Medina County Groundwater Conservation District
Groundwater Management Plan

Adopted February 17, 2016

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Medina County
Groundwater Conservation District
Management Plan

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Medina County Groundwater conservation District Background

District Mission

The Medina County Groundwater Conservation District (GCD) strives to achieve conservation, preservation, and the efficient, beneficial, and wise use of water for the benefit of the citizens and economy of Medina County.

About the District

The District has the same boundaries as the County of Medina. The Medina County Commissioners Court originally created the District on July 17, 1989, following the petition process. Confirmation and election of permanent directors was held on November 11, 1989. The District was then validated by Act of the legislature under Section 59, Article 16, of the Texas Constitution. The District was validated by the 72nd Legislature in 1991, Senate Bill 1058.

The District Board of Directors is composed of five members elected to staggered four-year terms. Elections for Directors are held in November. A director is elected from each of the county precincts and one Director is elected from the County at-large. The Board of Directors holds regular monthly meetings at the District offices located at 1607 Ave. K, Hondo, Texas. Meetings of the Board of Directors are public meetings noticed and held in accordance with public meeting requirements.

Since the creation of the Edwards Aquifer Authority, the District's jurisdiction is limited to those aquifers other than the Edwards aquifer found in Medina County. The District revised its programs and rules to reflect these changes. The Edwards Aquifer continues to be the major source of water for the citizens of Medina County and therefore information, education, and coordination between the District and the Edwards Aquifer Authority remains a priority to the District Board of Directors.

With pumping limitations now in effect for the Edwards Aquifer, the other aquifers within Medina County are becoming a supplemental supply. The District anticipates demand increasing in these aquifers. Additional interest in aquifer storage and recovery projects also exists, as does the potential of transport of these groundwater resources outside the District boundaries.

The District is located in three Groundwater Management Areas (GMAs): 9, 10 and 13. Chapter 36 Texas Water Code requires the Medina County GCD to coordinate its management of groundwater with other GCDs in its GMAs. Medina County GCD is unique in that it is in three management areas requiring coordination with many other GCDs. Should the relevant GMA boundaries change, the District will adjust its coordination in accordance with that change.

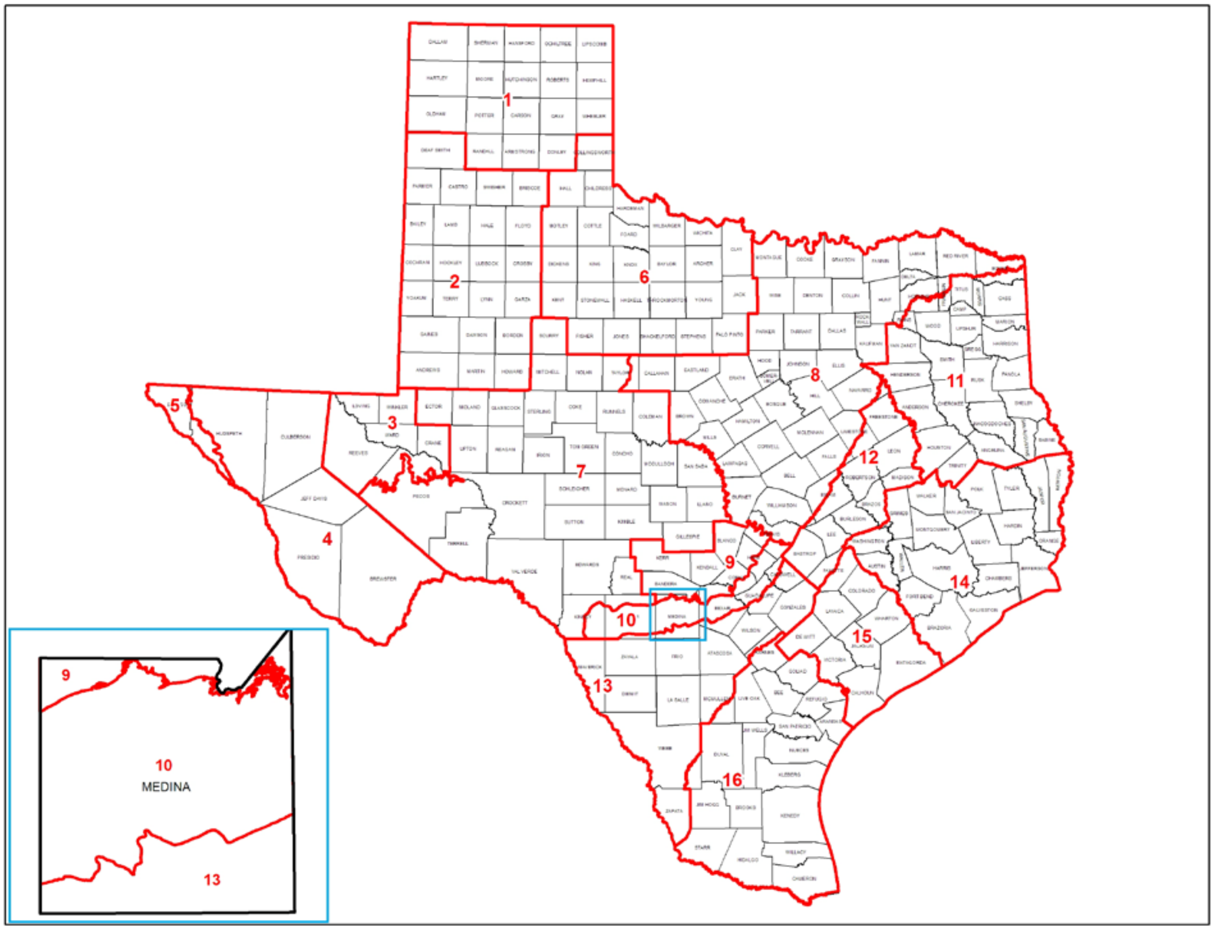


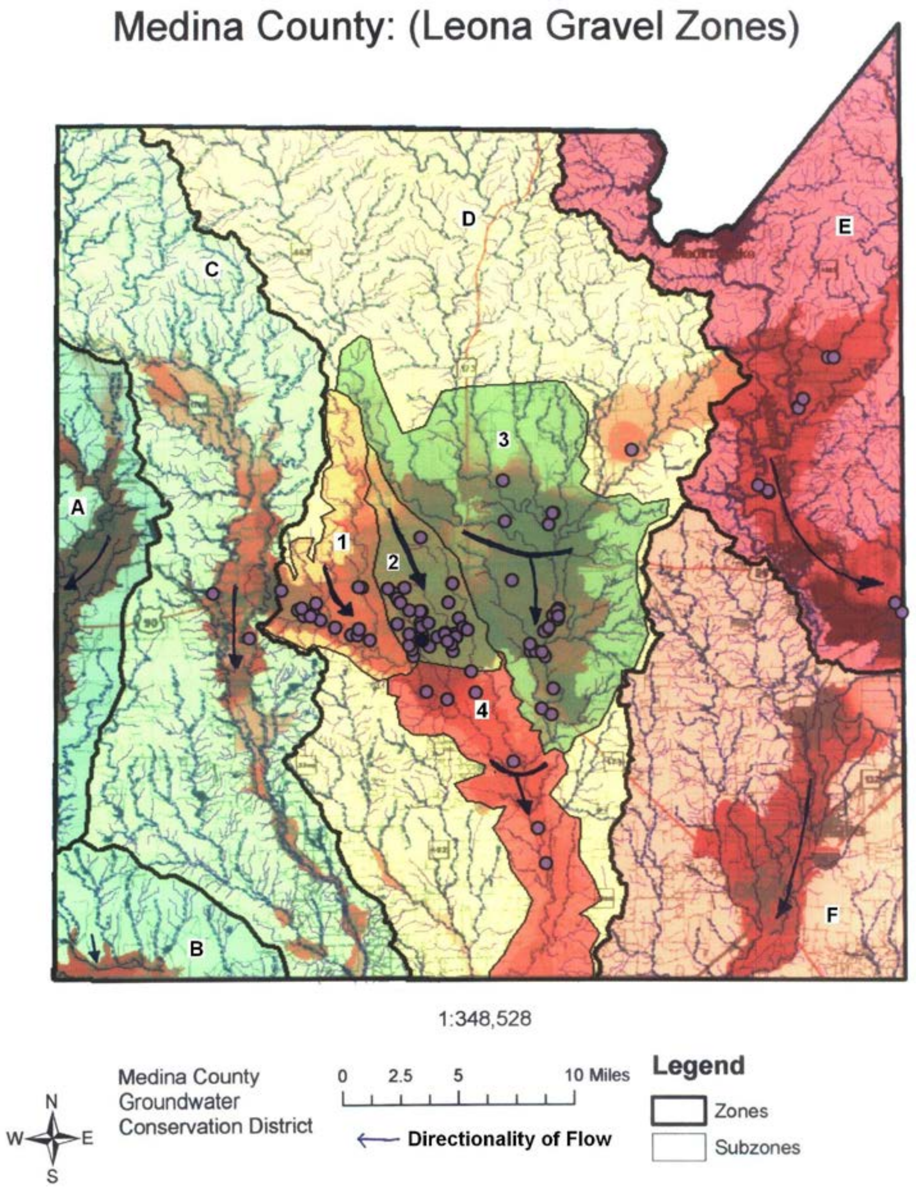
Figure 1. Groundwater Management Areas in Texas and Medina County

The District will coordinate with the GCDs and surface water management entities within Medina County by providing written notification via email or U.S. Postal Services when the Medina County GCD considers for revision and adoption by the Board of Directors the Groundwater Management Plan, Rules, and other policy related matters that impact the operation and management of the groundwater within Medina County. The other GCDs in the three GMAs, surface water management entities, and other interested parties are encouraged and invited to provide information and written or oral comments on issues of concern to them to the Medina County GCD Board of Directors. The District's standard practices will be used for posting public notice as established by the Board of Directors and in accordance with the Texas Open Meeting Acts and related requirements for GCDs in Texas.

Groundwater Resources of the District

The Aquifers within the jurisdiction of the District include the Carrizo-Wilcox, Trinity, Glen Rose, Leona Gravel, and Anacacho. Additional information on these aquifers is available from TWDB's Aquifers of Texas (Report 345, 1995). However, specific information on pumping, availability, and recharge are limited to the Carrizo-Wilcox and Trinity Aquifers. This plan, therefore, focuses on those aquifers.

Leona Gravel Aquifer



The dots on the depiction above are Leona gravel wells utilized for irrigation. The dark lines are ridgelines which separate the direction of runoff from rainfall (labeled zones A-F). The three areas encompassed by lighter lines are pools of Leona Gravel (labeled sub-zones 1-3) that seem to be separate from one another, but which join up in the fourth area south of them (labeled subzone 4). Interestingly, sub-zones 1 and 2 seem to have a very limited area where runoff recharges them.

The Leona Gravel Aquifer had been treated as one aquifer when it was in the desired future conditions process, but this treatment did not match up with the physical characteristics. As such, the Leona Gravel Aquifer in the District is managed locally. The Leona Gravel Aquifer did have a MAG, but given the physical separation between zones, and given actual pumping versus drawdown/recharge information and observations, the overall assumptions about the aquifer when developing the MAG seem insufficient as part of a management strategy. As such, the District needs to continue to study the aquifer and collect data in order to develop an understanding by which to generate a more sound management strategy.

Management Plan Purpose

Time Period for the Plan

This plan becomes effective upon adoption by the Board of Directors and will remain in effect for until a revised plan is approved by the Texas Water Development Board (TWDB) and adopted. The plan will be reviewed at least every five years.

Guiding Principles

The District recognizes that the groundwater resources of this region are of vital importance to the residents and that these resources must be managed effectively. A basic understanding of the aquifers and their hydrogeologic properties, as well as a quantification of resources is the foundation from which to build prudent planning measures. This management plan is intended as a tool to focus the programs and plans of the District.

Actions, Procedures, Performance, and Avoidance for Plan Implementation

In consideration of developing or implementing District rules, the District will take into account the need to afford each owner of groundwater in a common, subsurface reservoir a fair share. The District may deny a well construction permit or limit groundwater withdrawals in accordance with the guidelines stated in the rules of the District. In making a determination to deny a permit or limit groundwater withdrawals, the District will consider the public benefit against individual hardship after considering all appropriate testimony.

The District will use the Management Plan to guide the District in its efforts to preserve and protect the groundwater resources of Medina County and for determining the direction and priority of district activities. Operations of the District, agreements entered into by the District and planning efforts in which the District may participate will be consistent with the provisions of this plan.

Medina County GCD will implement the provisions of this management plan through the application of rules consistent with the management plan, using it as a guide to its principles and policies. Rules adopted by the District shall comply with Chapter 36 of the Texas Water Code and the provisions of this management plan. Promulgation and enforcement of the rules will be based on the best technical evidence available to the District. The District may amend the rules as necessary to insure the best management practices of the groundwater in the District and/or to comply with changes to Chapter 36 of the Texas Water Code. A copy of the District rules are available at the following website address: http://www.medinagwcd.org/information.htm.

The District will seek cooperation from municipalities, water supply companies, irrigators, and all other users of groundwater pumped in Medina County in the implementation of this plan and the management of groundwater supplies within the District. Medina County GCD also will seek to cooperate and coordinate with state and regional water planning authorities and agencies and adjacent groundwater conservation districts. Medina County GCD is committed to work and plan cooperatively with other GCDs in GMAs the GCD is a part of, currently GMA 9, GMA 10, and GMA 13. While managing the supply of groundwater within the district, Medina County GCD will account for the desired future conditions and modeled available groundwater derived from the planning process of GMAs the GCD are part of.

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

Methodology to Track District Progress in Achieving Management Goals
The General Manager of the District will prepare and present an annual report to the Board of Directors evaluating the impact of the District's activities on its goals, management objectives, and performance standards. The Annual Report will be presented 180 days following the completion of the District's fiscal year.

Technical Information Required by Texas Administrative Code

Estimated Modeled Available Groundwater in the District Based on the Desired Future Condition established under Section 36.108;

(in acre feet, per year)	MAG GMA 9	MAG GMA 10	MAG GMA 13	MAG Sum
Trinity	2,500	5,369		7,869
Leona Gravel		16,382	5,635	22,017
Carrizo-Wilcox			2,568	2,568
Totals	2,500	21,751	8,203	32,454

Please refer to Appendix A, Appendix B, Appendix C, Appendix D, and Appendix E

Amount of Groundwater Being Used Within the District on an Annual Basis
Please refer to Appendix G

Annual Amount of Recharge from Precipitation to the Groundwater Resources within the District
Please refer to Appendix F

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

Annual Volume of Flow into and out of the District within Each Aquifer and Between Aquifers in the District
Please refer to Appendix F

Projected Surface Water Supply in the District
Please refer to Appendix G

The Projected Total Demand for Water in the District
Please refer to Appendix G

Water Supply Needs
Please refer to Appendix G

Water Management Strategies
Please refer to Appendix G

<u>Management Goals</u>

(1) **Providing the Most Efficient Use of Groundwater**
   a. Objective: Develop and maintain a Water Well Permitting Program for tracking all permits authorizing water well operation and groundwater production.
   b. Performance Standard: Each year, after receiving all relevant Annual Use Surveys administered by the district, the District will summarize groundwater production from Operating Permits approved by Medina County GCD.

(2) **Controlling and Preventing Waste of Groundwater**
   a. Objective: Develop and maintain a Groundwater Conservation Education Program
   b. Performance Standard: Each year the District will summarize within the annual report the educational activities the District engages in which portend to controlling and preventing waste of groundwater.

(3) **Controlling and Preventing Subsidence**
   a. This goal is not applicable to the Medina County Groundwater Conservation District.

(4) **Conjunctive Surface Water Management Issues**
   a. Objective: Participate in the regional water planning process by attending at least one South Central Texas Regional Water Planning Group (Region L) meeting.
   b. Performance Standard: Report annually to the Board the attendees, dates and the number of meetings attended.

(5) **Natural Resource Issues**
   a. Objective: Develop and maintain a Well Monitoring Program.
   b. Performance Standard: Each year, the District will summarize within the annual report the monitoring activities including the number of wells monitored.

(6) **Drought Conditions**
   a. Objective: Drought can impact the availability of groundwater, and so must be considered in both long and short term availability strategies.
   b. Performance Standard: Each month, the District will download the updated National Oceanic and Atmospheric Administration (NOAA) U.S. Seasonal Drought Outlook map and check for periodic updates, as well as the Palmer Drought Severity Index (PDSI).

(7) **Conservation, Recharge Enhancement, Rainwater Harvesting, and Brush Control**
   a. Objective (Conservation): The District will submit at least one article regarding water conservation for publication each year to at least one newspaper of general circulation in Medina County.
   b. Performance Standard (Conservation): A copy of the article submitted will be included in the Annual Report given to the Board of Directors
   c. Objective (Recharge enhancement): The district will investigate methods for enhancing recharge.
   d. Performance Standard (Recharge enhancement): At least annually, the Board will be presented with information on potential recharge enhancement opportunities.
   e. Objective (Rainwater Harvesting): The District will provide information on rainwater harvesting each year.
   f. Performance Standard (Rainwater Harvesting): Each year the District will summarize within the annual report all efforts made in promoting rainwater harvesting including providing educational links to the district website and any other educational avenues.
   g. Objective (Precipitation Enhancement): Goals related to Precipitation Enhancement are not applicable to Medina County GCD.

h. Performance Standard (Precipitation Enhancement): Goals related to Precipitation Enhancement are not applicable to Medina County GCD.
i. Objective (Brush Control): The District will evaluate the State Brush Control Plan as it is revised from time to time at least once each year to determine whether projects within the District will increase the groundwater resources of the District.
j. Performance Standard (Brush Control): Upon review of a newly revised State Brush Control Plan, the District's Annual Report will include a copy of the most recent brush control information pertaining to the District.

(8) Addressing the Desired Future Conditions

a. Objective: The District will monitor water levels and evaluate whether the average change in water levels is in conformance with the DFC's adopted by the District. The District will estimate the total annual groundwater production for each aquifer based on water use reports, estimated exempt use and other relevant information and compare these production estimates to the MAG's.
b. Performance Standard: Each year the District will summarize within the annual report the monitoring activities including the number of wells monitored and the average annual change of water levels and compare them to the DFC's. The District will also record the estimated annual production from each aquifer and compare these amounts to the MAG. These production amounts will also be reported in the annual report.

List of Appendices

Appendix A - GTA Aquifer Assessment 10-07 MAG Leona Gravel Aquifer in Medina County Modeled Available Groundwater estimates, GMA 10

Appendix B - Aquifer Assessment 10-41 MAG: Aquifer Assessment for the Leona Gravel, GMA 13

Appendix C - Report GAM Run 10-050 MAG Version 2 Trinity aquifer, GMA 9

Appendix D - GTA Aquifer Assessment 10-29 MAG Trinity Aquifer, GMA 10

Appendix E - GAM Run 10-012 MAG: Modeled Available Groundwater for the Carrizo-Wilcox, Queen City, and Sparta Aquifers, GMA 13

Appendix F - GAM Run 15-002: Medina County Groundwater Conservation District Management Plan

Appendix G - Estimated Historical Water Use and 2012 State Water Plan Datasets: Medina County Groundwater Conservation District

Appendix H - Water Management Strategies from the 2012 State water Plan, Chapter 7

Appendix I - Additional Documentation

Appendix A
GTA Aquifer Assessment 10-07 MAG Leona Gravel Aquifer in Medina County Modeled Available Groundwater estimates, GMA 10

GTA Aquifer Assessment 10-07 MAG

by Robert G. Bradley
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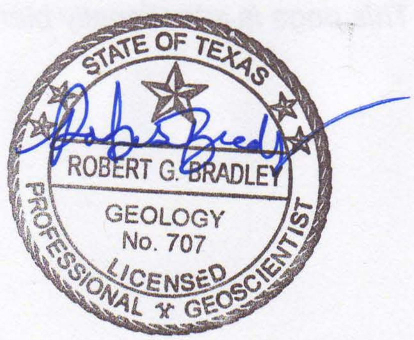
Groundwater Technical Assistance Section
(512) 936-0871



Robert G. Bradley, P.G. 707, authorized the seal appearing on this document on August 20, 2012.

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EXECUTIVE SUMMARY:

The estimated modeled available groundwater from the Leona Gravel Aquifer within Medina County that achieves the desired future condition adopted by members of Groundwater Management Area 10 is approximately 16,382 acre-feet per year and is summarized by county, regional water planning area, and river basin as shown in Table 1. The modeled available groundwater estimates were extracted from GTA Aquifer Assessment 09-01, which Groundwater Management Area 10 used as the basis for developing a desired future condition.

REQUESTOR:

Mr. Rick Illgner of the Edwards Aquifer Authority acting on behalf of the member groundwater conservation districts of Groundwater Management Area 10.

DESCRIPTION OF REQUEST:

In a letter received August 11, 2010, Mr. Rick Illgner provided the Texas Water Development Board (TWDB) with the desired future condition of Leona Gravel Aquifer within Medina County, adopted by the members of Groundwater Management Area 10. The desired future condition for the Leona Gravel Aquifer, as described in Resolution No. 2010-01 and adopted May 17, 2010 by the groundwater conservation districts in Groundwater Management Area 10 is summarized below:

> *An average annual drawdown of 15 feet over the next 50 years.*

In response to receiving the adopted desired future condition, TWDB has estimated the modeled available groundwater that achieves the above desired future condition for Groundwater Management Area 10.

METHODS:

Groundwater Management Area 10, located in South Central Texas, includes part of the Leona Gravel Aquifer (Figure 1). This is neither a major nor a minor aquifer, but has been determined to be locally relevant for joint planning purposes. At the request of Groundwater Management Area 10, the TWDB previously analyzed several water level decline scenarios for the Leona Gravel Aquifer, documented in GTA Aquifer Assessment 09-01.

One of the scenarios included the desired future condition of 15 feet of water level decline, and this was adopted as the desired future condition of the Leona Gravel Aquifer within Medina County for GMA 10.

The modeled available groundwater numbers are divided by regional water planning area and river basin. Medina County is completely within the South Central Regional Water Planning Area and the Medina County Groundwater Conservation District encompasses the whole county. Regional maps of these areas are shown in Figure 2.

PARAMETERS AND ASSUMPTIONS:

- Parameters, assumptions, volumetric calculations, and areas were obtained from GTA Aquifer Assessment 09-01 (George, 2010).
- Water-level declines of 15 feet were estimated to be uniform across the aquifer.

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 November 9, 2010, 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. The previous version of this report was completed prior to the readopting of the desired future conditions.

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.

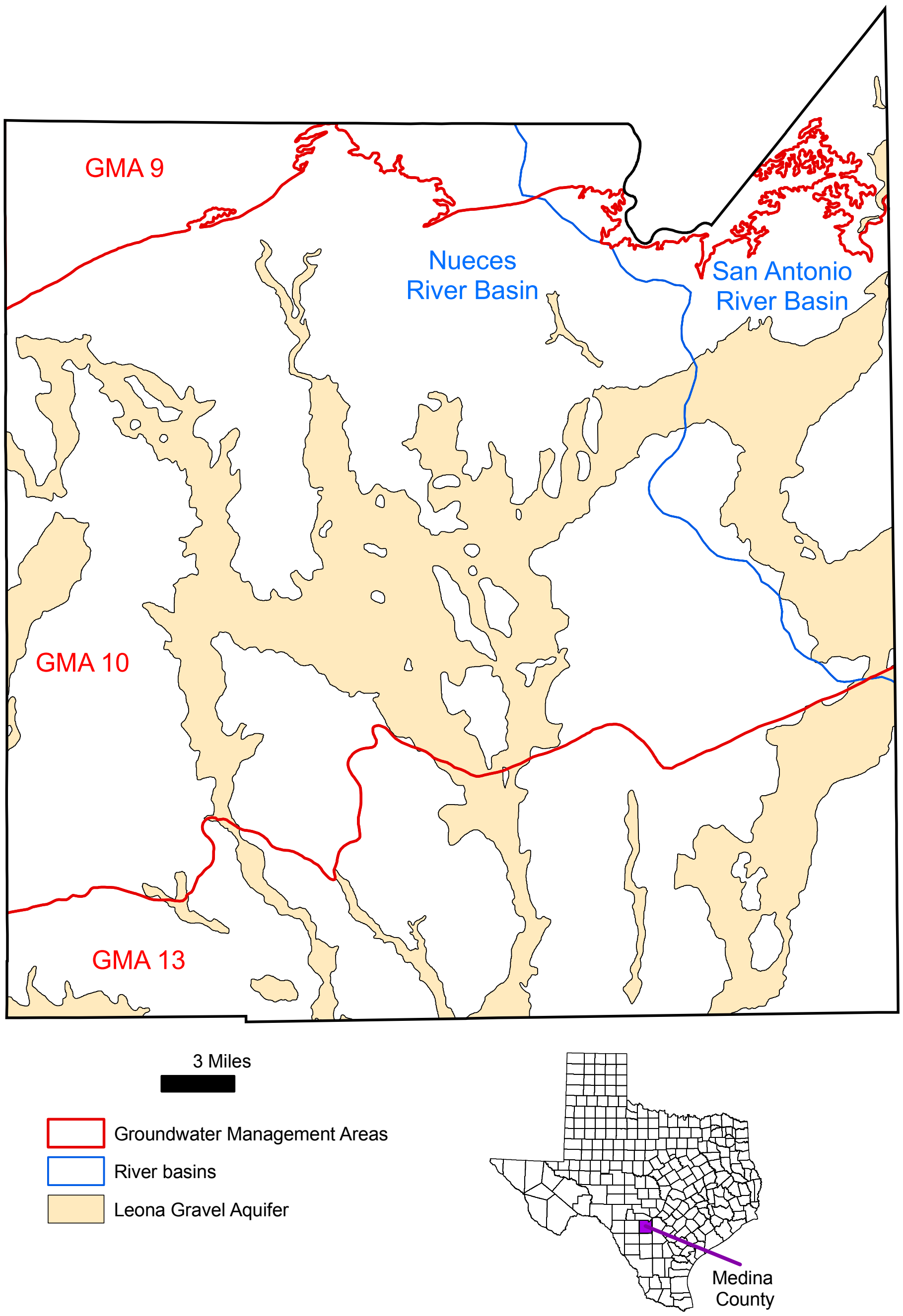

Figure 1. Map showing the groundwater management areas, river basins, and extent of the Leona Gravel Aquifer in Medina County (after George, 2010).

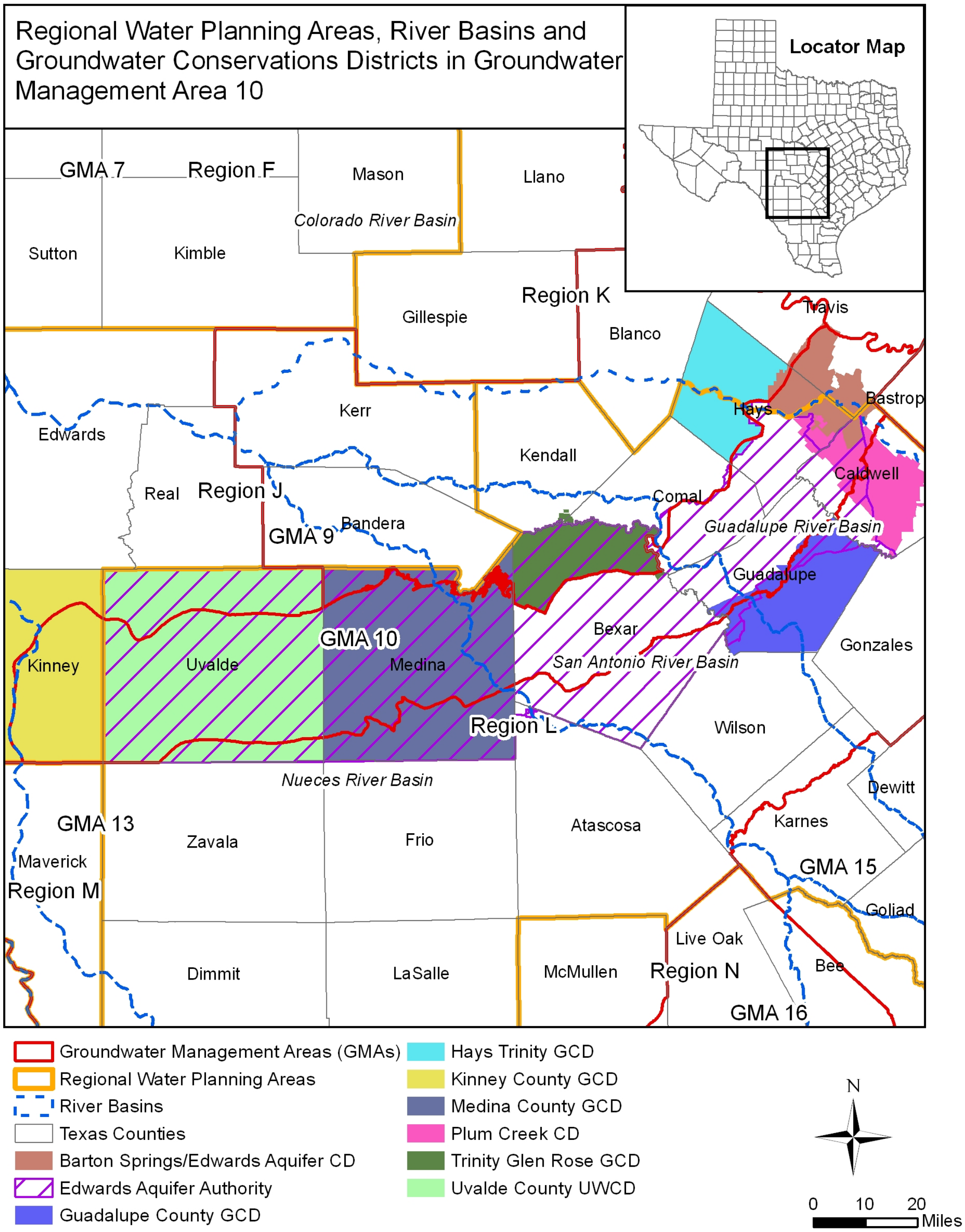

Figure 2. Map showing regional water planning areas, river basins, groundwater conservation districts, and counties in and neighboring Groundwater Management Area 10 (from Thorkildsen and Backhouse, 2010). CD = Conservation District, GCD = Groundwater Conservation District, UWCD = Underground Water Conservation District

RESULTS:

The estimated modeled available groundwater from the Leona Gravel Aquifer within Medina County in Groundwater Management Area 10 that achieves the adopted desired future condition is approximately 16,382 acre-feet per year. This pumping 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). In addition, the modeled available groundwater estimates are tabulated for the Medina County Groundwater Conservation District in Table 2.

Table 1. Estimated modeled available groundwater by decade for the Leona Gravel Aquifer in Groundwater Management Area 10. 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
Medina	L	Nueces	12,369	12,369	12,369	12,369	12,369	12,369
		San Antonio	4,013	4,013	4,013	4,013	4,013	4,013
Total			16,382	16,382	16,382	16,382	16,382	16,382

Table 2. Estimated modeled available groundwater for the Leona Gravel Aquifer in the Medina County Groundwater Conservation District for each decade between 2010 and 2060. Results are in acre-feet per year.

County	Year					
	2010	2020	2030	2040	2050	2060
Medina County Groundwater Conservation District	16,382	16,382	16,382	16,382	16,382	16,382

Limitations:

As indicated by George (2010), additional data are needed to create improved estimates; these estimates are a basic interpretation of the requested conditions. This analysis assumes homogeneous and isotropic aquifers; however, conditions for the Leona Gravel Aquifer may not behave in a uniform manner. There is uncertainty with respect to the distribution of the sand and gravel in the aquifer (Lowry and Couch, 2002; Green, 2003). The analysis further assumes that precipitation is the only source of aquifer recharge and that lateral inflow to the aquifer is equal to lateral outflow from the aquifer, and that future pumping will not alter this balance.

Discharge and recharge from other aquifers, such as the Edwards BFZ aquifer, are unknown as is recharge from streams. Discharge to streams from the Leona Gravel Aquifer is assumed to be 15,000 acre-feet per year (George, 2010), but this number needs to be investigated with gain-loss streamflow assessment research. The recharge rate is also a rough estimate as is the specific yield.

In addition, certain assumptions have been made regarding future precipitation, recharge, and streamflow in developing modeled available groundwater estimates. These assumptions need to be considered and compared to actual future data when evaluating achievement of the desired future condition.

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. 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 and water levels to know if they are achieving their desired future conditions. Because of the limitations and assumptions in this analysis, it is important that the groundwater conservation districts work with the TWDB to refine these 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.

REFERENCES:

George, P., 2010, GTA Aquifer Assessment 09-01: Texas Water Development Board, GTA Aquifer Assessment Report 09-01 Report, 14 p.

Green, R.T., 2003, Geophysical survey to determine the depth and lateral extent of the Leona Aquifer in the Leona river floodplain, south of Uvalde, Texas: Prepared for the Edwards Aquifer Authority by the Southwest Research Institute, 21 p.

Lowry, M.V., and Couch, B. E., 2002, Phase I Leona Gravel Aquifer Study: Prepared for the Medina County Groundwater Conservation District by Turner Collie & Braden Inc., 51 p.

Thorkildsen D. and Backhouse S., 2010, GTA Aquifer Assessment 10-29: Texas Water Development Board, GTA Aquifer Assessment 10-29 Report, 11 p.

Appendix B
Aquifer Assessment 10-41 MAG: Aquifer Assessment for the Leona Gravel, GMA 13

Aquifer Assessment 10-41: Aquifer Assessment for the Leona Gravel Aquifer in Groundwater Management Area 13

by Robert G. Bradley, P.G.
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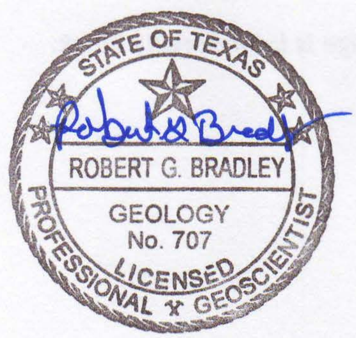
(512) 936-0870
August 20, 2012



Robert G. Bradley, P.G. 707, authorized the seal appearing on this document on August 20, 2012.

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AQUIFER ASSESSMENT 10-41: AQUIFER ASSESSMENT FOR THE LEONA GRAVEL AQUIFER IN GROUNDWATER MANAGEMENT AREA 13

by Robert G. Bradley, P.G.
Texas Water Development Board
Groundwater Resources Division
Groundwater Technical Assistance Section
(512) 936-0870
August 20, 2012

EXECUTIVE SUMMARY:

This report summarizes the final modeled available groundwater as calculated by George (2010) for the Leona Gravel Aquifer in Medina County that lies within Groundwater Management Area 13. The estimated modeled available groundwater from the Leona Gravel Aquifer within Medina County that achieves the desired future condition adopted by members of Groundwater Management Area 13 is approximately 5,635 acre-feet per year and is summarized by county, regional water planning area, and river basin as shown in Table 1.

REQUESTOR:

Ms. Luanna Buckner of the Medina County Groundwater Conservation District acting on behalf of Groundwater Management Area 13.

DESCRIPTION OF REQUEST:

In a letter received July 22, 2011, Ms. Luana Buckner provided the Texas Water Development Board (TWDB) with the desired future condition of Leona Gravel Aquifer within Medina County, adopted by the members of Groundwater Management Area 13. The desired future condition for the Leona Gravel Aquifer, as described in Resolution No. 2011-01 and adopted July 13, 2011 by the groundwater conservation districts in Groundwater Management Area 13 is summarized as an average drawdown of 15 feet for the Leona Gravel Aquifer in Medina County.

METHODS:

Groundwater Management Area 13, located in South Central Texas, includes part of the Leona Gravel Aquifer (Figure 1). This is neither a major nor a minor aquifer, but has been determined to be locally relevant for joint planning purposes. At the request of Groundwater Management Area 13, the TWDB previously analyzed several water level decline scenarios for the Leona Gravel Aquifer, documented in GTA Aquifer Assessment 09-01 (George, 2010).

One of the scenarios included the desired future condition of 15 feet of water level decline, and this was adopted as the desired future condition of the Leona Gravel Aquifer within Medina County for GMA 13.

The modeled available groundwater estimates are divided by regional water planning area and river basin. Medina County is completely within the South Central Regional Water Planning Area and the Medina County Groundwater Conservation District encompasses the whole county. Regional maps of these areas are shown in Figure 2.

PARAMETERS AND ASSUMPTIONS:

Parameters, assumptions, volumetric calculations, and areas were obtained from GTA Aquifer Assessment 09-01 (George, 2010). The water-level declines of 15 feet were estimated to be uniform across the aquifer.

RESULTS:

The estimated modeled available groundwater from the Leona Gravel Aquifer within Medina County in Groundwater Management Area 13 that achieves the adopted desired future condition is approximately 5,635 acre-feet per year. This pumping 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). In addition, the total pumping estimates are summarized by county in Table 2.

Table 1. Modeled available groundwater by decade for the Leona Gravel Aquifer in groundwater management area 13. Results are in acre-feet per year and are divided by county, regional water planning area, and river basin

County	Region	Basin	Year					
			2010	2020	2030	2040	2050	2060
Medina	L	Nueces	5,586	5,586	5,586	5,586	5,586	5,586
		San Antonio	49	49	49	49	49	49

LIMITATIONS:

As indicated by George (2010), additional data are needed to create improved estimates; these estimates are a basic interpretation of the requested conditions. This analysis assumes homogeneous and isotropic aquifers; however, conditions for the Leona Gravel Aquifer may not behave in a uniform manner. There is uncertainty with respect to the distribution of the sand and gravel in the aquifer (Lowry and Couch, 2002; Green, 2003). The analysis further assumes that precipitation is the only source of aquifer recharge and that lateral inflow to the aquifer is equal to lateral outflow from the aquifer, and that future pumping will not alter this balance.

Discharge and recharge from other aquifers, such as the Edwards (Balcones Fault Zone) Aquifer, are unknown as is recharge from streams. Discharge to streams from the Leona Gravel Aquifer is assumed to be 15,000 acre-feet per year (George, 2010), but this number needs to be investigated with gain-loss streamflow assessment research. The recharge rate and specific yield estimates are rough approximations.

This analysis was determined to be the best method to calculate a modeled available groundwater estimate; however, this method has limitations and should be replaced with better tools, including groundwater models and additional data that are not currently available, whenever possible. This analysis assumes that the aquifer is in a state of dynamic equilibrium. This assumption needs to be considered and compared to actual future data when evaluating achievement of the desired future condition.

Given these limitations, users of this information are cautioned that the modeled available groundwater estimates should not be considered a definitive, permanent description of the amount of groundwater that can be pumped to meet the adopted desired future condition. 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 and water levels to know if they are achieving their desired future conditions. Because of the limitations and assumptions in this analysis, it is important that the groundwater conservation districts work with the TWDB to refine these 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.

REFERENCES:

George, P., 2010, GTA Aquifer Assessment 09-01: Texas Water Development Board, GTA Aquifer Assessment Report 09-01 Report, 14 p.

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Thorkildsen D. and Backhouse S., 2011, GTA Aquifer Assessment 10-26: Texas Water Development Board, GTA Aquifer Assessment 10-26 Report, 11 p.

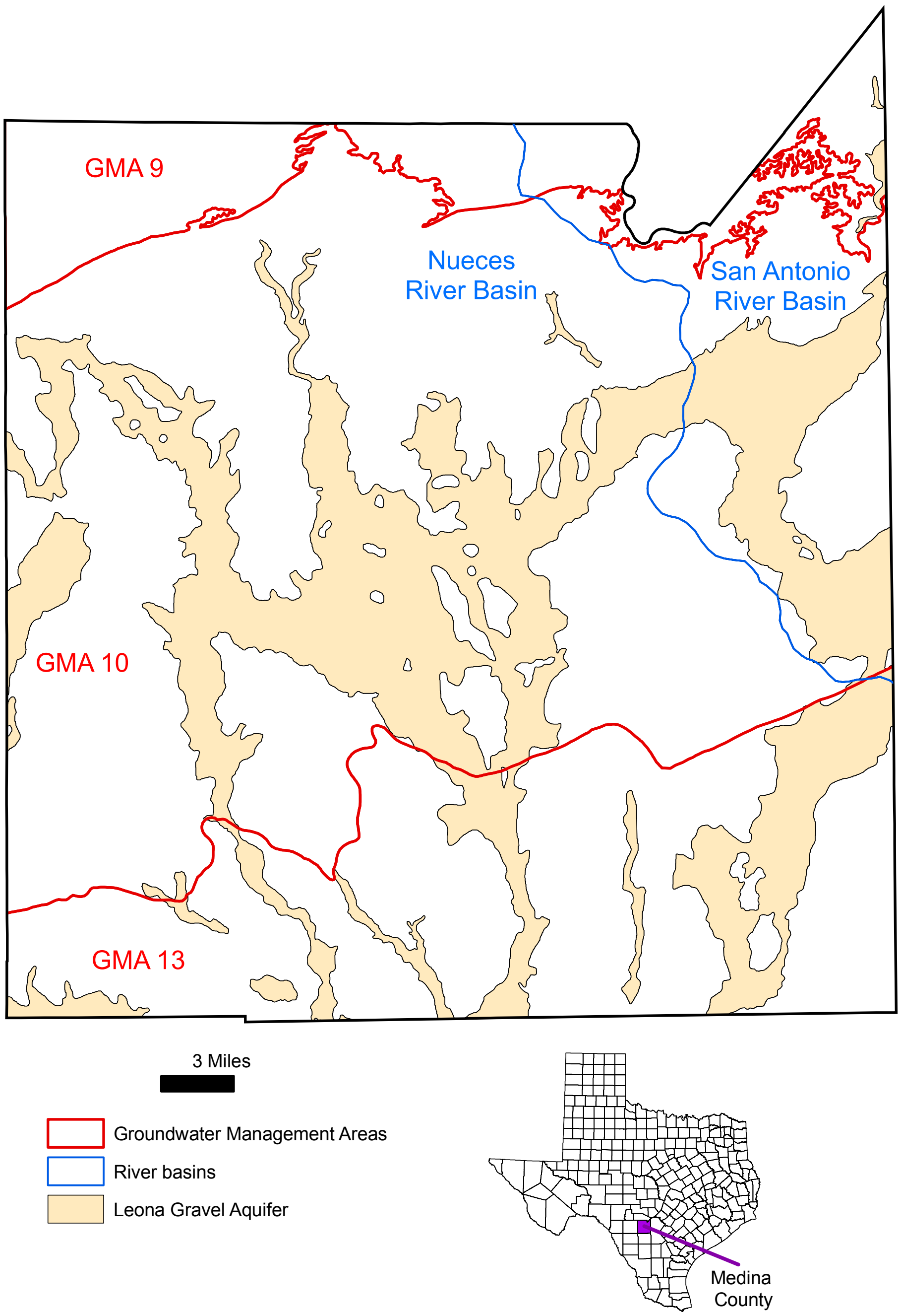


Figure 1. Map Showing the groundwater management areas, river basins, and extent of the Leona Gravel Aquifer in Medina County (After George, 2010).

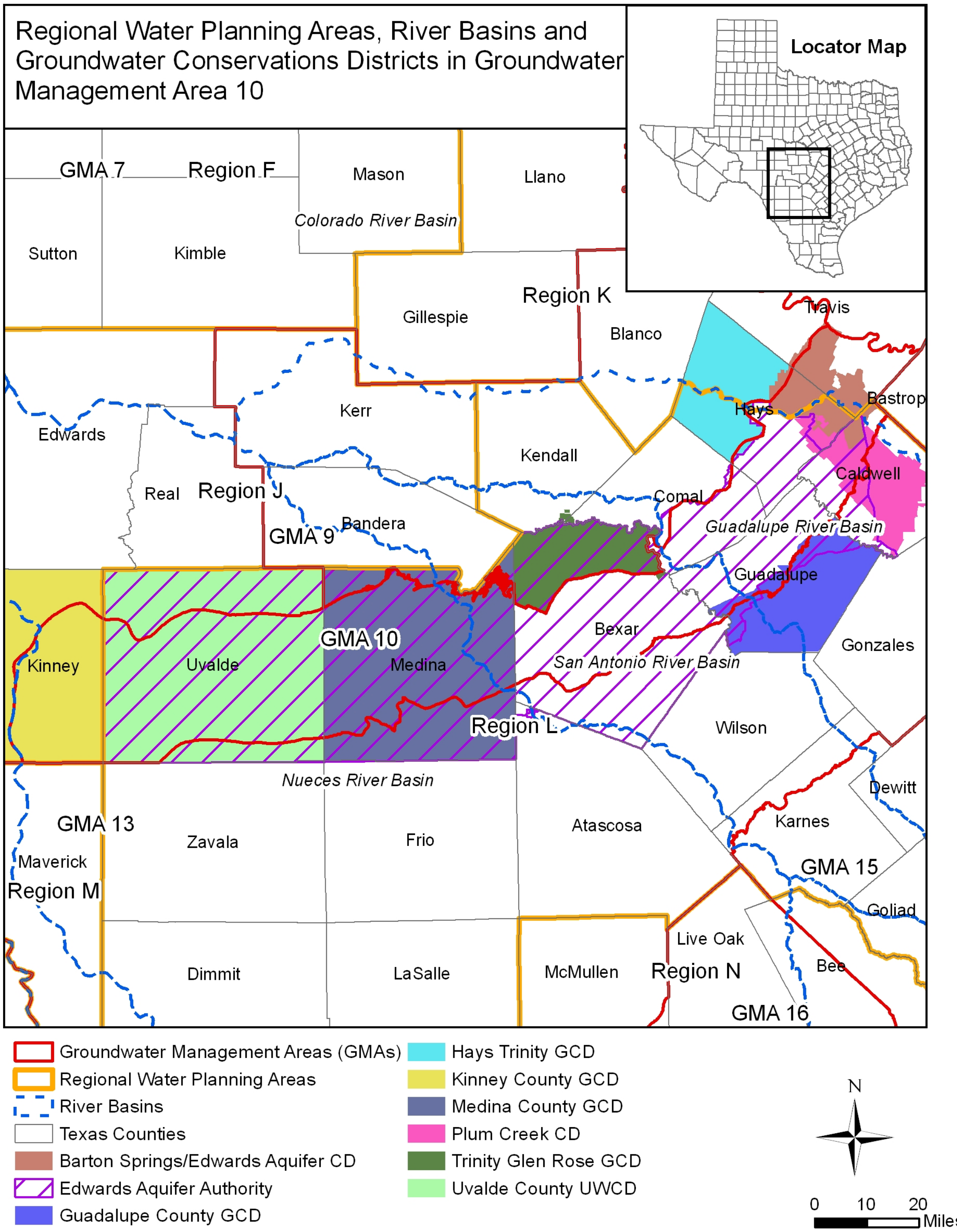


Figure 2. Map showing regional water planning areas, river basins, groundwater conservation districts, and counties in and neighboring groundwater management area 10 (from Thorkildsen and Backhouse, 2010).CD = conservation district, GCD = groundwater conservation district, UWCD = underground water conservation district

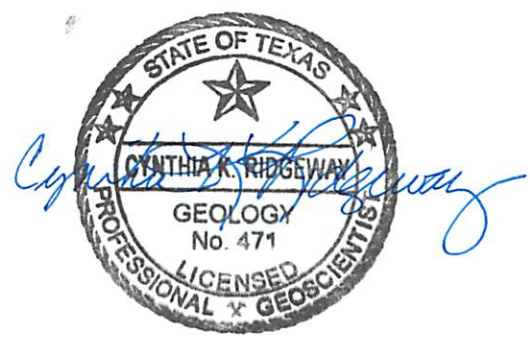
Appendix C
Report GAM Run 10-050 MAG Version 2 Trinity aquifer, GMA 9

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**

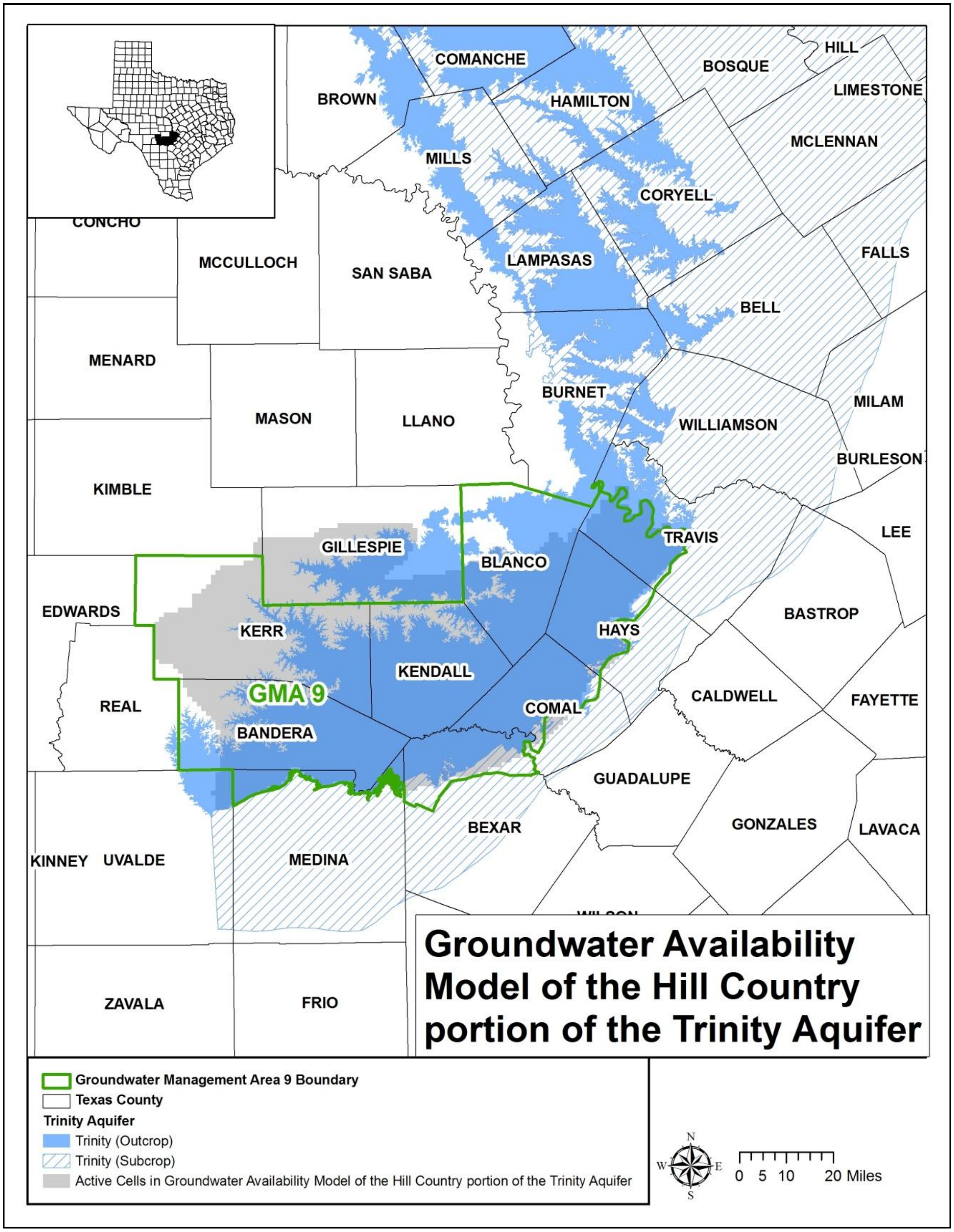

Figure 1: Map showing the areas covered by the groundwater availability model for the Trinity Aquifer.

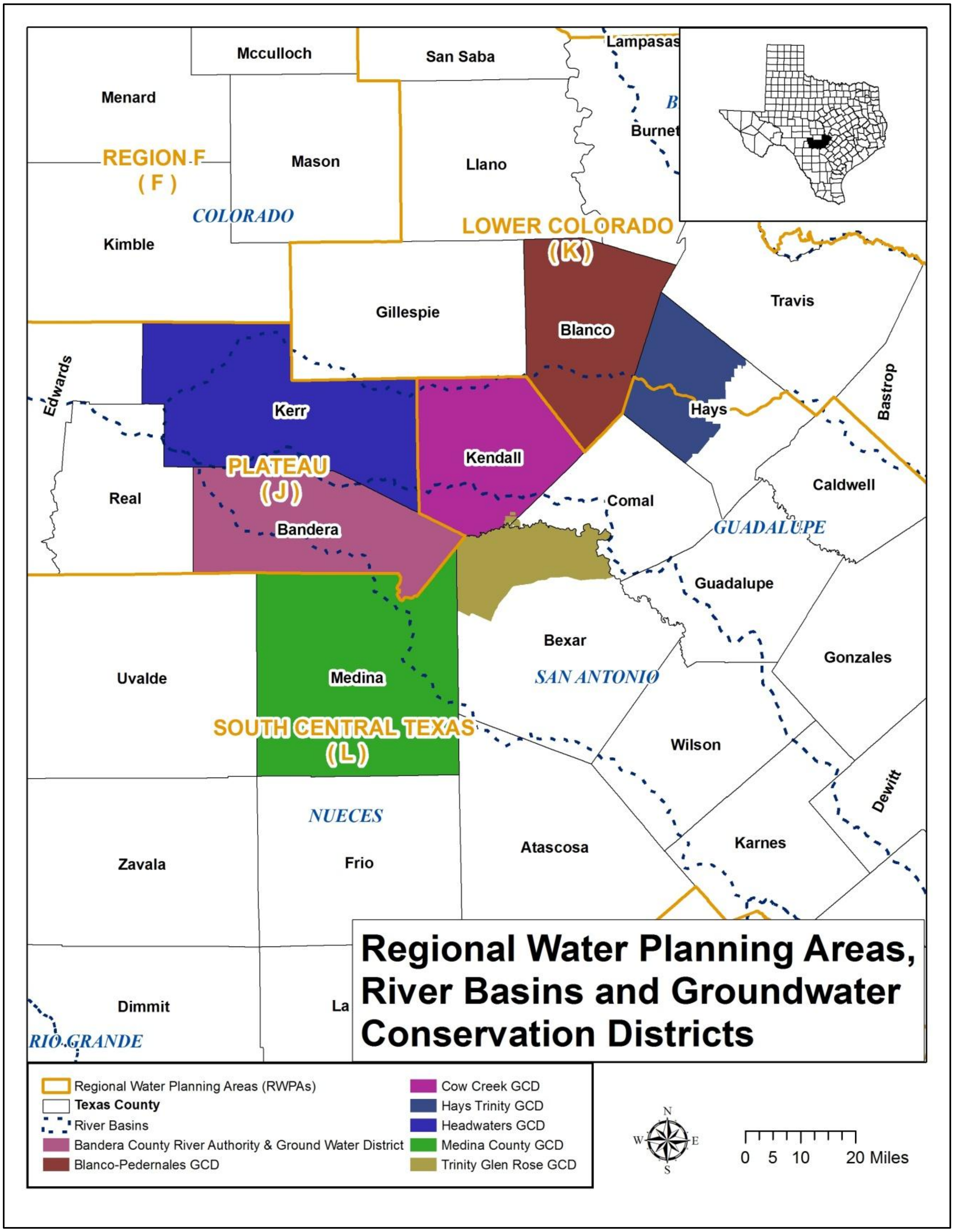

Figure 2: Map showing regional water planning areas (RWPAs), groundwater conservation districts (GCDs), counties, and river basins in Groundwater Management Area 9.

Appendix D
GTA Aquifer Assessment 10-29 MAG Trinity Aquifer, GMA 10

GTA Aquifer Assessment 10-29 MAG

by David Thorkildsen, P.G. and Sarah Backhouse
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STATE OF TEXAS
DAVID THORKILDSEN
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No. 705
LICENSED
PROFESSIONAL GEOSCIENTIST

David Thorkildsen, P.G. 705 authorized the seal appearing on this document on November 29, 2011.

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EXECUTIVE SUMMARY:

The modeled available groundwater for the Trinity Aquifer as a result of the desired future condition adopted by members of Groundwater Management Area 10 is approximately 59,746 acre-feet per year. This is divided by county, regional water planning area, and river basin in Table 2 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 3 through 6. Pumping estimates, as well as parameters and assumptions to determine additional modeled available groundwater estimates were extracted from GTA Aquifer Assessment 10-06, which Groundwater Management Area 10 used as the basis for developing a desired future condition stating that "*except as otherwise provided herein: regional average well drawdown during average recharge conditions that does not exceed 25 feet; within the jurisdiction of Hays-Trinity GCD: regional average well drawdown during average recharge conditions of zero (0) feet; and in the Uvalde County part of GMA-10: regional average well drawdown during average recharge conditions of no more than twenty (20) feet*" and declaring "*the Trinity Aquifer in the part of GMA 10 that is in the Trinity-Glen Rose GCD as a non-relevant aquifer*".

REQUESTOR:

Mr. Rick Illgner of the Edwards Aquifer Authority acting on behalf of the member groundwater conservation districts of Groundwater Management Area 10.

DESCRIPTION OF REQUEST:

In a letter received August 30, 2010, Mr. Illgner provided the Texas Water Development Board (TWDB) with the desired future condition of the Trinity Aquifer adopted by the members of Groundwater Management Area 10. The desired future condition for the Trinity Aquifer, as described in Resolution No. 2010-10 and adopted August 23, 2010 by the groundwater conservation districts in Groundwater Management Area 10 is described below:

1) *except as otherwise provided herein: regional average well drawdown during average recharge conditions that does not exceed 25 feet (including exempt and non-exempt well use);*
2) *within the jurisdiction of Hays-Trinity GCD: regional average well drawdown during average recharge conditions of zero (0) feet (including exempt and non-exempt use);*
3) *in the Uvalde County part of GMA-10: regional average well drawdown during average recharge conditions of no more than twenty (20) feet (including exempt and non-exempt well use);*

4) *declare the Trinity Aquifer in the part of GMA 10 that is in the Trinity-Glen Rose GCD as a non-relevant aquifer*

In response to receiving the adopted desired future condition, TWDB has estimated the modeled available groundwater that achieves the above desired future condition for Groundwater Management Area 10.

METHODS:

Groundwater Management Area 10, located in South Central Texas, includes part of the Trinity Aquifer (Figure 1). At the request of Groundwater Management Area 10 the TWDB previously analyzed several water level decline scenarios for the Trinity Aquifer, documented in GTA Aquifer Assessment 10-06. One of the scenarios included the desired future condition of 25 feet of water level decline, and one included the desired future condition of 20 feet of water level decline. For these two scenarios the pumping results presented here for Groundwater Management Area 10 are taken directly from GTA Aquifer Assessment 10-06 with the exception of the area in the Hays Trinity Groundwater Conservation District (GCD). The assessment did not include a 0 foot water level decline scenario, therefore new calculations to determine modeled available groundwater estimates were completed for this area (Table 1)

To calculate modeled available groundwater estimates for the desired future condition of 0 feet of water level decline for the Hays Trinity GCD parameters and assumptions for the volumetric storage, recharge, inflow calculations, map areas, and areal extent were obtained from GTA Aquifer Assessment 10-06 (Thorkildsen and Backhouse, 2010). It is important to note that only 3 percent (6,363 acres) of the total Hays Trinity GCD area occurs in Groundwater Management Area 10.

To calculate change in aquifer storage for the Hays Trinity GCD based on the desired future condition, map areas were multiplied by the estimated aquifer storativity or specific yield and then by a uniform water level decline of 0 feet. These volumes were then divided by 50 years to obtain a yearly volume. In cases where unconfined and confined conditions existed, those were calculated separately.

Modeled available groundwater estimates are divided by county, regional water planning area, river basin, and groundwater conservation district. These areas are shown in Figure 2.

PARAMETERS AND ASSUMPTIONS:

- Parameters, assumptions, volumetric calculations, and areas were obtained from GTA Aquifer Assessment 10-06 (Thorkildsen and Backhouse, 2010).
- Water-level declines were estimated to be uniform across the aquifer.
- The Edwards Aquifer Authority is not included in this assessment because they are restricted by their enabling legislation to manage only the Edwards Aquifer.

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 10, 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 estimated modeled available groundwater for the Trinity Aquifer in Groundwater Management Area 10 consistent with the adopted desired future condition is approximately 59,746 acre-feet per year. The volumetric calculations to determine the estimates for Hays Trinity GCD are shown in Table 1. The relatively small totals reflect the small percentage (3%) of the total district area that occurs in Groundwater Management Area 10.

Table 2 shows the modeled available groundwater by decade divided by county, regional water planning area, and river basin for use in the regional water planning process. Modeled available groundwater estimates are also summarized by county, regional water planning area, river basin, and groundwater conservation district and are shown in tables 3, 4, 5, and 6 respectively.

Table 1. Volumetric calculations estimating annual modeled available groundwater for the Trinity Aquifer in Hays Trinity GCD. Map areas and parameters were obtained from GTA Aquifer Assessment 10-06 (Thorkildsen and Backhouse, 2010).

GMA	Aquifer	County	GCD	Map Areas	Estimated storage coefficient	Areal extent (acres)	Desired total aquifer water level decline (feet)	Estimated total volume from water level decline (acre-feet)	Estimated annual volume from water level decline (acre-feet)	Estimated annual effective recharge (ac-ft/yr)	Estimated annual lateral inflow (ac-ft/yr)	Estimated annual total volume (ac-ft/yr)
10	Trinity	Hays	Hays Trinity Groundwater Conservation District	7	0.00001	994	0	0	0	0	39	39
				8	0.00001	4,342	0	0	0	0	80	80
				22	0.05	554	0	0	0	64	9	73
				23	0.05	473	0	0	0	57	9	66

GMA = groundwater management area ac-ft/yr = acre-feet per year

The formulas for this table are: storage coefficient * areal extent * desired total aquifer water level decline = estimated total volume from water level decline. Estimated total volume from water level decline/50 = estimated annual volume from water level decline. Then estimated annual volume from water level decline + estimated annual effective recharge + estimated annual lateral inflow = estimated annual total volume.

Table 2. Modeled available groundwater by decade for the Trinity Aquifer in Groundwater Management Area 10. 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**
Bexar	L	San Antonio	19,998	19,998	19,998	19,998	19,998	19,998
Caldwell	L	Guadalupe	0	0	0	0	0	0
Comal	L	Guadalupe	27,176	27,176	27,176	27,176	27,176	27,176
		San Antonio	2,108	2,108	2,108	2,108	2,108	2,108
Guadalupe	L	Guadalupe	0	0	0	0	0	0
		San Antonio	0	0	0	0	0	0
Hays	K	Colorado	955	955	955	955	955	955
	L	Guadalupe	2,860	2,860	2,860	2,860	2,860	2,860
Medina	L	Nueces	4,373	4,373	4,373	4,373	4,373	4,373
		San Antonio	996	996	996	996	996	996
Travis	K	Colorado	634	634	634	634	634	634
		Guadalupe	7	7	7	7	7	7
Uvalde	L	Nueces	639	639	639	639	639	639
Total			**59,746**	**59,746**	**59,746**	**59,746**	**59,746**	**59,746**

Table 3. Modeled available groundwater for the Trinity Aquifer summarized by county in Groundwater Management Area 10 for each decade between 2010 and 2060. Results are in acre-feet per year.

County	Year					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Bexar	19,998	19,998	19,998	19,998	19,998	19,998
Caldwell	0	0	0	0	0	0
Comal	29,284	29,284	29,284	29,284	29,284	29,284
Guadalupe	0	0	0	0	0	0
Hays	3,815	3,815	3,815	3,815	3,815	3,815
Medina	5,369	5,369	5,369	5,369	5,369	5,369
Travis	641	641	641	641	641	641
Uvalde	639	639	639	639	639	639
Total	**59,746**	**59,746**	**59,746**	**59,746**	**59,746**	**59,746**

Table 4. Modeled available groundwater for the Trinity Aquifer summarized by regional water planning area in Groundwater Management Area 10 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**
K	1,596	1,596	1,596	1,596	1,596	1,596
L	58,150	58,150	58,150	58,150	58,150	58,150
Total	**59,746**	**59,746**	**59,746**	**59,746**	**59,746**	**59,746**

Table 5. Modeled available groundwater for the Trinity Aquifer summarized by river basin in Groundwater Management Area 10 for each decade between 2010 and 2060. Results are in acre-feet per year.

River Basin	Year					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Colorado	1,589	1,589	1,589	1,589	1,589	1,589
Guadalupe	30,043	30,043	30,043	30,043	30,043	30,043
Nueces	5,012	5,012	5,012	5,012	5,012	5,012
San Antonio	23,102	23,102	23,102	23,102	23,102	23,102
Total	**59,746**	**59,746**	**59,746**	**59,746**	**59,746**	**59,746**

Table 6. Modeled available groundwater for the Trinity Aquifer summarized by groundwater conservation district in Groundwater Management Area 10 for each decade between 2010 and 2060. Results are in acre-feet per year.

	Year					
Groundwater Conservation District	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Barton Springs/Edwards Aquifer CD	1,288	1,288	1,288	1,288	1,288	1,288
Hays Trinity GCD	258	258	258	258	258	258
Medina County GCD	5,369	5,369	5,369	5,369	5,369	5,369
Plum Creek CD	238	238	238	238	238	238
Uvalde County UWCD	639	639	639	639	639	639
Total (excluding non-district areas)	**7,792**	**7,792**	**7,792**	**7,792**	**7,792**	**7,792**
No District	51,954	51,954	51,954	51,954	51,954	51,954
Total (including non-district areas)	**59,746**	**59,746**	**59,746**	**59,746**	**59,746**	**59,746**

GCD = Groundwater Conservation District CD = Conservation District UWCD = Underground Water Conservation District

LIMITATIONS:

The water budget in this analysis was determined to be the best method to calculate estimates of modeled available groundwater, however this method has limitations and should be replaced with better tools, including groundwater models and additional data that are not currently available, whenever possible.

This analysis assumes homogeneous and isotropic aquifers; however, aquifer conditions may not be uniform. In addition, certain assumptions have been made regarding future precipitation, recharge, and streamflow in developing these pumping estimates. These assumptions need to be considered and compared to actual future data when evaluating achievement of the desired future condition.

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. 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 and water levels to know if they are achieving their desired future conditions. Because of the limitations and assumptions in this analysis, it is important that the groundwater conservation districts work with the TWDB to refine these 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.

REFERENCES:

Thorkildsen and Backhouse, 2010, GTA Aquifer Assessment 10-06:Texas Water Development Board, GTA Aquifer Assessment 10-06 Report, 20 p.

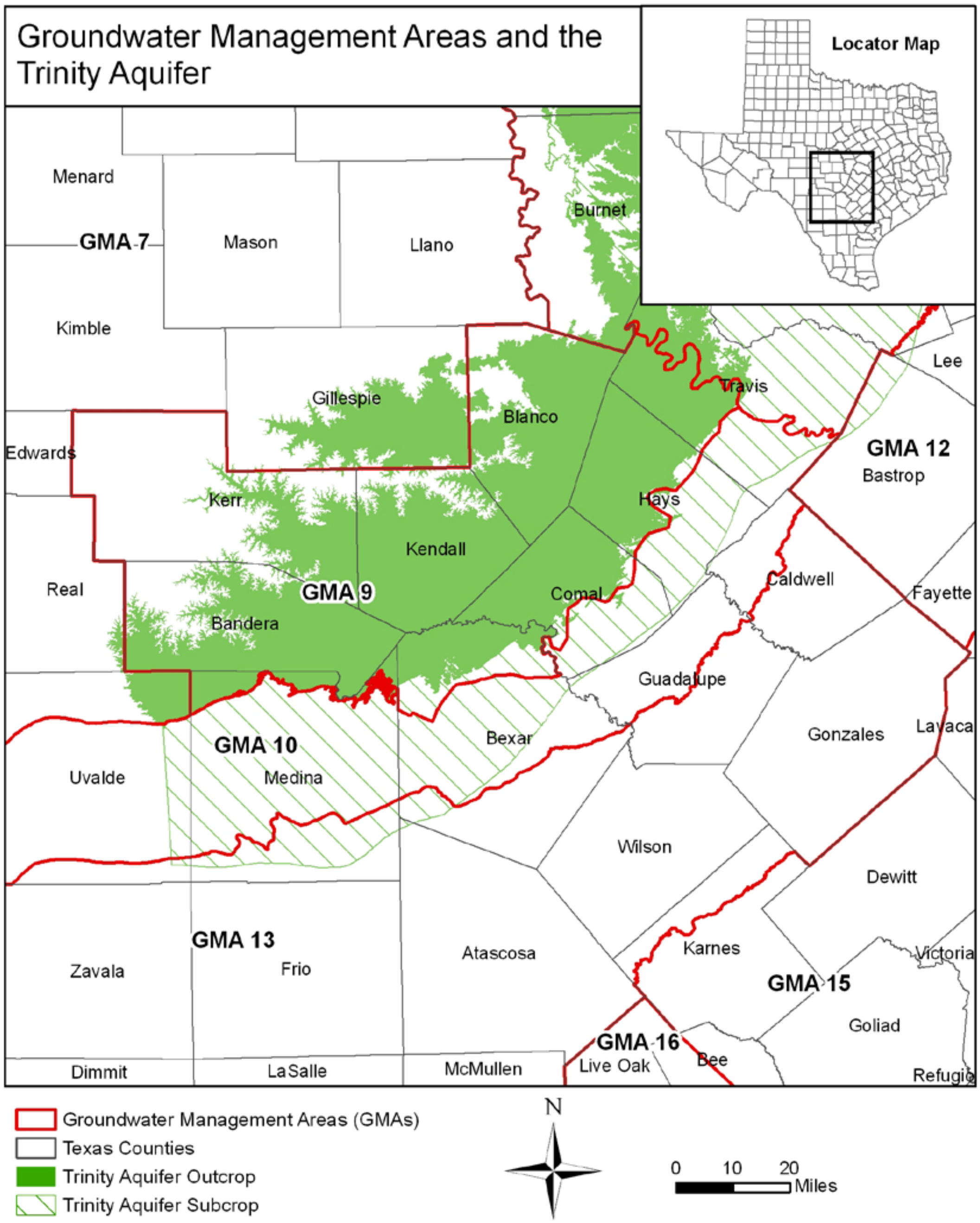

Figure 1. Map showing the areas covered by the Trinity Aquifer in and neighboring Groundwater Management Area 10.

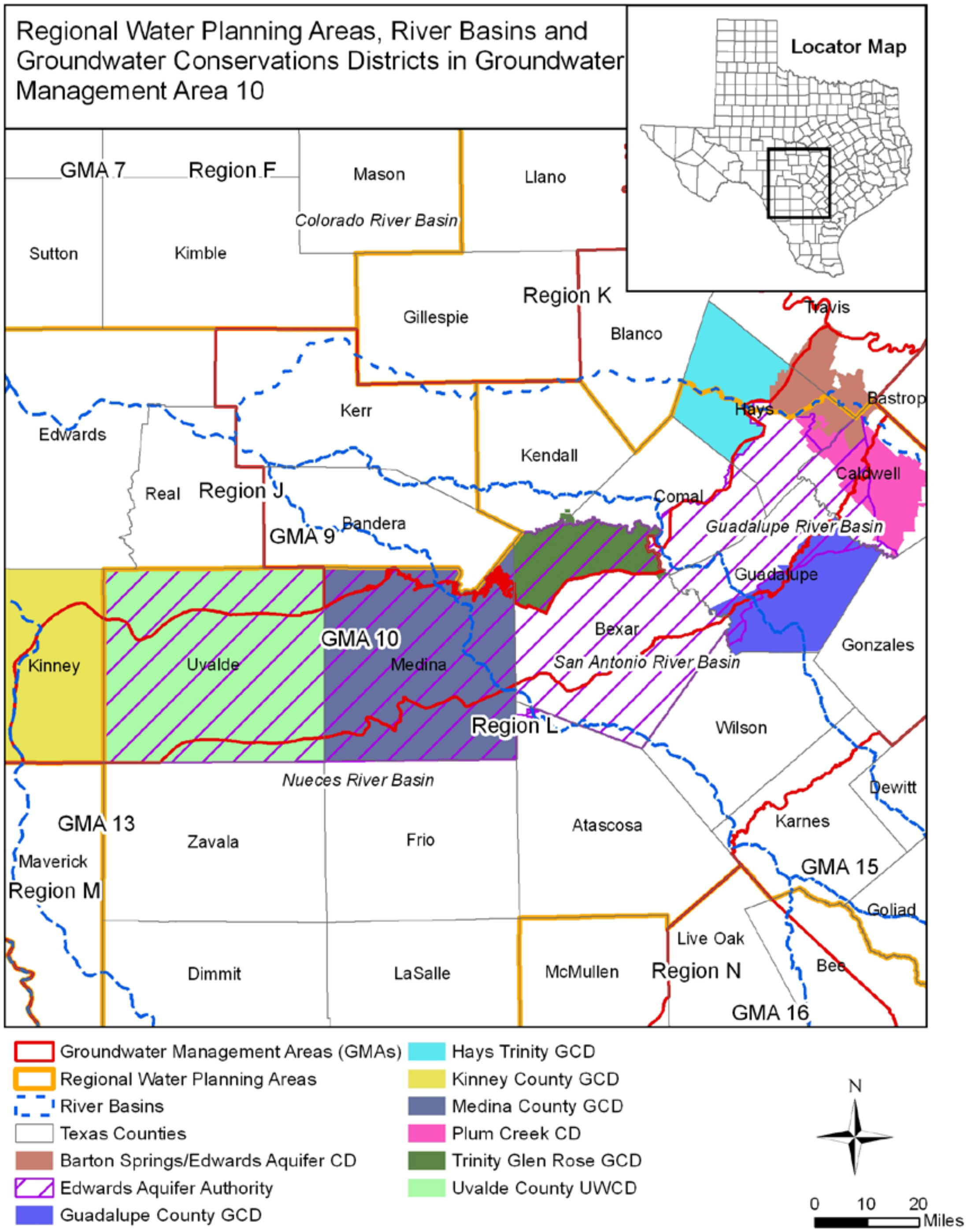

Figure 2. Map showing regional water planning areas, river basins, groundwater conservation districts and counties in and neighboring Groundwater Management Area 10. CD = Conservation District, GCD = Groundwater Conservation District, UWCD = Underground Water Conservation District

Appendix E
GAM Run 10-012 MAG: Modeled Available Groundwater for the Carrizo-Wilcox, Queen City, and Sparta Aquifers, GMA 13

GAM Run 10-012 MAG: Modeled Available Groundwater for the Carrizo-Wilcox, Queen City, and Sparta Aquifers in Groundwater Management Area 13

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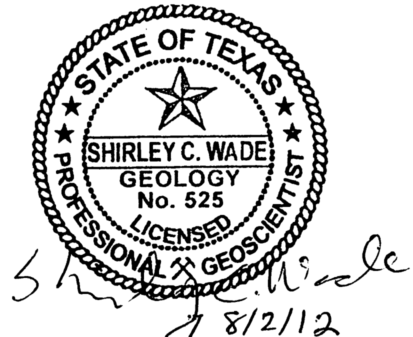
Groundwater Availability Modeling Section
(512) 936-0883
August 2, 2012



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GAM RUN 10-012 MAG: MODELED AVAILABLE GROUNDWATER FOR THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS IN GROUNDWATER MANAGEMENT AREA 13

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August 2, 2012

EXECUTIVE SUMMARY:

The modeled available groundwater for Groundwater Management Area 13 for the Carrizo-Wilcox, Queen City, and Sparta aquifers is summarized in Table 1, 2, and 3 for use in the regional water planning process. These values are also listed by decade for each aquifer by county (Table 4), river basin (Table 5), regional water planning group (Table 6), and groundwater conservation district (Table 7). The modeled available groundwater estimates for the Queen City, Sparta, and Carrizo-Wilcox aquifers range from approximately 399,000 acre-feet per year in 2010 to 425,000 acre-feet per year in 2060 (Table 4). The estimates were extracted from results of Groundwater Availability Model Run 09-034, scenario 4, which meets the desired future conditions adopted by members of Groundwater Management Area 13.

This report reflects the official release of the revised groundwater district boundaries by the Texas Commission on Environmental Quality (TCEQ). Specifically, this report reflects the division of modeled available groundwater between the Gonzales County Underground Water Conservation District and Plum Creek Conservation District based on the new groundwater conservation district boundaries.

REQUESTOR:

Mr. Mike Mahoney from the Evergreen Underground Water Conservation District acting on behalf of Groundwater Management Area 13.

DESCRIPTION OF REQUEST:

In a letter dated April 13, 2010 and received by the Texas Water Development Board (TWDB) on April 15, 2010, Mr. Mike Mahoney provided the TWDB with the desired future conditions of the Carrizo-Wilcox, Queen City, and Sparta aquifers adopted by the groundwater conservation districts in Groundwater Management Area 13. The desired future conditions for the Carrizo-Wilcox, Queen City, and Sparta aquifers, as described in Resolution R 2010-01 and adopted April 9, 2010 by the groundwater conservation districts within Groundwater Management Area 13, are described below:

- "In reference to GAM Run 09-034, the committee has considered, the base scenario of an average drawdown of 22 feet, scenario 2 an average drawdown of 22 feet, scenario 3 an average drawdown of 23 feet and scenario 4 an average drawdown of 23 feet;"
- "The district members of Groundwater Management Area 13, adopt scenario 4, and an average drawdown of 23 feet for the Sparta, Weches, Queen City, Reklaw, Carrizo, and the Wilcox Aquifers"

In response to receiving the adopted desired future conditions, TWDB has estimated the modeled available groundwater for the Carrizo-Wilcox, Queen City, and Sparta Aquifers in Groundwater Management Area 13.

METHODS:

Groundwater Management Area 13, located in south central Texas, includes the southern part of the Queen City, Sparta, and Carrizo-Wilcox aquifers (Figure 1). For the previously completed Groundwater Availability Model Run 09-034 (Wade and Jigmond, 2010) average recharge and evapotranspiration rates and initial streamflows based on the historical calibration-verification runs, representing 1981 to 1999 were summarized. These averages were then used for each year of the 61-year predictive simulations along with pumping specified by Groundwater Management Area 13 members in four scenarios. The results of the pumping scenarios were reviewed by members of Groundwater Management Area 13 to develop their desired future conditions. Model scenario 4 resulted in an overall average drawdown of 23 feet for the Queen City, Sparta, and Carrizo-Wilcox aquifers and for the Weches and Reklaw confining units. The pumping for scenario 4 was extracted from the model results and divided by county, river basin, regional water planning area and groundwater conservation district within Groundwater Management Area 13 (Figure 2).

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. 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 required to develop after soliciting input from applicable groundwater conservation districts, will be provided in a separate report.

PARAMETERS AND ASSUMPTIONS:

The parameters and assumptions for the groundwater availability model for the southern part of the Queen City, Sparta, and Carrizo-Wilcox aquifers are described below:

- Version 2.01 of the groundwater availability model for the southern part of the Queen City, Sparta, and Carrizo-Wilcox aquifers was used for this analysis
- See Deeds and others (2003) and Kelley and others (2004) for assumptions and limitations of the groundwater availability model for the southern part of the Queen City, Sparta, and Carrizo-Wilcox aquifers.
- The model includes eight layers representing:
- the Sparta Aquifer (layer 1),
- the Weches Formation (layer 2),
- the Queen City Aquifer (layer 3),
- the Reklaw Formation (layer 4),
- the Carrizo Aquifer (layer 5),
- the upper and where the upper is missing, the middle Wilcox Aquifer (layer 6),
- the middle Wilcox Aquifer (layer 7), and
- the lower Wilcox Aquifer (layer 8).

- Groundwater in the groundwater availability model for the southern portion of the Queen City, Sparta, and Carrizo-Wilcox aquifers ranges from fresh to saline (Kelley and others, 2004).

- The root mean square error (a measure of the difference between simulated and measured water levels during model calibration) in the entire model for 1999 is 23 feet for the Sparta Aquifer, 18 feet for the Queen City aquifer, and 33 feet for the Carrizo aquifer (Kelley and others, 2004).

- Recharge rates, evapotranspiration rates, and initial streamflows are averages of historic estimates from 1981 to 1999.

RESULTS:

The modeled available groundwater for the Carrizo-Wilcox Aquifer that achieves the desired future conditions adopted by Groundwater Management Area 13 increases from 375,654 to 404,000 acre-feet per year between 2010 and 2060 (Table 1). The modeled available groundwater for the Queen City Aquifer in Groundwater Management Area 13 declines from 16,311 to 14,538 acre-feet per year over the same time period (Table 2). The modeled available groundwater for the Sparta Aquifer in Groundwater Management Area 13 declines from 6,800 to 6,365 acre-feet per year (Table 3). The modeled available groundwater in tables 1, 2, and 3 has been summarized by county, river basin, and regional water planning area for use in the regional water planning process.

The modeled available groundwater is also summarized by county (Table 4), river basin (Table 5), regional water planning area (Table 6), and groundwater conservation district (Table 7). In Table 7, the modeled available groundwater among all districts has been calculated both excluding and including areas outside the jurisdiction of a groundwater conservation district.

LIMITATIONS:

The groundwater model 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.

REFERENCES:

Deeds, N., Kelley, V., Fryar, D., Jones, T., Whallon, A. J., and Dean, K. E., 2003, Groundwater Availability Model for the Southern Carrizo-Wilcox Aquifer: contract report to the Texas Water Development Board, 452 p.

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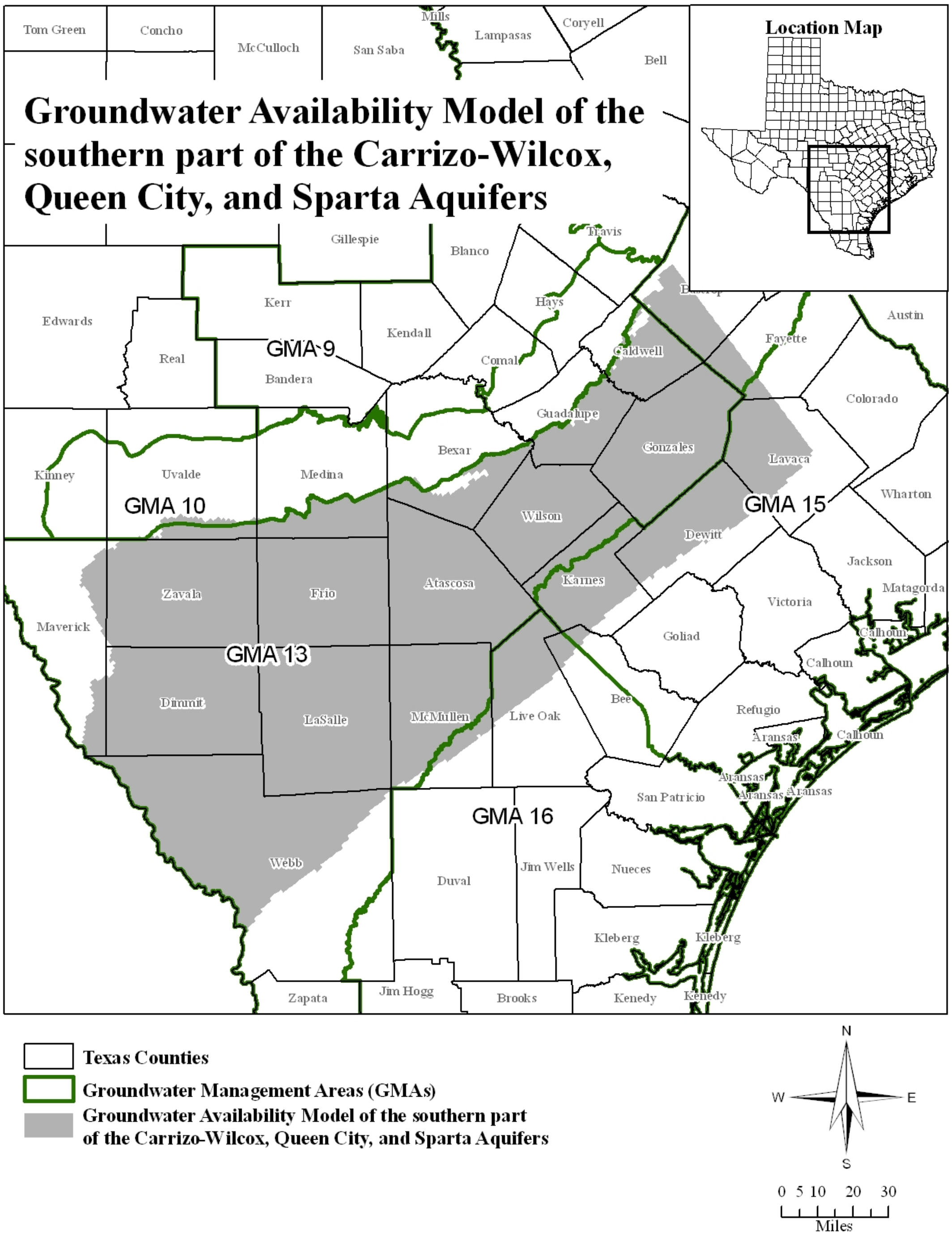

FIGURE 1.MAP SHOWING THE AREAS COVERED BY THE GROUNDWATER AVAILABILITY MODEL FOR THE SOUTHERN PART OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS.

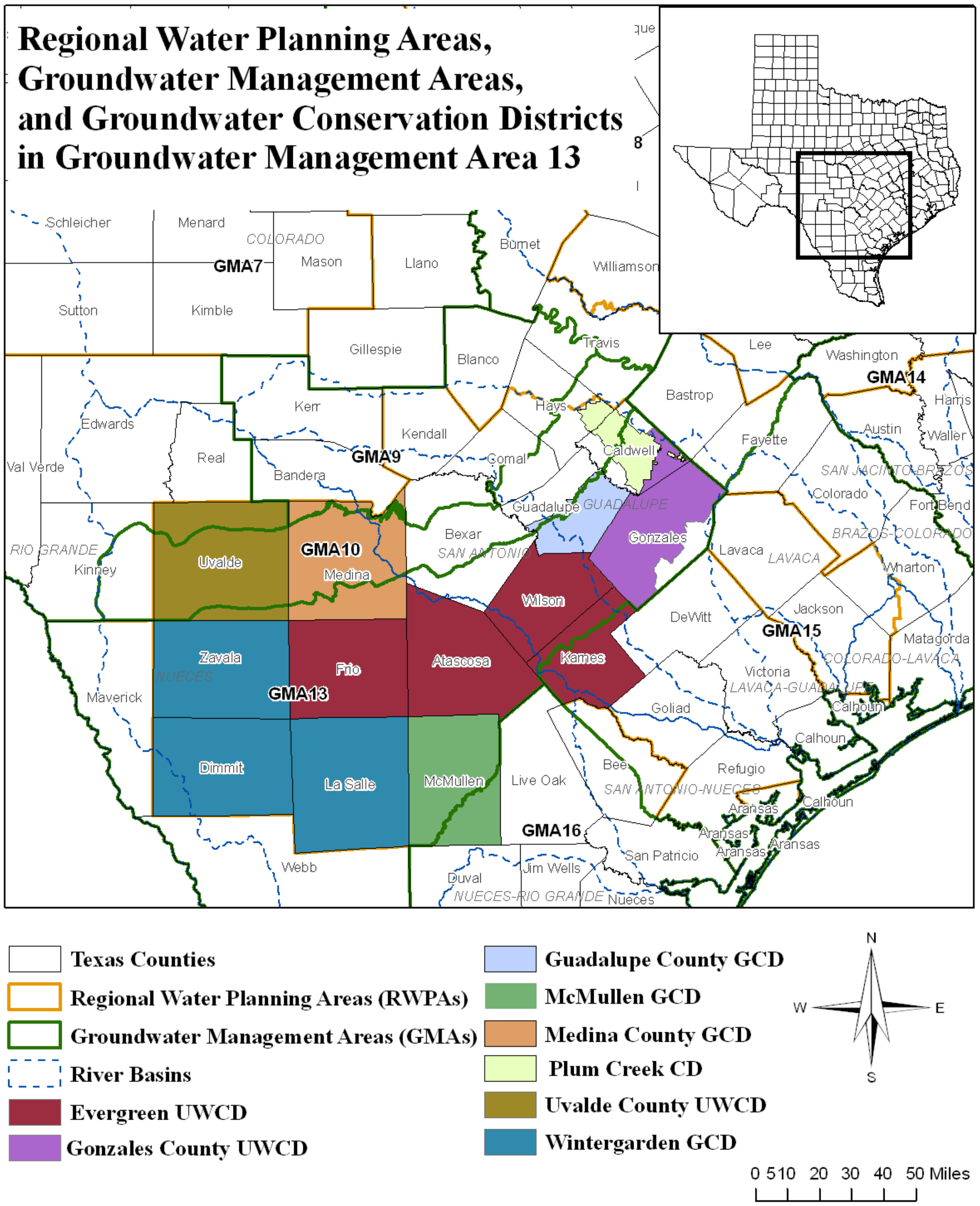

FIGURE 2.MAP SHOWING REGIONAL WATER PLANNING AREAS, GROUNDWATER MANAGEMENT AREAS, GROUNDWATER CONSERVATION DISTRICTS (GCDS), COUNTIES, AND RIVER BASINS IN AND NEIGHBORING GROUNDWATER MANAGEMENT AREA 13. UWCD REFERS TO UNDERGROUND WATER CONSERVATION DISTRICT.

TABLE 1. MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE CARRIZO-WILCOX AQUIFER IN GROUNDWATER MANAGEMENT AREA 13. RESULTS ARE IN ACRE-FEET PER YEAR AND ARE DIVIDED BY COUNTY, RIVER BASIN, AND REGIONAL WATER PLANNING AREA.

County	Regional Water Planning Area	Basin	Year					
			2010	2020	2030	2040	2050	2060
Atascosa	L	Nueces	67,829	68,656	70,249	71,827	73,666	75,688
		San Antonio	120	120	120	120	120	120
Bexar	L	Nueces	14,198	14,198	14,198	14,198	14,198	14,198
		San Antonio	12,080	12,080	12,080	12,080	12,080	11,909
Caldwell	L	Colorado	593	593	593	593	593	593
		Guadalupe	43,951	43,951	43,543	43,543	42,967	42,967
Dimmit	L	Nueces	3,253	3,253	3,253	3,253	3,253	3,253
		Rio Grande	106	106	106	106	106	106
Frio	L	Nueces	81,551	79,089	76,734	74,439	72,222	70,030
Gonzales	L	Guadalupe	52,268	62,101	70,102	75,576	75,755	75,755
		Lavaca	215	215	215	215	215	215
Guadalupe	L	Guadalupe	8,868	9,460	9,910	11,648	12,168	12,668
		San Antonio	1,373	1,373	1,373	1,373	1,373	1,373
Karnes	L	Guadalupe	185	195	207	215	220	224
		Nueces	87	92	97	101	103	105
		San Antonio	787	830	878	915	936	951
La Salle	L	Nueces	6,454	6,454	6,454	6,454	6,454	6,454
Maverick	M	Nueces	777	777	777	472	472	472
		Rio Grande	1,266	1,266	1,247	1,205	1,098	1,060
McMullen	N	Nueces	1,819	1,819	1,819	1,819	1,819	1,819
Medina	L	Nueces	2,542	2,519	2,507	2,507	2,507	2,507
		San Antonio	26	26	26	26	26	26
Uvalde	L	Nueces	2,971	1,230	828	828	828	828
Webb	M	Nueces	92	92	92	92	92	92
		Rio Grande	824	824	824	824	824	824
Wilson	L	Guadalupe	624	672	731	791	861	938
		Nueces	7,151	7,311	7,505	7,703	7,932	8,185
		San Antonio	27,785	29,003	30,481	31,992	33,738	35,671
Zavala	L	Nueces	35,859	35,859	35,521	35,388	35,288	34,969
Total			**375,654**	**384,164**	**392,470**	**400,303**	**401,914**	**404,000**

TABLE 2. MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE QUEEN CITY AQUIFER IN GROUNDWATER MANAGEMENT AREA 13. RESULTS ARE IN ACRE-FEET PER YEAR AND ARE DIVIDED BY COUNTY, RIVER BASIN, AND REGIONAL WATER PLANNING AREA.

County	Regional Water Planning Area	Basin	Year					
			2010	2020	2030	2040	2050	2060
Atascosa	L	Nueces	4,546	4,546	4,513	4,405	4,300	4,202
Caldwell	L	Guadalupe	306	306	306	306	306	306
Dimmit	L	Nueces	0	0	0	0	0	0
		Rio Grande	0	0	0	0	0	0
Frio	L	Nueces	4,748	4,582	4,422	4,270	4,124	3,983
Gonzales	L	Guadalupe	5,030	5,030	5,030	5,030	5,030	5,030
		Lavaca	35	35	35	35	35	35
Guadalupe	L	Guadalupe	0	0	0	0	0	0
Karnes	L	Guadalupe	0	0	0	0	0	0
		Nueces	0	0	0	0	0	0
		San Antonio	0	0	0	0	0	0
La Salle	L	Nueces	1	1	1	1	1	1
McMullen	N	Nueces	136	136	136	136	136	136
Webb	M	Nueces	0	0	0	0	0	0
		Rio Grande	0	0	0	0	0	0
Wilson	L	Guadalupe	128	114	101	90	80	72
		Nueces	148	132	117	104	93	83
		San Antonio	1,233	1,094	973	866	772	690
Zavala	L	Nueces	0	0	0	0	0	0
Total			**16,311**	**15,976**	**15,634**	**15,243**	**14,877**	**14,538**

TABLE 3. MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE SPARTA AQUIFER IN GROUNDWATER MANAGEMENT AREA 13. RESULTS ARE IN ACRE-FEET PER YEAR AND ARE DIVIDED BY COUNTY, RIVER BASIN, AND REGIONAL WATER PLANNING AREA.

County	Regional Water Planning Area	Basin	Year					
			2010	2020	2030	2040	2050	2060
Atascosa	L	Nueces	1,191	1,130	1,082	1,042	1,013	994
Dimmit	L	Nueces	0	0	0	0	0	0
Frio	L	Nueces	729	698	674	650	624	601
Gonzales	L	Guadalupe	3,529	3,529	3,529	3,529	3,529	3,529
		Lavaca	23	23	23	23	23	23
Karnes	L	Guadalupe	0	0	0	0	0	0
		Nueces	0	0	0	0	0	0
		San Antonio	0	0	0	0	0	0
La Salle	L	Nueces	987	987	987	987	987	987
McMullen	N	Nueces	90	90	90	90	90	90
Webb	M	Nueces	0	0	0	0	0	0
		Rio Grande	0	0	0	0	0	0
Wilson	L	Guadalupe	23	20	18	16	14	13
		Nueces	55	49	44	39	34	31
		San Antonio	173	154	137	121	108	97
Zavala	L	Nueces	0	0	0	0	0	0
Total			**6,800**	**6,680**	**6,584**	**6,497**	**6,422**	**6,365**

TABLE 4. MODELED AVAILABLE GROUNDWATER FOR THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS SUMMARIZED BY COUNTY IN GROUNDWATER MANAGEMENT AREA 13 FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR.

County	Year					
	2010	2020	2030	2040	2050	2060
Atascosa	73,686	74,452	75,964	77,394	79,099	81,004
Bexar	26,278	26,278	26,278	26,278	26,278	26,107
Caldwell	44,850	44,850	44,442	44,442	43,866	43,866
Dimmit	3,359	3,359	3,359	3,359	3,359	3,359
Frio	87,028	84,369	81,830	79,359	76,970	74,614
Gonzales	61,100	70,933	78,934	84,408	84,587	84,587
Guadalup	10,241	10,833	11,283	13,021	13,541	14,041
Karnes	1,059	1,117	1,182	1,231	1,259	1,280
La Salle	7,442	7,442	7,442	7,442	7,442	7,442
Maverick	2,043	2,043	2,024	1,677	1,570	1,532
McMullen	2,045	2,045	2,045	2,045	2,045	2,045
Medina	2,568	2,545	2,533	2,533	2,533	2,533
Uvalde	2,971	1,230	828	828	828	828
Webb	916	916	916	916	916	916
Wilson	37,320	38,549	40,107	41,722	43,632	45,780
Zavala	35,859	35,859	35,521	35,388	35,288	34,969
Total	**398,765**	**406,820**	**414,688**	**422,043**	**423,213**	**424,903**

TABLE 5. MODELED AVAILABLE GROUNDWATER FOR THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS SUMMARIZED BY RIVER BASIN IN GROUNDWATER MANAGEMENT AREA 13 FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR.

Basin	Year					
	2010	2020	2030	2040	2050	2060
Colorado	593	593	593	593	593	593
Guadalupe	114,912	125,378	133,477	140,744	140,930	141,502
Lavaca	273	273	273	273	273	273
Nueces	237,214	233,700	232,100	230,805	230,236	229,708
Rio Grande	2,196	2,196	2,177	2,135	2,028	1,990
San Antonio	43,577	44,680	46,068	47,493	49,153	50,837
Total	**398,765**	**406,820**	**414,688**	**422,043**	**423,213**	**424,903**

TABLE 6. MODELED AVAILABLE GROUNDWATER FOR THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS SUMMARIZED BY REGIONAL WATER PLANNING AREA IN GROUNDWATER MANAGEMENT AREA 13 FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR.

Regional Water	Year					
	2010	2020	2030	2040	2050	2060
L	393,761	401,816	409,703	417,405	418,682	420,410
M	2,959	2,959	2,940	2,593	2,486	2,448
N	2,045	2,045	2,045	2,045	2,045	2,045
Total	**398,765**	**406,820**	**414,688**	**422,043**	**423,213**	**424,903**

TABLE 7. MODELED AVAILABLE GROUNDWATER FOR THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) IN GROUNDWATER MANAGEMENT AREA 13 FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR. UWCD REFERS TO UNDERGROUND WATER CONSERVATION DISTRICT.

Groundwater Conservation District	Year					
	2010	2020	2030	2040	2050	2060
Evergreen UWCD	199,093	198,487	199,083	199,706	200,960	202,678
Gonzales County UWCD*	86,846	96,679	104,680	110,154	110,333	110,333
Guadalupe County	10,241	10,833	11,283	13,021	13,541	14,041
McMullen	2,045	2,045	2,045	2,045	2,045	2,045
Medina County	2,568	2,545	2,533	2,533	2,533	2,533
Plum Creek	18,122	18,122	17,714	17,714	17,138	17,138
Uvalde County UWCD	2,971	1,230	828	828	828	828
Wintergarden	46,660	46,660	46,322	46,189	46,089	45,770
Total (excluding non-district areas)	**368,546**	**376,601**	**384,488**	**392,190**	**393,467**	**395,366**
No District	30,219	30,219	30,200	29,853	29,746	29,537
Total (including non-district areas)	**398,765**	**406,820**	**414,688**	**422,043**	**423,213**	**424,903**

*Note: Gonzales County UWCD includes area in Caldwell County

Appendix A

Estimates of total pumping split by aquifer layers for Groundwater Conservation Districts

Evergreen Underground Water Conservation District		Year					
	Unit or Layer	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Pumping	Sparta	2,171	2,051	1,955	1,868	1,793	1,736
	Queen City	10,803	10,468	10,126	9,735	9,369	9,030
	Carrizo	151,373	151,222	152,256	153,357	155,052	157,166
	Wilcox (Layer 6)	375	375	375	375	375	375
	Wilcox (Layer 7)	371	371	371	371	371	371
	Wilcox (Layer 8)	34,000	34,000	34,000	34,000	34,000	34,000
	Total	**199,093**	**198,487**	**199,083**	**199,706**	**200,960**	**202,678**

Gonzales County Underground Water Conservation District		Year					
	Unit or Layer	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Pumping	Sparta	3,552	3,552	3,552	3,552	3,552	3,552
	Queen City	5,349	5,349	5,349	5,349	5,349	5,349
	Carrizo	45,884	55,717	63,718	69,192	69,371	69,371
	Wilcox (Layer 6)	0	0	0	0	0	0
	Wilcox (Layer 7)	12,159	12,159	12,159	12,159	12,159	12,159
	Wilcox (Layer 8)	19,902	19,902	19,902	19,902	19,902	19,902
	Total	**86,846**	**96,679**	**104,680**	**110,154**	**110,333**	**110,333**

Guadalupe County Groundwater Conservation District		Year					
	Unit or Layer	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Pumping	Carrizo	5,500	6,239	6,689	8,427	9,000	9,500
	Wilcox (Layer 6)	0	0	0	0	0	0
	Wilcox (Layer 7)	3,194	3,047	3,047	3,047	2,994	2,994
	Wilcox (Layer 8)	1,547	1,547	1,547	1,547	1,547	1,547
	Total	**10,241**	**10,833**	**11,283**	**13,021**	**13,541**	**14,041**

McMullen Groundwater Conservation District		Year					
	Unit or Layer	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Pumping	Sparta	90	90	90	90	90	90
	Queen City	136	136	136	136	136	136
	Carrizo	1,819	1,819	1,819	1,819	1,819	1,819
	Total	**2,045**	**2,045**	**2,045**	**2,045**	**2,045**	**2,045**

Medina County Groundwater Conservation District		Year					
	Unit or Layer	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Pumping	Carrizo	400	400	400	400	400	400
	Wilcox (Layer 6)	0	0	0	0	0	0
	Wilcox (Layer 7)	1,248	1,248	1,248	1,248	1,248	1,248
	Wilcox (Layer 8)	920	897	885	885	885	885
	Total	**2,568**	**2,545**	**2,533**	**2,533**	**2,533**	**2,533**

Plum Creek Conservation District		Year					
	Unit or Layer	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Pumping	Queen City	22	22	22	22	22	22
	Carrizo	3,498	3,498	3,498	3,498	3,498	3,498
	Wilcox (Layer 6)	0	0	0	0	0	0
	Wilcox (Layer 7)	4,869	4,869	4,869	4,869	4,293	4,293
	Wilcox (Layer 8)	9,733	9,733	9,325	9,325	9,325	9,325
	Total	**18,122**	**18,122**	**17,714**	**17,714**	**17,138**	**17,138**

Uvalde County Underground Water Conservation District		Year					
	Unit or Layer	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Pumping	Carrizo	828	828	828	828	828	828
	Wilcox (Layer 6)	2,143	402	0	0	0	0
	Total	**2,971**	**1,230**	**828**	**828**	**828**	**828**

Wintergarden Groundwater Conservation District		Year					
	Unit or Layer	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Pumping	Sparta	987	987	987	987	987	987
	Queen City	1	1	1	1	1	1
	Carrizo	31,990	31,990	31,652	31,519	31,419	31,100
	Wilcox (Layer 6)	9,259	9,259	9,259	9,259	9,259	9,259
	Wilcox (Layer 7)	4,007	4,007	4,007	4,007	4,007	4,007
	Wilcox (Layer 8)	416	416	416	416	416	416
	Total	**46,660**	**46,660**	**46,322**	**46,189**	**46,089**	**45,770**

Appendix F
GAM Run 15-002: Medina County Groundwater Conservation District Management Plan

GAM Run 15-002: Medina County Groundwater Conservation District Management Plan

by William Kohlrenken, GISP
Texas Water Development Board
Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 463-8279
June 30, 2015

Cynthia K. Ridgeway is the Manager of the Groundwater Availability Modeling Section and is responsible for oversight of work performed by William Kohlrenken under her direct supervision. The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G. 471 on June 30, 2015.

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GAM RUN 15-002: MEDINA COUNTY GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN

by William Kohlrenken, GISP
Texas Water Development Board
Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 463-8279
June 30, 2015

EXECUTIVE SUMMARY:

Texas State Water Code, Section 36.1071, Subsection (h) (Texas Water Code, 2011), states that, in developing its groundwater management plan, a groundwater conservation district shall use groundwater availability modeling information provided by the executive administrator of the Texas Water Development Board (TWDB) in conjunction with any available site-specific information provided by the district for review and comment to the executive administrator. 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—Part 2 of a two-part package of information from the TWDB to the Medina County Groundwater Conservation District—fulfills the requirements noted above. Part 1 of the two-part package is the Estimated Historical Water Use/State Water Plan data report. The District will receive this data report from the TWDB Groundwater Technical Assistance Section. Questions about the data report can be directed to Mr. Stephen Allen, stephen.allen@twdb.texas.gov, (512) 463-7317.

The groundwater management plan for the Medina County Groundwater Conservation District should be adopted by the district on or before January 14, 2016 and submitted to the executive administrator of the TWDB on or before February 13, 2016. The current management plan for the Medina County Groundwater Conservation District expires on April 13, 2016.

This report discusses the methods, assumptions, and results from model runs using the groundwater availability models for the Hill Country portion of the Trinity Aquifer (Jones and others, 2009) and the southern portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers (Kelley and others, 2004). Please note that the Edwards (Balcones Fault Zone) Aquifer occurs within the boundaries of the Medina County Groundwater Conservation District but is excluded from this report because the district does not have jurisdiction over that aquifer. This model run replaces the results of GAM Run 09-31 (Aschenbach, 2009). GAM Run 15-002 meets current standards set after the release of GAM Run 09-31. Tables 1 and 2 summarize the groundwater availability model data required by statute, and figures 1 and 2 show the area of the models from which the values in the table were extracted. If after review of the figures, the Medina County Groundwater Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the TWDB at your earliest convenience.

The Trinity Aquifer underlies the Edwards (Balcones Fault Zone) Aquifer within the district boundaries. However, the underlying portion of the Trinity Aquifer in not included in the groundwater availability model for the Hill Country portion of the Trinity Aquifer. Information for the Trinity Aquifer underlying the Edwards (Balcones Fault Zone) Aquifer is being provided separately from the Groundwater Technical Assistance Section of the TWDB.

METHODS:

In accordance with the provisions of the Texas State Water Code, Section 36.1071, Subsection (h), the groundwater availability model for the Hill Country portion of the Trinity Aquifer (Jones and others, 2009) and the southern portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers (Kelley and others, 2004) were run for this analysis. Medina County Groundwater Conservation District water budgets were extracted for the historical model period (1981 through 1997 for the Hill Country portion of the Trinity Aquifer and 1980 through 1999 for the southern portion of the Carrizo-Wilcox Aquifer) using ZONEBUDGET Version 3.01 (Harbaugh, 2009). The average annual water budget values for recharge, surface water outflow, inflow to the district, outflow from the district, net inter-aquifer flow (upper), and net inter-aquifer flow (lower) for the portion of the aquifer located within the district is summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Hill Country portion of the Trinity Aquifer System

- Version 2.01 of the groundwater availability model for the Hill Country portion of the Trinity Aquifer System was used for this analysis. See Jones and others (2009) for assumptions and limitations of the groundwater availability model.

- This groundwater availability model includes four layers, which represent the Edwards Group of the Edwards-Trinity (Plateau) Aquifer (Layer 1), the Upper Trinity Aquifer (Layer 2), the Middle Trinity Aquifer (Layer 3), and the Lower Trinity Aquifer (Layer 4).

- An overall water budget for the Medina County Groundwater Conservation District was determined for the Hill Country portion of the Trinity Aquifer System (Layers 2 through 4 collectively for the portions of the model that represent the Trinity Aquifer System).

- The General-Head Boundary (GHB) package of MODFLOW was used to represent flow out of the study area and across the Balcones Fault Zone (BFZ) into the Edwards (BFZ) Aquifer or the deeper Trinity Aquifer units located beneath the Edwards (BFZ). For simplicity, the GHB that corresponds to the uppermost layer of the Trinity Aquifer (Layer 2) was used to represent the flow from the Trinity Aquifer, across the Balcones Fault Zone and into the portion of the Edwards (BFZ) Aquifer within the Edwards Aquifer Authority (EAA) District. This flow is included in the management plan requirement for “estimated annual volume of flow out of the district within each aquifer in the district.” The GHB in Layer 3 was assumed to represent the flow from the Trinity Aquifer, across the Balcones Fault Zone into the deeper Trinity Aquifer units. This flow is not specifically listed in the management plan requirement tables.

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

Carrizo-Wilcox, Queen City, and Sparta Aquifers

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

- This groundwater availability model includes eight layers, which represent the Sparta Aquifer (Layer 1), the Weches Confining Unit (Layer 2), the Queen City Aquifer (Layer 3), the Reklaw Confining Unit (Layer 4), the Carrizo Aquifer (Layer 5), the Upper Wilcox Aquifer, (Layer 6), the Middle Wilcox Aquifer (Layer 7), and the Lower Wilcox Aquifer (Layer 8).
- An overall water budget for the Medina County Groundwater Conservation District was determined for the Carrizo-Wilcox Aquifer (Layers 5 through 8 collectively. The Sparta and Queen City aquifers are not present in Medina County Groundwater Conservation District
- The model was run with MODFLOW-96.

RESULTS:

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

- 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 springs.
- Flow into and out of district—The lateral flow within the aquifer between the district and adjacent counties.
- Flow between aquifers—The net vertical flow between the aquifer and adjacent 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.

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

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

Management Plan requirement	*Aquifer or confining unit*	*Results*
Estimated annual amount of recharge from precipitation to the district	Trinity Aquifer	6,918
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Trinity Aquifer	6,412
Estimated annual volume of flow into the district within each aquifer in the district	Trinity Aquifer	24,023
Estimated annual volume of flow out of the district within each aquifer in the district	Trinity Aquifer	23,176
Estimated net annual volume of flow between each aquifer in the district	Not Applicable*	Not Applicable*

*Not applicable because flow leaving the Trinity Aquifer and entering the Edwards (Balcones Fault Zone) Aquifer is considered flow leaving the district (from Medina County Groundwater Conservation District to the Edwards Aquifer Authority). The model also assumes a no flow barrier at the base of the Lower Trinity unit of the Trinity Aquifer.

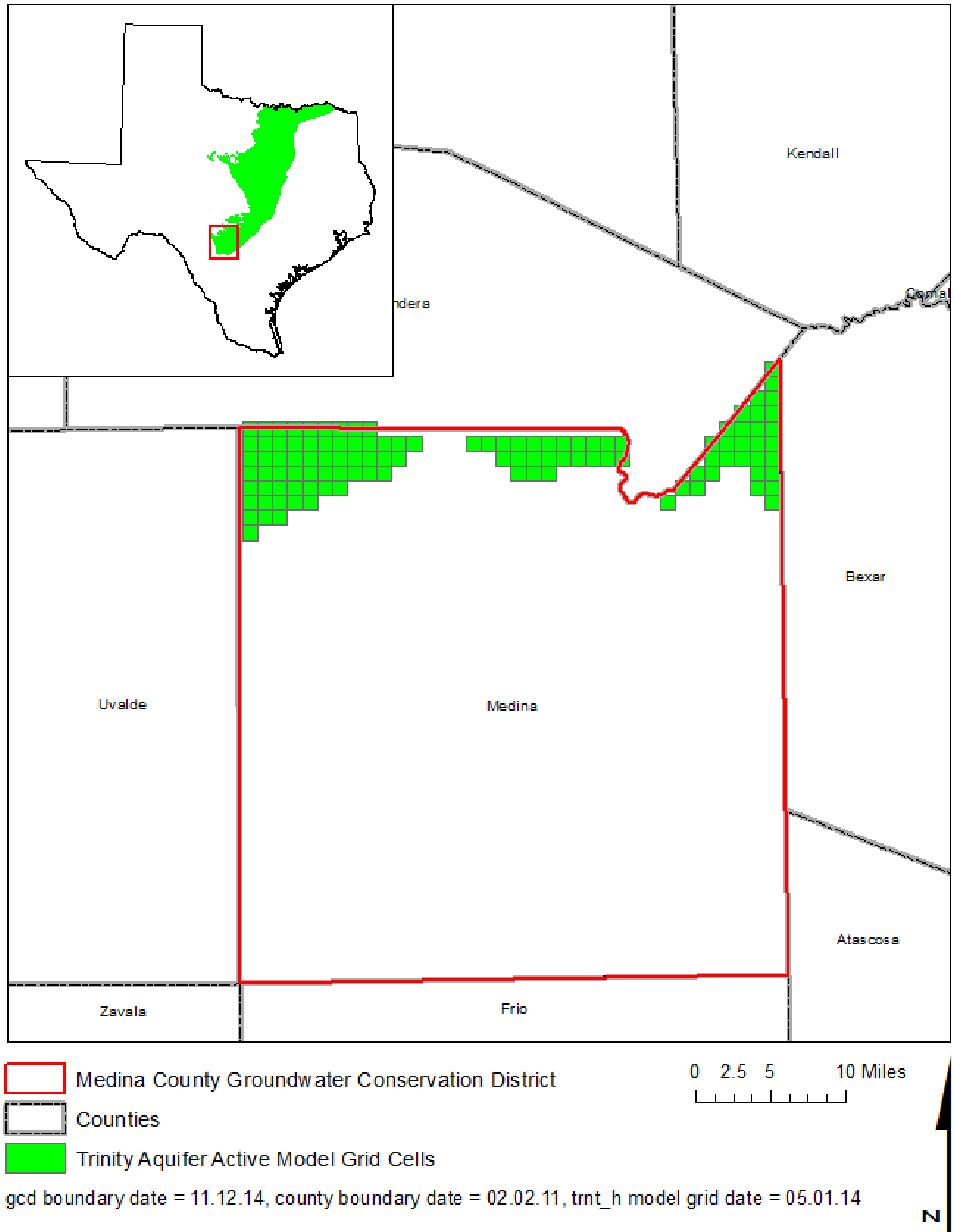

FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE HILL COUNTRY PORTION OF THE TRINITY AQUIFERS FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE TRINITY AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 2: SUMMARIZED INFORMATION FOR THE CARRIZO-WILCOX AQUIFER THAT IS NEEDED FOR THE MEDINA COUNTY GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	*Aquifer or confining unit*	*Results*
Estimated annual amount of recharge from precipitation to the district	Carrizo-Wilcox Aquifer	14,197
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Carrizo-Wilcox Aquifer	588
Estimated annual volume of flow into the district within each aquifer in the district	Carrizo-Wilcox Aquifer	1,294*
Estimated annual volume of flow out of the district within each aquifer in the district	Carrizo-Wilcox Aquifer	30,046*
Estimated net annual volume of flow between each aquifer in the district*	From the Carrizo-Wilcox Aquifer to the Reklaw Formation	14

*The model assumes a no flow barrier at the base of the Carrizo-Wilcox Aquifer.

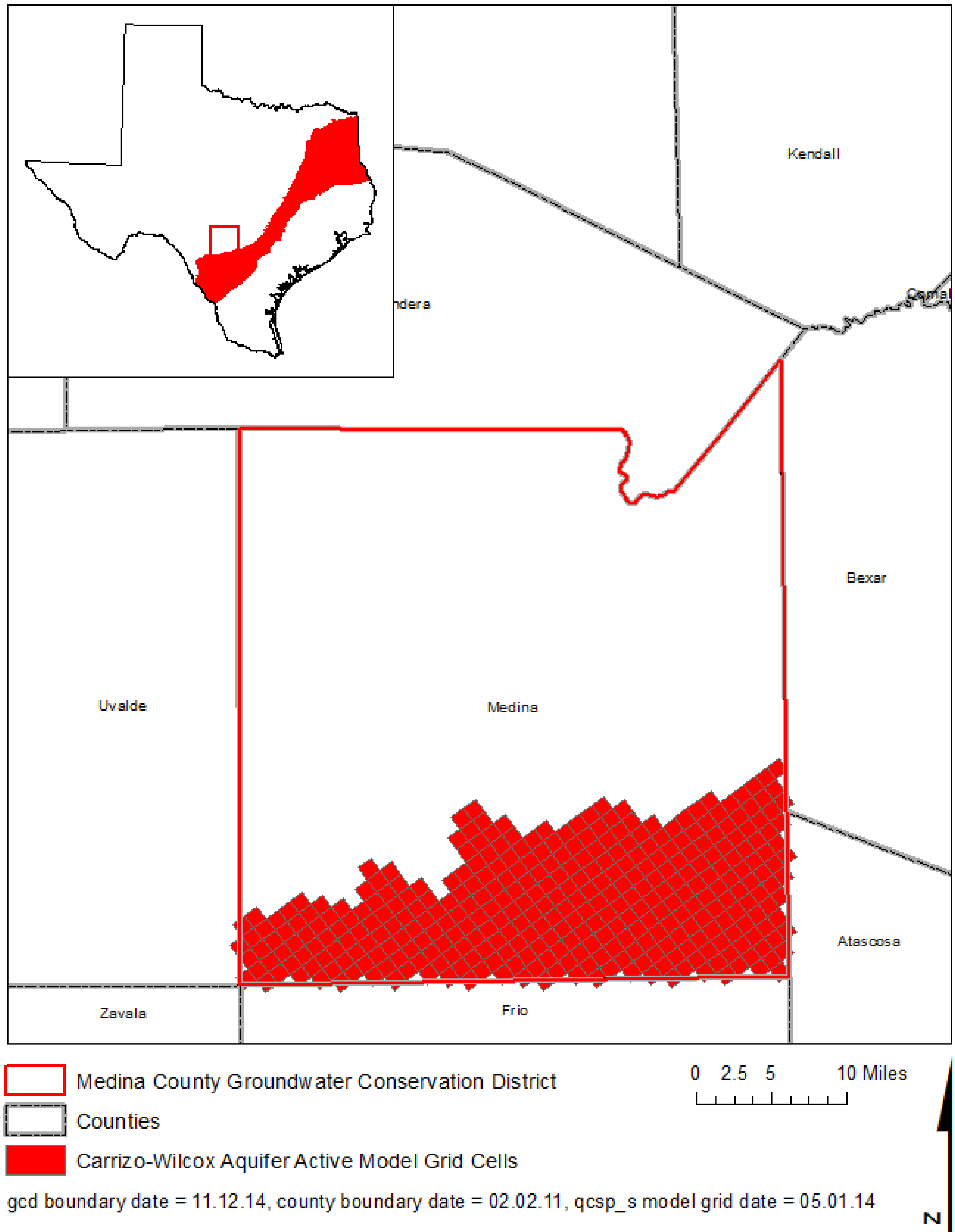

FIGURE 2: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE SOUTHERN PART OF THE CARRIZO-WILCOX AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE CARRIZO-WILCOX AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

LIMITATIONS:

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

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

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

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

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

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Jones, Ian. C., Anaya, R. and Wade, S., 2009, Groundwater Availability Model for the Hill County Portion of the Aquifer System, Texas: Numerical Simulations through 1999- Model Report, 196 p., http://www.twdb.texas.gov/groundwater/models/gam/trnt_h/TRNT_H_2009_Update_Model_Report.pdf.

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

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

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

Appendix G
Estimated Historical Water Use and 2012 State Water Plan Datasets: Medina County Groundwater Conservation District

Estimated Historical Water Use And 2012 State Water Plan Datasets:

Medina County Groundwater Conservation District

by Stephen Allen
Texas Water Development Board
Groundwater Resources Division
Groundwater Technical Assistance Section
stephen.allen@twdb.texas.gov
(512) 463-7317
October 19, 2015

GROUNDWATER MANAGEMENT PLAN DATA:

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

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

The five reports included in 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 Texas 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.

DISCLAIMER:

The data presented in this report represents the most up-to-date WUS and 2012 SWP data available as of 10/19/2015. Although it does not happen frequently, neither of these datasets are static so they are subject to change pending the availability of more accurate WUS data or an amendment to the 2012 SWP. District personnel must review these datasets and correct any discrepancies in order to ensure approval of their groundwater management plan.

The WUS dataset can be verified at this web address:

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

The 2012 SWP dataset can be verified by contacting Sabrina Anderson (sabrina.anderson@twdb.texas.gov or 512-936-0886).

For additional questions regarding this data, please contact Stephen Allen (stephen.allen@twdb.texas.gov or 512-463-7317) 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 year 2014. TWDB staff anticipates the calculation and posting of these estimates at a later date.

MEDINA COUNTY

All values are in acre-fee/year

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2013	GW	9,762	10	70	0	41,317	740	51,899
	SW	119	0	0	0	0	81	200
2012	GW	10,049	63	10	0	44,818	705	55,645
	SW	178	0	0	0	16,301	78	16,557
2011	GW	10,364	56	706	0	60,046	1,486	72,658
	SW	81	0	764	0	39,074	165	40,084
2010	GW	8,750	36	763	0	33,903	1,470	44,922
	SW	75	0	825	0	15,103	163	16,166
2009	GW	8,974	83	735	0	50,266	925	60,983
	SW	83	0	794	0	31,510	103	32,490
2008	GW	9,103	23	707	0	36,694	897	47,424
	SW	0	0	763	0	32,806	100	33,669
2007	GW	8,270	20	0	0	13,415	1,168	22,873
	SW	0	0	0	0	10,802	130	10,932
2006	GW	9,402	19	0	0	53,784	1,143	64,348
	SW	0	0	0	0	16,500	127	16,627
2005	GW	8,671	37	0	0	33,450	1,107	43,265
	SW	0	0	0	0	16,500	123	16,623
2004	GW	7,771	33	0	0	34,945	95	42,844
	SW	0	0	0	0	16,467	1,163	17,630
2003	GW	7,917	8	0	0	29,900	100	37,925
	SW	0	0	0	0	24,192	1,228	25,420
2002	GW	8,158	8	0	0	59,830	96	68,092
	SW	0	0	0	0	16,246	1,179	17,425
2001	GW	8,537	37	0	0	61,176	84	69,834
	SW	0	0	0	0	18,457	1,041	19,498
2000	GW	8,909	59	0	0	43,669	130	52,767
	SW	0	0	0	0	12,753	1,168	13,921

Projected Surface Water Supplies
TWDB 2012 State Water Plan Data

MEDINA COUNTY

All values are in acre-feet/year

RWPG	WUG	WUG Basin	Source Name	2010	2020	2030	2040	2050	2060
L	LIVESTOCK	NUECES	LIVESTOCK LOCAL SUPPLY	558	558	558	558	558	558
L	LIVESTOCK	SAN ANTONIO	LIVESTOCK LOCAL SUPPLY	91	91	91	91	91	91
	Sum of Projected Surface Water Supplies (acre-feet/year)			**649**	**649**	**649**	**649**	**649**	**649**

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.

MEDINA COUNTY

All values are in acre-feet/year

RWPG	WUG	WUG Basin	2010	2020	2030	2040	2050	2060
L	COUNTY-OTHER	NUECES	1,489	1,816	2,108	2,367	2,635	2,876
L	MANUFACTURING	NUECES	67	75	82	89	95	103
L	MINING	NUECES	68	71	72	73	74	75
L	IRRIGATION	NUECES	45,357	43,466	41,655	39,919	38,258	36,665
L	LIVESTOCK	NUECES	1,116	1,116	1,116	1,116	1,116	1,116
L	HONDO	NUECES	1,784	2,001	2,205	2,374	2,548	2,717
L	DEVINE	NUECES	837	850	856	862	878	896
L	LYTLE	NUECES	62	60	59	58	58	58
L	NATALIA	NUECES	330	374	415	450	485	519
L	EAST MEDINA SUD	NUECES	833	944	1,048	1,132	1,221	1,310
L	BENTON CITY WSC	NUECES	414	504	589	661	737	805
L	CASTROVILLE	SAN ANTONIO	680	743	802	854	908	961
L	LACOSTE	SAN ANTONIO	205	222	239	251	265	281
L	IRRIGATION	SAN ANTONIO	9,093	8,713	8,350	8,003	7,669	7,350
L	YANCEY WSC	SAN ANTONIO	832	1,013	1,180	1,328	1,469	1,603
L	EAST MEDINA SUD	SAN ANTONIO	48	54	60	65	70	75
L	BEXAR MET WATER DISTRICT	SAN ANTONIO	24	33	41	47	54	60
L	LIVESTOCK	SAN ANTONIO	182	182	182	182	182	182
L	MINING	SAN ANTONIO	62	64	65	66	67	68
L	COUNTY-OTHER	SAN ANTONIO	38	46	54	60	67	73
	Sum of Projected Water Demands (acre-feet/year)		**63,521**	**62,347**	**61,178**	**59,957**	**58,856**	**57,793**

Projected Water Supply Needs
TWDB 2012 State Water Plan Data

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

MEDINA COUNTY

All values are in acre-feet/year

RWPG	WUG	WUG Basin	2010	2020	2030	2040	2050	2060
L	BENTON CITY WSC	NUECES	173	83	-2	-74	-150	-218
L	BEXAR MET WATER DISTRICT	SAN ANTONIO	-15	-24	-32	-38	-45	-51
L	CASTROVILLE	SAN ANTONIO	-294	-357	-416	-468	-522	-575
L	COUNTY-OTHER	NUECES	91	-236	-528	-787	-1,055	-1,296
L	COUNTY-OTHER	SAN ANTONIO	138	130	122	116	109	103
L	DEVINE	NUECES	146	133	127	121	105	87
L	EAST MEDINA SUD	NUECES	13	-98	-202	-286	-375	-464
L	EAST MEDINA SUD	SAN ANTONIO	0	-6	-12	-17	-22	-27
L	HONDO	NUECES	-319	-536	-740	-909	-1,083	-1,252
L	IRRIGATION	NUECES	-7,770	-5,879	-4,068	-2,332	-671	922
L	IRRIGATION	SAN ANTONIO	2,776	3,156	3,519	3,866	4,200	4,519
L	LACOSTE	SAN ANTONIO	-92	-109	-126	-138	-152	-168
L	LIVESTOCK	NUECES	0	0	0	0	0	0
L	LIVESTOCK	SAN ANTONIO	0	0	0	0	0	0
L	LYTLE	NUECES	-16	-14	-13	-12	-12	-12
L	MANUFACTURING	NUECES	896	888	881	874	868	860
L	MINING	NUECES	7	4	3	2	1	0
L	MINING	SAN ANTONIO	6	4	3	2	1	0
L	NATALIA	NUECES	-194	-238	-279	-314	-349	-383
L	YANCEY WSC	SAN ANTONIO	-214	-395	-562	-710	-851	-985
	Sum of Projected Water Supply Needs (acre-feet/year)		**-8,914**	**-7,892**	**-6,980**	**-6,085**	**-5,287**	**-5,431**

Projected Water Management Strategies
TWDB 2012 State Water Plan Data

MEDINA COUNTY

WUG, Basin (RWPG)

All values are in acre-feet/year

Water Management Strategy	Source Name [Origin]	2010	2020	2030	2040	2050	2060
BENTON CITY WSC, NUECES (L)							
LOCAL GROUNDWATER CARRIZO-WILCOX AQUIFER (INCLUDES OVERDRAFTS)	CARRIZO-WILCOX AQUIFER [ATASCOSA]	0	0	154	154	153	306
MUNICIPAL WATER CONSERVATION	CONSERVATION [MEDINA]	0	0	0	4	16	29
BEXAR MET WATER DISTRICT, SAN ANTONIO (L)							
LOCAL GROUNDWATER CARRIZO-WILCOX AQUIFER (INCLUDES OVERDRAFTS)	CARRIZO-WILCOX AQUIFER [BEXAR]	15	24	32	38	45	51
CASTROVILLE, SAN ANTONIO (L)							
DROUGHT MANAGEMENT	DROUGHT MANAGEMENT [MEDINA]	34	0	0	0	0	0
EDWARDS TRANSFERS	EDWARDS-BFZ AQUIFER [UVALDE]	294	357	416	468	522	575
FACILITIES EXPANSION	EDWARDS-BFZ AQUIFER [MEDINA]	0	0	0	0	0	0
MUNICIPAL WATER CONSERVATION	CONSERVATION [MEDINA]	53	111	176	242	270	302
COUNTY-OTHER, NUECES (L)							
EDWARDS TRANSFERS	EDWARDS-BFZ AQUIFER [UVALDE]	0	236	528	787	1,055	1,296
MUNICIPAL WATER CONSERVATION	CONSERVATION [MEDINA]	0	20	41	86	160	244
DEVINE, NUECES (L)							
MUNICIPAL WATER CONSERVATION	CONSERVATION [MEDINA]	63	127	152	159	175	196
EAST MEDINA SUD, NUECES (L)							
EDWARDS TRANSFERS	EDWARDS-BFZ AQUIFER [UVALDE]	0	98	202	286	375	464
MUNICIPAL WATER CONSERVATION	CONSERVATION [MEDINA]	0	0	0	0	19	54
EAST MEDINA SUD, SAN ANTONIO (L)							
DROUGHT MANAGEMENT	DROUGHT MANAGEMENT [MEDINA]	44	0	0	0	0	0
EDWARDS TRANSFERS	EDWARDS-BFZ AQUIFER [UVALDE]	0	6	12	17	22	27

Projected Water Management Strategies
TWDB 2012 State Water Plan Data

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

Water Management Strategy	Source Name [Origin]	2010	2020	2030	2040	2050	2060
HONDO, NUECES (L)							
DROUGHT MANAGEMENT	DROUGHT MANAGEMENT [MEDINA]	89	0	0	0	0	0
EDWARDS TRANSFERS	EDWARDS-BFZ AQUIFER [UVALDE]	319	536	740	910	1,083	1,252
MUNICIPAL WATER CONSERVATION	CONSERVATION [MEDINA]	125	289	420	477	551	640
IRRIGATION, NUECES (L)							
IRRIGATION WATER CONSERVATION	CONSERVATION [MEDINA]	7,770	5,879	4,068	2,332	671	0
LACOSTE, SAN ANTONIO (L)							
DROUGHT MANAGEMENT	DROUGHT MANAGEMENT [MEDINA]	10	0	0	0	0	0
EDWARDS TRANSFERS	EDWARDS-BFZ AQUIFER [UVALDE]	92	109	126	138	152	168
MUNICIPAL WATER CONSERVATION	CONSERVATION [MEDINA]	0	0	0	0	4	11
LYTLE, NUECES (L)							
EDWARDS TRANSFERS	EDWARDS-BFZ AQUIFER [ATASCOSA]	16	14	13	12	12	12
MUNICIPAL WATER CONSERVATION	CONSERVATION [MEDINA]	3	5	6	6	7	8
NATALIA, NUECES (L)							
DROUGHT MANAGEMENT	DROUGHT MANAGEMENT [MEDINA]	17	0	0	0	0	0
EDWARDS TRANSFERS	EDWARDS-BFZ AQUIFER [UVALDE]	194	238	279	314	349	383
MUNICIPAL WATER CONSERVATION	CONSERVATION [MEDINA]	24	31	38	46	58	73
YANCEY WSC, SAN ANTONIO (L)							
EDWARDS TRANSFERS	EDWARDS-BFZ AQUIFER [UVALDE]	214	395	562	710	851	985
MUNICIPAL WATER CONSERVATION	CONSERVATION [MEDINA]	61	136	171	214	259	316
Sum of Projected Water Management Strategies (acre-feet/year)		**9,437**	**8,611**	**8,136**	**7,400**	**6,809**	**7,392**

Appendix H
Water Management Strategies from the 2012 State water Plan, Chapter 7

Quick Facts

Municipal conservation strategies are expected to result in about 650,000 acre-feet of supply by 2060, with irrigation and other conservation strategies totaling another 1.5 million acre-feet per year.

The planning groups recommended 26 new major reservoirs projected to generate approximately 1.5 million acre-feet per year by 2060. Other surface water strategies would result in about 3 million acre-feet per year.

Recommended strategies relying on groundwater are projected to result in about 800,000 additional acre-feet per year by 2060.

7 Water Management Strategies

The regional planning groups recommended 562 unique water supply projects designed to meet needs for additional water supplies for Texas during drought, resulting in a total, if implemented, of 9.0 million acre-feet per year in additional water supplies by 2060. Some recommended strategies are associated with demand reduction or making supplies physically or legally available to users.

After identifying surpluses and needs for water in their regions, regional water planning groups evaluate and recommend water management strategies to meet the needs for water during a severe drought. Planning groups must address the needs of all water users, if feasible. If existing supplies do not meet future demand, they recommend specific water management strategies to meet water supply needs, such as conservation of existing water supplies, new surface water and groundwater development, conveyance facilities to move available or newly developed water supplies to areas of need, water reuse, and others.

TWDB may provide financial assistance for water supply projects only if the needs to be addressed by the project will be addressed in a manner that is consistent with the regional water plans and the state water plan. This same provision applies to the granting of water right permits by the Texas Commission on Environmental Quality, although the governing bodies of these agencies may grant a waiver to the consistency requirement. TWDB funding programs that are targeted at the implementation of state water plan projects, such as the Water Infrastructure Fund, further require that projects must be recommended water management strategies in the regional water plans and the state water plan to be eligible for financial assistance.

TABLE 7.1. RECOMMENDED WATER MANAGEMENT STRATEGY SUPPLY VOLUMES BY REGION (ACRE-FEET PER YEAR)

Region	2010	2020	2030	2040	2050	2060
A	2,718	332,468	545,207	617,843	631,629	648,221
B	15,373	40,312	40,289	49,294	76,252	77,003
C	79,898	674,664	1,131,057	1,303,003	2,045,260	2,360,302
D	11,330	16,160	20,180	33,977	62,092	98,466
E	3,376	66,225	79,866	98,816	112,382	130,526
F	90,944	157,243	218,705	236,087	235,400	235,198
G	137,858	405,581	436,895	496,528	562,803	587,084
H	378,759	622,426	863,980	1,040,504	1,202,010	1,501,180
I	53,418	363,106	399,517	427,199	607,272	638,076
J	13,713	16,501	20,360	20,862	20,888	23,010
K	350,583	576,795	554,504	571,085	565,296	646,167
L	188,297	376,003	542,606	571,553	631,476	765,738
M	90,934	182,911	275,692	389,319	526,225	673,846
N	46,954	81,020	130,539	130,017	133,430	156,326
O	517,459	503,886	504,643	464,588	429,136	395,957
P	67,739	67,739	67,739	67,740	67,739	67,739
Total	**2,049,353**	**4,483,040**	**5,831,779**	**6,518,415**	**7,909,290**	**9,004,839**

7.1 EVALUATION AND SELECTION OF WATER MANAGEMENT STRATEGIES

After the water demand and supply comparisons and needs analyses were completed, planning groups evaluated potentially feasible water management strategies to meet the needs for water within their regions. A water management strategy is a plan or a specific project to meet a need for additional water by a discrete user group, which can mean increasing the total water supply or maximizing an existing supply. Strategies can include development of new groundwater or surface water supplies; conservation; reuse; demand management; expansion of the use of existing supplies such as improved operations or conveying water from one location to another; or less conventional methods like weather modification, brush control, and desalination.

Factors used in the water management strategy assessment process include

- the quantity of water the strategy could produce;
- capital and annual costs;
- potential impacts the strategy could have on the state's water quality, water supply, and agricultural and natural resources (Chapter 8, Impacts of Plans); and
- reliability of the strategy during time of drought.

Calculating the costs of water management strategies is done using uniform procedures to compare costs between regions and over time, since some strategies are recommended for immediate implementation, while others are needed decades into the future. Cost assumptions include expressing costs in 2008 dollars, using a 20-year debt service schedule, using capital costs of construction as well as annual operation and maintenance costs, and providing unit costs per acre-foot of water produced.

Reliability is an evaluation of the continued availability of an amount of water to the users over time, but particularly during drought. A water management strategy's reliability is considered high if water is determined to be available to the user all the time, but

TABLE 7.2. RECOMMENDED WATER MANAGEMENT STRATEGY SUPPLY VOLUMES BY TYPE OF STRATEGY (ACRE-FEET PER YEAR)

Type of Water Management Strategy	2010	2020	2030	2040	2050	2060
Municipal Conservation	137,847	264,885	353,620	436,632	538,997	647,361
Irrigation Conservation	624,151	1,125,494	1,351,175	1,415,814	1,463,846	1,505,465
Other Conservation *	4,660	9,242	15,977	18,469	21,371	23,432
New Major Reservoir	19,672	432,291	918,391	948,355	1,230,573	1,499,671
Other Surface Water	742,447	1,510,997	1,815,624	2,031,532	2,700,690	3,050,049
Groundwater	254,057	443,614	599,151	668,690	738,484	800,795
Reuse	100,592	428,263	487,795	637,089	766,402	915,589
Groundwater Desalination	56,553	81,156	103,435	133,278	163,083	181,568
Conjunctive Use	26,505	88,001	87,496	113,035	136,351	135,846
Aquifer Storage and Recovery	22,181	61,743	61,743	72,243	72,243	80,869
Weather Modification	0	15,206	15,206	15,206	15,206	15,206
Drought Management	41,701	461	461	461	461	1,912
Brush Control	18,862	18,862	18,862	18,862	18,862	18,862
Seawater Desalination	125	125	143	6,049	40,021	125,514
Surface Water Desalination	0	2,700	2,700	2,700	2,700	2,700
Total Supply Volumes	**2,049,353**	**4,483,040**	**5,831,779**	**6,518,415**	**7,909,290**	**9,004,839**

*Other conservation is associated with manufacturing, mining, and steam-electric power industries.

it is considered low or moderate if the availability is contingent on other factors.

The water management strategy evaluation process also considered other factors applicable to individual regions including difficulty of implementation, regulatory issues, regional or local political issues, impacts to recreation, and socioeconomic benefits or impacts.

Upon conclusion of a thorough evaluation process, planning groups recommended a combination of water management strategies to meet specific needs in their regions during a repeat of the drought of record. In this planning cycle, planning groups could also include alternative water management strategies in their plans. An alternative strategy may be substituted for a strategy that is no longer recommended, under certain conditions and with the approval of the TWDB executive administrator. All recommended and alternative water management strategies included in the 2011 regional water plans are presented in Appendix A.

7.2 SUMMARY OF RECOMMENDED WATER MANAGEMENT STRATEGIES

To meet the needs for water during a repeat of the drought of record, regional water planning groups evaluated and recommended water management strategies that would account for an additional 9.0 million acre-feet per year of water by 2060 if all are implemented (Tables 7.1 and 7.2). These strategies included 562 unique water supply projects designed to meet needs for additional water supplies for Texas during drought (this figure is lower than presented in previous plans because it does not separately count each entity participating in a given project).

7.2.1 WATER CONSERVATION

Conservation focuses on efficiency of use and the reduction of demands on existing water supplies. In 2010, almost 767,000 acre-feet per year of water conservation savings is recommended, increasing to nearly 2.2 million acre-feet per year by 2060 from all forms of conservation strategies (Table 7.3). Some of the savings from water conservation practices are achieved

TABLE 7.3. SUPPLY VOLUMES FROM RECOMMENDED CONSERVATION STRATEGIES BY REGION (ACRE-FEET PER YEAR)

Region	2010	2020	2030	2040	2050	2060
A	0	299,077	488,721	544,840	553,661	556,914
B	13,231	13,798	13,833	13,875	13,891	14,702
C	46,780	107,975	154,950	197,288	240,912	290,709
D	0	0	0	0	0	0
E	0	33,275	37,275	41,275	46,275	52,275
F	3,197	43,113	80,551	81,141	81,769	82,423
G	10,857	24,873	31,473	33,757	38,011	41,758
H	116,880	137,151	147,529	156,336	172,831	183,933
I	20,111	30,480	33,811	36,085	41,381	41,701
J	579	622	641	643	669	681
K	18,498	169,207	179,630	192,541	221,622	241,544
L	33,843	41,032	47,818	53,944	64,761	82,297
M	15,743	54,469	102,047	154,932	217,882	286,629
N	1,664	2,449	3,398	4,466	5,766	7,150
O	485,275	442,100	399,095	359,792	324,783	293,542
P	0	0	0	0	0	0
Total	**766,658**	**1,399,621**	**1,720,772**	**1,870,915**	**2,024,214**	**2,176,258**

passively in the normal course of daily activities, such as flushing a low-flow toilet or showering with a low-flow showerhead. Other savings are achieved through education and programs designed specifically to reduce water usage. Conservation includes water savings from municipal, irrigation, and "other" (mining, manufacturing, and power generation) water users. Water conservation is being recommended in greater quantities over time. Comparing the 2007 State Water Plan with the 2012 plan, there is an additional 129,400 acre-feet of water conservation recommended in the current plan.

7.2.2 SURFACE WATER STRATEGIES

Surface water strategies include stream diversions, new reservoirs, other surface water strategies such as new or expanded contracts or connection of developed supplies, and operational changes.

One long-term trend in Texas is the relative shift from reliance on groundwater to surface water. The volume of water produced by surface water strategies recommended in 2060 is five times greater than that produced by recommended groundwater strategies. Surface water strategies, excluding desalination and non-traditional strategies, compose about 51 percent of the recommended volume of new water, compared to 9 percent from groundwater strategies in the 2012 State Water Plan. Surface water management strategies recommended by the regional planning groups total in excess of 4.5 million acre-feet per year by 2060.

In the 2012 State Water Plan, 26 new major reservoirs are recommended to meet water needs in several regions (Figure 7.1). A major reservoir is defined as one having 5,000 or more acre-feet of conservation storage. These new reservoirs would produce 1.5 million acre-feet per year in 2060 if all are built, representing 16.7 percent of the total volume of all recommended strategies for 2060 combined (Figure 7.2). Not surprisingly, the majority of these projects would be located east of the Interstate Highway-35 corridor where rainfall and resulting runoff are more plentiful than in the western portion of the state.

FIGURE 7.1. RECOMMENDED NEW MAJOR RESERVOIRS.

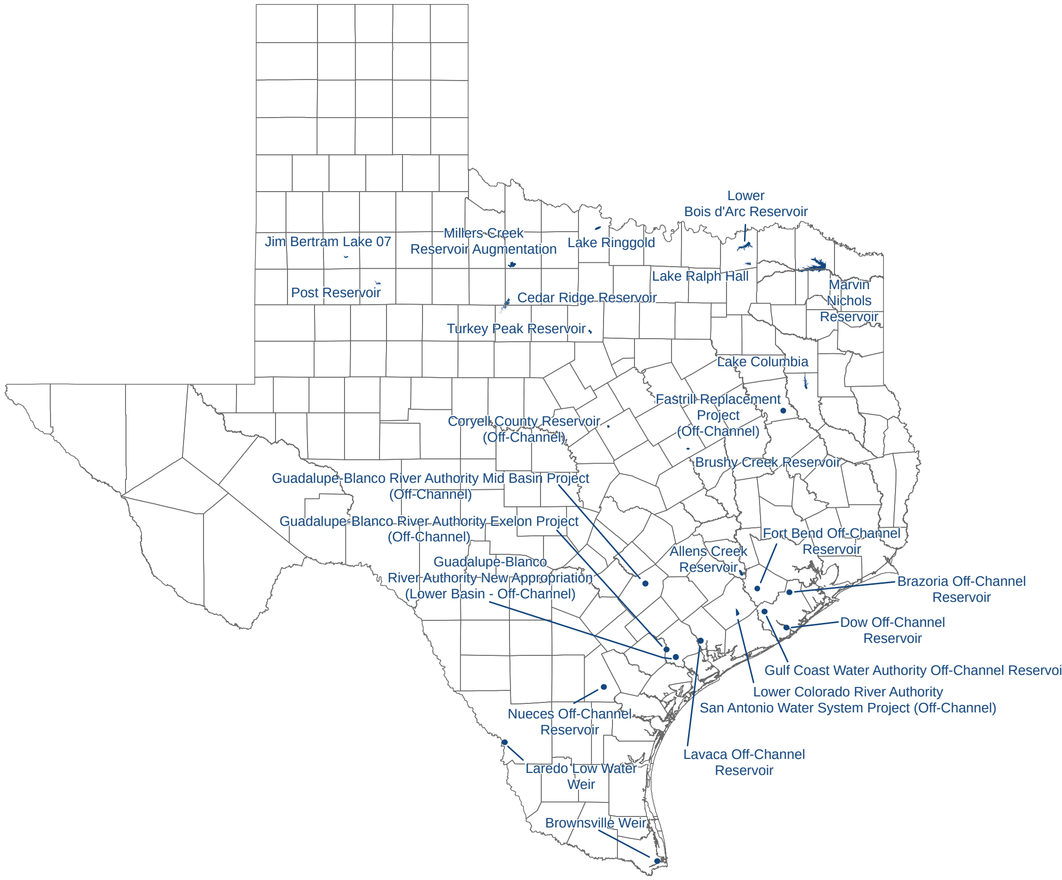


FIGURE 7.2. RELATIVE VOLUMES OF RECOMMENDED WATER MANAGEMENT STRATEGIES IN 2060.

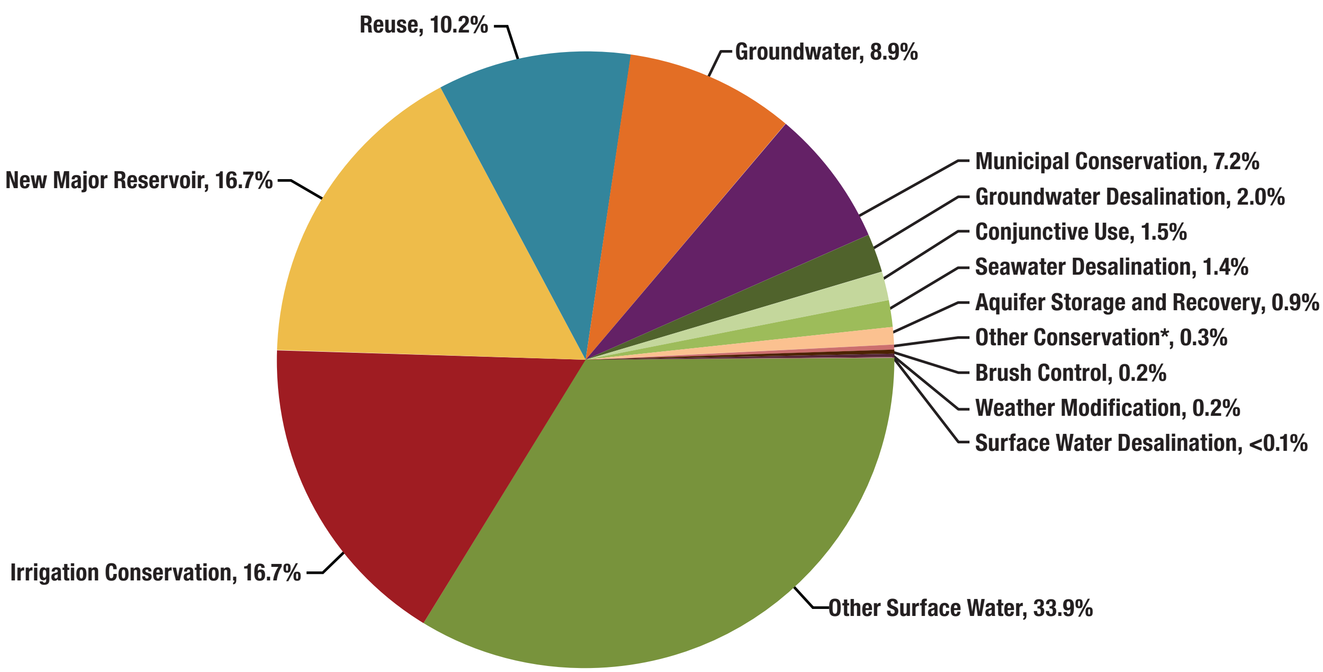
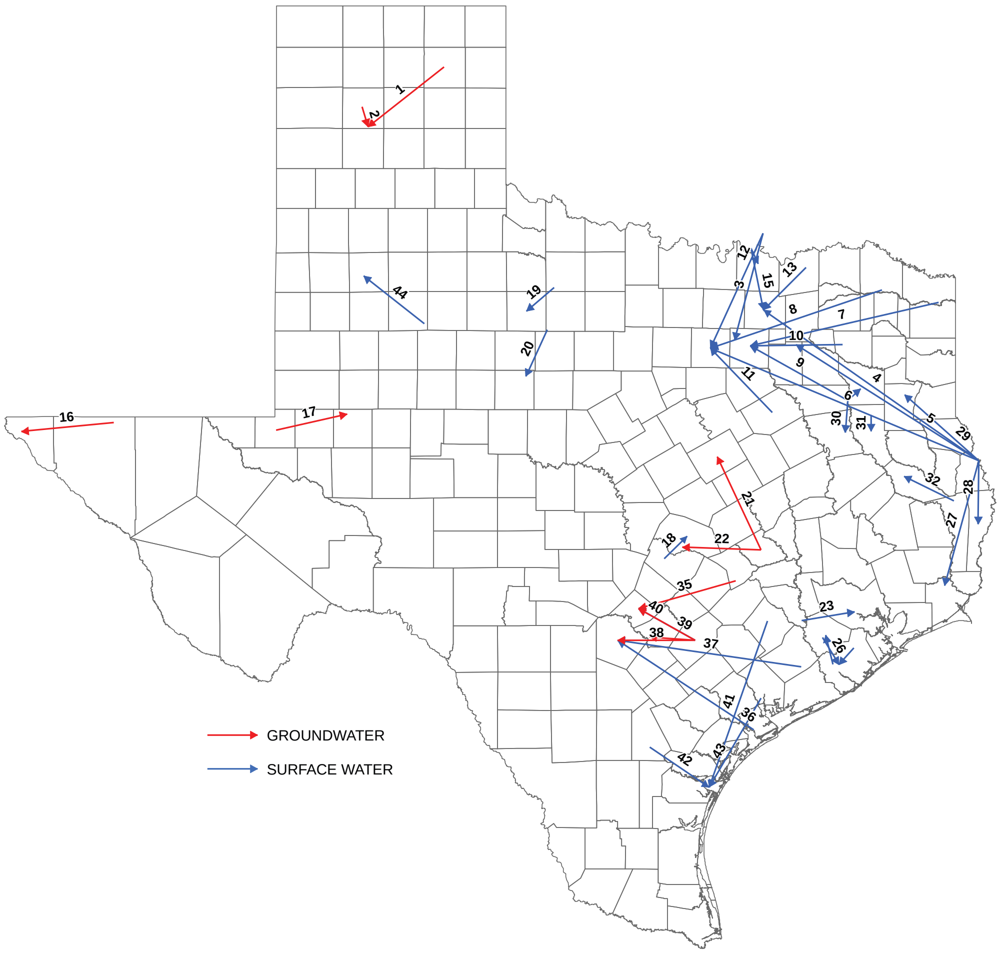


FIGURE 7.3. RECOMMENDED GROUND AND SURFACE WATER CONVEYANCE AND TRANSFER PROJECTS.



"Other surface water" strategies include existing supplies that are not physically or legally available at the present time. Examples include an existing reservoir that has no pipeline to convey water to some or all users, a water user that does not have a water supply contract with the appropriate water supplier, or an entity that has no "run-of-river" water right to divert water for use.

Other surface water strategies are recommended to provide in excess of 742,400 acre-feet per year of supply in 2010, and about 3 million acre-feet per year by 2060. Other surface water is the largest water management strategy category recommended, and usually requires additional infrastructure such as new pipelines to divert and convey water from an existing source to a new point of use. Transporting water from existing, developed sources such as reservoirs, to a new point of use many miles away, is very common in Texas and will become more prevalent in the future. An example is the current project to construct a joint pipeline from Lake Palestine to transport water to Dallas and water from Tarrant Regional Water District's lakes to Fort Worth. Figure 7.3 and Table 7.4 depict recommended major groundwater and surface water conveyance and transfer projects.

TABLE 7.4. RECOMMENDED GROUND AND SURFACE WATER CONVEYANCE AND TRANSFER PROJECTS

ID	Project	Conveyance From	To
1	Roberts County Well Field	Roberts County	Amarillo
2	Potter County Well Field	Potter County	Amarillo
3	Oklahoma Water to Irving	Oklahoma Lake/Reservoir	Irving
4	Toledo Bend Project	Toledo Bend Reservoir	Collin County
5	Toledo Bend Project	Toledo Bend Reservoir	Kaufman County
6	Toledo Bend Project	Toledo Bend Reservoir	Tarrant County
7	Wright Patman - Reallocation of Flood Pool	Wright Patman Lake	Dallas
8	Marvin Nichols Reservoir	Marvin Nichols Reservoir	Colin, Denton, Tarrant Counties
9	Lake Palestine Connection (Integrated Pipeline with Tarrant Regional Water District)	Lake Palestine	Dallas
10	Additional Pipeline From Lake Tawakoni (More Lake Fork Supply)	Lake Fork	Dallas
11	Tarrant Regional Water District Third Pipeline and Reuse	Navarro County	Tarrant County
12	Oklahoma Water to North Texas Municipal Water District, Tarrant Regional Water District, Upper Trinity Regional Water District	Oklahoma Lake/Reservoir	Colin, Denton, Tarrant Counties
13	Lower Bois D'Arc Creek Reservoir	Lower Bois D'Arc Reservoir	Collin County
14	Grayson County Project	Lake Texoma Non-System Portion	Collin, Grayson Counties
15	Lake Texoma - Authorized (Blend)	Lake Texoma North Texas Municipal Water District System	Collin County
16	Integrated Water Management Strategy - Import From Dell Valley	Dell City	El Paso
17	Develop Cenozoic Aquifer Supplies	Winkler County	Midland
18	Regional Surface Water Supply	Lake Travis	Williamson County
19	Millers Creek Augmentation	Millers Creek Reservoir	Haskell County
20	Cedar Ridge Reservoir	Cedar Ridge Reservoir	Abilene
21	Conjunctive Use (Lake Granger Augmentation)	Burleson County	Mclennan
22	Conjunctive Use (Lake Granger Augmentation)	Burleson County	Round Rock
23	Allens Creek Reservoir	Allens Creek Lake/Reservoir	Houston
24	Gulf Coast Water Authority Off-Channel Reservoir	Gulf Coast Water Authority Off-Channel Reservoir	Fort Bend County
25	Brazoria Off-Channel Reservoir	Brazoria Off-Channel Reservoir	Brazoria County
26	Fort Bend Off-Channel Reservoir	Fort Bend Off-Channel Lake/Reservoir	Brazoria County
27	Purchased Water	Toledo Bend Reservoir	Jefferson County
28	Purchased Water	Toledo Bend Reservoir	Newton County
29	Purchased Water	Toledo Bend Reservoir	Rusk County
30	Purchased Water	Lake Palestine	Anderson County
31	Lake Columbia	Lake Columbia	Cherokee County
32	Angelina County Regional Project	Sam Rayburn-Steinhagen Reservoir System	Lufkin
33	Lake Palestine Infrastructure	Lake Palestine	Tyler
34	Regional Carrizo For Schertz-Seguin Local Government Corporation Project Expansion	Gonzales County	Guadalupe County
35	Guadalupe-Blanco River Authority Simsboro Project	Lee County	Comal County
36	Seawater Desalination	Gulf Of Mexico Sea Water	Bexar County
37	Off-Channel Reservoir - Lower Colorado River Authority/ San Antonio Water System Project (Region L Component)	Colorado, Matagorda, Wharton Counties	Bexar County
38	Regional Carrizo For Saws (Including Gonzales County)	Gonzales County	Bexar County
39	Guadalupe-Blanco River Authority Mid-Basin (Surface Water)	Gonzales County	Comal County
40	Texas Water Alliance Regional Carrizo (Including Gonzales County)	Carrizo-Wilcox Aquifer	Comal County
41	Garwood Pipeline And Off-Channel Reservoir Storage	Colorado River	Corpus Christi
42	Off-Channel Reservoir Near Lake Corpus Christi	Nueces Off-Channel Reservoir	Corpus Christi
43	Lavaca River Off-Channel Reservoir Diversion Project	Lavaca Off-Channel Reservoir	Corpus Christi
44	Lake Alan Henry Pipeline	Lake Alan Henry	Lubbock

Some regions recommended operational improvement strategies for existing reservoirs to increase their efficiency by working in tandem with one or more other reservoirs as a system. "System operations" involves operating multiple reservoirs as a system to gain the maximum amount of water supply from them.

Reallocation of reservoir storage from one approved purpose to another is a strategy that was recommended by some regions to meet needs from existing reservoirs. This reallocation requires formal changes in the way reservoirs are operated and shifts more of the storage space from flood control or hydro-electric power generation to water supply. If the operational change involves a federal agency such as the U.S. Army Corps of Engineers, congressional approval is required if the reallocation involves more than 50,000 acre-feet. These operational changes may come at a cost, however. Compensation for lost electrical generation will likely be required for hydro-electric storage reallocation, and additional property damages from flooding are possible if flood storage capacity is reduced.

7.2.3 GROUNDWATER STRATEGIES

Groundwater management strategies recommended in the regional water plans total 254,057 acre-feet in 2010 and increasing to 800,795 acre-feet in 2060. Additional recommendations for groundwater desalination of 56,553 acre-feet in 2010 and 181,568 acre-feet in 2060 result in a total of 310,610 acre-feet of groundwater in 2010 and 982,363 acre-feet in 2060. Desalination of brackish groundwater and other groundwater management strategies compose about 11 percent of the total volume of water from recommended strategies in 2060. Not including desalination, the recommended groundwater strategies involve some combination of the following: 1) installing new wells; 2) increasing production from existing wells; 3) installing supplemental wells; 4) temporarily over-drafting aquifers to supplement supplies; 5) building, expanding, or replacing treatment plants to make groundwater meet water quality standards; and 6) reallocating or transferring groundwater supplies from areas where projections indicate that surplus groundwater will exist to areas with needs.

7.2.4 WATER REUSE STRATEGIES

Water management strategies involving reuse are recommended to provide roughly 100,600 acre-feet per year of water in 2010, increasing to approximately 915,600 acre-feet per year in 2060. This represents slightly more than 10 percent of the volume of water produced by all strategies in 2060. Reuse projects in the 2012 State Water Plan produce approximately 348,000 acre-feet less water than those recommended in 2007. This is directly related to several recommended wastewater effluent reuse projects that were funded through TWDB's Water Infrastructure Fund and have been implemented in the intervening five-year period.

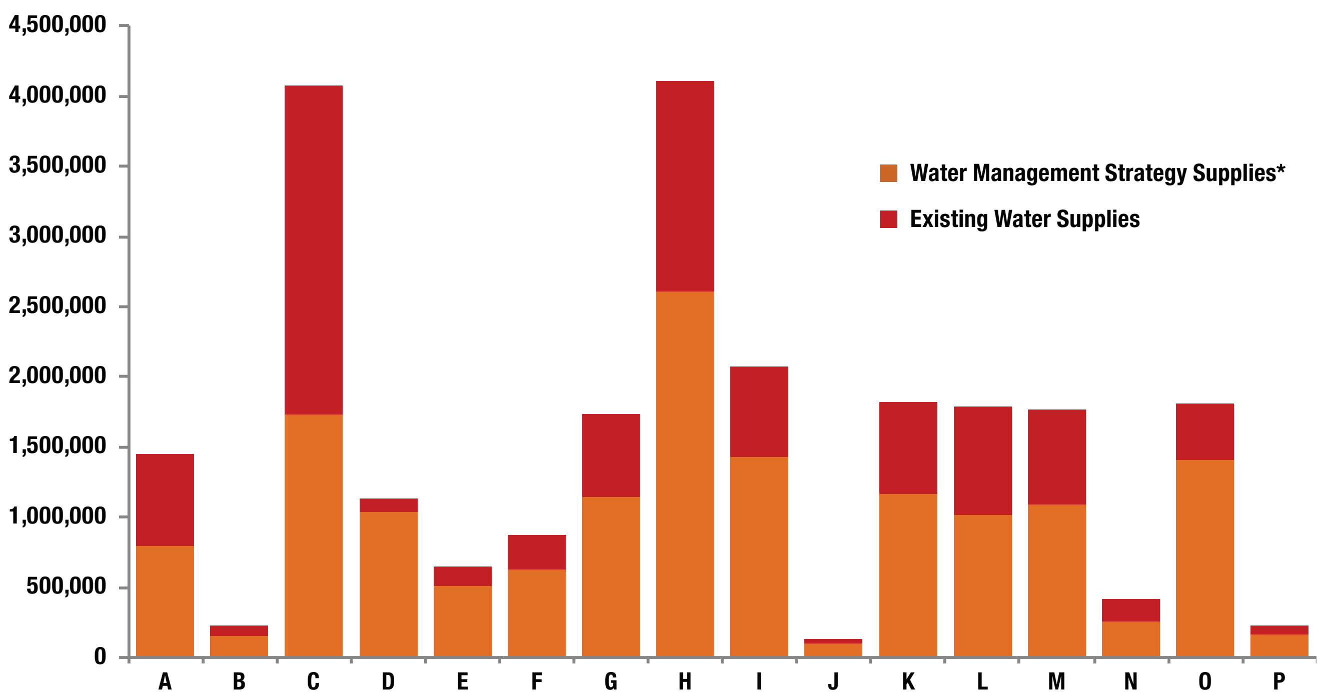
Direct reuse projects in which the wastewater never leaves the treatment system until it is conveyed through a pipeline to the point of use do not require an additional conveyance permit. These projects are commonly used to provide water for landscapes, parks, and other irrigation in many Texas communities.

Indirect reuse involves discharge of wastewater into a stream and later routing or diverting it for treatment as water supply. Since the wastewater is discharged into state water for conveyance downstream, it requires authorization known as a "bed and banks permit" from the Texas Commission on Environmental Quality.

TABLE 7.5. RECOMMENDED WATER MANAGEMENT STRATEGY CAPITAL COSTS BY REGION (MILLIONS OF DOLLARS)

Region	2010	2020	2030	2040	2050	2060	Total
A	$187	$129	$137	$287	—	—	$739
B	$110	—	—	$7	$383	—	$499
C	$9,922	$3,976	$3,891	$928	$17	$2,747	$21,482
D	$39	—	—	—	—	—	$39
E	—	$382	—	$246	$214	—	$842
F	$223	$439	$252	—	—	—	$915
G	$2,064	$745	$94	$273	$10	—	$3,186
H	$4,710	$4,922	$287	$1,135	$458	$506	$12,019
I	$363	$350	$79	$80	—	$12	$885
J	$11	$44	—	—	—	—	$55
K	$663	$67	$4	$169	—	$4	$907
L	$1,022	$2,973	$2,321	$2	$12	$1,294	$7,623
M	$2,070	$124	—	—	—	—	$2,195
N	$45	$113	$360	—	—	$139	$656
O	$669	$273	$167	—	—	—	$1,108
P	—	—	—	—	—	—	—
Total	**$22,097**	**$14,537**	**$7,592**	**$3,127**	**$1,095**	**$4,702**	**$53,150**

FIGURE 7.4. EXISTING SUPPLIES AND RECOMMENDED WATER MANAGEMENT STRATEGY SUPPLIES BY REGION (ACRE-FEET PER YEAR).



* Some water management strategies include demand reduction or shifts of existing supplies to other users.

Using artificially created wetlands to provide biological treatment such as nutrient uptake, the Tarrant Regional Water District was the first wholesale water provider in Texas to discharge treated wastewater through a natural filtering system before returning the water to its water supply lakes. This provides an additional source of water, which then can be diverted to water treatment plants for potable use. Similar indirect reuse projects are being implemented by other water suppliers in north Texas, and additional projects are in the planning stages.

7.2.5 OTHER STRATEGIES

Conjunctive use is the combined use of multiple sources that optimizes the beneficial characteristics of each source. Approximately 136,000 acre-feet of water per year is recommended by 2060 from this strategy.

Weather modification, sometimes referred to as cloud seeding, is the application of scientific technology that can enhance a cloud's ability to produce precipitation. More than 15,000 acre-feet per year of new supply is recommended from this strategy for all decades between 2020 and 2060 in Region A.

Drought management is a temporary demand reduction technique based on groundwater or surface water supply levels of a particular utility. Unlike conservation, which can be practiced most or all of the time, drought management is temporary and is usually associated with summer weather conditions. Drought management is recommended to supply nearly 2,000 acre-feet per year by 2060.

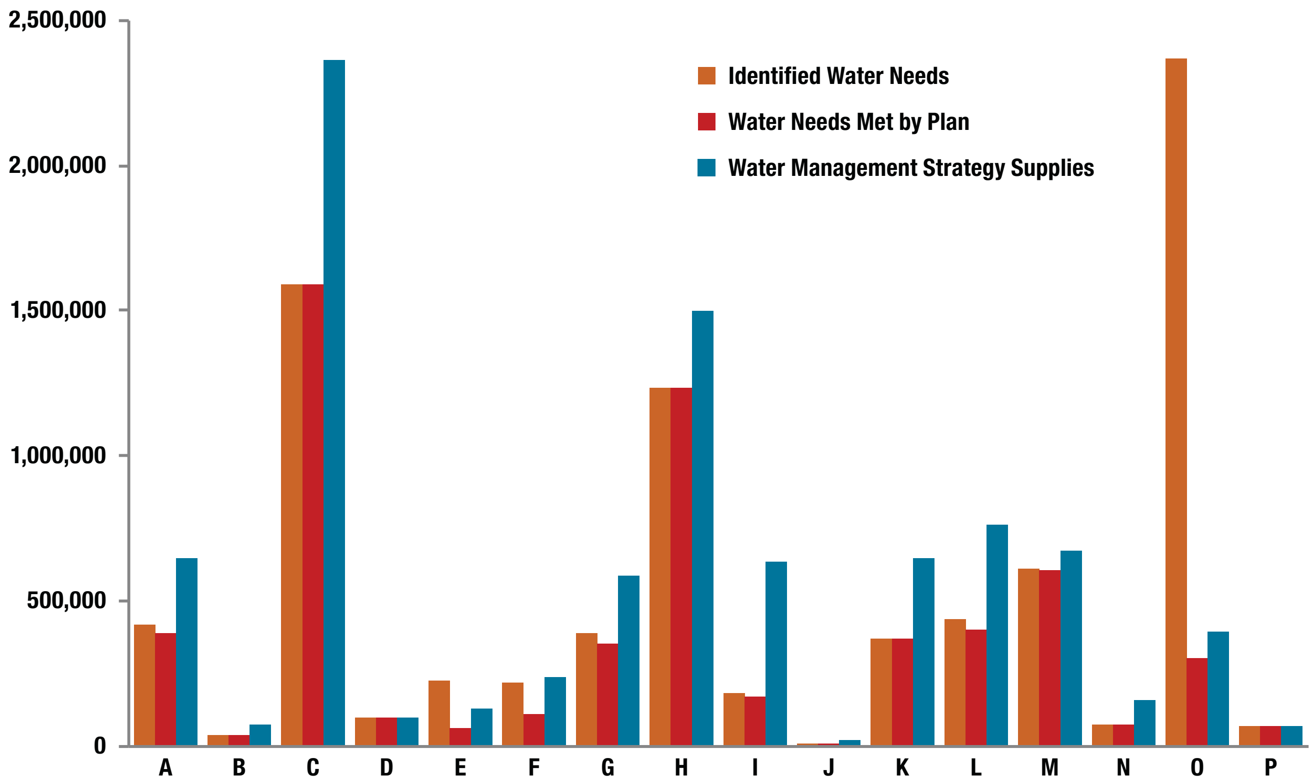
Aquifer storage and recovery refers to the practice of injecting potable water into an aquifer where it is stored for later use, often to meet summer peak usage demands. This strategy is feasible only in certain formations and in areas where only the utility owning the water can access it. It is recommended to provide almost 81,000 acre-feet per year by 2060.

Brush control and other land stewardship techniques have been recommended for many areas in the western half of the state. Removing ash juniper and other water consuming species has been shown in studies to restore springflow and improve surface water runoff in some cases. However, since water produced by this strategy during a drought when little rainfall occurs is difficult to quantify, it is not often recommended as a strategy to meet municipal needs. Brush control is recommended to supply approximately 19,000 acre-feet per year in all decades between 2010 and 2060.

Desalination, the process of removing salt from seawater or brackish water, is expected to produce nearly 310,000 acre-feet of potable water by 2060. Improvements in membrane technology, new variations on evaporative-condensation techniques, and other more recent changes have made desalination more cost-competitive than before. However, it is a very energy-intensive process and power costs have a significant effect on the price of produced water.

Rainwater harvesting is the capture, diversion, and storage of rainwater for landscape irrigation, drinking and domestic use, aquifer recharge, and stormwater abatement. Rainwater harvesting helps reduce outdoor irrigation demands on potable water systems. While it is often a component of municipal water conservation programs, rainwater harvesting was not recommended as a water management strategy to meet needs since, like brush control, the volume of water may not be available during drought conditions.

FIGURE 7.5. WATER NEEDS, NEEDS MET BY PLANS, AND STRATEGY SUPPLY BY REGION (ACRE-FEET PER YEAR).



DROUGHT MANAGEMENT

On April Fool's Day in 1911, legendary Texas cattleman and oil pioneer, W.T. "Tom" Waggoner, discovered oil on his family's ranch near Electra. In the midst of one of the worst droughts on record, he exclaimed, "Damn the oil, I need water for my cattle." (Time Magazine US, 2011).

Though his perspective may have changed with the expansion of the Waggoner ranching and oil empire, water has remained scarce in the region, particularly during times of drought. Nearly a century later, the town of Electra—named after Tom Waggoner's daughter—faced a desperate situation during the drought of 2000. With a mere 45-day water supply, the town imposed severe water restrictions. Residents were limited to 1,000 gallons of water per person per month, about a third of an average American's typical water use. All outdoor watering was banned and people were asked to use their toilets five times before flushing (CNN, 2000).

Drought management strategies, such as those used in Electra in 2000, are temporary measures that are used to reduce water demand during a drought. All wholesale and retail public water suppliers and irrigation districts in Texas must include these measures in drought contingency plans as required by the Texas Water Code. In Region B and many areas of Texas, water conservation and drought management are a way of life.

7.3 WATER MANAGEMENT STRATEGY TOTALS AND COSTS

As discussed further in Chapter 9 (Financing Needs), the total capital costs of the 2012 State Water Plan—representing all of the water management strategies recommended by the regional water planning groups—is $53 billion. The estimated capital costs of strategy implementation has increased significantly from the 2007 estimate of $31 billion, and it does not include annual costs such as operational and maintenance costs (Table 7.5). The increase in costs is attributable to several factors, including an increased volume of strategies in areas of high population growth, increased construction costs, increased costs of purchasing water rights, increased land and mitigation costs, and the addition of new projects to address uncertainty and other considerations.

In general, recommended water management strategy supply volumes increased significantly over the 50-year planning period due to the anticipated increase in population and water demands, coupled with a reduction of current supplies over time. In Figure 7.4, the total water supply volume from all recommended water management strategies for each region is shown in addition to the current water supplies. The total in this figure is not the total water available to the region because water management strategies include redistribution of existing supplies and water conservation, which are reductions in demands.

Some regions recommended water management strategies that would provide water in excess of their identified needs. This was done for various reasons including uncertainty in the ability of a strategy to be implemented; recommending the ultimate capacity of the strategy such as a reservoir in a decade before the entire firm yield is needed; potential acceleration of population and demand growth; and uncertainty related to demand and supply projections, due to various factors such as climate variability or the possibility of a drought worse than the drought of record (Figure 7.5).

REFERENCES

CNN, 2000, Texas Drought Order: Don't Flush, http://www.cnn.com/2000/WEATHER/08/01/drought.01/index.html.

Time Magazine US, 2011, Milestones December 23, 1934: Time Magazine, http://www.time.com/time/magazine/article/0,9171,711640,00.html#ixzz1LUcDQnR.

Appendix I
Additional Documentation

Union Commission Livestock Market Report

Feeder & Stocker Steers:			200-300 lbs.	$1.35 - 2.25
			300-400 lbs.	$1.67 - 2.20
			400-500 lbs.	$1.35 - 2.07
			500-600 lbs.	$1.20 - 1.73
			600-700 lbs.	$1.20 - 1.47
			700-800 lbs.	$1.15 - 1.41
Feeder & Stocker Heifers:			200-300 lbs.	none
			300-400 lbs.	$1.55 - 1.71
			400-500 lbs.	$1.27 - 1.67
Cattle	241	hd	500-600 lbs.	$1.25 - 1.57
Goats	51	hd	600-700 lbs.	$1.15 - 1.43
Burro	0	hd	700-800 lbs.	$ .95 - 1.31
Horse	0	hd	Slaughter Cows:	$ .60 - .77
Llama	0	hd	Slaughter Bulls:	$ .72 - 1.05
Buffalo	0	hd	Cow Calf pairs:	$1,000
Total head	292	hd	Stocker Cows:	$900 -1,675

TOO LATE TO CLASSIFY

FOR RENT - 3BR/2BA SW large mobile in Countryside Mobile Home Park, Lot #15. AC, range, fridge, fenced yard. Available Feb. 15. $800/mo., $400 deposit. Call Mike 830-741-9292. 2-4-2tp

YARD SALE - 1608 21st Street. Saturday, 8 a.m. - ? Sofas, appliances, table, other household items, children's clothes. 2-4-1tp

The Medina County Groundwater Conservation District (GCD) will be having a public meeting Wednesday, February 18th, 2016, at the GCD boardroom at 1607 Avenue K, Hondo, TX. At the meeting, the board will review the GCD Management Plan to be presented for adoption. Phone: (830) 741-3162; e-mail: gmmcgcd@att.

Call Crime Stoppers with information

The Board of Directors for Medina County Crimestoppers would like to remind everyone that in certain instances "Crime Does Pay."

Persons who have knowledge of any crime can call the Medina County Crimestoppers tip line at 1-800-367-2833, and be given a code number. You will never be asked to give your name.

Persons that call and their information leads to an arrest or indictment are eligible for a cash rewards of up to $1,000.00.

With the many homes and businesses that are being broken into and businesses that have been robbed, we would urge anyone having information about someone responsible for such crime to call in, while being totally anonymous.

So far in 2016, Medina County Crimestoppers has paid out a total of $1,000.00 for tip information received that led to drug arrests in the Hondo area.

So take a minute to make Crime pay for you! Call 1-800-367-2833, 24 hours a day, seven days a week.