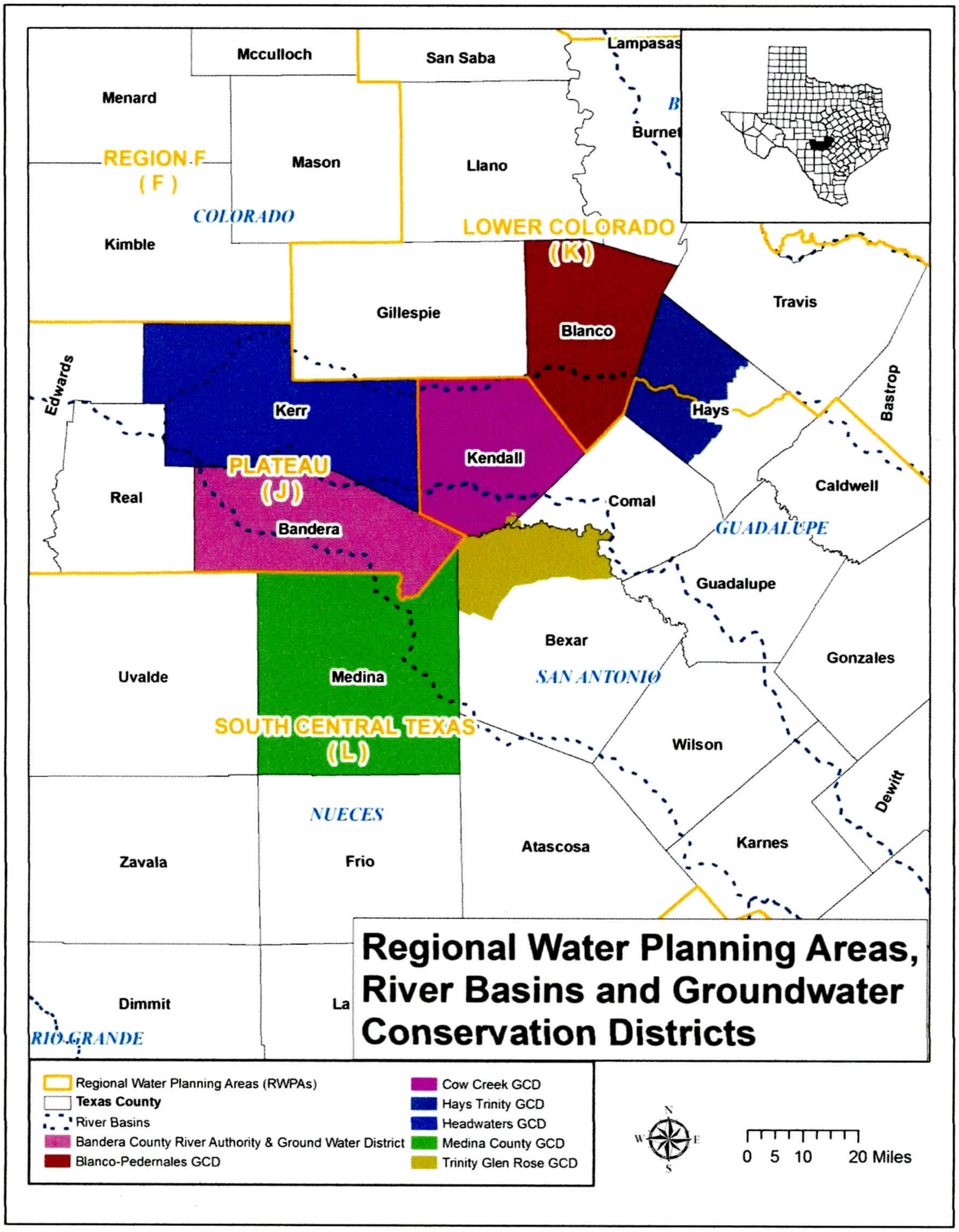

Figure 2: Map showing regional water planning areas (RWPAs), groundwater conservation districts (GCDs), counties, and river basins in Groundwater Management Area 9.

APPENDIX D

Estimated Historical Water Use And 2012 State Water Plan Datasets:

Bandera County River Authority And Ground Water District

by Stephen Allen
Texas Water Development Board
Groundwater Resources Division
Groundwater Technical Assistance Section
stephen.allen@twdb.texas.gov
(512) 463-7317
March 5, 2013

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.state.tx.us/groundwater/docs/GCD/GMPchecklist0113.pdf

The five reports included in part 1 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)

   reports 2-5 are from the 2012 State Water Plan (SWP)

Part 2 of the 2-part package is the groundwater availability model (GAM) report. 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.

Estimated Historical Water Use And 2012 State Water Plan Datasets:

Bandera County River Authority And Ground Water District

by Stephen Allen
Texas Water Development Board
Groundwater Resources Division
Groundwater Technical Assistance Section
stephen.allen@twdb.texas.gov
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March 5, 2013

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DISCLAIMER:

The data presented in this report represents the most updated Historical Water Use and 2012 State Water Planning data available as of 3/5/2013. Although it does not happen frequently, neither of these datasets are static and are subject to change pending the availability of more accurate data (Historical Water Use data) or an amendment to the 2012 State Water Plan (2012 State Water Planning data). District personnel must review these datasets and correct any discrepancies in order to ensure approval of their groundwater management plan.

The Historical Water Use dataset can be verified at this web address:

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

The 2012 State Water Planning dataset can be verified by contacting Wendy Barron (wendy.barron@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) or Rima Petrossian (rima.petrossian@twdb.texas.gov or 512-936-2420).

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

Groundwater and surface water historical use estimates are currently unavailable for calendar years 2005, 2011 and 2012. TWDB staff anticipates the calculation and posting of these estimates at a later date.

BANDERA COUNTY

All values are in acre-feet/year

Year	Source	Municipal	Manufacturing	Steam Electric	Irrigation	Mining	Livestock	Total
1974	GW	932	291	0	36	4	427	1,690
	SW	0	0	0	59	0	0	59
1980	GW	910	8	0	99	0	303	1,320
	SW	0	0	0	439	0	73	512
1984	GW	1,162	0	0	61	24	256	1,503
	SW	10	0	0	108	0	63	181
1985	GW	1,152	0	0	89	24	229	1,494
	SW	18	0	0	160	0	55	233
1986	GW	1,212	0	0	108	0	213	1,533
	SW	15	0	0	192	0	52	259
1987	GW	1,225	0	0	162	20	228	1,635
	SW	18	0	0	288	0	55	361
1988	GW	1,298	0	0	162	21	265	1,746
	SW	28	0	0	288	0	66	382
1989	GW	1,398	0	0	133	20	262	1,813
	SW	53	0	0	122	0	65	240
1990	GW	1,417	0	0	151	20	260	1,848
	SW	28	0	0	139	0	65	232
1991	GW	1,463	0	0	151	23	267	1,904
	SW	16	9	0	139	0	66	230
1992	GW	1,390	12	0	151	23	267	1,843
	SW	30	23	0	139	0	66	258
1993	GW	1,564	3	0	290	23	250	2,130
	SW	58	0	0	219	0	62	339
1994	GW	1,702	0	0	279	23	289	2,293
	SW	52	0	0	154	0	72	278
1995	GW	1,758	0	0	250	23	290	2,321
	SW	58	0	0	189	0	72	319
1996	GW	1,855	0	0	265	23	235	2,378
	SW	67	0	0	200	0	59	326
1997	GW	1,875	0	0	265	23	220	2,383

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

Groundwater and surface water historical use estimates are currently unavailable for calendar years 2005, 2011 and 2012. TWDB staff anticipates the calculation and posting of these estimates at a later date.

Year	Source	Municipal	Manufacturing	Steam Electric	Irrigation	Mining	Livestock	Total
1997	SW	90	0	0	200	0	55	345
1998	GW	2,065	0	0	279	23	230	2,597
	SW	84	0	0	185	0	58	327
1999	GW	1,998	0	0	279	23	277	2,577
	SW	91	0	0	185	0	69	345
2000	GW	2,053	0	0	325	23	252	2,653
	SW	101	0	0	278	0	63	442
2001	GW	1,797	0	0	263	23	141	2,224
	SW	223	0	0	224	0	173	620
2002	GW	1,991	0	0	263	23	125	2,402
	SW	249	0	0	224	0	153	626
2003	GW	2,474	0	0	161	23	108	2,766
	SW	313	0	0	8	0	133	454
2004	GW	1,680	0	0	266	23	114	2,083
	SW	207	0	0	5	0	139	351
2006	GW	2,231	0	0	284	0	197	2,712
	SW	0	0	0	0	0	66	66
2007	GW	2,231	0	0	365	0	209	2,805
	SW	0	0	0	0	0	70	70
2008	GW	2,660	0	0	374	0	184	3,218
	SW	0	0	0	0	0	61	61
2009	GW	2,590	0	0	888	0	196	3,674
	SW	0	0	0	0	0	66	66
2010	GW	2,600	0	0	887	0	224	3,711
	SW	0	0	0	0	0	73	73

Projected Surface Water Supplies
TWDB 2012 State Water Plan Data

BANDERA COUNTY

All values are in acre-feet/year

RWPG	WUG	WUG Basin	Source Name	2010	2020	2030	2040	2050	2060
J	COUNTY-OTHER	NUECES	SABINAL RIVER COMBINED RUN-OF-RIVER	2	2	2	2	2	2
J	COUNTY-OTHER	SAN ANTONIO	MEDINA RIVER COMBINED RUN-OF-RIVER	0	0	0	0	0	0
J	IRRIGATION	NUECES	HONDO CREEK RUN-OF-RIVER	20	20	20	20	20	20
J	IRRIGATION	NUECES	SABINAL RIVER COMBINED RUN-OF-RIVER	5	5	5	5	5	5
J	IRRIGATION	SAN ANTONIO	MEDINA RIVER COMBINED RUN-OF-RIVER	0	0	0	0	0	0
J	LIVESTOCK	SAN ANTONIO	OTHER LOCAL SUPPLY	72	72	72	72	72	72
	Sum of Projected Surface Water Supplies (acre-feet/year)			**99**	**99**	**99**	**99**	**99**	**99**

Projected Water Demands
TWDB 2012 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/year

RWPG	WUG	WUG Basin	2010	2020	2030	2040	2050	2060
J	COUNTY-OTHER	GUADALUPE	1	2	2	3	3	3
J	LIVESTOCK	GUADALUPE	6	6	6	6	6	6
J	COUNTY-OTHER	NUECES	183	255	327	386	439	491
J	IRRIGATION	NUECES	181	181	181	181	181	181
J	LIVESTOCK	NUECES	91	91	91	91	91	91
J	COUNTY-OTHER	SAN ANTONIO	2,425	3,381	4,330	4,817	4,932	5,232
J	BANDERA	SAN ANTONIO	259	284	312	332	351	371
J	MINING	SAN ANTONIO	24	24	24	24	24	24
J	IRRIGATION	SAN ANTONIO	283	283	283	283	283	283
J	LIVESTOCK	SAN ANTONIO	218	218	218	218	218	218
	Sum of Projected Water Demands (acre-feet/year)		**3,671**	**4,725**	**5,774**	**6,341**	**6,528**	**6,900**

Projected Water Supply Needs
TWDB 2012 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/year

RWPG	WUG	WUG Basin	2010	2020	2030	2040	2050	2060
J	BANDERA	SAN ANTONIO	951	926	898	878	859	839
J	COUNTY-OTHER	GUADALUPE	30	29	29	28	28	28
J	COUNTY-OTHER	NUECES	623	551	479	420	367	315
J	COUNTY-OTHER	SAN ANTONIO	8,248	7,292	6,343	5,856	5,741	5,441
J	IRRIGATION	NUECES	0	0	0	0	0	0
J	IRRIGATION	SAN ANTONIO	0	0	0	0	0	0
J	LIVESTOCK	GUADALUPE	0	0	0	0	0	0
J	LIVESTOCK	NUECES	4	4	4	4	4	4
J	LIVESTOCK	SAN ANTONIO	44	44	44	44	44	44
J	MINING	SAN ANTONIO	0	0	0	0	0	0
	Sum of Projected Water Supply Needs (acre-feet/year)		**0**	**0**	**0**	**0**	**0**	**0**

Projected Water Management Strategies
TWDB 2012 State Water Plan Data

BANDERA COUNTY

WUG, Basin (RWPG)

All values are in acre-feet/year

Water Management Strategy	Source Name [Origin]	2010	2020	2030	2040	2050	2060
BANDERA, SAN ANTONIO (J)							
CONSERVATION: PUBLIC INFORMATION	CONSERVATION [BANDERA]	3	3	3	3	4	4
SURFACE WATER ACQUISITION, TREATMENT AND ASR	MEDINA RIVER COMBINED RUN-OF-RIVER [BANDERA]	0	500	500	1,000	1,000	1,500
Sum of Projected Water Management Strategies (acre-feet/year)		**3**	**503**	**503**	**1,003**	**1,004**	**1,504**

APPENDIX E

GAM RUN 12-009: BANDERA COUNTY RIVER AUTHORITY AND GROUND WATER DISTRICT MANAGEMENT PLAN

by Ian C. Jones, Ph.D., P.G.
Texas Water Development Board
Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 463-6641
July 20, 2012

STATE OF TEXAS
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GEOLOGY
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The seal appearing on this document was authorized by Ian C. Jones, Ph.D., P.G. 477 on July 20, 2012.

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EXECUTIVE SUMMARY:

Texas State Water Code, Section 36.1071, Subsection (h), states that, in developing its groundwater management plan, groundwater conservation districts shall use groundwater availability modeling information provided by the executive administrator of the Texas Water Development Board in conjunction with any available site-specific information provided by the district for review and comment to the executive administrator. Information derived from groundwater availability models that shall be included in 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 supersedes the revised Groundwater Availability Model (GAM) Run 08-68 (Aschenbach, 2010). The results presented in this report differ from those in GAM Run 08-68. In GAM Run 08-68 the water budgets represent groundwater flow through the model layers representing the Trinity and Edwards groups while in this report, the water budgets represent groundwater flow through the official aquifers in Bandera County River Authority and Ground Water District—the Edwards-Trinity (Plateau) and Trinity aquifers. The purpose of this report is to provide information to Bandera County River Authority and Ground Water District for its groundwater management plan. The groundwater management plan for Bandera County River Authority and Ground Water District is due for approval by the executive administrator of the Texas Water Development Board before June 21, 2015.

This report discusses the methods, assumptions, and results from model runs using a groundwater model for the Edwards-Trinity (Plateau) and Trinity aquifers. Tables 1 and 2 summarize the groundwater model data required by the statute, and figures 1 and 2 show the area of each model from which the values in the respective tables were extracted. If after review of the figures, Bandera County River Authority and Ground Water District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the Texas Water Development Board immediately.

METHODS:

A groundwater model for the Edwards-Trinity (Plateau) Aquifer that also includes the Hill Country portion of the Trinity Aquifer was run for this analysis. Water budgets for selected years of the transient model period were extracted using ZONEBUDGET Version 3.01 (Harbaugh, 2009) and the average annual water budget values for recharge, surface water outflow, inflow to the district, outflow from the district, net inter-aquifer flow for the portions of the aquifers located 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) Aquifer. See Anaya and Jones (2009) for assumptions and limitations of this model.
- The Edwards-Trinity (Plateau) Aquifer model includes two layers representing the Edwards Group and equivalent limestone hydrostratigraphic units (Layer 1) and the undifferentiated Trinity Group hydrostratigraphic units (Layer 2) in the district.
- The root mean square error (a measure of the difference between simulated and actual water levels during model calibration) of the Edwards-Trinity (Plateau) groundwater availability model for the period of 1980 to 2000 is

143 feet, or six percent of the range of measured water levels (Anaya and Jones, 2009).

- We elected to use the groundwater availability model for the Edwards-Trinity (Plateau) Aquifer instead of the groundwater availability model for the Hill Country portion of the Trinity Aquifer because the model for the Edwards-Trinity (Plateau) Aquifer covers the entire district. Because the two models are aligned in slightly different orientations, we could not combine the results from each without either double accounting or omitting important information.

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

RESULTS:

A groundwater budget summarizes the amount of water entering and leaving the aquifer according to the groundwater availability model. Selected components were extracted from the groundwater budget for the aquifers located within the district and averaged over the duration of the calibration and verification portion of the model runs in the district, as shown in tables 1 and 2. The components of the modified budget shown in tables 1 and 2 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 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 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 district or county boundaries, is assigned to one side of the boundary based on the location of the centroid of the model cell. For example, if a cell contains two counties, the cell is assigned to the county where the centroid of the cell is located (see figures 1 and 2).

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 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 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.

TABLE 1: SUMMARIZED INFORMATION FOR THE EDWARD-TRINITY (PLATEAU) AQUIFER THAT IS NEEDED FOR BANDERA COUNTY RIVER AUTHORITY AND GROUND WATER DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	*Aquifer or confining unit*	*Results*
Estimated annual amount of recharge from precipitation to the district	Edwards-Trinity (Plateau) Aquifer	2,524
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	1,377
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	9,516
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	12,319
Estimated net annual volume of flow between each aquifer in the district	From the Edwards-Trinity (Plateau) Aquifer to the Trinity Aquifer	332

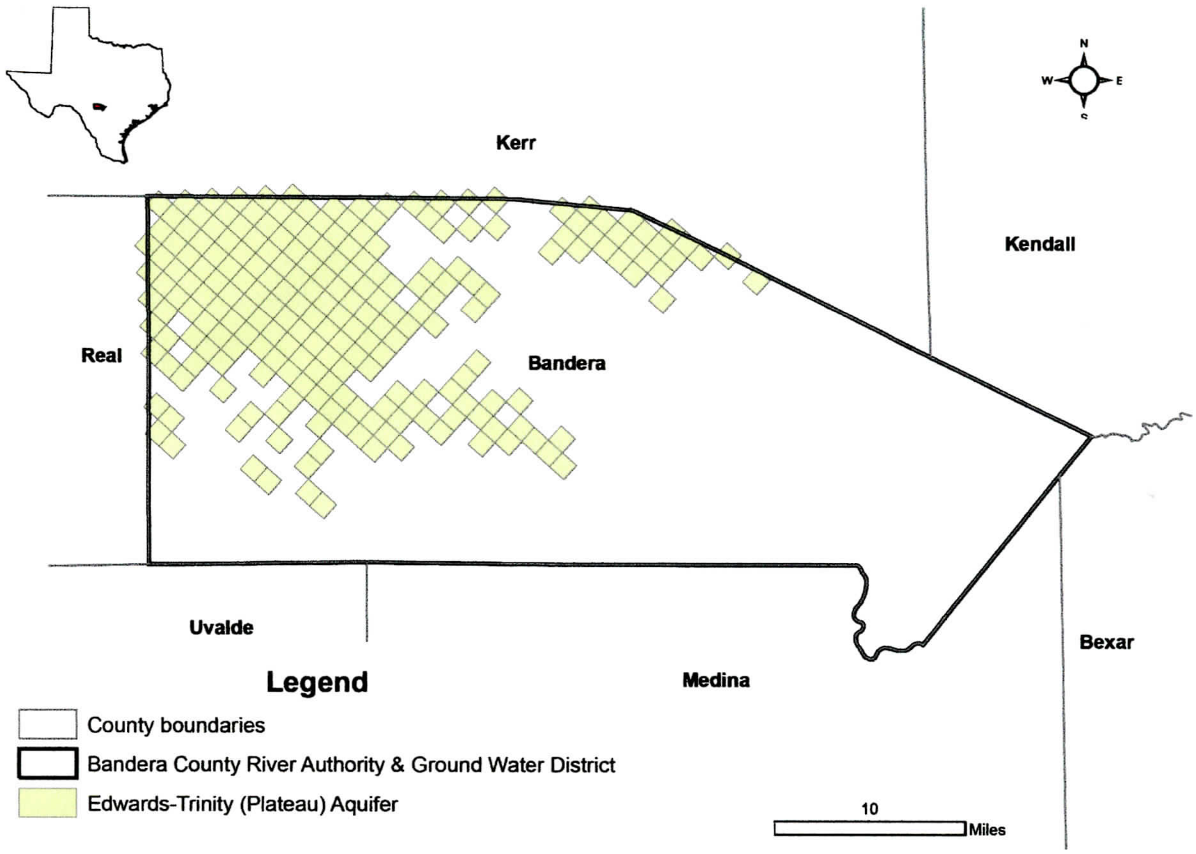

FIGURE 1: AREA OF THE GROUNDWATER MODEL FOR THE EDWARD-TRINITY (PLATEAU) AQUIFER FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

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

Management Plan requirement	*Aquifer or confining unit*	*Results*
Estimated annual amount of recharge from precipitation to the district	Trinity Aquifer	23,480
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Trinity Aquifer	17,781
Estimated annual volume of flow into the district within each aquifer in the district	Trinity Aquifer	20,094
Estimated annual volume of flow out of the district within each aquifer in the district	Trinity Aquifer	24,360
Estimated net annual volume of flow between each aquifer in the district	From the Edwards-Trinity (Plateau) Aquifer to the Trinity Aquifer	332

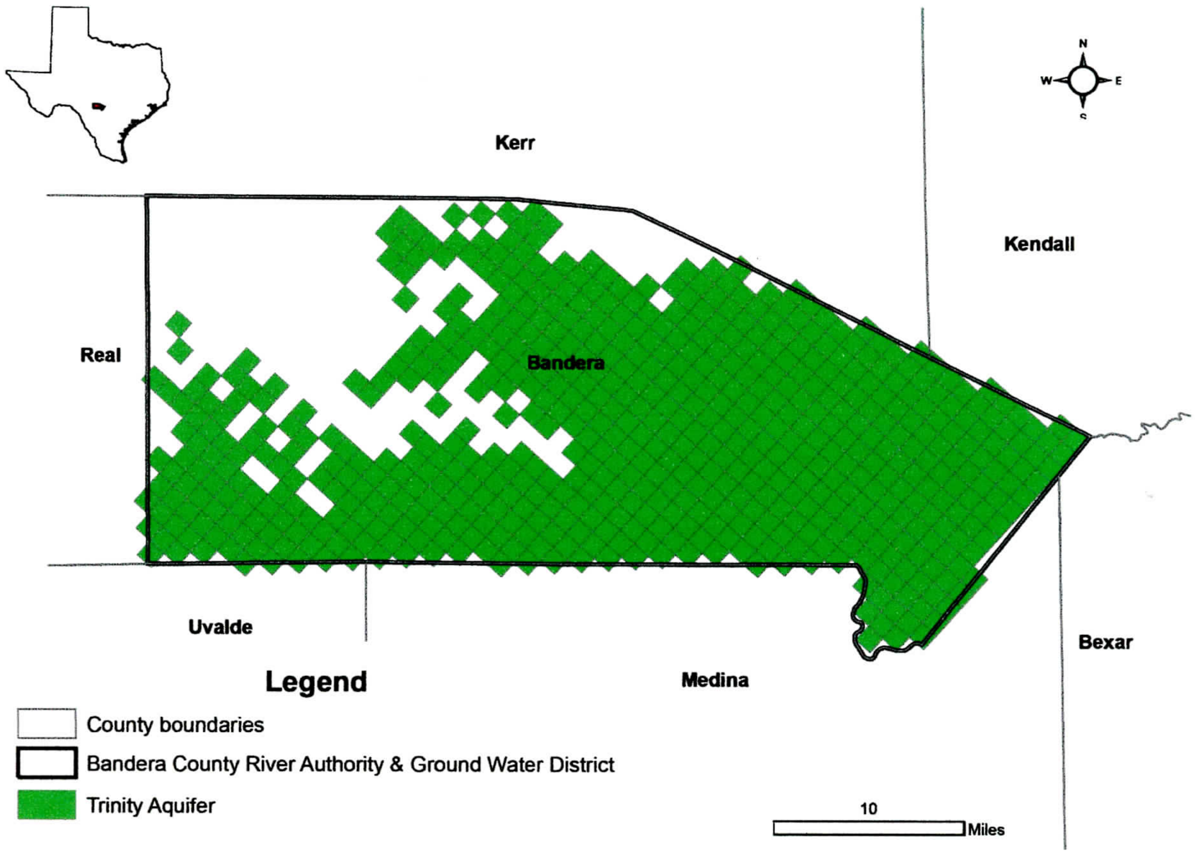

FIGURE 2: AREA OF THE GROUNDWATER MODEL FOR THE TRINITY AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

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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.

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