Clearwater
Every Drop Counts!

Clearwater Underground Water Conservation District
P.O. Box 729, Belton, Texas 76513
Phone: 254/933-0120 Fax: 254/770-2360
www.clearwaterdistrict.org

April 1, 2009

J. Kevin Ward, Executive Administrator
Texas Water Development Board
1700 N. Congress Avenue
Austin, TX 78701

Re: Desired Future Conditions Submittal for GMA 8

Dear Mr. Ward:

The Clearwater Underground Water Conservation District is the administrator for Groundwater Management Area 8 (GMA 8). On behalf of GMA 8, we are submitting revised desired future conditions (DFC) for two of the nine major and minor aquifers within our boundary. The aquifers for which revised DFCs have recently been adopted are as follows: Blossom and Nacatoch.

Our submittal includes the following information:

1) Desired Future Conditions Report for the 2 aquifers above.
2) Copies of agendas announcing the meeting at which the DFCs were adopted from each of the groundwater conservation districts in GMA 8. Approved minutes are not currently available but will be provided when approved at the next GMA 8 meeting.
3) A signed resolution adopting the desired future conditions and recording the member votes. The resolution references "Appendix B" which includes a 2-D spread sheet model developed by TCB, Inc. and various hydrogeologic reports and other studies used in developing the DFCs. These have not been included in this submittal but are available upon request.

Please note that the adopted DFCs reflect future aquifer conditions anticipated as a result of pumping from both exempt and non-exempt wells. When the managed available groundwater (MAG) figures are developed, they will reflect the amount of water available for use; however, if this full amount is permitted the desired future conditions will not be maintained because exempt well owners are also pumping groundwater. Therefore, it is our understanding that the groundwater conservation districts may reserve water for exempt well use which would result in a permitting figure that is less than the full MAG.

Please feel free to contact me if you have any questions or need additional information.

Sincerely,

Cheryl Maxwell

Cheryl Maxwell, AICP
Clearwater Underground Water Conservation District Manager
GMA 8 Administrator

cm
attachments

RESOLUTION TO ADOPT DESIRED FUTURE CONDITIONS

FOR AQUIFER(S) IN GROUNDWATER MANAGEMENT AREA 8

THE STATE OF TEXAS	§
	§
GROUNDWATER MANAGEMENT AREA 8	§
	§
GROUNDWATER CONSERVATION DISTRICTS	§

WHEREAS, Texas Water Code § 36.108 requires the groundwater conservation districts located in whole or in part in a groundwater management area ("GMA") designated by the Texas Water Development Board to adopt desired future conditions for the relevant aquifers located within the management area;

WHEREAS, the groundwater conservation districts located wholly or partially within Groundwater Management Area 8 ("GMA 8"), as designated by the Texas Water Development Board, as of the date of this resolution are as follows: Central Texas Groundwater Conservation District, Clearwater Underground Water Conservation District, Fox Crossing Water District, McLennan County Groundwater Conservation District, Middle Trinity Groundwater Conservation District, Northern Trinity Groundwater Conservation District, Post Oak Savannah Groundwater Conservation District, Saratoga Underground Water Conservation District, Tablerock Groundwater Conservation District, and Upper Trinity Groundwater Conservation District (collectively hereinafter "the GMA 8 Districts");

WHEREAS, the GMA 8 Districts are each governmental agencies and bodies politic and corporate operating under Chapter 36, Water Code;

WHEREAS, the GMA 8 Districts desire to fulfill the requirements of Texas Water Code § 36.108 through mutual cooperation and joint planning efforts;

WHEREAS, the GMA 8 Districts have had numerous public meetings at which they have engaged in joint planning efforts to promote more comprehensive management of the aquifers located in whole or in part in Groundwater Management Area 8;

WHEREAS, the GMA 8 Districts may establish different desired future conditions for: (1) each aquifer, subdivision of an aquifer, or geologic strata located in whole or in part within the boundaries of GMA 8; or (2) each geographic area overlying an aquifer in whole or in part or subdivision of an aquifer within the boundaries of GMA 8;

WHEREAS, the GMA 8 Districts recognize that GMA 8 includes a geographically and hydrologically diverse area with a variety of land uses and a diverse mix of water users;

WHEREAS, the GMA 8 Districts have considered the relevant aquifers, subdivisions thereof, and geologic strata located in whole or in part within the boundaries of GMA 8, and have further considered the hydrogeologic characteristics of the same, as well as the various uses and users of groundwater produced from such aquifers, subdivisions, and strata;

WHEREAS, GMA 8 Districts held a meeting, which was open to the public, at 10:00 a.m. on Monday, March 16, 2009, in the Bellmead City Hall located at 3015 Bellmead Drive, Bellmead, Texas;

WHEREAS, notice of said March 16, 2009, meeting was properly given by each and all of the GMA 8 Districts in accordance with Chapter 36, Water Code, and Chapter 551, Government Code, and a true and correct copy of each of the notices has been attached hereto in Appendix A and is incorporated herein for all purposes;

WHEREAS, at least two-thirds of the GMA 8 Districts had a voting representative in attendance at said March 16, 2009, meeting in accordance with Section 36.108(d-1), Texas Water Code; to wit, the following districts had a voting representative in attendance at said meeting: Central Texas Groundwater Conservation District, Clearwater Underground Water Conservation District, Fox Crossing Water District, McLennan County Groundwater Conservation District, Middle Trinity Groundwater Conservation District, Post Oak Savannah Groundwater Conservation District, Saratoga Underground Water Conservation District, Tablerock Groundwater Conservation District, and Upper Trinity Groundwater Conservation District (Northern Trinity Groundwater Conservation District did not have a voting representative present);

WHEREAS, it is the intent and purpose of the GMA 8 Districts by adoption of this resolution to fulfill the requirements of Texas Water Code § 36.108, including establishing "desired future conditions for the relevant aquifers" within GMA 8 for the specific aquifer(s) and desired future conditions described under "Appendix B" attached hereto and incorporated herein for all purposes;

WHEREAS, at said March 16, 2009, meeting, after a motion was duly made and seconded that the GMA 8 Districts adopt this resolution establishing desired future conditions for the aquifer described under "Appendix B", the motion prevailed by the following vote:

Blossom Aquifer: 9 Ayes and 0 Nays;

Nacatoch Aquifer: 9 Ayes and 0 Nays;

WHEREAS, in establishing these desired future conditions for the aquifer(s) set forth under Appendix B, the GMA 8 Districts have considered all of the criteria required by Chapter 36 of the Texas Water Code and other information, including without limitation groundwater availability models and runs of those models to determine the effects of various conditions and parameters, hydrogeologic reports available for the relevant aquifers, and other technical data and information;

WHEREAS, many of the groundwater availability models, runs, hydrogeologic reports, and other technical data and information considered and determined to be reliable sources of information by the GMA 8 Districts in establishing these desired future conditions for the aquifer(s) have been attached hereto or referenced in the documents attached hereto under Appendix B;

WHEREAS, in establishing these desired future conditions for the aquifer(s) set forth under Appendix B, the GMA 8 Districts have considered the uses and conditions of the aquifer(s) in different geographic areas within GMA 8 and what the effects and impacts of adopting such desired future conditions will have upon the condition of the aquifer(s) and the uses and users of groundwater from the aquifer(s) both now and in the future;

WHEREAS, after considering such anticipated effects and impacts these desired future conditions will have on the aquifer(s), uses, and users of groundwater, and considering all of the other criteria required by Chapter 36 of the Texas Water Code, including without limitation the groundwater resource management duties and responsibilities of the GMA Districts individually and collectively, the GMA 8 Districts have determined that the desired future conditions for the aquifer(s) set forth under Appendix B are reasonable;

NOW, THEREFORE, BE IT RESOLVED BY THE AUTHORIZED VOTING REPRESENTATIVES OF THE GMA 8 DISTRICTS AS FOLLOWS:

1. The above recitals are true and correct.

2. The authorized voting representatives of the GMA 8 Districts hereby establish the desired future conditions of the aquifer(s) as set forth in Appendix B by the vote reflected in the above recitals.

3. The GMA 8 Districts and their agents and representatives, individually and collectively, are further authorized to take any and all actions necessary to implement this resolution.

4. The desired future conditions of the aquifer adopted by the GMA 8 Districts and attached hereto shall be effective immediately and shall continue in effect until amended, superseded, or repealed.

AND IT IS SO ORDERED.

PASSED AND ADOPTED on this 16th day of March, 2009.

ATTEST:

Central Texas Groundwater Conservation District

Clearwater Underground Water Conservation District

Fox Crossing Water District

McLennan County Groundwater Conservation District

Middle Trinity Groundwater Conservation District

Northern Trinity Groundwater Conservation District

Post Oak Savannah Groundwater Conservation District

Saratoga Underground Water Conservation District

Tablerock Groundwater Conservation District

Upper Trinity Groundwater Conservation District

ATTACHMENTS
Appendix A: Copies of notices of March 16, 2009, meeting
Appendix B: Adopted Desired Future Conditions and supporting information

Appendix A

GROUNDWATER MANAGEMENT AREA 8

Notice is hereby given that the groundwater conservation districts located wholly or partially within Groundwater Management Area (GMA) 8, as designated by the Texas Water Development Board (TWDB), consisting of the Central Texas Groundwater Conservation District, Clearwater Underground Water Conservation District, Fox Crossing Water District, McLennan County Groundwater Conservation District, Middle Trinity Groundwater Conservation District, Northern Trinity Groundwater Conservation District, Post Oak Savannah Groundwater Conservation District, Saratoga Underground Water Conservation District, Tablerock Groundwater Conservation District, and Upper Trinity Groundwater Conservation District will hold a ***Joint Planning meeting at 10:00 A.M. on Monday, March 16, 2009,*** in the Bellmead City Hall located at 3015 Bellmead Drive, Bellmead, Texas 76705. The meeting will be open to the public. The following items of business will be discussed:

1. Invocation.
2. Call meeting to order and establish quorum.
3. Welcome and introductions.
4. Public comment.
5. Approve minutes of September 17, 2008 GMA 8 meeting.
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12. Discussion of funding needed to continue and support joint planning process.
13. Committee member comments.
14. Discuss agenda items for next meeting.
15. Set date, time, and place of next meeting.
16. Closing comments.
17. Adjourn.

Dated this 2nd day of March, 2009

Richard S. Bowers, General Manager
Central Texas Groundwater Conservation District

POSTED
March 2nd 2009
Janet Parker
County Clerk - Burnet County, Texas
By _____ Deputy

The Central Texas Groundwater Conservation District is committed to compliance with the Disabilities Act (ADA). Reasonable accommodations and equal opportunity for effective communications will be provided upon request. Please contact the District office at 512-756-4900 at least 24 hours in advance if accommodation is needed.
During the meeting, the Committee reserves the right to go into executive session for any of the purposes authorized under V.T.C.A., Government Code, Chapter 551, for any item on the above agenda or as otherwise authorized by law.

NOTICE OF MEETING
GROUNDWATER MANAGEMENT AREA 8

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13. Committee member comments.
14. Discuss agenda items for next meeting.
15. Set date, time, and place of next meeting.
16. Closing comments.
17. Adjourn.

Dated this 2 day of March, 2009

Horace Grace, CUWCD President

By: Cheryl Maxwell
Cheryl Maxwell, CUWCD Asst. Secretary

SHELLEY COSTON
CO. CLK. BELL CO. TX
2009 MAR -2 AM 11:48

The Clearwater Underground Water Conservation District is committed to compliance with the Americans with Disabilities Act. Reasonable accommodations and equal opportunity for effective communications will be provided upon request. Please contact the District office at 254-933-0120 at least 24 hours in advance if accommodation is needed.

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13. Committee member comments.
14. Discuss agenda items for next meeting.
15. Set date, time, and place of next meeting.
16. Closing comments.
17. Adjourn.

FILED FOR RECORD
At 11:03 O'Clock A M
MAR 02 2009
CAROLYN FOSTER County & District Clerk
Mills County, Texas
By _____ Deputy

Dated this 2nd day of March, 2009

Rodney Carlisle, President Fox Crossing Water District

By: _____
Sam Beaumont Secretary/Treasurer

The Clearwater Underground Water Conservation District is committed to compliance with the Americans with Disabilities Act. Reasonable accommodations and equal opportunity for effective communications will be provided upon request. Please contact the District office at 254-933-0120 at least 24 hours in advance if accommodation is needed.

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13. Committee member comments.
14. Discuss agenda items for next meeting.
15. Set date, time, and place of next meeting.
16. Closing comments.
17. Adjourn.

Dated this 2 day of March, 2009

Horace Grace, CUWCD President

By: Cheryl Maxwell
Cheryl Maxwell, CUWCD Asst. Secretary

2009 MAR -2 AM 11:43
SHELLEY COSTON
CO. CLK. BELL CO. TX

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This notice was posted March 10, 2009 at 9:00 a.m. at Bellmead City Hall, Bellmead, Texas.

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12. Discussion of funding needed to continue and support joint planning process.
13. Committee member comments.
14. Discuss agenda items for next meeting.
15. Set date, time, and place of next meeting.
16. Closing comments.
17. Adjourn.

POSTED
____ A.M. 7:45 P.M.

MAR - 2 2009

GWINDA JONES, COUNTY CLERK
ERATH COUNTY, TEXAS
BY gw DEPUTY

Dated this 2ND day of March, 2009

Joe Cooper, General Manager
Middle Trinity GCD

The Middle Trinity Groundwater Conservation District is committed to compliance with the Americans with Disabilities Act. Reasonable accommodations and equal opportunity for effective communications will be provided upon request. Please contact the District office at 254-965-6705 at least 24 hours in advance if accommodation is needed.

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11. Discussion and possible action on results of the Texas Water Development Board Groundwater Availability Model (GAM) simulation requests 08-06 and 08-09 for the Northern Trinity/Woodbine aquifers.
12. Discussion of funding needed to continue and support joint planning process.
13. Committee member comments
14. Discuss agenda items for next meeting.
15. Set date, time, and place of next meeting.
16. Closing comments
17. Adjourn.

Dated this ____ day of March, 2009

Jos Cooper, General Manager
Middle Trinity GCD

The Middle Trinity Groundwater Conservation District is committed to compliance with the Americans with Disabilities Act. Reasonable accommodations and equal opportunity for effective communications will be provided upon request. Please contact the District office at 254-965-6705 at least 24 hours in advance if accommodation is needed

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NOTICE OF MEETING
GROUNDWATER MANAGEMENT AREA 8

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13. Committee member comments.
14. Discuss agenda items for next meeting.
15. Set date, time, and place of next meeting.
16. Closing comments.
17. Adjourn.

The Northern Trinity Groundwater Conservation District is committed to public access. To request an accommodation for a person with a disability who wishes to attend the meeting, contact Mark Mendez at 817-884-2729 at least one business day prior to the posted meeting.

NOTICE OF MEETING
GROUNDWATER MANAGEMENT AREA 8

March 16, 2009 – 10:00 a.m.
Bellmead City Hall
3015 Bellmead Drive
Bellmead, Texas 76705

MAR 0 6 2009

AGENDA

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13. Committee member comments.
14. Discuss agenda items for next meeting.
15. Set date, time, and place of next meeting.
16. Closing comments.
17. Adjourn.

Signed this 4th day of March, 2009.

Gary Westbrook, General Manager, POSGCD

Filed 4th day of March
in 2009, At 9:11 M.
BARBARA VANSA
County Clerk, Milam County, Texas
By Jodi Morgan
Deputy

NOTICE OF MEETING
GROUNDWATER MANAGEMENT AREA 8

March 16, 2009 – 10:00 a.m.
Bellmead City Hall
3015 Bellmead Drive
Bellmead, Texas 76705

MAR 0 6 2009

AGENDA

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Signed this 4th day of March, 2009.

Gary Westbrook, General Manager, POSGCD

FILED
at 12:10 o'clock P M
MAR 05 2009
ANNA L. SCHELACK
COUNTY CLERK, BURLESON CO., TEX.
By Deputy

NOTICE OF MEETING
GROUNDWATER MANAGEMENT AREA 8

Notice is hereby given that the groundwater conservation districts located wholly or partially within Groundwater Management Area (GMA) 8, as designated by the Texas Water Development Board (TWDB), consisting of the Central Texas Groundwater Conservation District, Clearwater Underground Water Conservation District, Fox Crossing Water District, McLennan County Groundwater Conservation District, Middle Trinity Groundwater Conservation District, Northern Trinity Groundwater Conservation District, Post Oak Savannah Groundwater Conservation District, Saratoga Underground Water Conservation District, Tablerock Groundwater Conservation District, and Upper Trinity Groundwater Conservation District will hold a ***Joint Planning meeting at 10:00 A.M. on Monday, March 16, 2009,*** in the Bellmead City Hall located at 3015 Bellmead Drive, Bellmead, Texas 76705. The meeting will be open to the public. The following items of business will be discussed:

1. Invocation.
2. Call meeting to order and establish quorum.
3. Welcome and introductions.
4. Public comment.
5. Approve minutes of September 17, 2008 GMA 8 meeting.
6. Texas Water Development Board presentation on joint planning process and petition process.
7. Summary of GMA8 progress and status of pending Managed Available Groundwater figures.
8. Discussion and possible action to rescind desired future conditions for the Blossom and Nacatoch aquifers adopted at the December 17, 2007 GMA8 meeting.
9. Presentation of revised desired future conditions for the Blossom and Nacatoch aquifers.
10. Public hearing and possible action to adopt revised desired future conditions for the Blossom and Nacatoch aquifers.
11. Discussion and possible action on results of the Texas Water Development Board Groundwater Availability Model (GAM) simulation requests 08-64 and 08-66 for the Northern Trinity/Woodbine aquifers.
12. Discussion of funding needed to continue and support joint planning process.
13. Committee member comments.
14. Discuss agenda items for next meeting.
15. Set date, time, and place of next meeting.
16. Closing comments.
17. Adjourn.

Dated this 2nd day of March, 2009

Horace Grace, CUWCD President

By: Cheryl Maxwell, CUWCD Asst. Secretary

The Clearwater Underground Water Conservation District is committed to compliance with the Americans with Disabilities Act. Reasonable accommodations and equal opportunity for effective communications will be provided upon request. Please contact the District office at 254-933-0120 at least 24 hours in advance if accommodation is needed.

During the meeting, the Committee reserves the right to go into executive session for any of the purposes authorized under V.T.C.A., Government Code, Chapter 551, for any item on the above agenda or as otherwise authorized by law.

Posted 3-5-2009 RJMcGuire

AT 8:07 O'CLOCK A M
FILED
MAR 03 2009
COUNTY CLERK

NOTICE OF MEETING
GROUNDWATER MANAGEMENT AREA 8

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13. Committee member comments.
14. Discuss agenda items for next meeting.
15. Set date, time, and place of next meeting.
16. Closing comments.
17. Adjourn.

Dated this 2nd day of March, 2009

W. N. Ament

Wyllis Ament, Tablerock GCD President

By: Loren Herschler, Asst. Secretary

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7. Summary of GMA8 progress and status of pending Managed Available Groundwater figures.
8. Discussion and possible action to rescind desired future conditions for the Blossom and Nacatoch aquifers adopted at the December 17, 2007 GMA8 meeting.
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13. Committee member comments.
14. Discuss agenda items for next meeting.
15. Set date, time, and place of next meeting.
16. Closing comments.
17. Adjourn.

Dated this 2nd day of March, 2009

Mike Massey, UTGCD President

By: Brian Sledge, General Counsel

The Upper Trinity Groundwater Conservation District is committed to compliance with the Americans with Disabilities Act. Reasonable accommodations and equal opportunity for effective communications will be provided upon request. Please contact the District office at 817-523-5200 at least 24 hours in advance if accommodation is needed.

During the meeting, the Committee reserves the right to go into executive session for any of the purposes authorized under V.T.C.A., Government Code, Chapter 551, for any item on the above agenda or as otherwise authorized by law.

Appendix B

Desired Future Conditions

Blossom Aquifer
Bowie, Lamar and Red River Counties

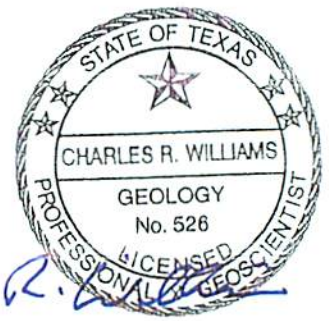
AECOM
400 West 15th Street, Suite 500, Austin, Texas 78701
T 512.472.4519 F 512.472.7519 www.tcb.aecom.com

Memorandum

To: Cheryl Maxwell, Administrative Manager
Clearwater Underground Water Conservation District

From: Charles R. Williams, P.G. No. 526

Date: March 30, 2009



Re: Re-Defined Desired Future Condition of Blossom Aquifer

Introduction

Groundwater Management Area 8 (GMA-8) is a groundwater management area of the State of Texas as defined by Statute with responsibility for developing a desired future condition (DFC) for aquifers within an approximately 46-County area. Membership of the GMA is composed of the groundwater conservation districts (GCDs) that occur all or in part within the GMA boundary. (Fig. 1) At the request of GMA-8, AECOM USA Group Inc. (AECOM) (fka TCB Inc.) developed statements describing DFCs for the portions of the Blossom aquifer recognized by the Texas Water Development Board (TWDB) to occur in whole or in part within GMA-8. (Fig. 2)

Methodology

To predict the effects of pumping in the Blossom aquifer a spreadsheet model was developed. The model uses estimates of: the area of the aquifer recharge (unconfined) and the artesian (confined) zones; the annual amount of aquifer use (pumping); and the coefficient of storage of the aquifer in the confined and unconfined zones to predict the annual volume of water that could be produced from the aquifer and result in a specified amount of aquifer draw-down after 50 years. Predictions are made for each of the sub-zones of the Blossom aquifer established in the unconfined and confined zones of the aquifer within each river basin in each County in which the aquifer occurs in GMA-8. Predictions of the estimated annual amount of groundwater that could be produced for the several sub-zones in the unconfined zone and confined zone of the aquifer in each County are summed for presentation. Aquifer-zone area estimates are from the TWDB geographic information system (GIS) coverages. Estimates of the annual aquifer use by County are from the TWDB Annual Water Use Survey data. The coefficients of storage values of the Blossom aquifer are considered to be similar to the storage coefficients of

the Nacatoch aquifer. (McLaurin, 1988) The storage coefficients used in the projections are the values for the Nacatoch aquifer given in TWDB Report 305. (Ashworth, 1988)

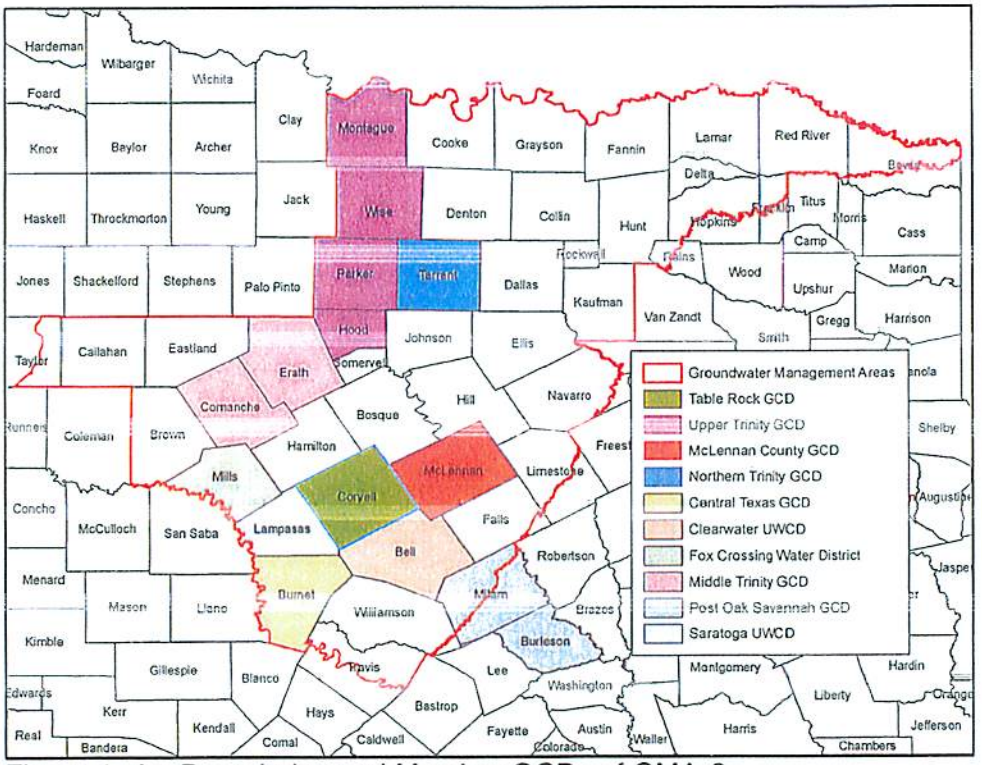


Figure 1, the Boundaries and Member GCDs of GMA-8

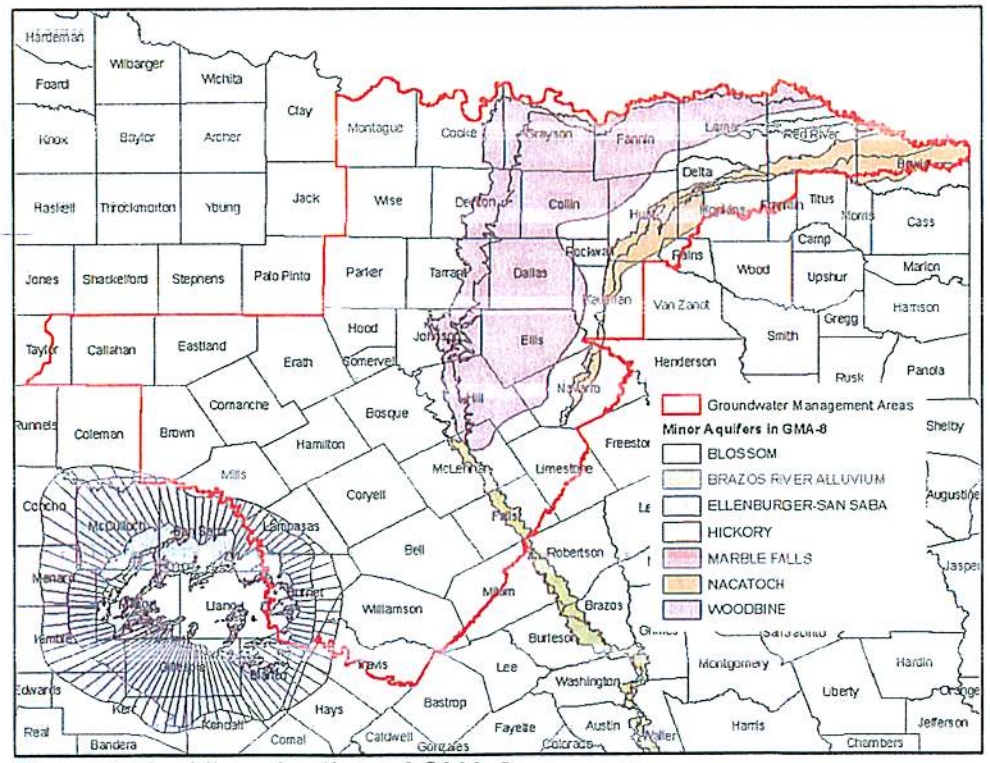


Figure 2, the Minor Aquifers of GMA-8

Discussion

The GMA-8 intent in developing a Blossom aquifer DFC is to describe a DFC resulting in a Managed Available Groundwater (MAG) value approximately equal to the sum of the County values (highest value after year 2000) for Regional Water Plan (RWP) availability for the aquifer in each County where the aquifer occurs. GMA-8 determined to take this course of action because its solicitations for public involvement brought only limited attendance with few comments and because the RWP values were adopted through a previous public process with local involvement.

In GMA-8, the Blossom aquifer occurs in Bowie, Lamar and Red River Counties. GMA-8 initially developed DFCs for the Blossom aquifer using a spreadsheet model to predict the percentage of estimated aquifer saturated thickness maintained after 50 years. (Williams, 2007) This DFC development approach resulted in a draft MAG value from TWDB significantly less than the intended amount. (Bradley, 2008) GMA-8 then determined to rescind the originally stated DFCs for the Blossom aquifer and re-adopt a revised DFC to achieve the intended MAG values.

The revised GMA-8 approach to DFC development for the Blossom aquifer is to describe a DFC in terms of the average draw down (in feet) for the unconfined and confined zone of the aquifer in each County where the aquifer occurs. GMA-8 maintains the intent to describe a DFC for the Blossom aquifer that will result in a MAG approximately equal to the sum of the County values (highest value after year 2000) for RWP availability value for the aquifer in Bowie, Lamar and Red River Counties.

DFC Development Approach

The purpose of the spreadsheet model is to conveniently predict the estimated amount of water that could be produced annually for 50 years without exceeding a specified level of draw down. The models are used to aid in the DFC development process for aquifers where a TWDB GAM is not available. Iterative trials of a range of draw down values were made until the desired amount of annual water use was achieved for each aquifer sub-zone in County. (Table 1) The results of the annual water use values from the final iteration for each aquifer sub-zone within each County were summed for comparison to the RWP availability values. (Table 2) The spreadsheet model project the effects of pumping using the following relationships:

$$\mathbf{Q(t) = R(t) - D(t) + dS/dt}$$

Where:
Q(t) = the total rate of groundwater withdrawal (ac-ft/yr)
R(t) = the total rate of groundwater recharge to the basin (aquifer) (ac-ft/yr)
D(t) = the total rate of groundwater discharge from the basin (aquifer) (ac-ft/yr)
dS/dt = change in aquifer storage of groundwater over time (draw down in feet)
(Freeze and Cherry, 1979)

The results of water-level monitoring of the Blossom aquifer appear to show little change over the period of record and suggest that annual aquifer use (pumping) is approximately equal to annual aquifer recharge. (Bradley, 2008) If annual pumping is approximately equal to annual recharge; the factors for recharge and discharge in the aquifer will cancel each other and the relationship may be simplified to:

Q(t) = dS/dt

If it is assumed that the annual amount of recharge to the aquifer is approximately equal to the most recent (2004) TWDB estimates for groundwater use from the aquifer in each County. The step-by-step description of the process to develop the DFC for each county is as follows:

1. The total area occupied by the aquifer in each county is subdivided by river basin and then by aquifer zone (confined or unconfined).
2. Within each County; the area of each aquifer sub-zone is divided by the total area occupied by the aquifer in the County to give the percentage of the total aquifer area in the County represented by each sub-zone.
3. The estimate of annual recharge (assumed to be equal to the estimate annual aquifer pumping) for each County is divided by the percentage value of the total aquifer area in the County represented by each aquifer sub-zone in the County to give an estimate of recharge to each aquifer sub-zone (in acre-feet per year).
4. The area (in acres) of each aquifer sub-zone in each County is multiplied by an estimated amount of aquifer draw-down (in feet) $_1$ and then multiplied by the storage coefficient of the aquifer sub-zone (expressed as a decimal fraction) $_2$ to give an estimate of the amount of water (in acre-feet) that could be removed from the aquifer if the estimated amount of aquifer draw-down occurred.
5. The estimated volume of water that could be produced from each aquifer sub-zone with the specified estimate of aquifer draw-down is divided by 50 (years) to estimate the amount of water that could be produced each year from the aquifer sub-zone over a 50-year period to result in the estimated amount of aquifer draw-down at the end to the 50-year time period.
6. The estimated annual amount of water that could be produced from each aquifer sub-zone in each County (in acre-feet per year) is added to the estimate of annual recharge for the sub-zone (in acre-feet per year) to give the estimated MAG value for the aquifer sub-zone (in acre-feet per year).
7. The estimated MAG values (in acre-feet per year) of the several aquifer sub-zones in each County are summed to give a total estimated MAG value for the aquifer in each County. (Table 2)

Notes:

1. The estimated average aquifer draw-down values were kept constant for the several sub-zones of the confined and unconfined zones of the aquifer within each County.
2. The storage coefficient values for the confined and unconfined zones were kept constant for all sub-zones in the aquifer zone in all Counties.

County	River Basin	Aquifer zone	Sub-zone Area (acres)	Total Aquifer Area in County (acres)	Sub-zone Percent of Total Area	Estimated Total County Pumping (ac-ft per year)	Assigned Annual Recharge Volume (ac-ft)	Estimated Average Aquifer Draw-down (ft)	Storage Co-efficient (dimen-sionless)	Total With-drawal Volume (ac-ft)	Annual With-drawal Volume (ac-ft)	MAG Estimate (ac-ft)
Lamar	Red	un-confined	2,864	43,732	7%	245	17	2.4	0.1	687	14	31
Lamar	Sulphur	un-confined	28,028	43,732	64%	245	157	2.4	0.1	6727	135	292
Red River	Sulphur	un-confined	23,629	121,043	20%	689	138	6.5	0.1	15359	307	445
Red River	Red	un-confined	52,392	121,043	43%	689	296	6.5	0.1	34055	681	977
Bowie	Red	un-confined	9,832	12,663	78%	95	74	5.4	0.1	5309	106	180
Lamar	Sulphur	confined	12,839	43,732	29%	245	71	20	0.00005	13	0	71
Red River	Sulphur	confined	31,477	121,043	26%	689	179	20	0.00005	31	1	180
Red River	Red	confined	13,548	121,043	11%	689	76	20	0.00005	14	0	76
Bowie	Red	confined	2,831	12,663	22%	95	21	20	0.00005	3	0	21
Totals			177,438				1,029			62,198	1,244	2,273

Table 1, Identification of Blossom Aquifer Sub-zones by County, Sub-zone Area, Percentage of Each Sub-zone of the Total Aquifer Area in the County, Estimated Annual Aquifer Use by County, Estimated Annual Recharge by Aquifer Sub-zone, Estimated Average Aquifer Draw Down in Each Sub-zone, Estimated Total Water Withdrawal by Sub-zone, Estimated Annual Water Withdrawal by Sub-zone and Estimated MAG by Sub-zone

County	Sum of Blossom Aquifer RWP Groundwater Availability Values (ac-ft per year)	Sum of Blossom Aquifer Sub-zone Estimated MAG Values (ac-ft per year)
Lamar	391	394
Red River	1,679	1,678
Bowie	200	201

Table 2, Sum of Regional Water Plan Blossom Aquifer Availability Values by County and Sum of Blossom Aquifer Estimated MAG Values by County

GMA-8 Desired Future Conditions for the Blossom Aquifer

Bowie County

- From estimated year 2009 conditions, the average draw down of the unconfined zone of the Blossom aquifer should not exceed approximately 5.4 feet after 50 years.
- From estimated year 2009 conditions, the average draw down of the confined zone of the Blossom aquifer should not exceed approximately 20 feet after 50 years.

Lamar County

- From estimated year 2009 conditions, the average draw down of the unconfined zone of the Blossom aquifer should not exceed approximately 2.4 feet after 50 years.
- From estimated year 2009 conditions, the average draw down of the confined zone of the Blossom aquifer should not exceed approximately 20 feet after 50 years.

Red River County

- From estimated year 2009 conditions, the average draw down of the unconfined zone of the Blossom aquifer should not exceed approximately 6.5 feet after 50 years.
- From estimated year 2009 conditions, the average draw down of the confined zone of the Blossom aquifer should not exceed approximately 20 feet after 50 years.

Note: The observations and assessments made in this report were based on data supplied by GMA-8 members, TWDB, or available from referenced published sources available at the time of the report preparation. The conclusions drawn in the report are based on the available data and reasonable methods of assessment. The Desired Future Conditions presented in this report reflect policy decisions made by GMA-8. If new or different data is made available, the conclusions of this report may change.

Bibliography

Ashworth, John B., 1988; Ground-Water Resources of the Nacatoch Aquifer; Texas Water Development Board Report 305

Bradley, Robert G., 2008; GTA Aquifer Assessment 07-5mag (Draft); Texas Water Development Board

Freeze, R. Allan and Cherry, John A., 1979; Groundwater; Prentice-Hall Inc; ISBN 0-13-365312-9

McLaurin, Celeste, 1988; Occurrence, Availability, and Chemical Quality of Ground Water in the Blossom Sand Aquifer; Texas Water Development Board Report 307

Williams, Charles R., 2007; Adopted Desired Future Conditions of Minor Aquifers (in Groundwater Management Area 8)

Desired Future Conditions

Nacatoch Aquifer
Bowie, Delta, Ellis, Franklin, Hopkins, Hunt, Kaufman, Lamar,
Navarro, Rains, Red River and Rockwall Counties

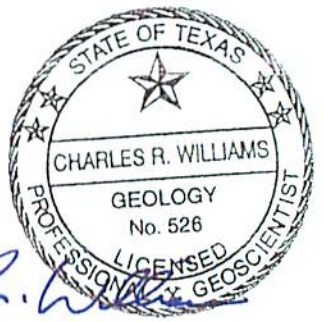
AECOM
400 West 15th Street, Suite 500, Austin, Texas 78701
T 512.472.4519 F 512.472.7519 www.tcb.aecom.com

Memorandum

To: Cheryl Maxwell, Administrative Manager
Clearwater Underground Water Conservation District

From: Charles R. Williams, P.G. No. 526

Date: March 30, 2009



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Methodology

To predict the effects of pumping in the Nacatoch aquifer a spreadsheet model was developed. The model uses estimates of: the area of the aquifer recharge (unconfined) and the artesian (confined) zones; the annual amount of aquifer use (pumping); and the coefficient of storage of the aquifer in the confined and unconfined zones to predict the annual volume of water that could be produced from the aquifer and result in a specified amount of aquifer draw-down after 50 years. Predictions are made for each of the sub-zones of the Nacatoch aquifer established in the unconfined and confined zones of the aquifer within each river basin in each County in which the aquifer occurs in GMA-8. Predictions of the estimated annual amount of groundwater that could be produced for the several sub-zones in the unconfined zone and confined zone of the aquifer in each County are summed for presentation. Aquifer-zone area estimates are from the TWDB geographic information system (GIS) coverages. Estimates of the annual aquifer use by County are from the TWDB Annual Water Use Survey data. The storage coefficients used in the projections are the values for the Nacatoch aquifer given in TWDB Report 305. (Ashworth, 1988)

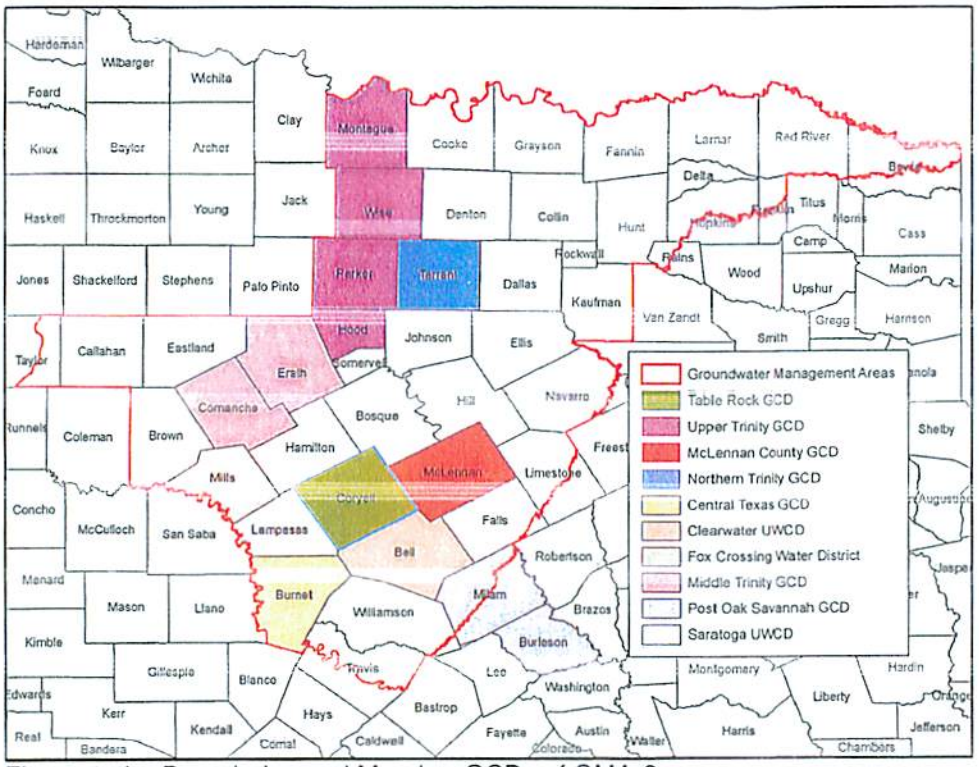

Figure 1, the Boundaries and Member GCDs of GMA-8

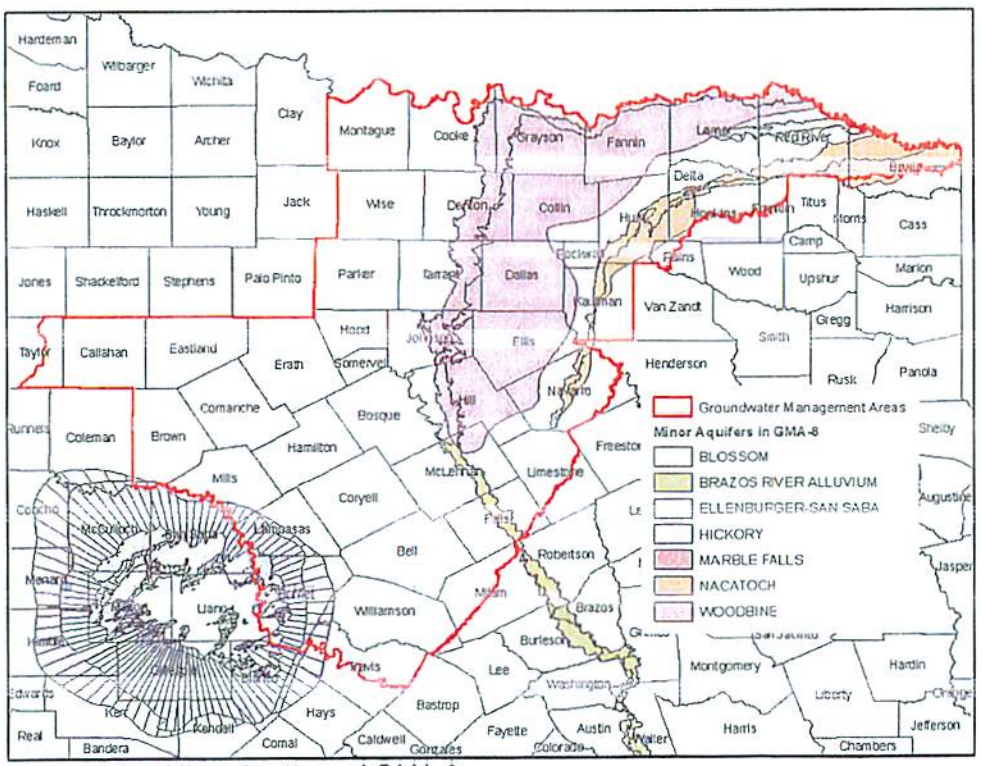

Figure 2, the Minor Aquifers of GMA-8

Discussion

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In GMA-8, the Nacatoch aquifer occurs in Bowie, Delta, Ellis, Franklin, Hopkins, Hunt, Kaufman, Lamar, Navarro, Rains, Red River and Rockwall Counties. GMA-8 initially developed DFCs for the Nacatoch aquifer using a spreadsheet model to predict the percentage of estimated aquifer saturated thickness maintained after 50 years. (Williams, 2007) This DFC development approach resulted in a draft MAG value from TWDB significantly less than the intended amount. (Bradley, 2008) GMA-8 then determined to rescind the originally stated DFCs for the Nacatoch aquifer and re-adopt a revised DFC to achieve the intended MAG values.

The revised GMA-8 approach to DFC development for the Nacatoch aquifer is to describe a DFC in terms of the average draw down (in feet) for the unconfined and confined zone of the aquifer in each County where the aquifer occurs. GMA-8 maintains the intent to describe a DFC for the Nacatoch aquifer that will result in a MAG approximately equal to the sum of the County values (highest value after year 2000) for RWP availability value for the aquifer in Bowie, Delta, Ellis, Franklin, Hopkins, Hunt, Kaufman, Lamar, Navarro, Rains, Red River and Rockwall Counties.

DFC Development Approach

The purpose of the spreadsheet model is to conveniently predict the estimated amount of water that could be produced annually for 50 years without exceeding a specified level of draw down. The models are used to aid in the DFC development process for aquifers where a TWDB GAM is not available. Iterative trials of a range of draw down values were made until the desired amount of annual water use was achieved for each aquifer sub-zone in County. (Table 1) The results of the annual water use values from the final iteration for each aquifer sub-zone within each County were summed for comparison to the RWP availability values. (Table 2) The spreadsheet model project the effects of pumping using the following relationships:

$$Q(t) = R(t) - D(t) + dS/dt$$

Where:
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R(t) = the total rate of groundwater recharge to the basin (aquifer) (ac-ft/yr)
D(t) = the total rate of groundwater discharge from the basin (aquifer) (ac-ft/yr)
dS/dt = change in aquifer storage of groundwater over time (draw down in feet)
(Freeze and Cherry, 1979)

The results of water-level monitoring of the Nacatoch aquifer appear to show little change over the period of record and suggest that annual aquifer use (pumping) is approximately equal to annual aquifer recharge. (Bradley, 2008) If annual pumping is approximately equal to annual recharge; the factors for recharge and discharge in the aquifer will cancel each other and the relationship may be simplified to:

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1. The total area occupied by the aquifer in each county is subdivided by river basin and then by aquifer zone (confined or unconfined).
2. Within each County; the area of each aquifer sub-zone is divided by the total area occupied by the aquifer in the County to give the percentage of the total aquifer area in the County represented by each sub-zone.
3. The estimate of annual recharge (assumed to be equal to the estimate annual aquifer pumping) for each County is divided by the percentage value of the total aquifer area in the County represented by each aquifer sub-zone in the County to give an estimate of recharge to each aquifer sub-zone (in acre-feet per year).
4. The area (in acres) of each aquifer sub-zone in each County is multiplied by an estimated amount of aquifer draw-down (in feet) $_1$ and then multiplied by the storage coefficient of the aquifer sub-zone (expressed as a decimal fraction) $_2$ to give an estimate of the amount of water (in acre-feet) that could be removed from the aquifer if the estimated amount of aquifer draw-down occurred.
5. The estimated volume of water that could be produced from each aquifer sub-zone with the specified estimate of aquifer draw-down is divided by 50 (years) to estimate the amount of water that could be produced each year from the aquifer sub-zone over a 50-year period to result in the estimated amount of aquifer draw-down at the end to the 50-year time period.
6. The estimated annual amount of water that could be produced from each aquifer sub-zone in each County (in acre-feet per year) is added to the estimate of annual recharge for the sub-zone (in acre-feet per year) to give the estimated MAG value for the aquifer sub-zone (in acre-feet per year).
7. The estimated MAG values (in acre-feet per year) of the several aquifer sub-zones in each County are summed to give a total estimated MAG value for the aquifer in each County. (Table 2)

Notes:

1. The estimated average aquifer draw-down values were kept constant for the several sub-zones of the confined and unconfined zones of the aquifer within each County.
2. The storage coefficient values for the confined and unconfined zones were kept constant for all sub-zones in the aquifer zone in all Counties.

County	River Basin	Aquifer zone	Sub-zone Area (acres)	Total Aquifer Area in County (acres)	Sub-division Percent of Total Area	Estimated Total County Pumping (ac-ft per year)	Assigned Annual Recharge Volume (ac-ft)	Estimated Average Aquifer Draw-down (ft)	Storage Co-efficient (dimen-sionless)	Total With-drawal Volume (ac-ft)	Annual With-drawal Volume (ac-ft)	MAG Estimate (ac-ft)
Bowie	Sulphur	un-confined	18897	316,821	6%	1304	78	10.4	0.1	19445	389	467
Bowie	Sulphur	confined	105218	316,821	33%	1304	430	20	0.00005	105	2	432
Bowie	Red	un-confined	107929	316,821	34%	1304	443	10.4	0.1	112248	2245	2688
Bowie	Red	confined	84977	316,821	27%	1304	352	20	0.00005	85	2	354
Delta	Sulphur	un-confined	41104	41,104	100%	48	48	3	0.1	12331	247	293
Ellis	Trinity	un-confined	88	88	100%	0	0	5	0.1	43	1	1
Franklin*	Sulphur	confined	3898	3,897	100%	10	10	20	0.00005	4	0	10
Franklin*	Sulphur	confined	1	3897	0%	10	0	20	0.00005	0	0	0
Hopkins	Sulphur	un-confined	38570	128,821	30%	495	149	5.5	0.1	21214	424	573
Hopkins	Sulphur	confined	43059	128,821	33%	495	163	20	0.00005	43	1	164
Hopkins	Sulphur	confined	16378	128,821	6%	495	62	20	0.00005	16	0	40
Hopkins	Sulphur	confined	65	128,821	0%	495	0	20	0.00005	0	0	0
Hopkins	Sabine	confined	36,749	128,821	29%	495	144	20	0.00005	37	1	145
Hunt	Trinity	un-confined	13	237,240	0%	1373	0	8.1	0.1	11	0	0
Hunt	Sabine	un-confined	59,771	237,240	25%	1373	343	8.1	0.1	48415	968	1311
Hunt	Sabine	un-confined	14,398	237,240	6%	1373	82	8.1	0.1	11654	233	315
Hunt	Sabine	confined	132,699	237,240	56%	1373	769	20	0.00005	133	3	772
Hunt	Sulphur	un-confined	29	237,240	0%	1373	0	8.1	0.1	23	0	0
Hunt	Sulphur	un-confined	24856	237,240	10%	1373	137	8.1	0.1	20133	403	540
Hunt	Sulphur	confined	2,455	237,240	1%	1373	14	20	0.00005	2	0	14
Hunt	Sulphur	confined	3029	237,240	1%	1373	14	20	0.00005	3	0	14
Hunt	Sulphur	confined	0	237,240	0%	1373	0	20	0.00005	0	0	0
Kaufman	Trinity	un-confined	48,297	89,229	54%	258	139	0.8	0.1	2898	58	136
Kaufman	Trinity	confined	26,622	89,229	30%	258	77	20	0.00005	27	1	78
Kaufman	Trinity	confined	13,068	89,229	15%	258	38	20	0.00005	13	0	38
Kaufman	Sabine	un-confined	1,242	89,229	1%	258	3	0.8	0.1	75	2	5
Lamar	Sulphur	un-confined	7234	7,234	100%	0	0	3.1	0.1	2243	45	45
Navarro	Trinity	un-confined	56,484	98,870	58%	97	56	1.2	0.1	6776	136	192
Navarro	Trinity	confined	40,406	98,870	42%	97	41	20	0.00005	40	1	42
Rains*	Sabine	confined	3,550	6,590	100%	10	10	20	0.00005	7	0	10
Red River	Sulphur	un-confined	135811	180,517	75%	393	297	1.1	0.1	14917	298	595
Red River	Sulphur	confined	39897	180,517	22%	393	87	20	0.00005	39	1	88
Red River	Red	un-confined	6009	180517	3%	393	12	1.1	0.1	661	13	25
Rockwall	Trinity	un-confined	287	554	52%	0	0	1	0.1	29	1	1
Rockwall	Trinity	un-confined	195	554	35%	0	0	1	0.1	20	0	0
Rockwall	Sabine	un-confined	23	554	4%	0	0	1	0.1	2	0	0
Rockwall	Sabine	un-confined	48	554	9%	0	0	1	0.1	5	0	0
Totals			1,103,952				3,973			273,689	6,475	9,448

Table 1, Identification of Nacatoch Aquifer Sub-zones by County, Sub-zone Area, Percentage of Each Sub-zone of the Total Aquifer Area in the County, Estimated Annual Aquifer Use by County, Estimated Annual Recharge by Aquifer Sub-zone, Estimated Average Aquifer Draw Down in Each Sub-zone, Estimated Total Water Withdrawal by Sub-zone, Estimated Annual Water Withdrawal by Sub-zone and Estimated MAG by Sub-zone * Note – In the absence of TWDB Pumping Data: Pumping is Assumed to be 10 acre-feet per year

County	Sum of Nacatoch Aquifer RWP Groundwater Availability Values (ac-ft per year)	Sum of Nacatoch Aquifer Sub-zone Estimated MAG Values (ac-ft per year)	Difference Between Estimated MAG and RWP Availability Values (ac-ft per year)
Bowie	3936	3941	5
Delta	282	293	11
Ellis	0	1	1
Franklin	10	10	0
Hopkins	915	922	7
Hunt	2956	2966	10
Kaufman	318	317	-1
Lamar	45	45	0
Navarro	229	234	5
Rains	10	10	0
Red River	700	708	8
Rockwall	1	1	0

Table 2, Sum of Regional Water Plan Nacatoch Aquifer Availability Values by County and Sum of Nacatoch Aquifer Estimated MAG Values by County

GMA-8 Desired Future Conditions for the Nacatoch Aquifer

Bowie County

- From estimated year 2009 conditions, the average draw down of the unconfined zone of the Nacatoch aquifer should not exceed approximately 10.4 feet after 50 years.
- From estimated year 2009 conditions, the average draw down of the confined zone of the Nacatoch aquifer should not exceed approximately 20 feet after 50 years.

Delta County

- From estimated year 2009 conditions, the average draw down of the unconfined zone of the Nacatoch aquifer should not exceed approximately 3 feet after 50 years.

Ellis County

- From estimated year 2009 conditions, the average draw down of the unconfined zone of the Nacatoch aquifer should not exceed approximately 5 feet after 50 years.

Franklin County

- From estimated year 2009 conditions, the average draw down of the confined zone of the Nacatoch aquifer should not exceed approximately 20 feet after 50 years.

Hopkins County

- From estimated year 2009 conditions, the average draw down of the unconfined zone of the Nacatoch aquifer should not exceed approximately 5.5 feet after 50 years.
- From estimated year 2009 conditions, the average draw down of the confined zone of the Nacatoch aquifer should not exceed approximately 20 feet after 50 years.

Hunt County

- From estimated year 2009 conditions, the average draw down of the unconfined zone of the Nacatoch aquifer should not exceed approximately 8.1 feet after 50 years.
- From estimated year 2009 conditions, the average draw down of the confined zone of the Nacatoch aquifer should not exceed approximately 20 feet after 50 years.

Kaufman County

- From estimated year 2009 conditions, the average draw down of the unconfined zone of the Nacatoch aquifer should not exceed approximately 0.6 feet after 50 years.
- From estimated year 2009 conditions, the average draw down of the confined zone of the Nacatoch aquifer should not exceed approximately 20 feet after 50 years.

Lamar County

- From estimated year 2009 conditions, the average draw down of the unconfined zone of the Nacatoch aquifer should not exceed approximately 3.1 feet after 50 years.

Navarro County

- From estimated year 2009 conditions, the average draw down of the unconfined zone of the Nacatoch aquifer should not exceed approximately 1.2 feet after 50 years.
- From estimated year 2009 conditions, the average draw down of the confined zone of the Nacatoch aquifer should not exceed approximately 20 feet after 50 years.

Rains County

- From estimated year 2009 conditions, the average draw down of the confined zone of the Nacatoch aquifer should not exceed approximately 20 feet after 50 years.

Red River County

- From estimated year 2009 conditions, the average draw down of the unconfined zone of the Nacatoch aquifer should not exceed approximately 1.1 feet after 50 years.
- From estimated year 2009 conditions, the average draw down of the confined zone of the Nacatoch aquifer should not exceed approximately 20 feet after 50 years.

Rockwall County

- From estimated year 2009 conditions, the average draw down of the unconfined zone of the Nacatoch aquifer should not exceed approximately 1 foot after 50 years.

Note: The observations and assessments made in this report were based on data supplied by GMA-8 members, TWDB, or available from referenced published sources available at the time of the report preparation. The conclusions drawn in the report are based on the available data and reasonable methods of assessment. The Desired Future Conditions presented in this report reflect policy decisions made by GMA-8. If new or different data is made available, the conclusions of this report may change.

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