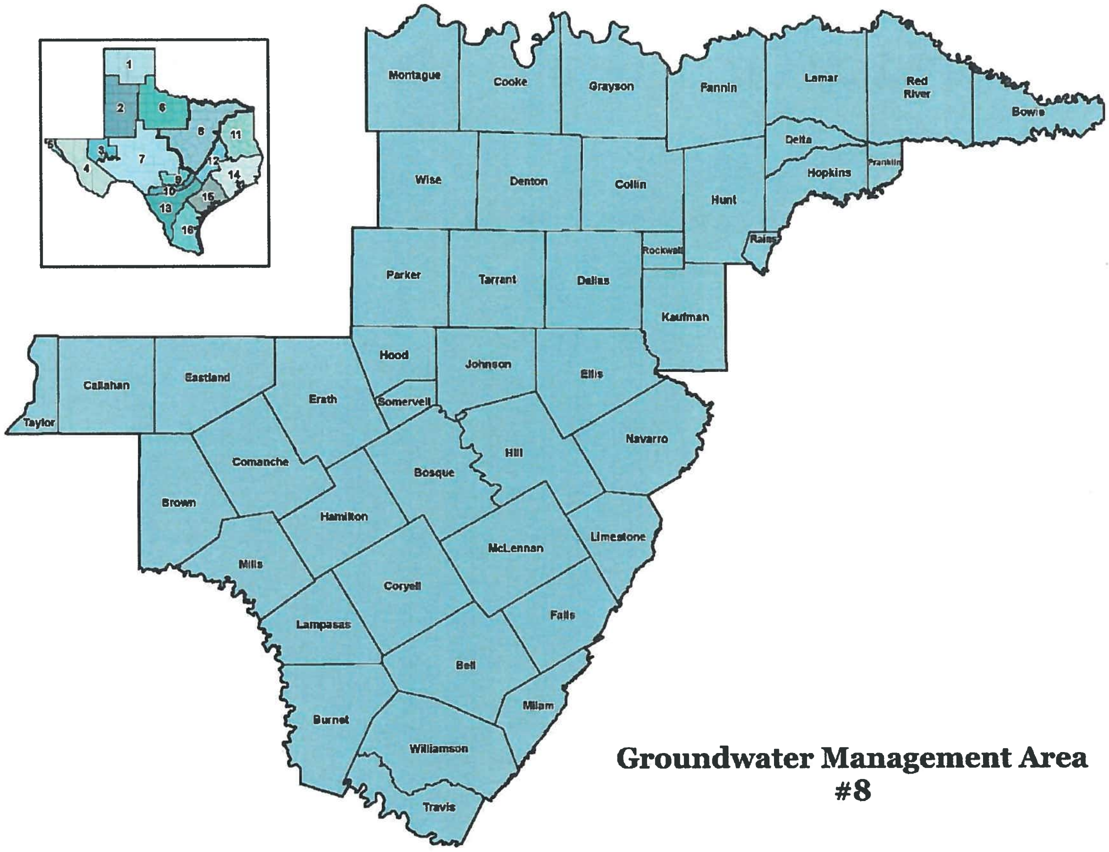

Desired Future Conditions Explanatory Report

Prepared by Groundwater Management Area 8

With assistance from

Mullican and Associates

Desired Future Conditions Explanatory Report

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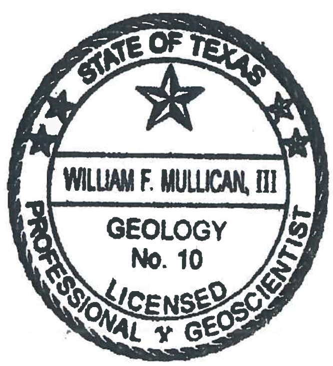

William F. Mullican III, PG
Principal, Mullican and Associates

February 10, 2017

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1.0 EXECUTIVE SUMMARY

On January 31, 2017, District Representatives in Groundwater Management Area 8 ("GMA 8"), after posting notice, met and adopted statements of desired future conditions ("DFCs") for all relevant aquifers within the boundaries of GMA 8 as required by Texas Water Code Section 36.108. The resolution adopting these DFCs is included in this Explanatory Report as part of the requirements included in Texas Water Code Section 36.108. The adopted DFCs were developed as part of the joint-planning process for the current round of joint planning.

This GMA 8 Explanatory Report contains two main elements required in statute for the joint-planning process: the DFC statement for all relevant aquifers adopted by District Representatives for GMA 8 during a regularly scheduled meeting on January 31, 2017, and also documentation of all data, analyses, and supporting materials including policy and technical justifications considered by the District Representatives of GMA 8 from September 21, 2013, through January 31, 2017. All required considerations as set forth in Texas Water Code Section 36.108 (d)(1-9) are included in this GMA 8 Explanatory Report.

The Texas Water Development Board ("TWDB") has made available an "Explanatory Report Checklist," which it uses to determine administrative completeness with respect to the requirements of statute and administrative rules. To facilitate this review by the TWDB, a populated Explanatory Report Checklist is included in Appendix A.

This Explanatory Report documents that the District Representatives in GMA 8 have considered all of the elements required by Texas Water Code Section 36.108(d-3) in establishing the 2017 DFCs by:

(1) Identifying each DFC;

(2) Providing the policy and technical justifications for each DFC;

(3) Documenting that the factors under Texas Water Code Section 36.108(d) were considered by the districts along with how the adopted DFCs impact each factor;

(4) Listing other DFC options considered, if any, and the reasons why those options were not adopted; and

(5) Discussing reasons why recommendations made by any advisory committee and relevant public comments received by the districts were or were not incorporated into the desired future conditions.

All discussions, considerations, and decisions made by District Representatives in GMA 8 were made in open, publicly-noticed meetings in accordance with Texas Water Code Section 36.108. Meeting notices, meeting agendas, and meeting minutes for the eleven (11) GCDs in GMA 8 for this round of joint-planning are included for review in Appendix B.

The primary tools for analyzing groundwater conditions and for groundwater management are computer simulations or models. Computer models are the preferred means of assessing the effects of past, current, and future pumping and droughts on groundwater availability. Modeling involves developing and using computer programs to estimate future trends in the amount of water available in an aquifer based on hydrogeologic principles, actual aquifer measurements, and stakeholder guidance. In correspondence dated November 21, 2014, the TWDB formally approved the updated Northern Trinity and Woodbine Aquifer Groundwater Availability Model as the official Groundwater Availability Model ("GAM") for the Northern Trinity and Woodbine aquifers in GMA 8 ("Northern Trinity and Woodbine Aquifer GAM") (Appendix C). The 2017 DFCs adopted are the result, in part, of the modeling prepared by the GMA's consultants using the updated Northern Trinity and Woodbine Aquifer GAM.

Texas Water Code Section 36.108(d) states "Not later than September 1, 2010, and every five years thereafter, the districts shall consider groundwater availability models and other data or information for the management area and shall propose for adoption desired future conditions for the relevant aquifers within the management area. Before voting on the proposed desired future conditions of the aquifers under Subsection (d-2)..." In addition, Texas Water Code Section 36.108(d) also requires GCDs to consider nine factors, which includes other relevant information before adopting proposed DFCs and to prepare a report documenting that the factors were considered. The nine factors are discussed below and in greater detail in Section 3.2.

1. AQUIFER USES AND CONDITIONS

The Northern Trinity, Woodbine, Edwards, Ellenburger, and Hickory aquifers in GMA 8 are predominant sources of water for GMA 8. Groundwater data was obtained from the TWDB, which maintains records and reports of groundwater use, water wells, and other relevant data. The District Representatives received presentations from its technical consultants of the modeled effects of the adopted DFCs on existing aquifer uses and conditions.

2. WATER SUPPLY NEEDS AND WATER MANAGEMENT STRATEGIES

The District Representatives considered the water supply needs (the amount of projected water demand beyond existing supplies) and water management strategies (new water supplies to meet water supply needs) for GMA 8. Specifically, information on water supply needs and water management strategies from the 2011 Regional Water Plans and the 2012 Texas State Water Plan was considered. GMA 8 includes parts of Regional Water Planning Areas B, C, D, F, G, and K. The reports show most future water supplies will be from sources other than groundwater.

3. HYDROLOGIC CONDITIONS

The District Representatives considered presentations and reports on the total estimated recoverable storage ("TERS"), average annual recharge, inflows and discharge for the relevant aquifers. After the District Representatives began the work for the 2017 DFCs, the

TWDB provided the TERS numbers for GMA 8, a required consideration in establishing the DFCs. TERS is the estimated amount of groundwater within an aquifer that accounts for recoverable storage scenarios that range between 25 percent and 75 percent of the porosity-adjusted aquifer volume. The District Representatives also considered potentiometric surface contour maps showing the current aquifer/hydrologic conditions. All of this information was used to set the adopted DFCs.

4. ENVIRONMENTAL FACTORS

The District Representatives considered the potential impacts by the DFCs on environmental factors such as spring flow and other interactions between groundwater and surface water. Available information from the models and other technical resources relevant to these potential impacts were presented. The District Representatives determined there are varying degrees of interactions between the aquifer systems as a whole and surface water within the region encompassing GMA 8.

5. SUBSIDENCE

The potential impacts of subsidence resulting from the DFCs, based on information presented by GMA 8 consultants, were determined to not be of concern or significant to the overall considerations.

6. SOCIOECONOMIC IMPACTS

The District Representatives considered the socioeconomic impact analysis provided by the TWDB to Water Planning Regions B, C, D, F, G, and K, for the 2011 Regional Water Plans. In addition, GMA 8 District Representatives developed and executed a survey tool with each of the 11 GCDs to more fully understand the wide spectrum of socioeconomic impacts from the DFCs. While there are economic impacts to limiting groundwater production, the negative socioeconomic impacts of lower water quality, higher groundwater production costs and other socioeconomic impacts discussed support the adopted DFCs.

7. PRIVATE PROPERTY RIGHTS

The District Representatives in GMA 8 extensively considered the potential effects of the DFCs on the interests and rights in private property. It was recognized that there are many property owners competing to pump groundwater and that excessive withdrawals can cause increased pumpage costs, the lowering of water tables, and the potential need to convert to alternative supplies. District Representatives, using a survey tool developed for use by each of the 11 GCDs, reported individually on the impacts of the DFCs on private property rights and how GCD Management Plans and Rules have been developed to protect private property rights.

8. FEASIBILITY OF ACHIEVING THE DFCs

The District Representatives considered groundwater modeling and information about historic use, current and projected supplies, projected water demands, and applicable management plans, rules, regulations, and laws to determine that the adopted DFCs are feasible. The GCDs have adequate authority to implement regulations necessary to achieve the adopted DFCs.

9. OTHER RELEVANT INFORMATION

The GMA 8 District Representatives considered other material and relevant information as reflected in the materials contained in this Explanatory Report. For example, many GMA 8 GCDs initiated groundwater monitoring programs to further improve current and future model calibrations in predictive groundwater availability modeling simulations.

CONCLUSION

The District Representatives in GMA 8 have extensively reviewed and evaluated the adopted 2017 DFCs and determined that they are reasonable under the criteria set forth in the Texas Water Code.

2.0 INTRODUCTION

Groundwater Management Area 8 ("GMA 8"), delineated by the Texas Water Development Board ("TWDB") on December 15, 2002, for the purposes of joint planning as required by Texas Water Code Section 36.108, covers all or portions of 45 counties and eleven (11) groundwater conservation districts ("GCDs") (Table 1). In addition, GMA 8 extends into six (6) regional water planning areas: Regions B, C, D, F, G, and K. GMA 8 extends from Austin in Travis County in the south to the Texas border with Oklahoma and Arkansas in the north and northeast (Figure 1, Figure 2 and Figure 3). The relationship between GMA boundaries and regional water planning area boundaries are illustrated in Figure 4.

Table 1. Listing of GCDs and counties included, in whole or in part, in GMA 8.

District	County
Central Texas GCD	Burnet
Clearwater UWGD	Bell
Middle Trinity GCD	Bosque
	Comanche
	Coryell
	Erath
North Texas GCD	Collin
	Cooke
	Denton

District	County
Northern Trinity GCD	Tarrant
Post Oak Savannah GCD	Milam
Prairielands GCD	Ellis
	Hill
	Johnson
	Somervell
Red River GCD	Fannin
	Grayson
Saratoga UWCD	Lampasas
Southern Trinity GCD	McLennan
Upper Trinity GCD	Hood
	Montague
	Parker
	Wise
No GCD	Bowie
	Brown
	Callahan
	Dallas
	Delta
	Eastland
	Falls
	Franklin
	Hamilton
	Hopkins
	Hunt
	Kaufman
	Lamer
	Limestone
	Mills
	Navarro
	Rains
	Red River
	Rockwall
	Taylor
	Travis

District	County
	Williamson

GMA 8 is one of the largest aerially and most demographically complex management areas of the sixteen (16) GMAs in Texas, with both major metropolitan and rural areas providing a rich diversity of economic and social settings. According to population projections adopted by the TWDB for the regional and state water planning processes which recently culminated in the adoption of the 2017 Texas State Water Plan, GMA 8 is projected to have a population of 11,115,148 residents in 2020 and is projected to increase to 20,870,081 by 2070 (see Table 2). This 87.8 percent population increase, both in magnitude and scale, places significant importance and incentives on District Representatives in GMA 8 to adequately consider water use, water demands, water management strategies, hydrologic conditions, environmental impacts, impacts on subsidence, socioeconomic impacts, and impacts on private property rights, for the planning period from 2020 – 2070.

Following is a summary of DFCs adopted for GMA 8, information considered regarding the nine factors included in Texas Water Code Section 36.108(d)(1–9), and a description of aquifers in GMA 8 designated as non-relevant for the purposes of joint planning.

Table 2. Population projections adopted by the TWDB for 2020 – 2070 for use in the 2016 regional water plans and 2017 Texas State Water Plan[1].

GMA 8 Population Projections by County 2020-2070						
County	2020	2030	2040	2050	2060	2070
BELL	371,956	430,647	494,582	560,252	624,686	688,107
BOSQUE	20,310	22,184	23,147	23,747	24,129	24,362
BOWIE	95,703	98,413	99,263	99,263	99,263	99,263
BROWN	39,761	40,717	40,717	40,717	40,717	40,717
BURNET	53,114	64,268	73,673	82,668	90,571	97,426
CALLAHAN	14,482	15,504	16,061	16,351	16,564	16,700
COLLIN	956,716	1,116,830	1,363,229	1,646,663	1,853,878	2,053,638
COMANCHE	14,502	15,078	15,467	15,974	16,406	16,814
COOKE	42,033	45,121	48,079	53,532	64,047	96,463
CORYELL	86,105	97,771	110,752	122,101	134,199	146,240
DALLAS	2,566,134	2,822,809	3,107,541	3,355,539	3,552,602	3,697,105
DELTA	5,320	5,376	5,376	5,376	5,376	5,376
DENTON	901,645	1,135,397	1,348,271	1,576,424	1,846,314	2,090,485

[1] Texas Water Development Board, 2016 Regional Water Plan County Population Projections for 2020 – 2070 (January 2015). See: https://www3.twdb.texas.gov/Reports17/report/Projections/pop_county

GMA 8 Population Projections by County 2020-2070						
County	2020	2030	2040	2050	2060	2070
EASTLAND	19,289	19,712	19,730	19,732	19,732	19,732
ELLIS	183,814	224,000	276,931	362,668	488,768	683,974
ERATH	42,135	46,923	50,968	54,827	58,474	61,844
FALLS	19,413	20,397	20,610	20,126	20,736	21,364
FANNIN	38,346	43,391	52,743	69,221	101,915	138,497
FRANKLIN	11,124	11,627	11,930	12,226	12,447	12,622
GRAYSON	134,785	148,056	164,524	185,564	250,872	344,127
HAMILTON	8,562	8,703	8,703	8,703	8,703	8,703
HILL	37,828	40,277	41,935	43,643	44,937	45,989
HOOD	61,316	71,099	78,111	84,147	88,785	92,339
HOPKINS	37,978	40,895	43,555	46,610	49,556	52,517
HUNT	104,894	130,351	164,886	212,575	280,518	379,250
JOHNSON	173,835	200,573	228,160	258,414	291,047	325,967
KAUFMAN	146,623	191,707	239,940	309,619	428,577	571,840
LAMAR	52,170	54,189	55,683	57,037	58,092	58,943
LAMPASAS	21,800	24,100	25,874	27,689	29,296	30,741
LIMESTONE	25,136	26,615	27,817	29,134	30,206	31,152
MCLENNAN	252,211	272,216	289,887	307,661	325,373	342,757
MILAM	26,234	27,793	28,896	30,300	31,501	32,629
MILLS	4,912	5,076	5,213	5,417	5,625	5,859
MONTAGUE	20,507	21,260	21,600	21,979	22,223	22,401
NAVARRO	52,544	57,032	61,667	71,452	86,952	107,814
PARKER	199,955	255,133	291,007	366,596	480,530	629,277
RAINS	11,888	12,605	12,809	12,947	13,007	13,035
RED RIVER	12,976	12,976	12,976	12,976	12,976	12,976
ROCKWALL	104,887	137,304	160,918	198,279	249,594	301,970
SOMERVELL	9,482	10,594	11,395	12,013	12,539	12,958
TARRANT	2,006,473	2,281,666	2,579,553	2,797,060	2,991,972	3,184,348
TAYLOR	140,675	147,183	152,561	156,822	160,004	162,423
TRAVIS	1,273,260	1,508,642	1,732,860	1,897,769	2,033,120	2,185,909
WILLIAMSON	632,433	794,478	987,495	1,195,374	1,431,101	1,675,901
WISE	79,882	94,734	110,668	149,261	188,770	227,527
GMA 8 Total	11,115,148	12,851,422	14,717,763	16,636,448	18,676,700	20,870,081

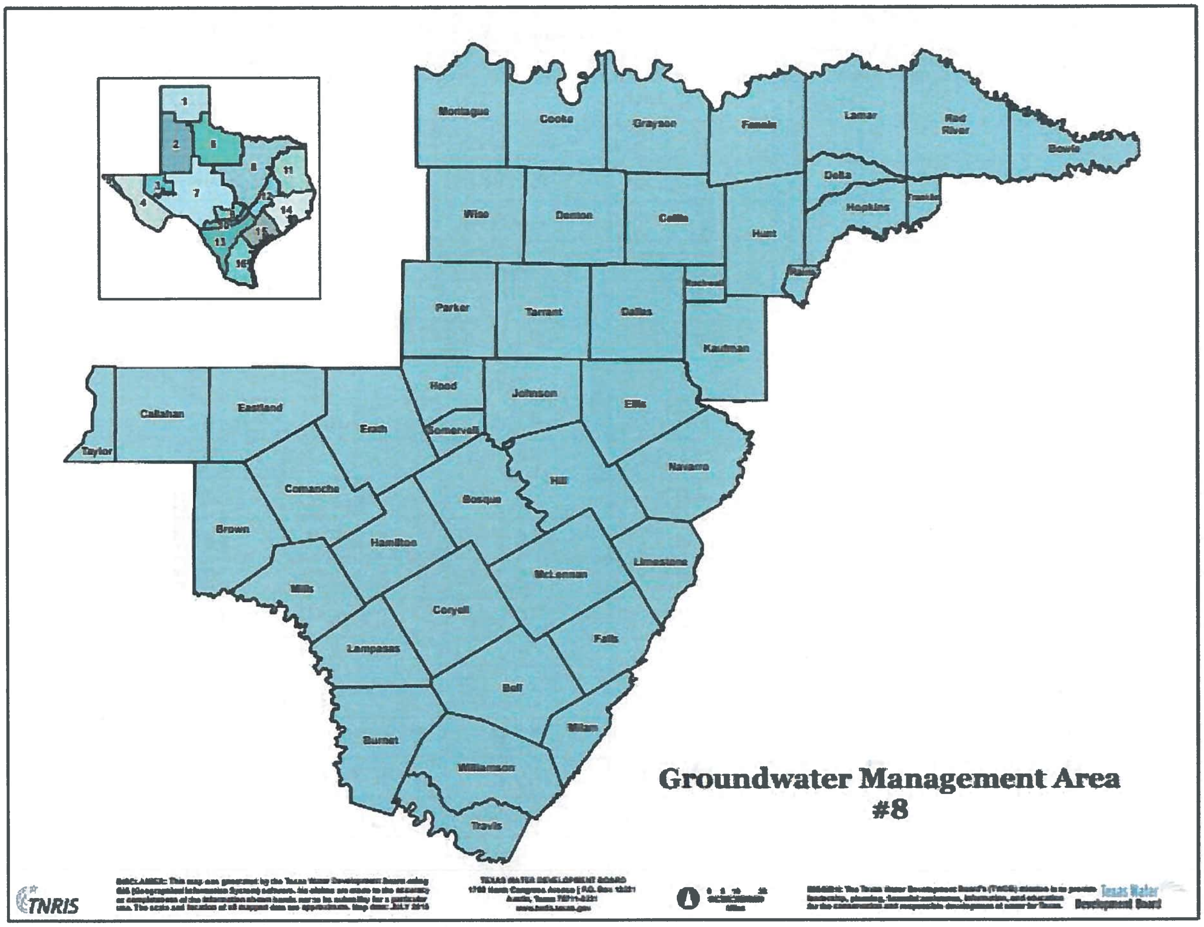

Figure 1. Counties in Groundwater Management Area 8[2]

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[2] Texas Water Development Board, Groundwater Management Area 8 Map
http://www.twdb.texas.gov/mapping/doc/maps/gma/GMA_8_8x11.pdf

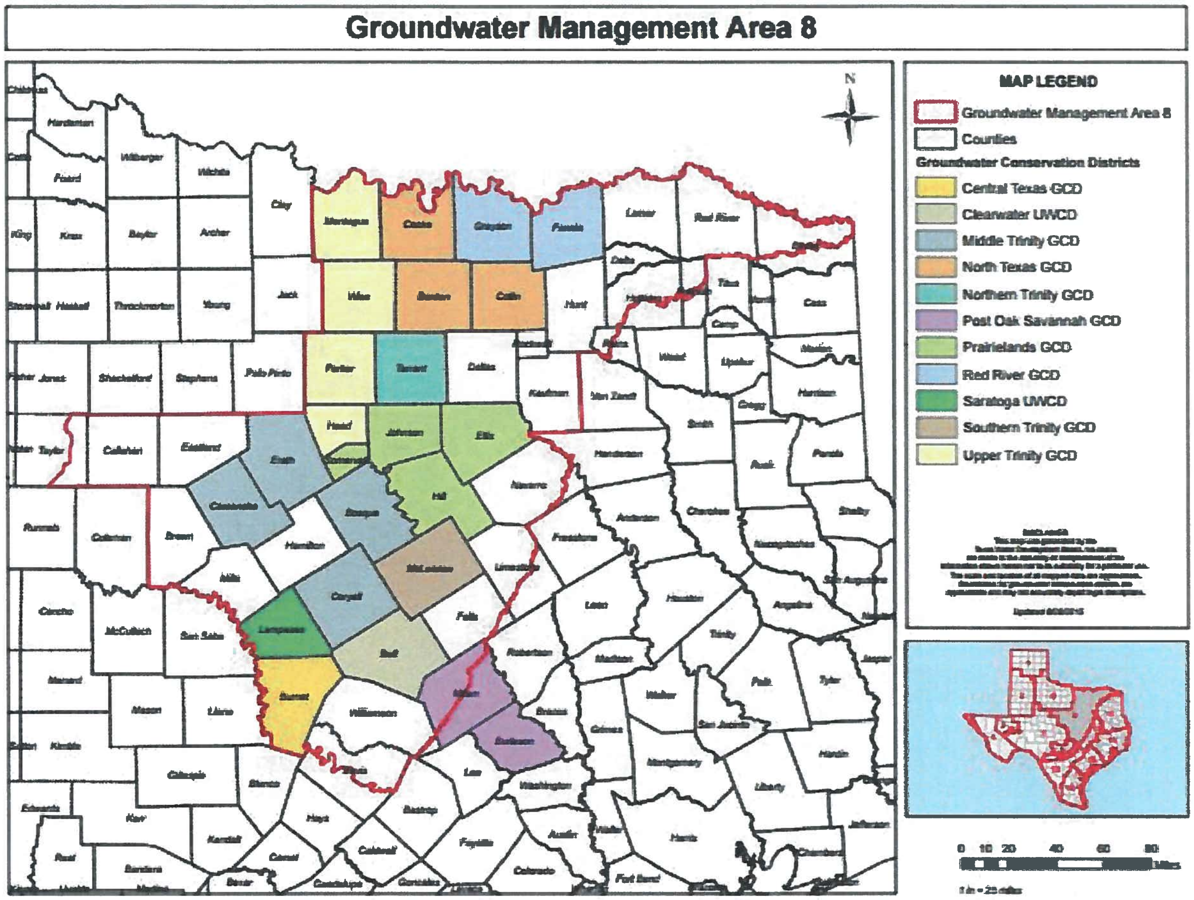

Figure 2. Groundwater Conservation Districts in Groundwater Management Area 8.[3]

[3] Texas Water Development Board Groundwater Management Area 8 Map
http://www.twdb.texas.gov/groundwater/management_areas/maps/GMA8_GCD.pdf

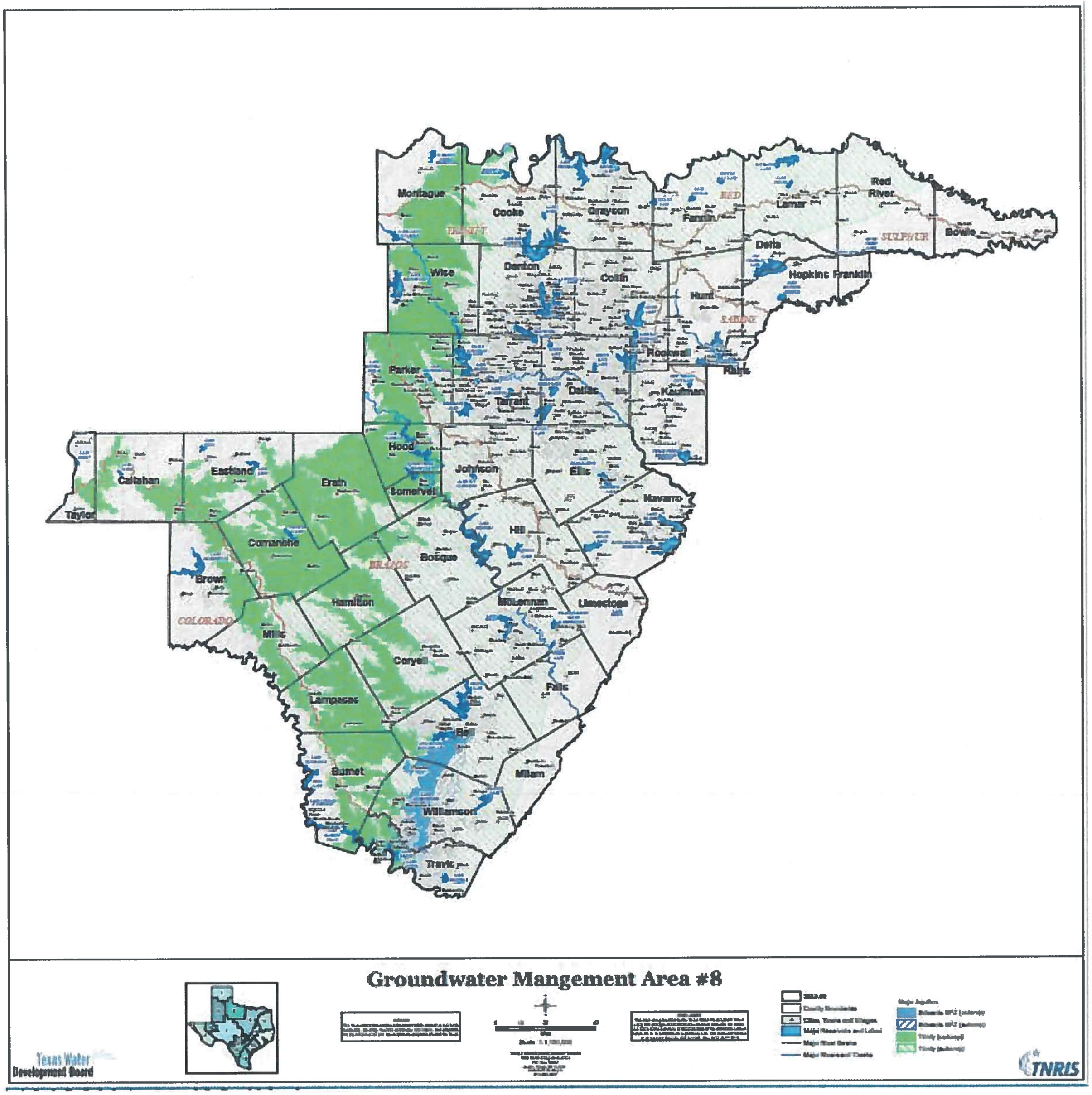

Figure 3. Map of GMA 8 highlighting location of major aquifers, rivers, and surface water reservoirs.[4]

[4] Texas Water Development Board Groundwater Management Area 8 Map
http://www.twdb.texas.gov/mapping/doc/maps/gma/GMA_8_24x24.pdf

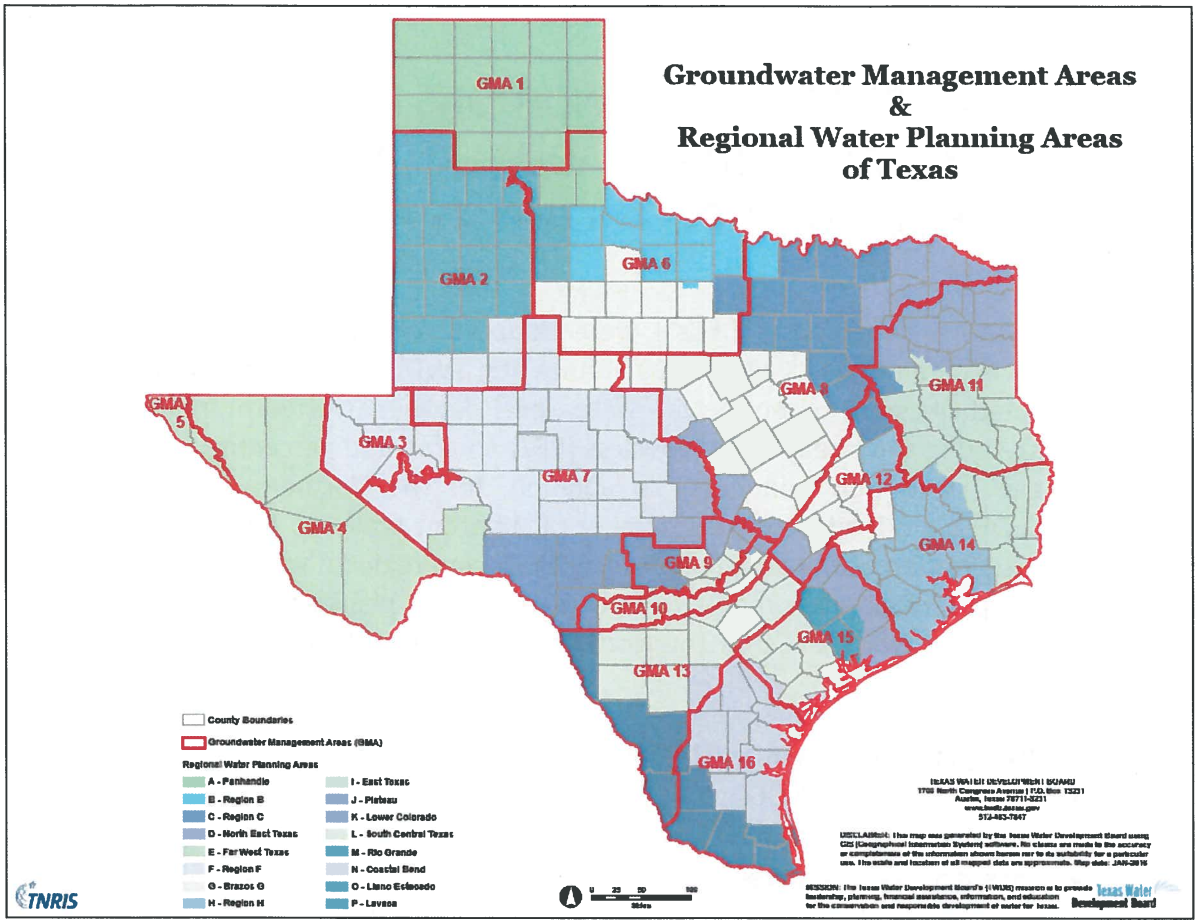

Figure 4. Map illustrating relationship between GMAs and regional water planning areas in Texas. Note that GMA 8 includes all or parts of Regions B, C, D, F, G, and K.[5]

[5] Texas Water Development Board map delineating Regional Water Planning Areas and Groundwater Management Areas. See http://www.twdb.texas.gov/mapping/doc/maps/RWPAs_GMAs_8x11.pdf

3.0 DESIRED FUTURE CONDITIONS FOR THE NORTHERN TRINITY AND WOODBINE AQUIFERS, THE EDWARDS (BFZ) AQUIFERS, AND THE LLANO UPLIFT AQUIFERS

Desired Future Conditions ("DFCs") were adopted for GMA 8 using a wide variety of quantitative parameters as allowed by statute and TWDB rules. These parameters on which the adopted DFCs are based include water level declines (Northern Trinity and Woodbine aquifers), spring and stream flow (Edwards (BFZ) Aquifer, and percentage of water remaining in storage (Llano Uplift Aquifers). In addition, for the Northern Trinity and Woodbine aquifers, DFCs were adopted at a number of different scales to facilitate the efficient and effective utilization of the adopted DFCs by GCDs and regional water planning groups when evaluating potential amendments to GCD management plans and rules and regional water plans. Scales for which DFCs for the Northern Trinity and Woodbine aquifers were adopted include:

- By aquifer for the entire GMA 8;
- By aquifer for each GCD;
- By aquifer for each county; and
- By outcrop and subcrop.

The following tables are extracted from Resolution 2017-01, which was adopted unanimously by the 11 designated District Representatives of GMA 8 on January 31, 2017. The entirety of Resolution 2017-01-01 is included in Appendix D.

DFCs for the Northern Trinity and Woodbine aquifers in GMA 8 are based on the "Results of Predictive Simulation in Support of GMA 8 Joint Planning—NTGCD GMA 8 Run 10" memorandum included in this Explanatory Report in Appendix E. DFCs for the Edwards (BFZ) Aquifer in GMA 8 are based on GAM Run 08-10mag that is included in this Explanatory Report in Appendix F. DFCs for the Llano Uplift Aquifers in GMA 8 are based on the Numerical Model Report: Minor Aquifers of the Llano Uplift Region of Texas (Marble Falls, Ellenburger-San Saba, and Hickory) that is included in this Explanatory Report in Appendix G.

Table 3. GMA 8 DFCs adopted at an aquifer-wide scale for Northern Trinity and Woodbine aquifers based on total average drawdown (both unconfined and confined drawdown). Planning period from January 1, 2010 through December 31, 2070 (feet)

GMA 8 Adopted DFCs -Aquifer-Wide Scale	
Woodbine	146
Paluxy	144
Glen Rose	116

GMA 8 Adopted DFCs -Aquifer-Wide Scale	
Twin Mountain	313
Travis Peak	177
Hensell	118
Hosston	206
Antlers	177

Table 4. GMA 8 DFCs adopted at a GCD scale for Northern Trinity and Woodbine aquifers (except for Upper Trinity GCD, see Table 5 below for Upper Trinity GCD) based on total average drawdown (both unconfined and confined drawdown). Planning period from January 1, 2010 through December 31, 2070 (feet).

GMA 8 Adopted DFCs - GCD Scale								
GCD	Wood-bine	Paluxy	Glen Rose	Twin Mtn	Travis Peak	Hensell	Hosston	Antlers
Central Texas GCD	—	—	2	—	16	7	20	—
Clearwater UWCD	—	19	83	—	300	137	330	—
Middle Trinity GCD	—	6	27	6	88	72	111	10
North Texas GCD	278	671	341	569	—	—	—	290
Northern Trinity GCD	7	101	148	315	—	—	—	148
Post Oak Savannah GCD	—	—	212	—	345	229	345	—
Prairielands GCD	39	35	126	142	258	190	289	—
Red River GCD	204	699	283	377	269	—	—	304
Saratoga UWCD	—	—	1	—	6	1	11	—
Southern Trinity GCD	6	35	133	—	471	220	542	—

Table 5. GMA 8 DFCs adopted for Upper Trinity GCD for Northern Trinity and Woodbine aquifers based on total average drawdown, discretized based on outcrop and downdip extent. Planning period from January 1, 2010 through December 31, 2070 (feet)

GMA 8 Adopted DFCs - Upper Trinity GCD		
Antlers	**Outcrop**	24
	Downdip	142
Paluxy	**Outcrop**	5
	Downdip	1
Glen Rose	**Outcrop**	8
	Downdip	28
Twin Mtn	**Outcrop**	3
	Downdip	46

Table 6. GMA 8 DFCs adopted at a county scale for Northern Trinity and Woodbine aquifers (except for Upper Trinity GCD counties, see **Error! Reference source not found.** below for these counties) based on total average drawdown (both unconfined and confined drawdown). Planning period from January 1, 2010 through December 31, 2070 (feet).

GMA 8 Adopted DFCs - County Scale								
County	Wood-bine	Paluxy	Glen Rose	Twin Mtn	Travis Peak	Hensell	Hosston	Antlers
Bell	—	19	83	—	300	137	330	—
Bosque	—	6	49	—	167	129	201	—
Bowie	—	—	—	—	—	—	—	—
Brown	—	—	2	—	1	1	1	2
Burnet	—	—	2	—	16	7	20	—
Callahan	—	—	—	—	—	—	—	1
Collin	459	705	339	526	—	—	—	570
Comanche	—	—	1	—	2	2	3	9
Cooke	2	—	—	—	—	—	—	176
Coryell	—	7	14	—	99	66	130	—
Dallas	123	324	263	463	348	332	351	—
Delta	—	264	181	—	186	—	—	—
Denton	22	552	349	716	—	—	—	395
Eastland	—	—	—	—	—	—	—	3
Ellis	61	107	194	333	301	263	310	—
Erath	—	1	5	6	19	11	31	12
Falls	—	144	215	—	462	271	465	—

GMA 8 Adopted DFCs - County Scale								
County	Wood-bine	Paluxy	Glen Rose	Twin Mtn	Travis Peak	Hensell	Hosston	Antlers
Fannin	247	688	280	372	269	—	—	251
Franklin	—	—	—	—	—	—	—	—
Grayson	160	922	337	417	—	—	—	348
Hamilton	—	2	4	—	24	13	35	—
Hill	20	38	133	—	298	186	337	—
Hopkins	—	—	—	—	—	—	—	—
Hunt	598	586	299	370	324	—	—	—
Johnson	2	-61	58	156	179	126	235	—
Kaufman	208	276	269	381	323	309	295	—
Lamar	38	93	97	—	114	—	—	122
Lampasas	—	—	1	—	6	1	11	—
Limestone	—	178	271	—	392	183	404	—
McLennan	6	35	133	—	471	220	542	—
Milam	—	—	212	—	345	229	345	—
Mills	—	1	1	—	7	2	13	—
Navarro	92	119	232	—	290	254	291	—
Rains	—	—	—	—	—	—	—	—
Red River	2	21	36	—	51	—	—	13
Rockwall	243	401	311	426	—	—	—	—
Somervell	—	1	4	31	51	26	83	—
Tarrant	7	101	148	315	—	—	—	148
Taylor	—	—	—	—	—	—	—	0
Travis	—	—	85	—	141	50	146	—
Williamson	—	—	77	—	173	74	177	—

Table 7. GMA 8 DFCs adopted at a county scale for Upper Trinity GCD counties for Northern Trinity and Woodbine aquifers based on total average drawdown for outcrop and downdip areas. Planning period from January 1, 2010 through December 31, 2070 (feet).

GMA 8 Adopted DFCs - Upper Trinity GCD by county (O-Outcrop, D-Downdip)				
County	Antlers	Paluxy	Glen Rose	Twin Mtn
Hood -O	—	5	7	4
Hood-D	—	—	28	46
Montague-O	18	—	—	—

GMA 8 Adopted DFCs - Upper Trinity GCD by county (O-Outcrop, D-Downdip)				
County	Antlers	Paluxy	Glen Rose	Twin Mtn
Montague-D	—	—	—	—
Parker-O	11	5	10	1
Parker-D	—	1	28	46
Wise-O	34	—	—	—
Wise-D	142	—	—	—

Table 8. GMA 8 DFCs adopted for the Edwards (BFZ) Aquifer. Planning period from January 1, 2010 through December 31, 2070. DFCs are in cubic feet per month spring/stream flow in Bell, Travis, and Williamson counties.

County	DFC
Bell	Maintain at least 100 acre-feet per month of stream/spring flow in Salado Creek during a repeat of the drought of record
Travis	Maintain at least 42 acre-feet per month of aggregated stream/spring flow during a repeat of the drought of record
Williamson	Maintain at least 60 acre-feet per month of aggregated stream/spring flow during a repeat of the drought of record

Table 9. GMA 8 DFCs adopted for the Llano Uplift Aquifers. Planning period from January 1, 2010 through December 31, 2070.

County	Ellenburger-San Saba Aquifer	Hickory Aquifer	Marble Falls Aquifer
Brown	Maintain 90 percent of saturated thickness	Maintain 90 percent of saturated thickness	Maintain 90 percent of saturated thickness
Burnet	Maintain 90 percent of saturated thickness	Maintain 90 percent of saturated thickness	Maintain 90 percent of saturated thickness
Lampasas	Maintain 90 percent of saturated thickness	Maintain 90 percent of saturated thickness	Maintain 90 percent of saturated thickness
Mills	Maintain 90 percent of saturated thickness	Maintain 90 percent of saturated thickness	Maintain 90 percent of saturated thickness

3.1 POLICY AND TECHNICAL JUSTIFICATIONS

The purpose of this section of the Explanatory Report is to provide the policy and technical justifications for the DFCs adopted by the District Representatives of GMA 8 as required by Texas Water Code Section 36.108(d-3)(2). In general, the policy and technical justifications for the adopted DFCs are embodied by, and not differentiable from, the careful consideration and balancing by the GMA 8 District Representatives of all of the policy and technical information that was considered in working through the statutory criteria required by Texas Water Code Section 36.108 and detailed in Section 3.2 of this Explanatory Report. Nonetheless, below are some of the policy and technical justifications that can be gleaned from the information considered by District Representatives of GMA 8 in their evaluation and adoption of the DFCs. The policy and technical justifications discussed in this section are not intended to be exhaustive of all of the considerations of the GMA 8 District Representatives or the individual GMA 8 GCDs.

3.1.1 Policy justifications

The adoption of DFCs by GCDs, pursuant to the requirements and procedures set forth in Texas Water Code Chapter 36, is an important policy-making function. GMA 8 District Representatives believe that their most important task in developing and adopting DFCs is to carefully consider all available information related to the aquifers and their past, present, and future use, including without limitation, all information related to the statutory criteria detailed in Section 3.2 of this Explanatory Report, and also to achieve an appropriate balance of those criteria using their best judgment and discretion, as well as the best available science. From a policy perspective, a number of key considerations emerge from that "balancing act" that justify the adoption of the DFCs.

Socioeconomic impacts and impacts on the interests and rights in private property are two significant policy considerations that justify the DFCs adopted for all relevant aquifers by GMA 8 District Representatives. As described further herein, these policy considerations are inevitably and fundamentally interconnected. Ultimately, the primary socioeconomic and private property impact analyses that were considered by GMA 8 District Representatives, which justified the adoption of the DFCs, included the impacts of the adopted DFCs on the economic costs to landowners producing groundwater, the ability of landowners to recover their reasonable investment-backed expectations that utilize groundwater, and the continued availability of groundwater in the future for other landowners whose lands overlie the aquifers, while also attempting to promote conservation to address the significant historic water level declines in many parts of the aquifers. These inseparable economic, private property rights, and groundwater conservation considerations served as the controlling policy factors behind the selections of the DFCs adopted by GMA 8 District Representatives.

The consideration of socioeconomic impacts included, among other factors, the cost to individual landowners to drill a well and produce quality groundwater in sufficient quantities, the protection of existing economic investments in wells, and the existing water management strategies that rely on groundwater from GMA 8 in the recently adopted Texas State Water Plan. GMA 8 is unique relative to some of the other groundwater management areas in the state because both the 2012 and 2017 Texas State Water Plans project the use of new surface water supplies to meet most of the needs in the area over the joint planning period. The water management strategies listed in the 2012 and 2017 Texas State Water Plans were an important consideration for GMA 8 in considering future groundwater uses and needs.

The cost of drilling a producing water well is largely driven by how deep the well must be drilled to reach the quantity and quality of groundwater required. The cost to lift the water from the pump to the land surface is also relevant, not only in terms of the initial cost to properly equip the well with the appropriate pump and wiring to extend the length of the well bore, but also in terms of the ongoing cost of energy to lift the water. Additionally, the water needs to be of a sufficient quality that it can either be used for its beneficial purpose without treatment or with economically-affordable treatment. In some areas, groundwater quality tends to diminish as groundwater levels decline in the aquifer and landowners could be forced to produce ever-deepening groundwater resources. And, finally, the amount of groundwater that the water well will yield at the land surface is an important consideration for a landowner in determining whether drilling a well is economically feasible for the intended purpose.

In the subcrop areas of aquifers, minimizing water level declines is advantageous in maintaining well yields and in avoiding increased pumping costs. The vast majority of groundwater produced in GMA 8 comes from the subcrop areas of the various layers of the Northern Trinity and Woodbine aquifers where confining conditions create artesian pressure and push groundwater into and up water well bores and to water well pumps. Without the driving force of that artesian pressure, the costs of drilling and equipping a well, lifting the water to the surface, the potential decrease in well yields, and in some cases water quality degradation may decrease the economic feasibility of drilling a water well. In addition, maintaining an investment in an existing well may become economically infeasible to most landowners over the subcrop of the aquifer. And, for a large number of landowners throughout GMA 8, the subcrop is the only water supply option available to their properties. Without water being economically available on their properties, the negative impacts to the property values of landowners can be significant in some cases.

The preservation of artesian pressure in the subcrops of the aquifers and the preservation of sufficient saturated thickness of groundwater in the outcrops of the aquifers protects landowners' private property rights in the groundwater located beneath their property as well as current and future use of the resource. As set forth in Texas Water Code Chapter 36, and reiterated by the Texas Supreme Court in Edwards Aquifer Authority v. Day[6], landowners

[6] *Edwards Aquifer Authority v. Day, 369 S.W.3d 814, 823 (Tex. 2012).*

own the groundwater beneath their property "in place," meaning landowners have a vested property interest in the groundwater before that groundwater is ever produced. Landowners with existing water wells on their property have made investments in their water wells and the economic activities that those wells support, and may have expectations that those investments will continue to be recovered in the foreseeable future. Landowners also have an expectation of being able to drill cost-affordable water wells on their properties in the future. Virtually all well owners, both existing and future, both large and small, count upon the availability of quality groundwater in sufficient quantities at a reasonable depth from the land surface. In GMA 8, by and large, this means preservation of artesian conditions in the subcrops of the Northern Trinity and Woodbine aquifers and preservation of an adequate amount of saturated thickness of groundwater in its outcrops throughout the joint planning period.

Because the cost of drilling and equipping a water well is directly related to its depth from land surface, most landowners with investment-backed expectations in existing wells, including water utility service providers, historically drilled wells only to the depths needed to produce the amount of groundwater desired for their purposes. Water levels have declined substantially over time throughout most of GMA 8. Allowing continued pumping at historical amounts or increased pumping in order to make water available to existing and new users will continue to cause water level declines. And, allowing such production will necessarily have impacts to shallower wells, causing many of them to go dry or otherwise fail to produce groundwater in a manner sufficient for their intended purpose. While many landowners could still physically produce groundwater through new or deepened wells, there are economic costs associated with the need to do so—ranging from several thousand to millions of dollars, depending upon the nature of the investment and the depth to groundwater at a specific location. At the same time, setting DFCs at levels that would protect every existing well, no matter how shallow it was completed from the land surface, would mean cutting groundwater production amounts from current rates to levels so severe that it would have enormous economic consequences for both existing and future well owners. This reality, which was modeled under different pumping scenarios using the state-of-the-art Northern Trinity and Woodbine Aquifer Groundwater Availability Model "(Northern Trinity and Woodbine Aquifer GAM") for the region, is one of many analyses that were carefully considered by District Representatives in striking a balance between the highest practicable amount of groundwater that can be produced in the region while promoting conservation in order to protect investments by landowners in existing wells. In a parallel manner, this balancing test was achieved in DFCs adopted for the Edwards, Ellenburger, Hickory, and Marble Falls aquifers where present in GMA 8. Therefore, for all aquifers designated as relevant for joint-planning purposes, this balance is represented by the DFCs that were adopted for GMA 8, and is one of the policy justifications for them.

It is undisputed that heavy population growth, specifically along the Interstate-35 corridor around the City of Waco and the Dallas/ Fort Worth Metroplex, and increased water demands, have resulted in the steady decline of aquifer water levels in the various layers of the Northern Trinity and Woodbine aquifers in GMA 8, with some areas experiencing more than 1,000 feet in water level declines over the last 130+ years. In order to address continued groundwater level declines and the problems resulting from those declines, and after carefully balancing the statutory criteria that must be considered in the development and establishment of DFCs, GMA 8 District Representatives adopted DFCs that establish desired drawdown levels between now and 2070 for each of the relevant aquifers underlying GMA 8, including each hydrogeologic unit comprising the Northern Trinity Aquifer Group, the Woodbine Aquifer, the Edwards (BFZ) Aquifer, and the Ellenburger, Hickory, and Marble Falls aquifers of the Llano Uplift, and in each geographic area of the region based upon varying hydrogeologic conditions and varying uses of groundwater on the land overlying those aquifers. From a policy standpoint, the adopted DFCs set goals for the future conditions of the aquifers in terms of limiting drawdown levels, percentage of water in storage, or spring flows, in order to preserve artesian pressure and confined conditions in the subcrops of the aquifers to allow for the economically feasible production of groundwater to protect private property rights for all landowners in the region on a long-term basis.

The outcrop areas of the Northern Trinity Aquifer Group and Woodbine aquifers typically are not very deep, have less saturated thickness, and can be impacted by drought conditions on the land surface. The outcrop areas of the aquifers generally do not have enough water to be utilized in the long-term as a supply source for high-volume wells. The main uses in the outcrop areas for most landowners in GMA 8 both presently and in the long-term provide a source of water to overlying lands for domestic, livestock, smaller municipal and commercial purposes, and other relatively low-volume needs, especially in areas where alternative water supplies are not economically viable. If the outcrop areas of the aquifers are depleted to a point where even low-volume water wells are not viable, there would be significant economic consequences across large areas of land in the outcrop as the cost to build the infrastructure throughout those large areas to deliver water to every property from alternative water supplies would not be economically feasible. Thus, the District Representatives considered the need to preserve the availability of saturated thickness in the outcrop areas of the aquifers and the current and future economic considerations set for landowners in those areas, as well as the hydraulic connection between pumping in the subcrops of the aquifers and associated impacts to the outcrop areas, when establishing the DFCs, thereby justifying the adoption of the DFCs.

3.1.2 Technical justifications

It is impossible to articulate the technical justifications for the adopted DFCs in terms that are not intricately connected to the policy justifications set forth above. Rather, the technical information considered by GMA 8 District Representatives in balancing the competing interests associated with the establishment of DFCs and evaluating the various interests and economic costs to landowners associated with groundwater production both drive and support those policy justifications.

As set forth under Subsection 3.1.1, the adopted DFCs are primarily focused on achieving the appropriate balance of all of the statutory criteria required to be considered by maintaining appropriate groundwater levels in all areas of GMA 8, whether in terms of maintaining appropriate artesian levels in the subcrop areas of the aquifers' layers or water table levels and saturated thickness in the outcrop areas. In that regard, while this section will highlight a number of the technical justifications for the adopted DFCs, all of the technical information detailed in Section 3.2 of this Explanatory Report was considered by GMA 8 District Representatives as required by Texas Water Code Section 36.108.

In addition to the technical justifications discussed below for DFCs adopted for the Northern Trinity Group and Woodbine Aquifer, GMA 8 District Representatives also adopted DFCs for the Edwards (Balcones Fault Zone or BFZ) Aquifer and aquifers of the Llano Uplift present within the geographic boundaries of GMA 8 (Ellenberger, Hickory, and Marble Falls aquifers). The primary technical justifications for DFCs adopted for the two aquifer systems is based on information presented in reports by Anaya (2008[7]) [hereinafter GAM Run 08–10mag] (see Appendix F), Bradley (2011[8]) [hereinafter GTA Aquifer Assessment 10-16 MAG] (see Appendix H), and Shi and others (2016[9]) [hereinafter Numerical Model Report: Minor Aquifers of the Llano Uplift Region of Texas) (see Appendix G). Technical justifications for DFCs adopted for the Edwards (BFZ) Aquifer remain unchanged since the adoption of DFCs in GMA 8 during the first round of joint planning from 2005 – 2010. However, the TWDB recently published an updated groundwater availability model for the aquifers of the Llano Uplift (Numerical Model Report: Minor Aquifers of the Llano Uplift Region of Texas) and this information serves as the new technical supporting documentation for these aquifers.

The primary tool utilized by GMA 8 District Representatives in the development of DFCs for the Northern Trinity and Woodbine aquifers was the Northern Trinity and Woodbine Aquifer Groundwater Availability Model ("Northern Trinity and Woodbine Aquifer GAM[10]") (see Appendix I, J, and K), which was significantly improved and updated from 2012 to 2014 to include the most up-to-date data and technical information available. The Northern Trinity and Woodbine Aquifer GAM, and the information embodied in it, presently represents the best available science on these aquifers. The updated Northern Trinity and Woodbine Aquifer GAM is composed of eight model layers that corresponded with the hydrogeologic units (i.e. aquifers) comprising the Trinity Aquifer Group, as well as the Woodbine Aquifer (such as the Woodbine, Fredericksburg/Washita, Antlers, Paluxy, Glen Rose, Twin Mountains/Travis Peak, Hensell, and Hosston). These different hydrogeologic units comprising the Trinity Aquifer Group and Woodbine Aquifer underlying GMA 8 were

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[7] Anaya, R., 2008, GAM Run 08 – 10mag: Texas Water Development Board, 7 p.

[8] Bradley, R. G., 2011, GTA Aquifer Assessment 1 0-16 MAG: Texas Water Development Board, 9 p.

[9] Shi, J., Boghici, R., Kohlrenken, W., and Hutchinson, W., Numerical Model Report: Minor Aquifers of the Llano Uplift Region of Texas (Marble Falls, Ellenburger-San Saba, and Hickory): Texas Water Development Board, variously paginated.

[10] Kelley, -V.A., Ewing, J., Jones, T. L., Young, S. C., Deeds, N., and Hamlin, S., 2014, Updated groundwater availability model of the Northern Trinity and Woodbine Aquifers: - Final Report: Prepared for the North Texas Groundwater Conservation District, Northern Trinity Groundwater Conservation District, Prairielands Groundwater Conservation District, and Upper Trinity Groundwater Conservation District by INTERA, Inc., The Bureau of Economic Geology, and LBG-Guyton Associates, Volumes I, II, and III, variously paginated.

evaluated according to their hydrostratigraphy, hydraulic properties, and lithology and the extent to which the units were differentiable at different locations. Ultimately, the technical results of this evaluation and the advanced capabilities of the updated Northern Trinity and Woodbine Aquifer GAM justified using the Antlers, Paluxy, Glen Rose, Twin Mountains, Travis Peak, Hensell, and Hosston aquifers, which collectively represent the Trinity Aquifer Group, and the Woodbine Aquifer to define the spatial and vertical extent for which to adopt different DFCs.

In developing the different DFCs for each of these aquifers, GMA 8 District Representatives used the Northern Trinity and Woodbine Aquifer GAM to Run 10 different primary predictive simulations based on selected pumping scenarios over the joint planning horizon through 2070. Some of those simulations included multiple analyses and sub-simulations. Generally, in conducting these runs, GMA 8 District Representatives looked at variations in declines in the water levels and artesian head levels for each of the aquifers, the number of existing wells that would go dry at various water level drops, the specific users and types of uses impacted based on local needs and demands, and the impacts of groundwater produced between GCDs in GMA 8. Ultimately, all 10 model runs served an important role towards the development of the adopted DFCs. As further described herein, the purpose of each run and the conclusions derived from those simulations illustrate the technical justifications that lead to the adoption of the DFCs for GMA 8.

GMA 8's first model run for the Northern Trinity and Woodbine Aquifer GAM was a re-simulation of the Modeled Available Groundwater ("MAG") estimates generated by the old model[11] from the first round of joint planning. The purpose of this run was to better understand the advanced capabilities of the new model by comparing the results of the updated Northern Trinity and Woodbine Aquifer GAM to the old model. A technical memorandum and GMA 8 meeting presentation materials are included in this Explanatory Report as Appendix L, M, and N, respectively. As expected, due to the Northern Trinity and Woodbine Aquifer GAM's updated structure and hydrogeologic properties, the new model predicted different drawdowns at local and regional levels. Next, GMA 8 conducted Runs 2 and 3 in an effort to establish relevant bookends between the highest practicable level of groundwater production and conservation of the groundwater resources (see Appendix N). Run 2, the "highest practicable" run, attempted to achieve 2070 future conditions where the confined head in all aquifers was assumed to decline to an elevation 10 feet above the top of each aquifer. Run 3, the "conservation" run, attempted to achieve current (2010) water levels using constant 2010 pumping rates from 2010 to 2025 (15 years) at which point pumping was decreased by a factor adequate to recover to 2010 water levels at the end of the planning simulation (2070). The assumption was that alternative supplies would become available by 2026 to augment groundwater pumping. While neither of these runs resulted in realistic DFCs for the aquifers, the runs were beneficial in setting parameters to identify the

[11] R.W. Harden & Associates, Inc., Freese & Nichols, Inc., HDR Engineering, Inc., LBG-Guyton Associates, United States Geological Survey, and Dr. Joe Yelderman, Jr., 2004, Northern Trinity / Woodbine Aquifer Groundwater Availability Model: Contract report to the Texas Water Development Board, 192 p.

bookends that must necessarily be balanced in adopting reasonable DFCs pursuant to Texas Water Code Section 36.108(d-2), and in determining what might or might not be physically possible or feasible to achieve based upon the current conditions in the aquifers and their hydraulic properties.

In light of the results in Runs 1, 2, and 3, GMA 8 District Representatives focused on achieving a baseline run based on 2010 pumping conditions in GMA 8. As a result, Run 4 was performed to estimate the impacts associated with continued pumping at present rates over the course of the planning period (see Appendixes L and N). However, upon further review of the data upon which Run 4 was based and after comparing it to the latest available data on current groundwater production, current pumping conditions were later revised, and thus a new baseline run was established by re-running the model in Run 5 (see Appendixes O and P) to reflect such changes. All subsequent predictive simulations, including Runs 6, 7, 8, 9, and 10, utilized Run 5 and its improved 2010 pumping data as the baseline to compare and evaluate aquifer conditions, impacts, and pumping under varying levels of decreased and increased groundwater production from 2010 levels.

After establishing a supportable baseline in Run 5, GMA 8 conducted a series of additional runs to better understand potential impacts from increased pumping on an aquifer-wide basis as well as between counties and GCDs. Run 6 included a set of simulations that provided technical information on aquifer conditions resulting from pro-rata increases and decreases in Run 5 baseline-pumping levels on an aquifer-wide basis, including 0.7, 1.1, 1.2, 1.3, 1.6, and 1.9 times baseline pumping (see Appendix O and P).

Run 7 also addressed increases to Run 5 baseline pumping, but this time increases in pumping were applied on a county-by-county basis in order to illustrate the impacts of increased pumping by one county or GCD on neighboring counties and GCDs in GMA 8 (see Appendix Q). Specifically these runs illustrated not only the varying impacts of pumping increases by one county on groundwater levels in other counties in the region, but also that in certain cases increased pumping in the subcrop of the aquifer resulted in significant drawdowns in the outcrop areas of the aquifer, impacting landowners' ability to produce groundwater. With that said, GMA 8 District Representatives also considered the transient hydrodynamics of the regional Trinity and Woodbine aquifer systems regardless of pumping. This was accomplished in Run 8, which included a predictive simulation approach that terminated all pumping in the GMA over a 50-year time period (see Appendix Q). The results from this run showed that even with no pumping, some counties may continue to see average water level declines through the planning predictive period, whereas other counties may recover strongly. The reason for this is that the existing, steep drawdown cones in the deep confined sections of the aquifer system do not completely recover, even with no pumping, over the joint planning horizon. As a result, groundwater continues to flow from areas of relatively little drawdown to the areas of higher drawdown even if there were no pumping whatsoever in the aquifer. While this model run does not represent the DFCs for the aquifers, it provides important technical information as to the practical realities and limitations of what the District Representatives and the GCDs comprising GMA 8 could achieve.

Each of the aquifer units comprising the Trinity Aquifer Group (Antlers, Paluxy, Glen Rose, Twin Mountains, Travis Peak, Hensell and Hosston), as well as the Woodbine Aquifer, have both an outcrop area, where the aquifer is at the land surface, and a subcrop area. In the subcrop area the aquifer dips underneath another geologic layer, which typically confines the aquifer and creates pressure in it, causing water levels in a well to rise above the top of the aquifer. Based on the model runs, GMA 8 District Representatives determined that, in some areas, if pumping levels caused loss of confined conditions in the subcrop areas so that water levels in a well completed in an aquifer dropped below the top of that aquifer, the result would be reduced well yields and increased costs associated with pumping. Such drops in water levels would also render many existing pumps to encounter dry conditions, requiring pumps to be lowered where possible and, in some instances, deepening the well or abandonment of the well entirely and the loss of the economic investment in the well.

Runs 6, 7, and 8 all generated important technical information that assisted GMA 8 District Representatives in understanding the conditions of the aquifers and impacts of various pumping scenarios on an aquifer-wide scale and on a county-by-county basis. Upon analysis of this information coupled with the need to account for more pumping already occurring in the southern parts of the region, GMA 8 District Representatives elected to perform two additional model runs, Runs 9 and 10 (see Appendixes R, S, T, and U). Run 9 applied baseline pumping from Run 5 to certain areas of the GMA, generally the GCDs in the northern portion of GMA 8, while the southern GCDs in the GMA increased Run 5 baseline pumping by various multipliers to account for increases in anticipated future pumping over the course of the planning period. These numbers were later further refined for purposes of Run 10, after northern GCDs, in a manner similar to the southern GCDs in Run 9, increased certain predicted pumping levels to account for increases in anticipated future pumping over the course of the planning period. In Run 10, the pumping file from Run 9 was used as the baseline for pumping amounts and distributions for GCDs in the southern portion of GMA 8, and then modified based on input from the northern GCDs. The District Representatives also considered Run 10.1, which was similar to Run 10, but which involved different pumping distributions using the Northern Trinity and Woodbine Aquifer GAM (see Attachment V).

In considering the different pumping scenarios, District Representatives in GMA 8 found the pumping scenario and resulting impacts to the aquifers and landowners in the region used in Run 10 struck the best balance of the required statutory criteria set forth in Texas Water Code Section 36.108. Run 10 also most accurately reflected current pumping in each county and predictions of future production to meet water demands throughout the planning period. Run 10 generated important technical information resulting from the simulated pumping, such as changes in hydraulic head (drawdowns) on an aquifer and county basis, the impacts of drawdowns to existing water wells, water budget information including recharge, discharge, lateral flow, and cross formational flow on an aquifer, and county basis, remaining vertical separation between potentiometric surface and the top of the aquifer to maintain confined conditions on an aquifer and county basis, and average annual changes in water levels. After careful evaluation of this information as described in more detail in Section 3.2.3 of this Explanatory Report, GMA 8 District Representatives adopted DFCs for each of the aquifers in the Trinity and Woodbine Aquifer system in terms of available drawdowns on an aquifer, GCD, and county basis as simulated by Run 10, which do not differ substantially in their application. These adopted DFCs set drawdown levels that are acceptable to preserve artesian pressure and reduce impacts to existing wells for both existing and future well owners, and strike an appropriate balance of the statutory criteria in Texas Water Code Section 36.108.

3.1.3 Other GCD-Specific Justifications

As part of the GMA 8 joint planning process, the Upper Trinity Groundwater Conservation District (UTGCD) requested that DFCs within their boundaries (Hood, Montague, Parker and Wise counties) be stated in terms of outcrop and subcrop, rather than an average of the two. This request was based on recommendations submitted by the UTGCD in response to the 90-day public comment period. GMA 8 District Representatives unanimously approved this request at the September 29, 2016, GMA 8 meeting. A brief summary of why the UTGCD made this request follows.

The UTGCD is in a unique position due to its location on the northwest edge of the Trinity Aquifer and the large number of shallow exempt domestic wells completed each year. In data received from the TWDB, from 2005-2015, there were more domestic wells drilled in Parker County than in any other county in Texas (approximately 5,300). In the last few years, Parker County has seen an average of about 550-600 new domestic wells per year. Furthermore, Wise County has also seen a large number of new domestic wells, averaging around 200 per year. The vast majority of these wells are completed into the shallow outcrop portions of the Trinity Aquifer Group. This situation is due to two conditions: the majority of Parker County and a smaller portion of Wise County are extremely high growth areas due to proximity to the Dallas/Fort Worth Metroplex, and the geology of the area leads to the capability to complete a productive water well at a relatively low cost (the majority of these wells are approximately 250 feet in total depth). Thus, the majority of housing subdivisions in these counties are relying on private water wells as the sole source of water rather than developing public water systems and transmission infrastructure.

Also, the UTGCD is faced with a unique geology as compared to the other GMA 8 GCDs. The slope and thickness of the formation within UTGCD's boundaries are such that averaging simulated drawdown for the outcrop and subcrop in the DFC statement would not provide a meaningful measurement for groundwater management purposes for the people that live within the UTGCD.

To illustrate this point, the average DFC for the Twin Mountains portion of the Trinity Group in Hood County is 25 ft. of drawdown; however when the outcrop and subcrop are separated the DFCs are 4 ft. of drawdown in the outcrop and 46 ft. of drawdown in the subcrop. Also, the average DFC for the Antlers portion of the Trinity Group in Wise County is 45 ft. of drawdown; however when the outcrop and subcrop are separated the DFCs are 34 ft. of drawdown in the outcrop and 142 ft. of drawdown in the subcrop.

Because of the geology of the four counties that make up the UTGCD, the District intends to manage the aquifers on an outcrop/subcrop basis. However, in order to avoid any confusion by the public as to why UTGCD may seem to be managing the aquifers differently than what the DFCs state, the separation of the outcrop and subcrop is crucial to better correlate the District's groundwater management efforts in both the outcrop and the subcrop with the goals that have been established for the aquifer in those respective areas.

Furthermore, the Board of Directors of UTGCD has determined, for the purpose of groundwater management within the boundaries of the UTGCD, that it is in the best interests of the UTGCD and its citizens to also utilize the existing simulated model runs of the Northern Trinity and Woodbine Aquifer GAM that distribute projected pumping within each layer of the model in the district (surficial layer, Antlers, Paluxy, Glen Rose, and Twin Mountains). Because many of the water wells in UTGCD are actually completed in shallow sands represented by the upper layer of the Northern Trinity and Woodbine Aquifer GAM, model runs which allowed for water level declines in the model cells of that layer provide a more appropriate portrayal of local future groundwater conditions and water level impacts from pumping within the boundaries of the UTGCD. The UTGCD Board of Directors believes that local management options within UTGCD's boundaries are best considered with the insight developed from these model runs. This decision by the UTGCD Board of Directors is largely due to the unique geology within the District which is largely predominated by shallow outcrop areas.

3.2 FACTOR CONSIDERATIONS

During this round of joint-planning, GMA 8 District Representatives had multiple discussions on the eight factors required by Texas Water Code Section 36.108 (d)(1 – 8). The meeting dates during which specific factors were discussed are documented in Table 10 below. Meeting agendas and meeting minutes are included in their entirety for these meetings in Appendix B.

Table 10. GMA 8 Meeting dates during which factors to be considered by District Representatives, as required by Texas Water Code Section 36.108 (d)(1 - 9) were discussed.

	GMA 8 Meeting Dates												
Factor	9/21/2013	1/21/2014	4/22/2014	7/29/2014	11/3/2014	3/25/2015	5/27/2015	9/2/2015	11/18/2015	2/27/2016	3/23/2016	4/1/2016	9/29/2016
1				✓							✓		
2				✓							✓		

3	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
4					✓						✓		
5								✓			✓		
6							✓	✓	✓		✓	✓	
7				✓			✓				✓	✓	
8											✓		
9													

3.2.1 Aquifer uses and conditions

Texas Water Code Section 36.108(d)(1) requires District Representatives in a GMA to consider “aquifer uses or conditions within the management area, including conditions that differ substantially from one geographic area to another.” GMA 8 District Representatives considered aquifer uses, both historical and projected, along with historical, current, and projected aquifer conditions. Data and presentation materials are included in Appendix W, X, Y, Z, and AA.

The major aquifers in GMA 8 are shown in Figure 5. As defined by TWDB, a major aquifer is one that supplies a large volume of water over a large area. There are two major aquifers in GMA 8: the northern portion of the Trinity Aquifer (herein referred to as the Northern Trinity Aquifer) and the Edwards (Balcones Fault Zone or BFZ) Aquifer. The Northern Trinity Aquifer occupies most of GMA 8 and is the primary source of groundwater in the area. The northern portion of the Edwards (BFZ) Aquifer occurs only in southern GMA 8 in Travis, Williamson, and Bell counties.

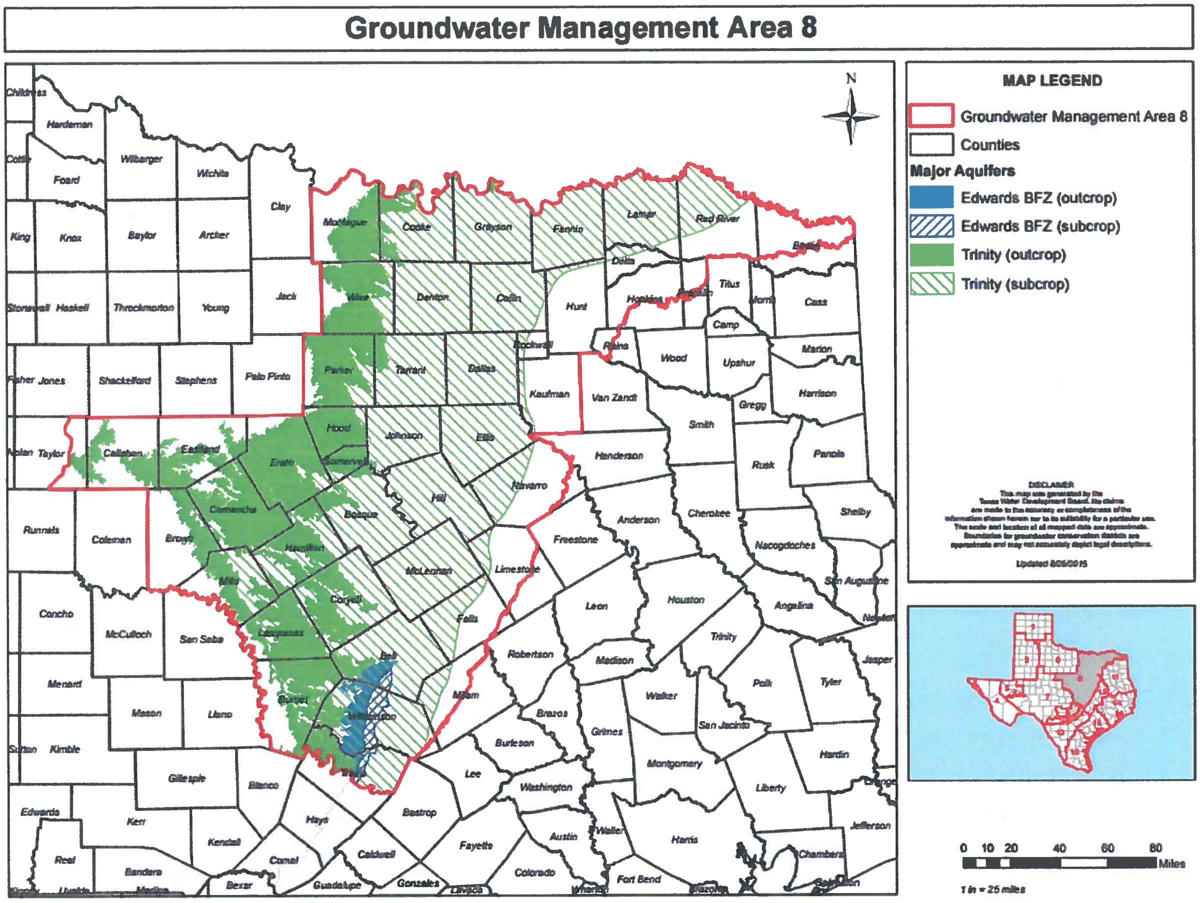

Figure 5. Major aquifers in GMA 8.[12]

The minor aquifers in GMA 8 are shown in Figure 6. As defined by TWDB, a minor aquifer is one that supplies either a large volume of water over a small area or a small volume of water over a large area. The seven minor aquifers in GMA 8 include the Brazos River Alluvium, Nacatoch, Blossom, Woodbine, Marble Falls, Ellenburger – San Saba and Hickory aquifers. Of these the Woodbine Aquifer occurs over the largest area in GMA 8 and overlies the Northern Trinity Aquifer. The Blossom and Nacatoch aquifers are in far eastern GMA 8, while the older Marble Falls, Ellenburger – San Saba and Hickory aquifers are in far southwestern GMA 8 in central Texas. These aquifers, present in much older geologic strata, are collectively known as the Llano Uplift aquifers because of their occurrence in an area of geologic uplift surrounding Llano County in neighboring Groundwater Management Area 7.

[12] Texas Water Development Board, Major Aquifers in Groundwater Management Area 8 Map (updated Aug. 26, 2015) http://www.twdb.texas.gov/groundwater/management_areas/maps/GMA8_MajorAquifer.pdf

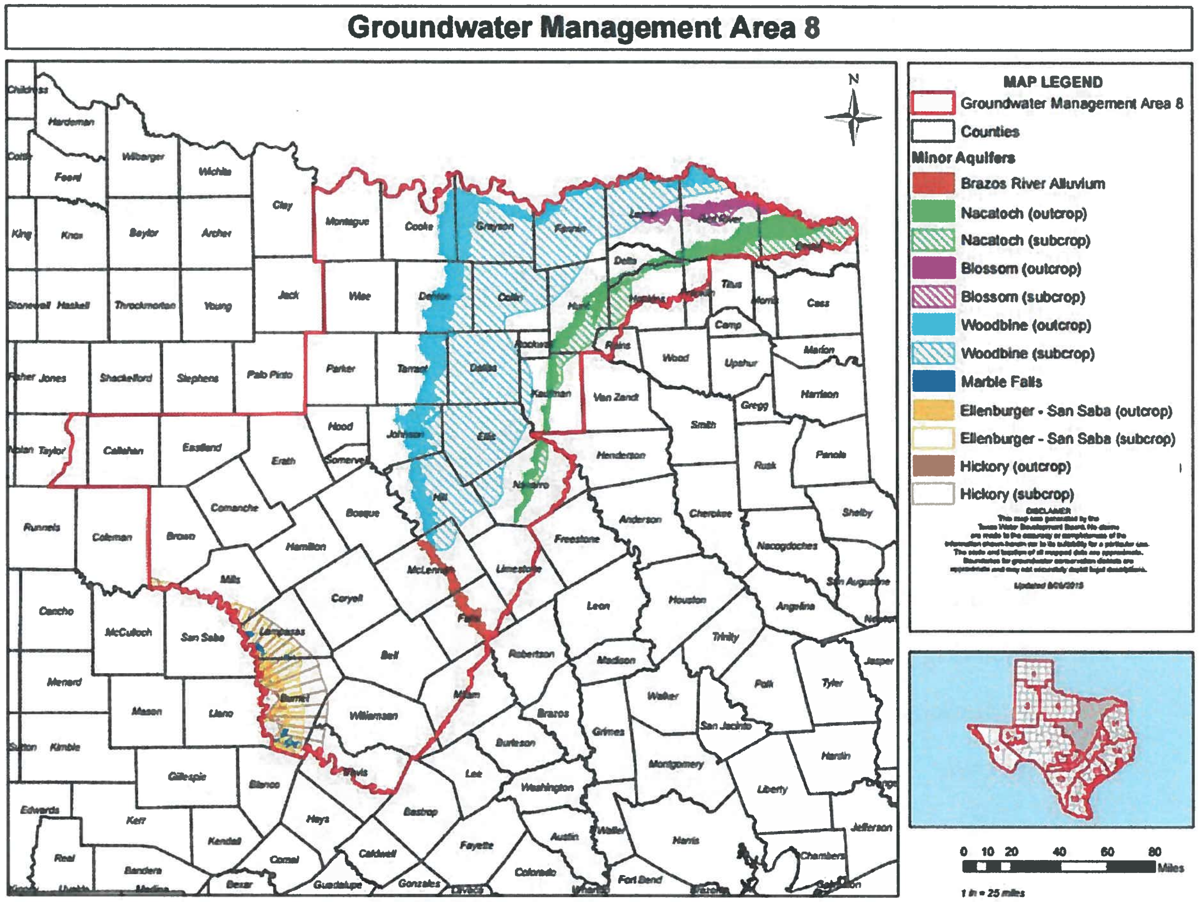

Figure 6. Minor aquifers in GMA 8.[13]

Information on historical aquifer uses was taken from two primary sources: 1) the Texas Water Development Board Groundwater Pumpage Estimates developed as part of the Water Use Survey program, and 2) the Northern Trinity and Woodbine Aquifer GAM.[14] Note that these are not two independent sources because the Northern Trinity and Woodbine Aquifer GAM used the TWDB data as one of many sources of pumping information.

Figure 7 shows the groundwater pumping estimated by the TWDB Water Use Survey program for GMA 8. The values shown are the average for the period from 2007 to 2011 – the last five years that were available when information for this factor was compiled for consideration by GMA 8 District Representatives. Municipal use is approximately 150,000 acre-feet per year, comprising 58 percent of the estimated groundwater pumping in GMA 8. The second major sector of use is irrigation, estimated at approximately 62,000 acre-feet per

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[13] Texas Water Development Board, Minor Aquifers in Groundwater Management 8 Map (updated Aug. 26, 2015) *available at* http://www.twdb.texas.gov/groundwater/management_areas/maps/GMA8_MinorAquifer.pdf

[14] Kelley, V.A., Ewing, J., Jones, T.L., Young, S.C., Deeds, N., and Hamlin, S., 2014, Updated Groundwater Availability Model of the Northern Trinity and Woodbine Aquifers – Draft Final Model Report (May 2014), 984 p.

year. Note that these totals include all aquifers for all counties in GMA 8. For counties where an aquifer is only partially within GMA 8 (e.g. Travis County), the volume of pumping from the TWDB Groundwater Pumpage estimates was reduced using the fraction of the area of the county that is in GMA 8.

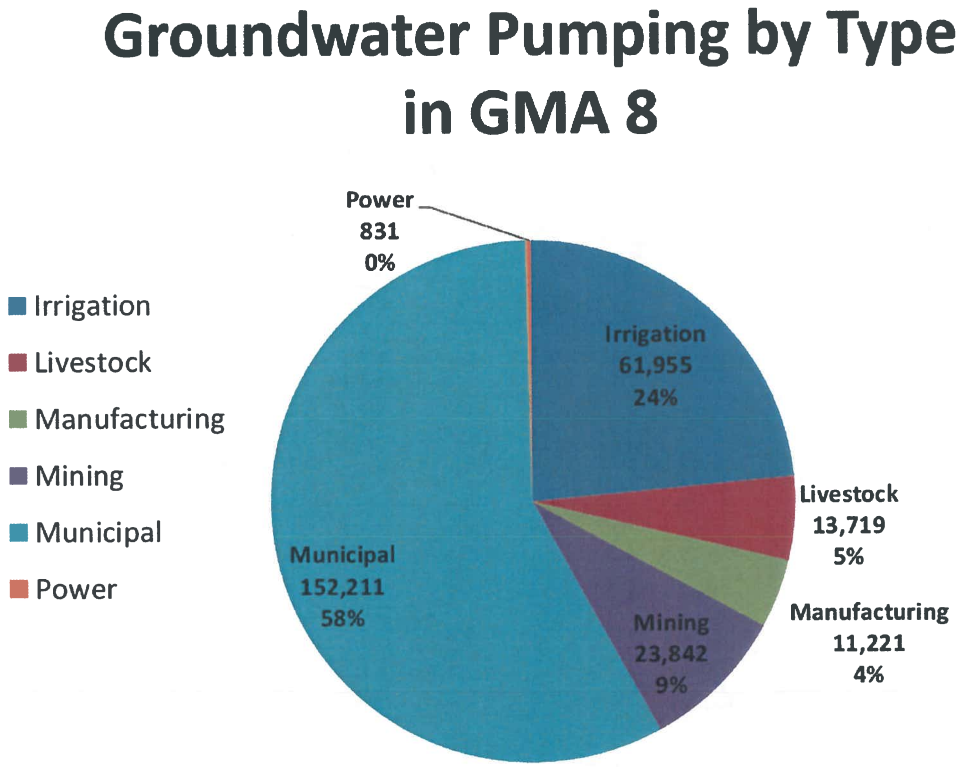

Figure 7. Average groundwater pumping in GMA 8 between 2007 and 2011 from TWDB Groundwater Pumpage estimates by type of water use. Values shown are in acre-feet per year.

Whereas Figure 7 shows the total volume of groundwater produced in GMA 8 as estimated by TWDB for the major water use sectors, Figure 8 shows the breakdown of total groundwater produced from each aquifer. Note that these values are from the Northern Trinity and Woodbine Aquifers GAM, and therefore include only the Trinity, Woodbine, Edwards (Balcones Fault Zone), and Brazos River Alluvium aquifers. According to TWDB Water Use Surveys, the total use from the other aquifers in GMA 8 – the Blossom, Ellenburger-San Saba, Hickory, Marble Falls, and Nacatoch aquifers – ranged from approximately 10,000 to 16,000 acre-feet per year between 2007 and 2011. The Trinity Aquifer is the largest source of groundwater in GMA 8, supplying between 160,000 and 200,000 acre-feet per year over the last 30 to 40 years.

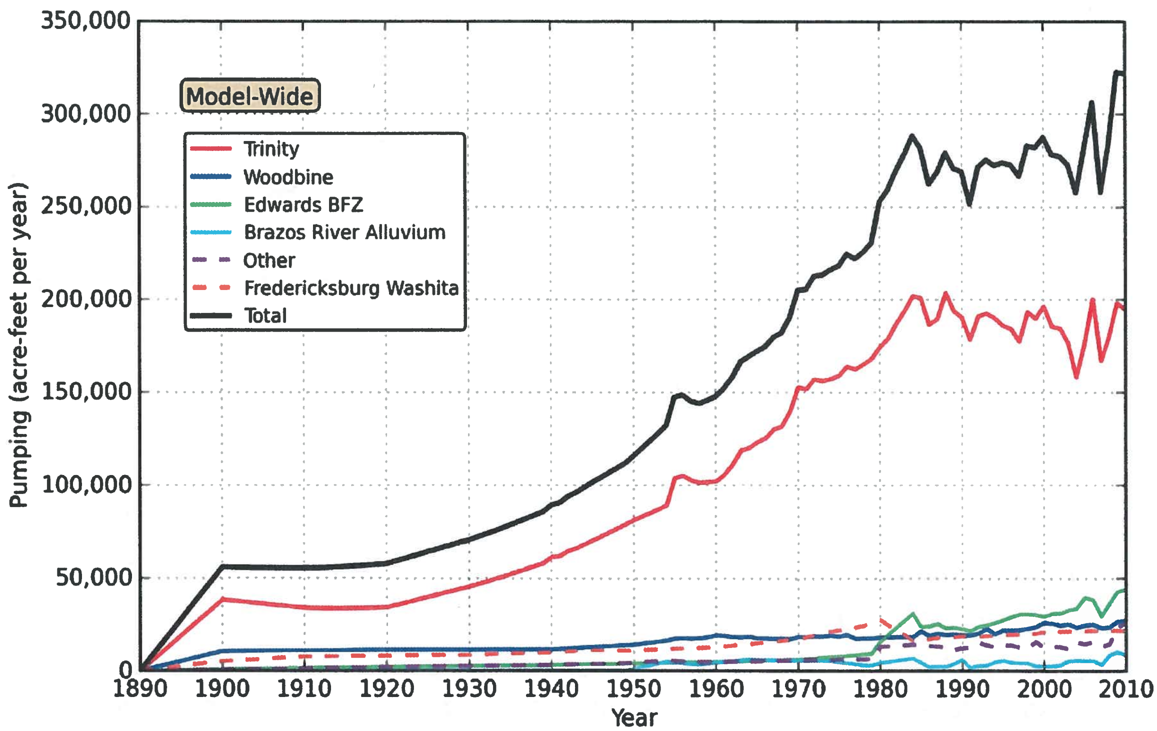

Figure 8. Estimated pumping for the Trinity, Woodbine, Edwards (Balcones Fault Zone) and Brazos River Alluvium aquifers in GMA 8.[15]

Estimates of groundwater pumping in Texas are characterized as estimates because much, if not most, of groundwater production is not metered, except for public water supply systems. This is particularly true in areas without GCDs. TWDB employs many methods to estimate pumping, which we will not describe in detail here, but which carry certain assumptions and limitations.

As an example, the TWDB Groundwater Pumpage Estimates are reported by aquifer. However, about 95 percent of groundwater pumping for mining activities (which includes oil and gas uses) is classified as occurring from "Unknown Aquifer." There is also an "Other Aquifer" designation, which averages over 30,000 acre-feet per year in GMA 8 between 2007 and 2011. This is intended to be used for groundwater produced from aquifers not officially recognized as major or minor aquifers by TWDB such as the Paleozoic Aquifers in western GMA 8. However, use from named aquifers is sometimes mistakenly classified as "Other Aquifer" because of differences in what the aquifer is called locally. For example, in the northern portion of GMA 8, the Trinity Aquifer is often called the Antlers Aquifer. Individuals completing online Water Use Surveys may not recognize that these refer to the same aquifer and fill in "Other Aquifer" instead. Despite some inherent limitations, the water use surveys and groundwater pumpage estimates are an indispensable source of data for estimating pumping and are a key input to groundwater availability models.

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[15] *Id.*

Appendix Y shows Groundwater Planning Datasheets that were compiled to assist with development of DFCs. A datasheet was developed for each county and distributed to the District Representatives in GMA 8 early in this round of joint planning. For each decade between 2010 and 2070, these datasheets include the following:

- Estimated current pumping from Northern Trinity and Woodbine Aquifer GAM by aquifer
- The Modeled Available Groundwater for each aquifer for the DFCs developed during the last round of joint planning
- Groundwater pumping in the 2012 Texas State Water Plan and the percent of the total pumping allocated to each aquifer
- Total water demand in the 2012 Texas State Water Plan between 2010 and 2060 and the fraction of that total demand designated to be met by groundwater supplies
- Total water demand in the 2017 Texas State Water Plan between 2020 and 2070 and the annual volume designated to be met by each aquifer.

An example of one of these datasheets is shown in Figure 9 below for Bell County. Appendix W contains datasheets for all counties reflecting the 2010 and 2070 planning period.

Bell County Groundwater Planning Datasheet
(all values in acre-feet per year unless otherwise noted)

	2010	2020	2030	2040	2050	2060	2070
NTGAM Est. Current Pumping (avg. 2010-12)	**6,237**						
Edwards (BFZ)	2,793						
Trinity	1,689						
Other	1,755						
Modeled Available Groundwater	**13,537**	**13,537**	**13,537**	**13,537**	**13,537**	**13,537**	
Edwards (BFZ)	6,469	6,469	6,469	6,469	6,469	6,469	
Trinity	7,068	7,068	7,068	7,068	7,068	7,068	
Other							
Groundwater Pumping in 2012 SWP	**5,378**	**5,378**	**5,378**	**5,378**	**5,378**	**5,378**	
Edwards (BFZ)	2,010	2,010	2,010	2,010	2,010	2,010	
Trinity	3,368	3,368	3,368	3,368	3,368	3,368	
Other							
Edwards (BFZ) Percent	37%	37%	37%	37%	37%	37%	
Trinity Percent	63%	63%	63%	63%	63%	63%	
Other Percent	0%	0%	0%	0%	0%	0%	
Total Demand in 2012 SWP	**63,783**	**77,506**	**84,599**	**90,499**	**95,994**	**101,625**	
GW Pumping % of Demand in 2012 SWP	8%	7%	6%	6%	6%	5%	
Total Demand in 2017 SWP		**76,075**	**85,958**	**97,041**	**109,131**	**121,622**	**134,411**
Projected GW Pumping in 2017 SWP		**5,279**	**5,464**	**5,767**	**6,114**	**6,436**	**7,113**
Edwards (BFZ)		1,973	2,042	2,155	2,285	2,405	2,658
Trinity		3,306	3,422	3,612	3,829	4,031	4,455
Other							

Figure 9. Example of Groundwater Planning Datasheet developed for each county in GMA 8 and included in Appendix Y.

3.2.2 Water supply needs and water management strategies

Texas Water Code Section 36.108 (d)(2), requires District Representatives in a GMA to consider the water supply needs and water management strategies included in the Texas State Water Plan. In order to meet this requirement, District Representatives in GMA 8 considered the continued population growth in the area (see Table 2), all water supplies needs, and recommended water management strategies included in the 2011 regional water plans and the 2012 Texas State Water Plan. Applicable information for this factor is included in its entirety in Appendixes Y, Z, AA, BB, CC, DD, and EE,

This factor directly connects the Texas regional water planning process with the joint-planning process. The principle embodied by this factor is that District Representatives in a GMA, when adopting DFCs for groundwater resources, must consider water supply needs and water management strategies included within regional water plans for the area. Consideration of this factor first included a discussion of terminology important to the regional water planning process in Texas. To understand the process for quantifying "water supply needs," first the process for quantifying "water demands" must be established. In the Texas regional water planning process, water demands (or projections) as opposed to estimates of water use, is the volume of water projected to be needed during drought conditions. Water demand projections are always for the future. For the regional water planning process, they are calculated on a decadal basis. The difference in water demands and water supplies on a water user group or wholesale water supplier basis quantifies surpluses and needs. Water availability is the maximum amount of water available from a source during the drought of record, regardless of whether the supply is physically or legally available to water user groups. Existing water supply is the maximum amount of water available from existing sources for use during drought of record conditions that is physically and legally available for use by a water user group. Therefore, a water supply need (referred to Texas Water Code Section 36.108 (d)(2)), exists when the water demand for a water user group or a wholesale water provider is greater than the existing supply for that same planning entity.

A "water management strategy" in the Texas regional water planning process is described as a plan or 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, including through reducing demands. A "water user group" is an identified user or group of users for which water demands and water supplies have been identified and analyzed and plans developed to meet water needs. Water user groups include cities, and on a county aggregate basis rural, manufacturing, irrigation, steam electric power generation, mining, and livestock watering for each county. Water supply needs are also calculated for "wholesale water providers" which are defined as any person or entity, including river authorities and irrigation districts, that has contracts to sell more than 1,000 acre-feet of water wholesale in any one year during the five years immediately preceding the adoption of the last regional water plan.

Due to the demographic complexity of GMA 8 (population, urban rural, etc.), and the corresponding diversity of challenges that water user groups and wholesale water providers face in the region, the amount and complexity of information regarding water supply needs and water management strategies included in the current Texas State Water Plan to be considered by GMA 8 District Representatives is quite significant. To facilitate these considerations, data tables in multiple formats for water supply needs and water management strategies included in the 2012 Texas State Water Plan were made available via the GMA 8 website for further consideration at the individual GCD level. Information considered by GMA 8 District Representatives regarding water supply needs is included in Appendixes BB and CC. Similarly, information considered on water management strategies is included in Appendixes DD and EE.

3.2.3 Hydrological Conditions

Texas Water Code Section 36.108(d)(3) requires District Representatives in a GMA to consider "hydrological conditions, including for each aquifer in the management area the total estimated recoverable storage as provided by the executive administrator, and the average annual recharge, inflows, and discharge." Of the eight factors required to be considered in the joint-planning process, the factor considered most often, based on technical presentations and discussions was "hydrological conditions." Two comprehensive presentations given to GMA 8 District Representatives are included in Appendixes M and AA.

The overarching hydrological condition in GMA 8 regarding the Northern Trinity and Woodbine aquifers relates to historical decline in artesian water levels, especially in the Dallas/Fort Worth and Waco metropolitan areas. As illustrated in Figure 10, water level declines in this region of the state are greater than any other aquifer or region. The impact of any DFC option considered throughout the joint-planning process included a discussion of how any additional water level declines would impact current hydrological conditions.

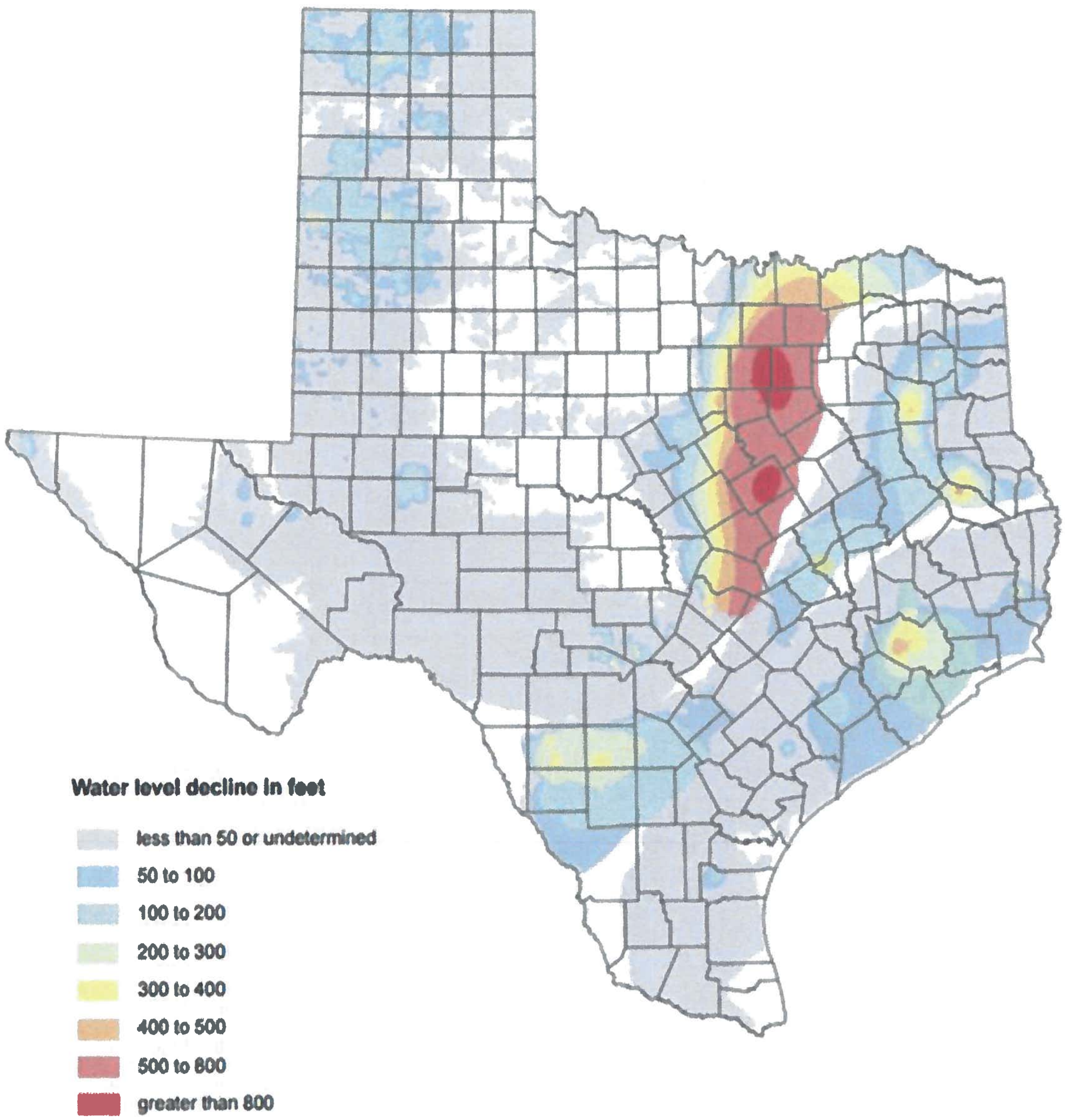

Figure 10. Map illustrating location and magnitude of historical water level declines in the aquifers of Texas (from George and others, 2011[16]).

Figure 11 shows a conceptual cross-section of many of the aquifer units in GMA 8 as described in Kelley and others (2014[17]) (see Appendixes I, J, and K). The Paluxy, Glen Rose,

[16] George, P. G., Mace, R. E., and Petrossian, R., 2011, Aquifers of Texas: Texas Water Development Board, Report 380, 172 p.

[17] Kelley, -V.A., Ewing, J., Jones, T. L., Young, S. C., Deeds, N., and Hamlin, S., 2014, Updated groundwater availability model of the Northern Trinity and Woodbine Aquifers: - Final Report: Prepared for the North Texas Groundwater Conservation District, Northern Trinity Groundwater Conservation District, Prairielands

Hensell, Pearsall-Cow Creek-Hammett, and Hosston units make up the Trinity Aquifer. The Woodbine Aquifer overlies the Trinity Aquifer as well as the Fredericksburg and Washita Groups, which include the Edwards (BFZ) Aquifer in the southern portion of GMA 8. The Blossom and Nacatoch aquifers are younger units in far eastern GMA 8. The Hickory, Ellenburger – San Saba and Marble Falls aquifers are older units in southwestern GMA 8.

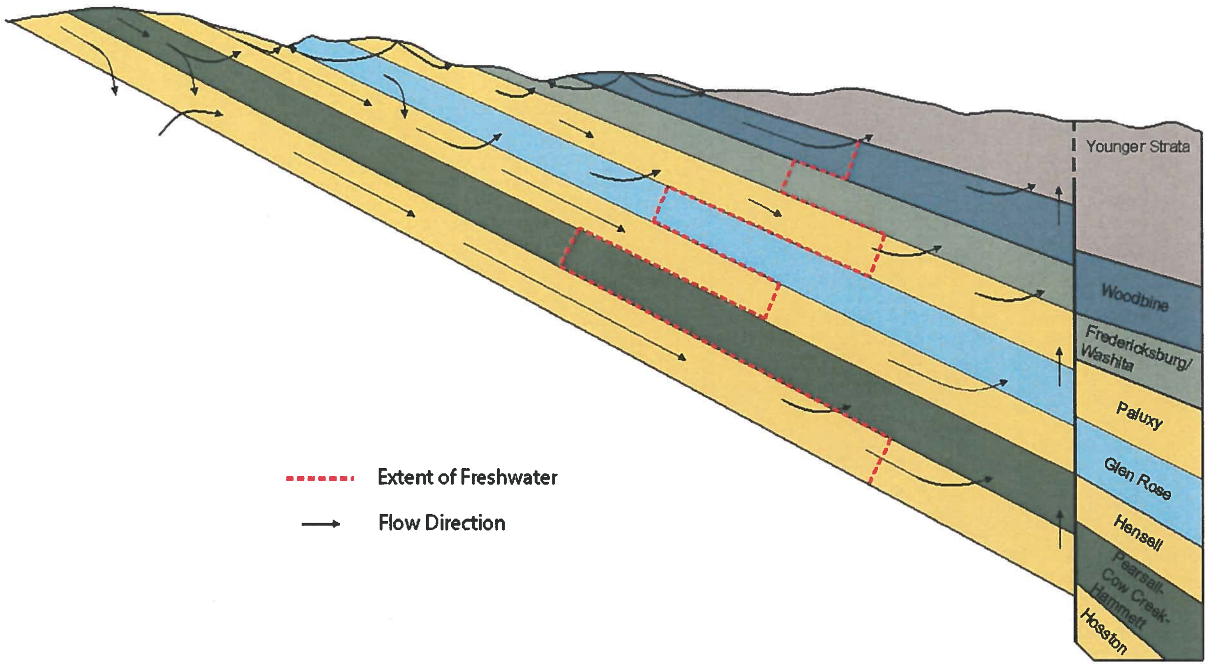

Figure 11. Conceptual cross-section of the Trinity and Woodbine Aquifers in GMA 8.

As mentioned in 3.1.2 and Section 3.2.1 above and in Kelley and others (2014), the makeup of the Trinity Aquifer varies significantly across GMA 8. Figure 12 is a map from Kelley and others (2014) delineating distinct aquifer regions in GMA 8. Figure 13 shows a diagram designating the local aquifer names used in each region.

In Region 1, the Trinity Aquifer is generally known as the Antlers Aquifer. In Regions 2 and 3, the Glen Rose unit is present and acts to separate the overlying Paluxy from the underlying Twin Mountains/Travis Peak units. Note that in some areas the Twin Mountains is simply referred to as the "Trinity," distinct from the overlying Paluxy, even though both units are considered part of the Trinity Aquifer as defined by TWDB. In Regions 4 and 5, the Pearsall/Cow Creek/Hammett/Sligo confining units are present, dividing the Travis Peak into the overlying Hensell and underlying Hosston units.

Figure 14 shows a cross-section of geophysical logs for each region. The locations of the logs used in the cross-section are shown in Figure 12. In Figure 14, the yellow represents sand,

Groundwater Conservation District, and Upper Trinity Groundwater Conservation District by INTERA, Inc., The Bureau of Economic Geology, and LBG-Guyton Associates, Volumes I, II, and III, variously paginated.

the blue represents limestone, and the brown represents clay or shale. The sand zones are the most common targets for water well completions, though limestone can provide significant groundwater where it is fractured or partially dissolved. The clay and shale zones restrict the flow of groundwater and act as confining units. The differences between each of the aquifer regions described above correlate with the differences in lithology shown in Figure 14.

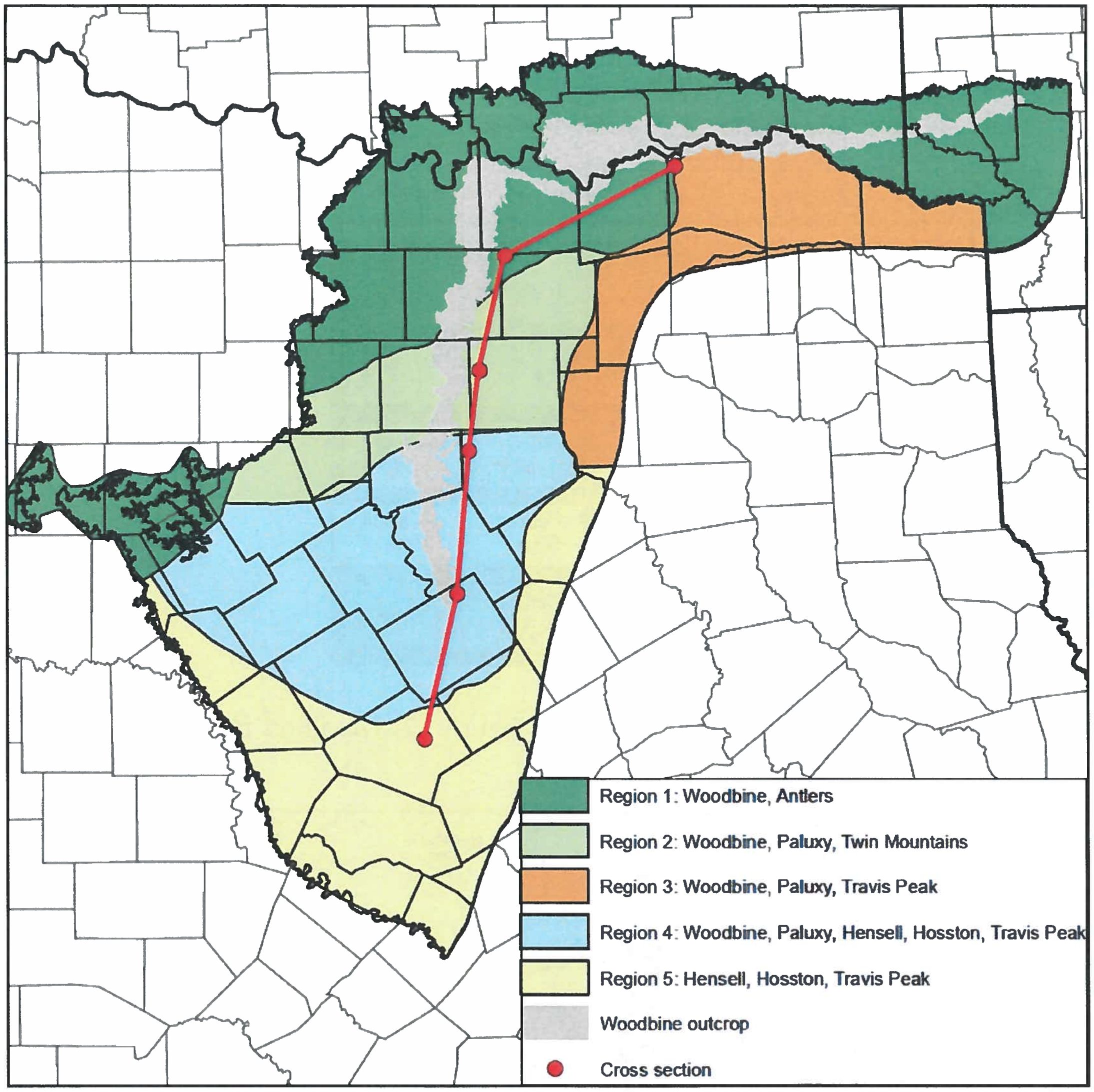

Figure 12. Regions of the Trinity and Woodbine Aquifers.[18] (Note – these regional delineations are not to be confused with regional water planning area boundaries illustrated on Figure 4.)

[18] Kelley, -V.A., Ewing, J., Jones, T. L., Young, S. C., Deeds, N., and Hamlin, S., 2014, Updated groundwater availability model of the Northern Trinity and Woodbine Aquifers: - Final Report: Prepared for the North Texas Groundwater Conservation District, Northern Trinity Groundwater Conservation District, Prairielands Groundwater Conservation District, and Upper Trinity Groundwater Conservation District by INTERA, Inc., The Bureau of Economic Geology, and LBG-Guyton Associates, Volumes I, II, and III, variously paginated.

Model Terminology	Region 1	Region 2	Region 3	Region 4	Region 5
Woodbine Aquifer	Woodbine	Woodbine	Woodbine	Woodbine	Woodbine (no sand)
Washita/ Fredericksburg Groups	Washita/ Fredericksburg	Washita/ Fredericksburg	Washita/ Fredericksburg	Washita/ Fredericksburg	Washita/ Fredericksburg
Paluxy Aquifer	Antlers	Paluxy	Paluxy	Paluxy	Paluxy (no sand)
Glen Rose Formation	Antlers	Glen Rose	Glen Rose	Glen Rose	Glen Rose
Hensell Aquifer	Antlers	Twin Mountains	Travis Peak	Hensell/ Travis Peak	Hensell/ Travis Peak
Pearsall Formation	Antlers	Twin Mountains	Travis Peak	Pearsall/ Sligo	Pearsall/ Sligo
Hosston Aquifer	Antlers	Twin Mountains	Travis Peak	Hosston/ Travis Peak	Hosston/ Travis Peak

Figure 13. Aquifer names by region shown in Figure 12. Modified from Kelley and others (2014).

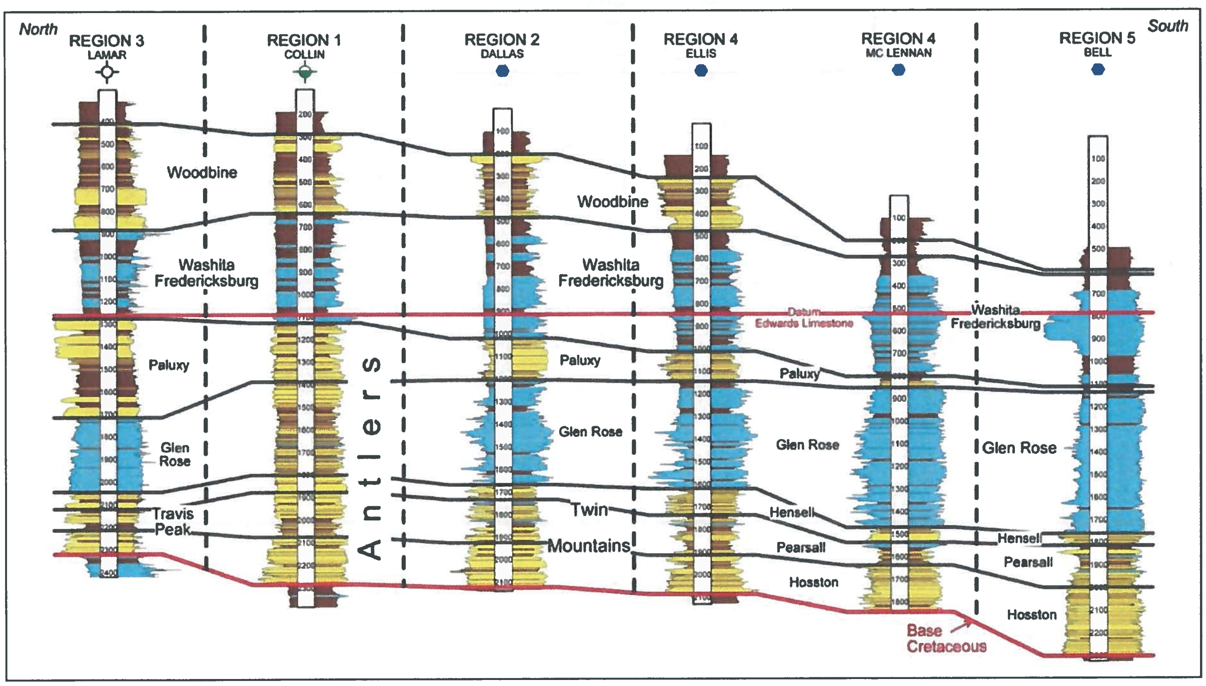

Figure 14. Cross-section showing representative geophysical logs for each aquifer region. The cross-section location is shown in Figure 12.

3.2.3.1 Total estimated recoverable storage

As described in Title 31, Texas Administrative Code Section 356.10, the total estimated recoverable storage is defined by TWDB as "[t]he estimated amount of groundwater within an aquifer that accounts for recovery scenarios that range between 25% and 75% of the porosity-adjusted aquifer volume." The total estimated recoverable storage estimates developed by TWDB are shown in in GAM Task 13-031, which is included in Appendix FF.[19]

As described in GAM Task 13-031, the total storage is calculated by TWDB as the product of the aquifer area, saturated thickness, and specific yield. For confined aquifers, a small amount of additional water is added to the total storage using the storativity or specific storage and the height of the potentiometric surface (water level as measured in a well) above the top of the aquifer. This total storage calculation is then reported along with the 25 percent and 75 percent bounds to reflect the amount that may be recoverable based on the bounds established by the TWDB.

Total estimated recoverable storage should not be confused with groundwater availability. For example, as described in GAM Task 13-031:

> Total estimated recoverable storage values may include a mixture of water quality types, including fresh, brackish, and saline groundwater, because the available data and the existing groundwater availability models do not permit the differentiation of different water quality types. These values do not take into account the effects of land surface subsidence, degradation of water quality, or any changes to surface water-groundwater interaction that may occur due to pumping.[20]

In addition, the total estimated recoverable storage calculation does not consider aquifer lithology (the distribution of sands and clays) or the practicality and economics of recovering volumes of water within the 25 percent to 75 percent range of total storage.

While the total estimated recoverable storage for the aquifers in GMA 8 is not analogous to groundwater availability or how much can be pumped, it serves as a reminder of the large volume of water in the aquifers. As required by Texas Water Code Section 36.108 (d)(3), GMA 8 District Representatives considered these total estimated recoverable storage values along with the other factors in Texas Water Code Section 36.108(d)(3) when developing DFCs. The total estimated recoverable storage for each aquifer in GMA 8 is shown below in Table 11 through Table 19.

[19] Shi, J., Bradley, R.G., Wade, S., Jones, J., Anaya, R., Seiter-Weatherford, C., 2014, GAM Task 13-031: Total Estimated Recoverable Storage for Aquifers in Groundwater Management Area 8, Texas Water Development Board GAM Task Report, 41 p.

[20] *Id.*

Table 11. Total estimated recoverable storage by county for the Hickory Aquifer in GMA 8. Values have been rounded to two significant figures.

County	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
Brow	55,000	165,000
Burnet	1,650,000	4,950,000
Lampasas	700,000	2,100,000
Mills	157,500	472,500
Travis	8,250	24,750
Williamson	4,250	12,750
Total	**2,575,000**	**7,725,000**

Table 12. Total estimated recoverable storage by county for the Ellenburger – San Saba Aquifer in GMA 8. Values have been rounded to two significant figures.

County	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
Brow	55,000	165,000
Burnet	1,650,000	4,950,000
Lampasas	700,000	2,100,000
Mills	157,500	472,500
Travis	8,250	24,750
Williamson	4,250	12,750
Total	**2,575,000**	**7,725,000**

Table 13. Total estimated recoverable storage by county for the Marble Falls Aquifer in GMA 8. Values have been rounded to two significant figures.

County	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
Burnet	9,500	28,500
Lampasas	9,750	29,250
Total	**19,250**	**57,750**

Table 14. Total estimated recoverable storage by county for the Trinity Aquifer in GMA 8. Values have been rounded to two significant figures.

County	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
Bell	14,750,000	44,250,000
Bosque	10,000,000	30,000,000
Brow	650,000	1,950,000
Burnet	2,750,000	8,250,000
Callahan	450,000	1,350,000
Collin	22,000,000	66,000,000
Comanche	2,075,000	6,225,000
Cooke	11,250,000	33,750,000
Coryell	8,500,000	25,500,000
Eastland	400,000	1,200,000
Ellis	19,500,000	58,500,000
Erath	5,000,000	15,000,000
Falls	9,000,000	27,000,000
Fannin	19,750,000	59,250,000
Grayson	15,750,000	47,250,000
Hamilton	5,500,000	16,500,000
Hill	13,000,000	39,000,000
Hood	2,750,000	8,250,000
Hunt	3,000,000	9,000,000
Johnson	8,750,000	26,250,000
Kaufman	2,350,000	7,050,000
Lamar	19,250,000	57,750,000
Lampasas	3,000,000	9,000,000
Limestone	2,750,000	8,250,000
McLennan	14,750,000	44,250,000
Milam	5,500,000	16,500,000
Mills	2,125,000	6,375,000
Montague	1,950,000	5,850,000
Navarro	9,750,000	29,250,000
Parker	5,500,000	16,500,000
Red River	11,000,000	33,000,000
Rockwall	1,225,000	3,675,000
Somervell	1,500,000	4,500,000
Tarrant	12,250,000	36,750,000
Taylor	157,500	472,500
Travis	9,750,000	29,250,000
Williamson	19,250,000	57,750,000
Wise	5,000,000	15,000,000
Total	**339,882,500**	**1,019,647,500**

Table 15. Total estimated recoverable storage by county for the Edwards (Balcones Fault Zone) Aquifer in GMA 8. Values have been rounded to two significant figures.

County	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
Bell	2,750	8,250
Travis	1,475	4,425
Williamson	19,500	58,500
Total	**23,725**	**71,175**

Table 16. Total estimated recoverable storage by county for the Woodbine Aquifer in GMA 8. Values have been rounded to two significant figures.

County	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
Collin	8,000,000	24,000,000
Cooke	300,000	900,000
Dallas	7,500,000	22,500,000
Denton	2,225,000	6,675,000
Ellis	6,250,000	18,750,000
Fannin	9,750,000	29,250,000
Grayson	8,000,000	24,000,000
Hill	1,675,000	5,025,000
Hunt	2,050,000	6,150,000
Johnson	1,125,000	3,375,000
Kaufman	1,175,000	3,525,000
Lamar	5,250,000	15,750,000
McLennan	225,000	675,000
Navarro	850,000	2,550,000
Red River	1,125,000	3,375,000
Rockwall	11,500	34,500
Tarrant	1,325,000	3,975,000
Total	**56,836,500**	**170,509,500**

Table 17. Total estimated recoverable storage by county for the Nacatoch Aquifer in GMA 8. Values have been rounded to two significant figures.

County	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
Bowie	525,000	1,575,000
Delta	25,000	75,000
Ellis	17	50
Franklin	1,825	5,475
Hopkins	82,500	247,500
Hunt	137,500	412,500
Kaufman	30,000	90,000
Lamar	3,000	9,000
Navarro	23,750	71,250
Rains	4,500	73,500
Red River	145,000	435,000
Rockwall	70	210
Total	**978,162**	**2,934,485**

Table 18. Total estimated recoverable storage by county for the Blossom Aquifer in GMA 8. Values have been rounded to two significant figures.

County	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
Bowie	227,500	682,500
Lamar	242,500	727,500
Red River	1,300,000	3,900,000
Total	**1,770,000**	**5,310,000**

Table 19. Total estimated recoverable storage by county for the Brazos River Alluvium Aquifer in GMA 8. Values have been rounded to two significant figures.

County	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
Bosque	2,400	7,200
Falls	40,000	120,000
Hill	1,650	4,950
McLennan	22,500	67,500
Milam	2,175	6,525
Total	**68,725**	**206,175**

3.2.3.2 Water budgets

A water budget is an accounting of the inflows and outflows to and from an aquifer. These budgets are important to understanding how the aquifer works and what characteristics of the aquifer are most important when evaluating groundwater availability.

Table 20 shows a partial water budget for the Trinity and Woodbine aquifers for the period prior to development (pumping) of the aquifer. This budget is for the extent of the Northern Trinity and Woodbine Aquifer GAM, which encompasses most of GMA 8. In Table 20, positive values indicate inflows to the aquifer and negative values indicate outflows.

As shown in Table 20, recharge to the Trinity and Woodbine aquifers prior to development is approximately 1.8 million acre-feet per year. However, the vast majority of this volume discharged in the outcrop area of the aquifer by evapotranspiration ("ET") or into streams and springs. Only approximately 12,000 acre-feet per year of recharged water percolated down into the deeper portions of the aquifer through cross-formational flow.

Table 20. Partial pre-development water budget for the Trinity and Woodbine aquifers from Kelley and others (2014). All values are in acre-feet per year.

Pre-development	Cross-formational Flow			Recharge	ET	Ephemeral Streams	Perennial Streams	Spring
	Surficial	Top	Bottom					
Younger Formations	0	0	8,354	0	0	0	0	0
Woodbine Aquifer	2,561	-8,354	5,901	326,201	-13,334	-197,776	-97,917	-61
Wash/Fred Groups	5,886	-5,901	275	532,484	-6,633	-270,802	-236,638	-286
Paluxy Aquifer	1,859	-275	-1,565	245,673	-6,771	-113,235	-120,812	-126
Glen Rose Formation	16,844	1,565	-18,638	230,422	-6,503	-83,409	-131,395	-86
Hensell Aquifer	-11,214	18,638	-6,579	208,440	-11,756	-130,060	-67,678	-188
Pearsall Formation	3,374	6,579	-9,899	45,455	-3,697	-38,571	-24,689	0
Hosston Aquifer	-7,050	9,899	0	177,891	-4,352	-122,037	-58,080	-343
Total	**12,259**	**22,151**	**-22,151**	**1,766,567**	**-53,046**	**-955,888**	**-737,209**	**-1,090**

Table 21 presents the water budget for 2000, a relatively low-recharge year. Recharge is still the largest inflow, but for this year, more water discharged through evapotranspiration (ET) and by ephemeral and perennial streams and springs than came into the aquifer. As this is a post-development water budget, it contains new terms for reservoirs, pumping ("Well"), flowing wells ("Flowing"), and storage. Following the convention in hydrogeology, water removed from storage in the aquifer is shown as a positive value. For this dry year, the volume of pumping from these aquifers was approximately 266,000 acre-feet, but the reduction in storage in the aquifer was approximately 787,000 acre-feet.

Table 21. Water budget for 2000 for the Trinity and Woodbine Aquifers from Kelley and others (2014). All values are in acre-feet per year.

		Woodbine Aquifer	Wash/Fred Groups	Paluxy Aquifer	Glen Rose	Hensell Aquifer	Pearsall	Hosston Aquifer	Total
Cross-formational Flow	Surficial	24,864	58,069	23,325	64,531	17,688	21,485	22,725	232,687
	Top	5,407	5,976	25,510	21,510	73,590	56,062	72,303	260,358
	Bottom	-5,976	-25,510	-21,510	-73,590	-56,062	-72,303	0	-254,951
Recharge		231,840	345,628	173,587	142,829	151,900	32,744	127,805	1,206,333
ET		-13,556	-8,652	-7,235	-6,716	-12,074	-3,702	-4,270	-56,205
Ephemeral		-208,440	-298,137	-124,408	-88,150	-137,903	-38,336	-126,396	-1,021,770
Perennial		-96,990	-181,195	-99,809	-114,108	-56,508	-22,424	-50,753	-621,787
Reservoir		-4,596	-11,257	-459	-540	-821	-384	-991	-19,048
Spring		-64	-227	-118	-85	-198	0	-318	-1,010
Well		-26,241	-41,062	-31,035	-16,179	-37,487	-8,821	-105,581	-266,406
Flowing		-904	0	-56	-6	-520	-15	-226	-1,727
Storage		136,163	226,979	91,566	125,376	89,177	25,638	91,890	786,789

Recharge to aquifers in GMA 8 depends on the precipitation on the outcrop areas of the aquifers and the characteristics of the land surface and geologic units. Figure 15 shows the estimated average annual recharge to the Trinity and Woodbine aquifers in inches per year. This ranges from less than 0.5 inches per year in the far western portion of GMA 8 to over 4 inches per year in northern GMA 8 along the Texas-Oklahoma Border.

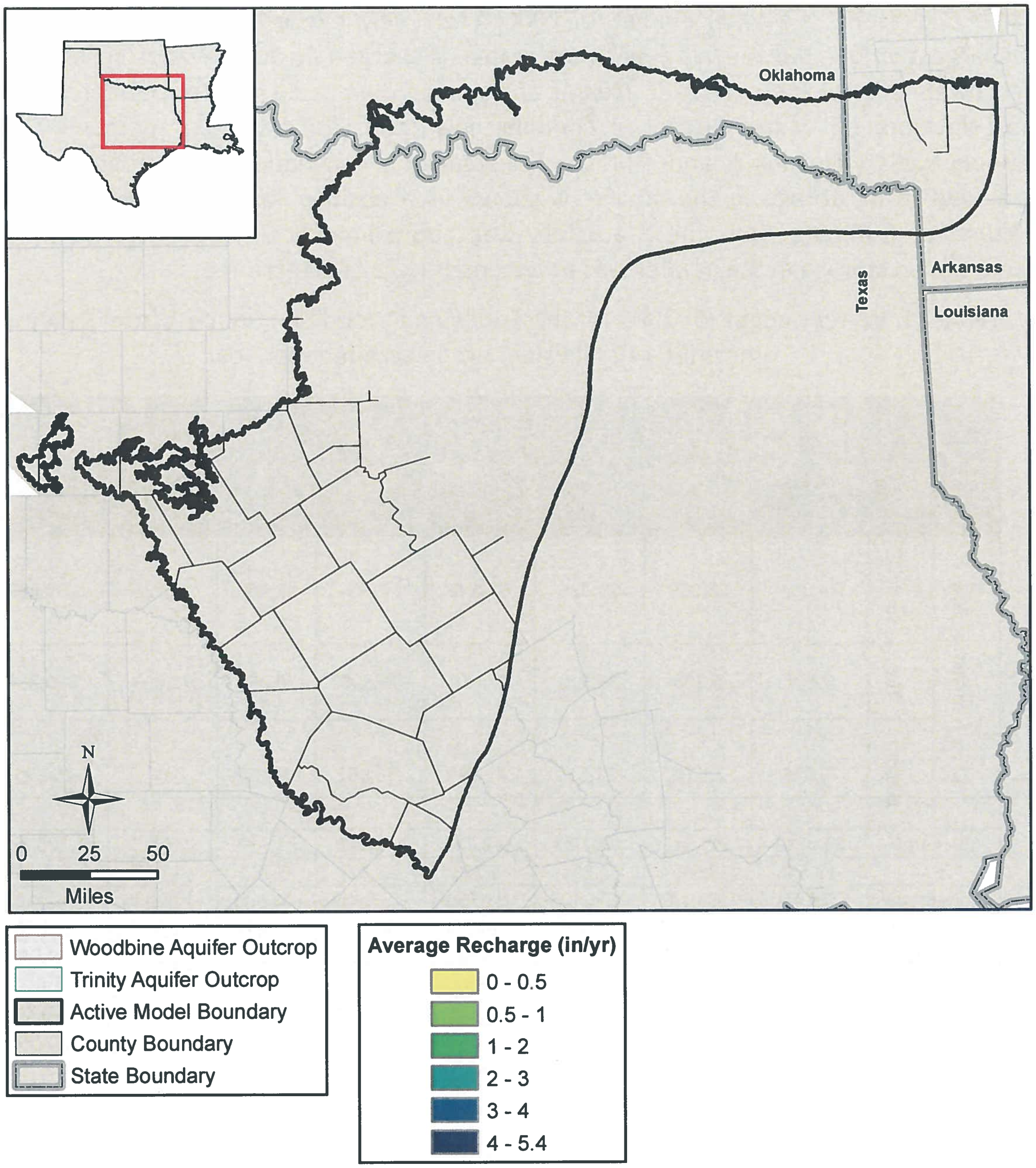

Figure 15. Estimated average recharge to the Trinity and Woodbine Aquifers

The water budget information presented above, which includes average annual recharge, inflows and outflows, was reviewed by District Representatives in GMA 8 and is included in the Kelley and others (2014), documenting development of the updated groundwater availability model for the northern portion of the Trinity and Woodbine aquifers. In addition, GMA 8 District Representatives reviewed water budget information for potential DFCs as they were considered. For Run 10, water budget information was prepared for each aquifer in each county by decade between 2010 and 2070. This information is provided in Appendix T, and an example of one of these tables is included in Table 22 below for the Paluxy Aquifer in Bosque County.

Note in the example below that recharge remains constant through the period with the exception of 2060 due to inclusion of a one-time drought-of-record in the simulation. Pumping in Bosque County is relatively limited, but water level declines still occur (positive storage). This is caused by increased leakage to underlying aquifers and results in decreased outflow to perennial and ephemeral streams.

Table 22. Example water budget for Run 10.[21] All values are in acre-feet per year.

Bosque County – Paluxy Aquifer							
Component	2010	2020	2030	2040	2050	2060	2070
Lateral Flow	477	433	411	398	389	365	375
Leakage (Above)	6,824	7,107	7,254	7,329	7,372	7,361	7,400
Leakage (Below)	-4,825	-5,325	-5,544	-5,661	-5,731	-5,767	-5,799
Recharge	3,681	3,681	3,681	3,681	3,681	2,060	3,681
Perennial	-3,988	-3,517	-3,424	-3,371	-3,335	-3,062	-3,269
Ephemeral	-3,043	-2,875	-2,796	-2,741	-2,699	-2,621	-2,615
Evapotranspiration	0	0	0	0	0	0	0
Springs	0	0	0	0	0	0	0
Reservoir	0	0	0	0	0	0	0
Wells	-357	-357	-357	-357	-357	-357	-357
Flowing	0	0	0	0	0	0	0
Storage	1,233	855	776	723	681	2,022	584
Total	**2**	**1**	**1**	**1**	**0**	**0**	**0**

Water budget information for the Edwards (BFZ) Aquifer can be found as part of the groundwater availability model developed for the northern segment of the Edwards (BFZ) Aquifer (Jones, 2003[22]). The Northern Edwards (BFZ) Aquifer GAM was used in the development of GAM Run 08-10mag (Anaya, 2008[23]) referenced in the Resolution 2017-01-01 (see Appendix F) for the Edwards (BFZ) Aquifer. This GAM Run report is itself based on GAM Run 07-21 (Anaya, 2007[24]). The area of the GAM for the northern segment of the Edwards (BFZ) Aquifer closely aligns with GMA 8. The water budget information in Jones (2003) indicates that the majority of recharge to the aquifer discharges through spring flow and cross-formational flow to overlying units.

Water budget information for the Llano Uplift Aquifers (Marble Falls, Ellenburger – San Saba, and Hickory) can be found as part of the groundwater availability model recently completed

[21] Beach, J., Keester, M., and Konetchy, B., 2016, Results of Predictive Simulation in Support of GMA 8 Joint Planning – NTGCD GMA 8 Run 10, 186 p.

[22] Jones, I.C., 2003, Groundwater availability modeling: northern segment of the Edwards Aquifer, Texas, Texas Water Development Board Report 358, 83 p.

[23] Anaya, R.A., 2008, GAM Run 08-10mag, Texas Water Development Board Managed Available Groundwater GAM run report, 7 p.

[24] Anaya, R.A., 2007, GAM Run 07-21, Texas Water Development Board GAM run report, 11 p.

for these aquifers (see Appendix G). [25] As indicated in the Resolution adopted April 1, 2016, at the time DFCs were proposed for GMA 8, only the draft groundwater availability model report for the Llano Uplift Aquifers was available. As of this writing, however, the final report is now available through the TWDB. As shown in the Numerical Model Report: Minor Aquifers of the Llano Uplift Region of Texas, the majority of recharge to the Llano Uplift Aquifers in the counties in GMA 8 discharges to rivers and lakes, though in some counties (for example, Burnet), pumping accounts for a significant portion of the county-wide water budget.

As described in Section 6.0, District Representatives in GMA 8 considered the Nacatoch, Brazos River Alluvium, and Blossom aquifers non-relevant for joint planning purposes. There is, however, some water budget information available for these aquifers. The Nacatoch Aquifer groundwater availability model contains water budget information by county including recharge and discharge mechanisms (Beach and others, 2009.[26] The TWDB is in the process of developing a groundwater availability model for the Brazos River Alluvium Aquifer. See Ewing and others (2016)[27] for the report documenting the conceptual model of this aquifer, including some water budget components such as recharge and discharge to surface water. The TWDB is also currently developing a groundwater availability model for the Blossom Aquifer, though no results from this study are available for review as of the date of this Explanatory Report.

3.2.4 Environmental impacts

Texas Water Code Section 36.108(d)(4) requires District Representatives in a GMA to consider "other environmental impacts, including impacts on spring flow and other interactions between groundwater and surface water." The water budget components described in Section 3.2.3 for Run 10 above include impacts on spring flow and interactions between groundwater and surface water for each aquifer in each county relevant to the DFCs. These are presented in Appendix T. Some additional information on spring flow and groundwater – surface water interaction is included below. A detailed analysis of these components was completed and reviewed by District Representatives in GMA 8 as part of the update to the groundwater availability model for the northern portion of the Trinity and Woodbine aquifers. This is included in Appendix M, and also at the conclusion of the joint-planning process in Appendix AA.

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[25] Shi, J., Boghici, R., Kohlrenken, W., and Hutchinson, W., Numerical Model Report: Minor Aquifers of the Llano Uplift Region of Texas (Marble Falls, Ellenburger-San Saba, and Hickory): Texas Water Development Board, variously paginated.

[26] Beach, J.A., Huang, Y., Symank, L., Ashworth, J.B., Davidson, T., Vreugdenhil, A.M., Deeds, N.E., 2009, Final report: Nacatoch Aquifer Groundwater Availability Model, Prepared for the Texas Water Development Board, 304 p.

[27] Ewing, J.E., Harding, J.J., Jones, T.L., Griffith, C., Albright, J.S., Scanlon, B.R., 2016, Final Conceptual Model Report for the Brazos River Alluvium Aquifer Prepared for the Texas Water Development Board, 514 p.

3.2.4.1 Spring flow

Figure 16 shows the locations of springs in GMA 8 presented by aquifer and data source. Since a spring is a feature where groundwater discharges at the land surface, the springs are aligned with the aquifer outcrops – where it is exposed at land surface. The southern portion of GMA 8 contains the greatest density of springs. Many of these issue from the Fredericksburg/Washita group, which includes the Edwards BFZ Aquifer in this area of GMA 8. There are also many springs that issue from the far western extent of the Trinity Aquifer and in northern GMA 8 and in the counties that comprise Upper Trinity GCD (Hood, Montague, Parker, and Wise counties).

Groundwater discharges from a spring when the water level elevation of the aquifer is above the elevation of a spring hydrogeologically connected to it. The rate of flow from the spring directly relates to the difference in these two elevations. Water level declines in the outcrop area of aquifers can significantly reduce or stop spring flow if the groundwater level drops close to or below the spring elevation. The water budgets described in Section 3.2.3 and included in Appendix T reflect reductions in spring flow in areas where the desired future conditions include drawdowns in aquifer outcrop areas.

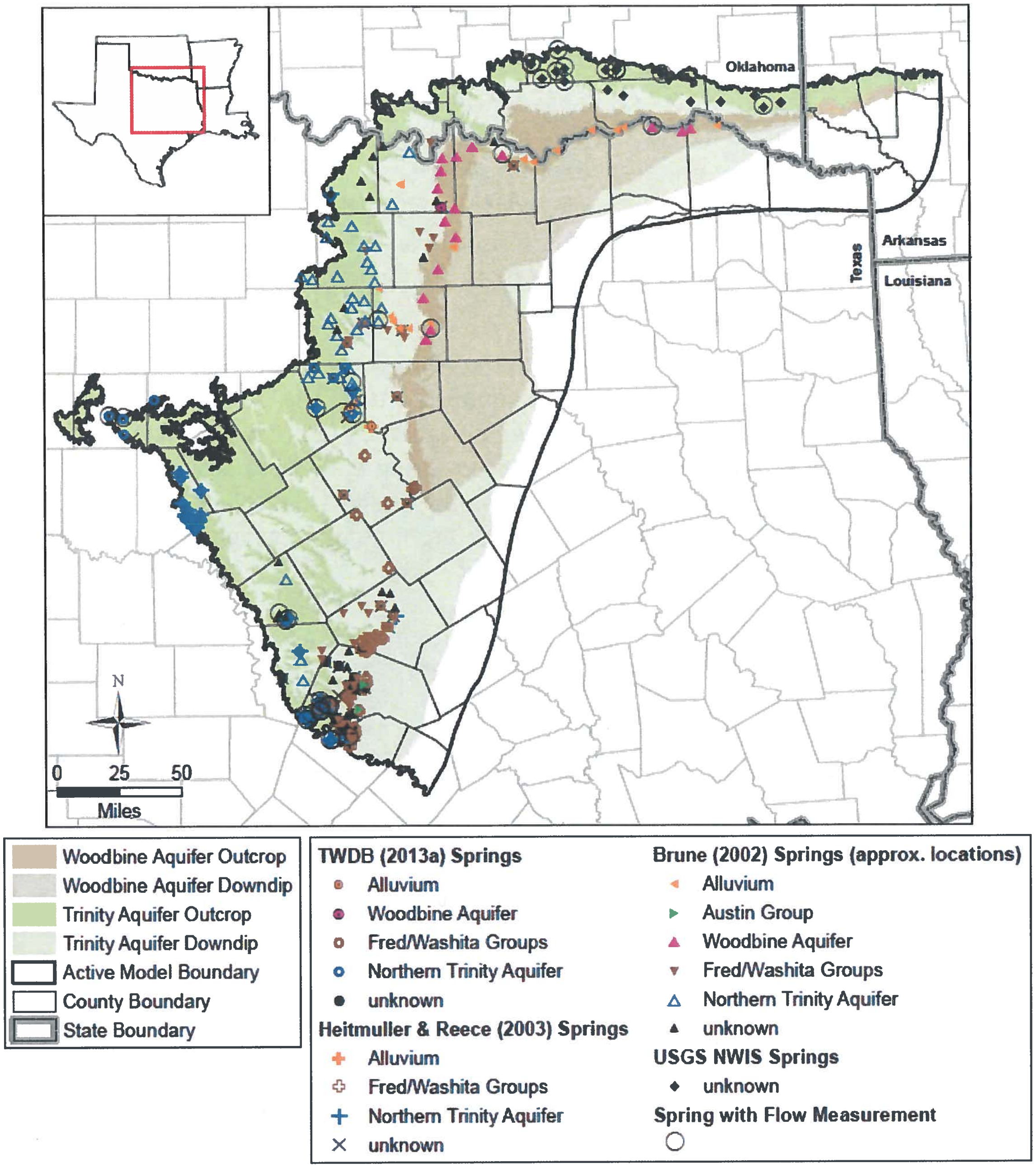

Figure 16. Spring locations by data source and aquifer in GMA 8. Please refer to Kelley and other (2014) for full data source references.[28]

3.2.4.2 Groundwater/Surface water interaction

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[28] Kelley, -V.A., Ewing, J., Jones, T. L., Young, S. C., Deeds, N., and Hamlin, S., 2014, Updated groundwater availability model of the Northern Trinity and Woodbine Aquifers: - Final Report: Prepared for the North Texas Groundwater Conservation District, Northern Trinity Groundwater Conservation District, Prairielands Groundwater Conservation District, and Upper Trinity Groundwater Conservation District by INTERA, Inc., The Bureau of Economic Geology, and LBG-Guyton Associates, Volumes I, II, and III, variously paginated.

Figure 17 shows the average annual baseflow to streams intersecting the aquifers in GMA 8. Note that this is limited to sections of streams with more than ten years of unregulated stream gage data. "Unregulated" refers to sections of streams in their natural state as opposed to those where the flow is influenced by dams or diversions. This information was reviewed by District Representatives in GMA 8 as part of the development and update of the Northern Trinity and Woodbine Aquifer GAM and again in GMA 8 meetings to consider environmental impacts in the development of the DFCs.

Baseflow is the contribution of flow in a stream or river that is sourced from groundwater discharges along the stream channel. Similar to the mechanics of spring flow, baseflow to streams occurs when the water level in the aquifer is above the water level in the stream. Streams where this occurs are known as "gaining streams." Unlike springs, interaction between streams and aquifers can occur in either direction. If the water level in the aquifer is below the water level in the stream, water will flow from the stream into the aquifer. Streams where this occurs are known as "losing streams."

As shown in Figure 17, the streams in GMA 8 are typically gaining streams. However, water level declines in aquifer outcrop areas can lead to reductions in baseflow to streams or even a reversal in the direction of flow. The water budgets included in Appendix T show the estimated changes in baseflow to streams resulting from the adopted DFCs.

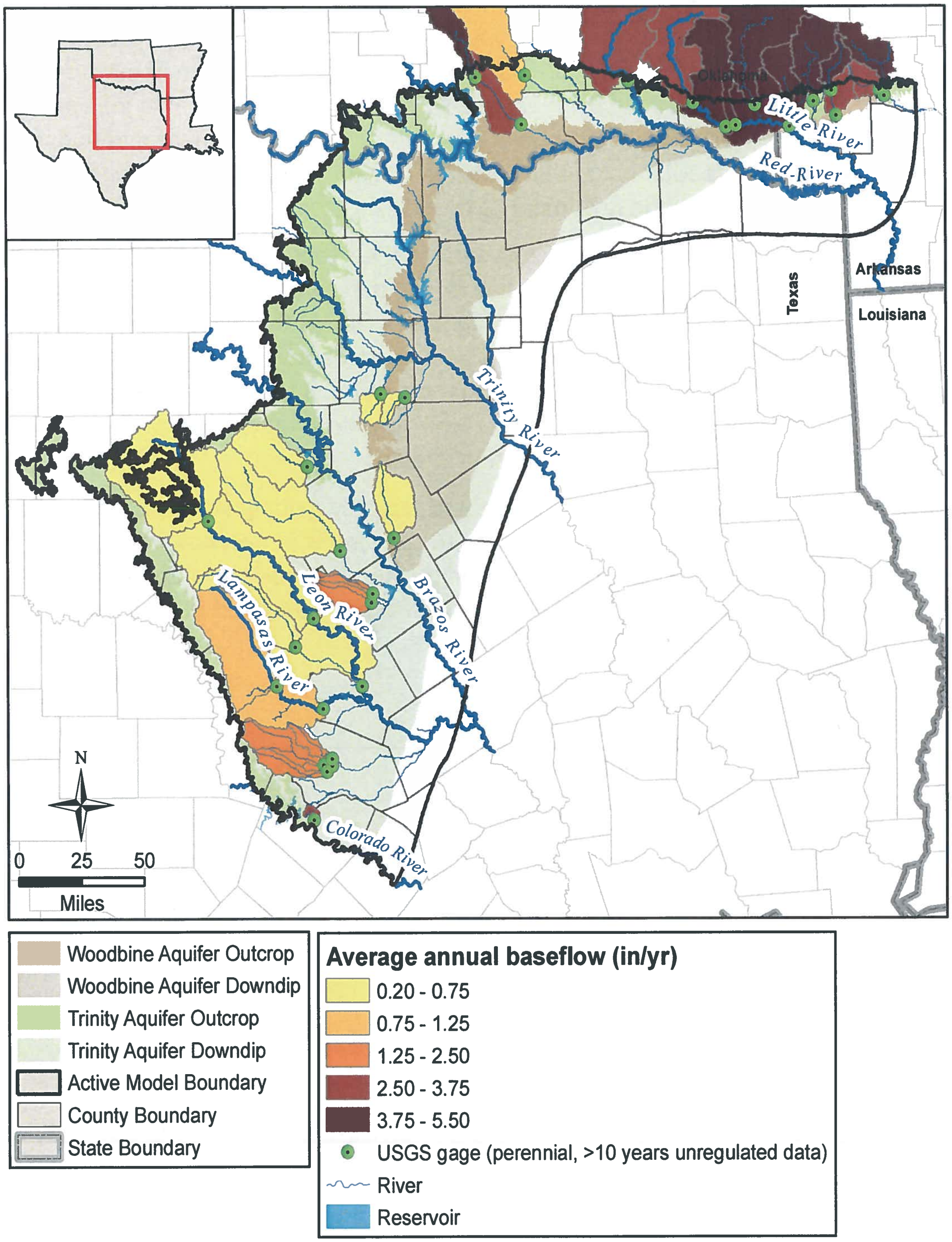

Figure 17. Average annual baseflow to streams with greater than 10 years of unregulated stream gage data.[29]

[29] Kelley, -V.A., Ewing, J., Jones, T. L., Young, S. C., Deeds, N., and Hamlin, S., 2014, Updated groundwater availability model of the Northern Trinity and Woodbine Aquifers: - Final Report: Prepared for the North Texas

3.2.5 Subsidence impacts

Texas Water Code Section 36.108(d)(5) requires District Representatives in a GMA to consider the impacts of proposed desired future conditions on subsidence. Subsidence is the geologic term used to describe the sinking of the land surface with respect to sea level. Subsidence may occur as a result of natural causes or from man-induced or anthropogenic causes. Subsidence, especially in low lying coastal areas, may cause significant damage due to flooding, including structural damage to roads and buildings. For example, subsidence in the Houston/Galveston area has been caused by removal of oil and gas minerals as well as groundwater from the confined Gulf Coast Aquifer. Subsidence may also result from the removal of other minerals in the subsurface such as salt and sulfur.[30]

When subsidence is the result of the removal of fluids, this is because the fluids are pressurized or confined. Therefore, when naturally occurring, the pressurized fluids act to hold up the loosely consolidated sedimentary particles in the subsurface (clays, silts, and sands). Due to the inelastic nature of the sediments, in particular clays in areas where subsidence occurs, subsidence is permanent. Flooding resulting from subsidence in the Harris/Galveston area has resulted in major losses to land and property over the past fifty plus years.

Mace and others (1994)[31] reported on the observed and potential effects of water-level declines in the Woodbine, Paluxy, and Trinity aquifers on subsidence and water quality. Based on an analysis of water-level declines and the elastic and hydraulic properties of confining units for the subject aquifers, Mace and others (1994) concluded that either because of the structural stability of the geologic units in the region or due to a consolidation time-lag, no subsidence has been observed in the North-Central Texas area (coincident with GMA 8). This conclusion was supported by the absence of any measured subsidence by the U.S. Geological Survey in the region from 1957-1991.

Based on the geologic and hydrogeologic characteristics in the region of GMA 8, the adopted DFCs will not have any impacts on subsidence.

3.2.6 Socioeconomic impacts

Texas Water Code Section 36.108 (d)(6) requires District Representatives in a GMA to consider socioeconomic impacts reasonably expected to occur as a result of the proposed

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Groundwater Conservation District, Northern Trinity Groundwater Conservation District, Prairielands Groundwater Conservation District, and Upper Trinity Groundwater Conservation District by INTERA, Inc., The Bureau of Economic Geology, and LBG-Guyton Associates, Volumes I, II, and III, variously paginated.

[30] Mullican, W. F., III, 1988, Subsidence and collapse of Texas Salt Domes: The University of Texas at Austin, Bureau of Economic Geology Geological Circular 88-2, 36 p.

[31] Mace, R. E., Dutton, A. R., and Nance, H. S., 1994, Water-level declines in the Woodbine, Paluxy, and Trinity aquifers of North-Central Texas: Transactions of the Gulf Coast Association of Geological Sciences, Vol. XLIV, pp. 413-420.

DFCs for relevant aquifers. Consideration of socioeconomic impacts as part of water planning in Texas, both at the regional and state level, has been a primary element of the water planning process dating back to the 1960s. This includes statutory guidance for regional water planning [32] and state water planning[33]. Title 31 of Texas Administrative Code, Section 357.7(4)(A) provides the following:

> The executive administrator shall provide available technical assistance to the regional water planning groups, upon request, on water supply and demand analysis, including methods to evaluate the social and economic impacts of not meeting needs.[34]

This technical assistance and analysis provided by the executive administrator is the only consistent analysis of socioeconomic impacts available for joint-planning in regards to socioeconomic impacts, at the local, regional, and state level. Title 31 of Texas Administrative Code, Section 357.40(a) states that regional water plans "shall include a quantitative description of the socioeconomic impacts of not meeting the identified water needs pursuant to §357.33(c) of this title (relating to Needs Analysis: Comparison of Water Supplies and Demands)." This analysis is based on water supply needs from the regional water plans. This analysis consists of a series of point estimates of 1-year droughts at 10-year intervals. The socioeconomic impact analysis attempts to measure the impacts in the event that water user groups do not meet their identified water supply needs associated with a drought-of-record for one year. For this socioeconomic impact analysis, multiple impacts are examined, including (1) sales, income, and tax revenue, (2) jobs, (3) population, and (4) school enrollment. Results from this analysis are then incorporated into the final regional water plan, and then comprehensively presented in the subsequent state water plan. Socioeconomic impact analysis reports provided by the executive administrator of the TWDB for the 2011 regional water plans in Regions B, C, D, F, G, and K, are included in Appendixes GG – LL, respectively. Concepts and details of this information was considered during the May 27, 2015, GMA 8 meeting. This presentation is included in its entirety in Appendixes AA and MM.

Information regarding socioeconomic impacts reasonably expected to occur as a result of the proposed DFCs was developed by District Representatives utilizing a survey tool developed specifically for use by GMA 8. This survey tool was used by individual District Representatives to discuss and consider both socioeconomic impacts and impacts on private property rights (see Section 3.2.7) of DFCs under consideration with each GMA 8 GCD Board of Directors. Results from this survey for each individual GCD were presented at the April 1, 2016, GMA 8 meeting and the completed surveys are included in their entirety in Appendix NN.

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[32] Texas Water Code Section 16.053 (a), (b) (West, 2016).
[33] Texas Water Code Section 16.051 (a), (b) (West, 2016).
[34] 31 Texas Administrative Code Section 357.7(4)(A) (2016).

The GMA 8 survey asked individual GCDs for both binary responses (yes/no) to a set of questions and, for certain questions, requested any additional information that the GCD considered during discussions of potential socioeconomic impacts. The questions and binary responses are included in Table 23 below. While it is difficult to specifically characterize survey responses from a qualitative perspective, it is clear that GMA 8 GCDs recognize that in their deliberation and adoption of DFCs, management plans, and rules, it is critical to evaluate all policy decisions based, in part, on the potential socioeconomic impacts of the policy question under consideration. A partial listing of socioeconomic impacts considered include: impacts of lowering water levels on costs of production including increased pumping lifts, decreasing well yields and potential need for additional wells, potential for and additional costs of developing alternative supplies, and the need to meet water supply needs in order to avoid socioeconomic impacts of water shortages.

Due to the absence of non-exempt pumping in the Northern Trinity and Woodbine aquifers in Post Oak Savannah GCD, the District's responses to questions pertaining to socioeconomic impacts of proposed DFCs were determined to be "not applicable." Five GCDs provided specific information regarding additional socioeconomic impact studies deemed to be relevant to the individual GCD. GCDs submitting district-specific information on socioeconomic impacts include Central Texas GD, Clearwater UWCD, Post Oak Savannah GCD, Southern Trinity GCD, and Upper Trinity GCD. All additional information considered by these five GCDs is included along with survey responses in Appendix NN. Overall, almost all of the questions regarding whether or not a GCD's Board of Directors considered a specific aspect of socioeconomic impacts potentially resulting from proposed DFCs were answered in the affirmative (61 – yes; 4 – no). In addition, an examination of survey responses illustrates that the GCDs in GMA 8 held focused discussions during multiple properly-noticed, Board of Directors' meetings, on the socioeconomic impacts of proposed DFCs within their individual GCDs.

Table 23. GCD Survey questions and responses.

Survey questions regarding socioeconomic impacts of proposed DFCs	GMA 8 GCD Survey Responses										
	CTGCD	CUWCD	MTGCD	NTGCD	Ntrinty GCD	POSGCD	PGCD	RRGCD	SUWCD	STGCD	UTGCD
Has your GCD identified any socioeconomic studies that relate directly or indirectly to the Section 36.108 (d)(6) planning criterion that should be considered by GMA 8 as part of the joint planning process?	Y	Y	N	N	N	Y	N	N	N	Y	Y
Did your GCD discuss and consider the information provided by the Texas Water Development Board on socioeconomic impacts of not meeting needs included in the applicable 2011 regional water plans and the 2012 state water plan?	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y
From a qualitative perspective, both positive and negative socioeconomic impacts may potentially result from implementation of proposed DFCs. Did your GCD discuss the potential socioeconomic impacts that may result from proposed DFCs due to a need for conversion to an alternative supply, including increased costs associated to infrastructure, operation, and maintenance?	Y	Y	Y	Y	Y	NA	Y	Y	Y	Y	Y
Did your GCD discuss how proposed DFCs may reduce/eliminate the costs of lowering pumps and either deepening existing wells or drilling new wells?	Y	Y	Y	Y	Y	NA	Y	Y	Y	Y	Y
Did your GCD discuss the potential that proposed DFCs may serve to sustain/enhance economic growth due to assurances provided by a diversified water portfolio?	Y	Y	Y	Y	Y	NA	Y	Y	Y	Y	Y
Did your GCD discuss how proposed DFCs may result in short-term reduction in utility rates due to reduction in cost of alternative water management strategy implementation?	N	Y	Y	Y	N	NA	Y	Y	Y	Y	Y
Did your GCD discuss how proposed DFCs may result in significant but unquantified production costs due to lowering of artesian water levels in local aquifers?	Y	Y	Y	Y	Y	NA	Y	Y	Y	Y	Y

3.2.7 Private property impacts

Texas Water Code Section 36.108(d)(7) requires that District Representatives in a GMA consider the impact of proposed DFCs on the interests and rights in private property, including ownership and the rights of management area landowners and their lessees and assigns in groundwater, as recognized under Texas Water Code Section 36.002. GMA 8 District Representatives formally considered this factor throughout the joint-planning process (including formal focused discussions on this criterion during meetings on July 29, 2014, May 27, 2015, March 23, 2016, and April 1, 2016). In addition, each GMA District Representative was responsible for facilitating the discussion and consideration of the impacts of proposed DFCs on private property rights with their individual GCDs Board of Directors as part of this effort.

During initial GMA 8 discussions regarding the impacts of proposed DFCs on private property rights, District Representatives identified the following issues/topics for subsequent discussions with individual GCDs:

- Existing uses within the GCD
- Projected future uses within the GCD
- Investment-backed expectations of existing users and property owners within the GCD
- Long-term viability of groundwater resources in area
- Availability of water to all properties and ability to allocate MAG through rules after DFC adoption
- Whether immediate cutbacks would be required in setting a particular DFC or whether cutbacks, if any, would need to occur over a certain timeframe
- For outcrop areas, how the outcrop depletes rapidly in dry times, and whether drought rules or triggers based on the DFC/MAG for the outcrop could be beneficial to ensure viability of the resource during dry times
- Economic consequences to existing users (i.e., cost to drop pumps, reconfigure or drill new wells upon water table dropping, etc.). Also consider the reverse—economic consequences of less water available to protect the existing users from the economic consequences relevant to existing users—reaching a balance between these two dynamics
- Review the sustainability GAM run versus additional GAM runs that provide for more pumping from an aquifer, and how those two differ with respect to private property rights
- Focus on finding a balance, as that balance is defined by each GCD, between all of these considerations

In addition, as part of this consideration, a survey tool was developed and utilized by each of the GMA 8 District Representatives with their individual GCDs Board of Directors to initiate and then document that this critical factor in the joint-planning process was appropriately considered. The survey and results from each GMA 8 District Representative are presented in Appendix NN.

While it is clear that GMA 8 District Representatives invested significant time during multiple GMA 8 meetings on the impacts of proposed DFCs on private property rights, it is also understood that the impacts of proposed DFCs on private property rights has truly been an overarching consideration throughout the joint-planning process. Each District Representative provided input to GMA 8 on not only the impacts of proposed DFCs, but also how individual GCD management plans and rules have been developed to achieve current DFCs (adopted in 2007, 2008, 2009, and 2011) while protecting private property rights. GCDs must consider all private property rights when considering management plans, rules, and permit decisions. GCDs must balance the interests of historic groundwater users, landowners who desire to preserve the aquifer levels beneath their property, and property owners who may be damaged by either groundwater-level declines, reduction of water in storage, and reduced spring flow. The adopted DFCs attempt to strike a balance between all of these property interests.

A summary of results from the GMA 8 Survey with respect to private property rights is presented below in Table 24. Ten of the eleven GCDs in GMA 8 reported that they discussed the impacts of proposed DFC options on private property. The exception was Post-Oak Savannah GCD, which stated that due to the absence of established production within their jurisdictional boundaries from any relevant aquifers designated in GMA 8, the proposed DFCs are not applicable to Post Oak Savannah GCD. Northern Trinity GCD reported that they did not discuss how the proposed DFCs may impact the ability of existing well owners and property owners who have yet to drill a well. All of the remaining responses by GMA 8 District Representatives to the Survey were in the affirmative (see Table 24).

Table 24. Summary of GMA 8 Survey regarding impacts of proposed DFCs on private property rights.

GMA 8 Survey questions regarding impacts of proposed DFCs on private property rights	GMA 8 GCD Survey Responses										
	CTGCD	CUWCD	MTGCD	NTGCD	Ntrinty GCD	POSGCD	PGCD	RRGCD	SUWCD	STGCD	UTGCD
Did your GCD discuss and consider the impacts of proposed DFC options on interests and rights in private property, including ownership and the rights of management area landowners and their lessees and assigns in groundwater?	Y	Y	Y	Y	Y	NA	Y	Y	Y	Y	Y
Did your GCD discuss how proposed DFCs may impact the ability of both: (1) existing well owners, and (2) property owners who have not yet drilled a well but may have an expectation of being able to do so in the future, to recover their investment-backed expectations from their investments in their water wells and their investments in their properties?	Y	Y	Y	Y	N	NA	Y	Y	Y	Y	Y
Did your GCD discuss how proposed DFCs may impact the availability of water to all properties overlying the aquifer in your district, and whether property owners of various economic means will be able to complete affordable water wells with sufficient well yields for projected uses, or whether affordable water from alternative water supplies would be available to those properties?	Y	Y	Y	Y	Y	NA	Y	Y	Y	Y	Y

For a more complete record of these discussions, see survey results presented in Appendix NN and the approved GMA 8 meeting minutes for the April 1, 2016, GMA 8 meeting included in Appendix B. While the approach to protecting private property rights varies somewhat from GCD to GCD in GMA 8, depending upon local conditions, it is recognized that in addition to the adopted DFCs, all GCDs in GMA 8 have developed management plans and rules that fundamentally work to protect private property rights.

For reference, Texas Water Code Section 36.002 reads as follows:

a) The legislature recognizes that a landowner owns the groundwater below the surface of the landowner's land as real property.

b) The groundwater ownership and rights described by this section:

1) entitle the landowner, including a landowner's lessees, heirs, or assigns, to drill for and produce the groundwater below the surface of real property, subject to Subsection (d), without causing waste or malicious drainage of other property or negligently causing subsidence, but does not entitle a landowner, including a landowner's lessees, heirs, or assigns, to the right to capture a specific amount of groundwater below the surface of that landowner's land; and

2) do not affect the existence of common law defenses or other defenses to liability under the rule of capture.

c) Nothing in this code shall be construed as granting the authority to deprive or divest a landowner, including a landowner's lessees, heirs, or assigns, of the groundwater ownership and rights described by this section.

d) This section does not:

1) prohibit a district from limiting or prohibiting the drilling of a well by a landowner for failure or inability to comply with minimum well spacing or tract size requirements adopted by the district;

2) affect the ability of a district to regulate groundwater production as authorized under Section 36.113, 36.116, or 36.122 or otherwise under this chapter or a special law governing a district; or

3) require that a rule adopted by a district allocate to each landowner a proportionate share of available groundwater for production from the aquifer based on the number of acres owned by the landowner.

e) This section does not affect the ability to regulate groundwater in any manner authorized under:

1) Chapter 626, Acts of the 73rd Legislature, Regular Session, 1993, for the Edwards Aquifer Authority;

2) Chapter 8801, Special District Local Laws Code, for the Harris-Galveston Subsidence District; and

3) Chapter 8834, Special District Local Laws Code, for the Fort Bend Subsidence District.

While this provision of the Texas Water Code Section 36.002 was substantively amended to its current scope with the passage of Senate Bill 660 by the Texas Legislature in 2011,[35] the spirit of this section has been at the core of groundwater laws regarding groundwater management since passage of House Bill 162 by the Texas Legislature in 1949.[36] GMA 8 District Representatives ultimately based the adopted DFCs on a balancing of private property rights, for both current and future users, as exemplified in each GCDs' management plan and rules.

3.2.8 Feasibility of achieving Desired Future Conditions

Texas Water Code Section 36.108(d)(8) requires District Representatives in a GMA to consider the feasibility of achieving the proposed desired future condition(s). This requirement was added to the joint-planning process with the passage in 2011 of Senate Bill 660 by the 82nd Texas Legislature.[37] This evaluation consideration dates back to the rules adopted by the TWDB in 2007 to provide guidance to District Representatives in GMAs as to what would be considered by the TWDB during a petition process regarding the reasonableness of an adopted DFC. In these rules (subsequently amended), the TWDB required that an adopted DFC must be physically possible from a hydrological perspective. During the first round of joint planning, the TWDB definition for DFCs was "the desired, quantified condition of groundwater resources (such as water levels, water quality, spring flows, or volumes) for a specified aquifer within a management area at a specified time or times in the future, through at least the period that includes the current planning period for the development of regional water plans pursuant to §16.053, Texas Water Code, or in perpetuity, as defined by participating groundwater conservation districts within a groundwater management area as part of the joint-planning process. Desired future conditions have to be physically possible, individually and collectively, if different desired future conditions are stated for different geographic areas overlying an aquifer or subdivision of an aquifer."[38]

In addition, in these original rules, Title 31, Texas Administrative Code Section 356.34 (1) stated the following: "Submission Package - Districts must include the following when submitting an adopted desired future condition to the board:(1) the desired future condition

[35] Act of May 29, 2011, 82nd Leg., R.S., ch. 1233, 2011 Tex. Gen. Laws 3287.
[36] Act of May 23, 1949, 51st Leg., R.S., ch. 306, 1949 Tex. Gen. Laws 559.
[37] Act of May 29, 2011, 82nd Leg., R.S., ch. 1233, 2011 Tex. Gen. Laws 3287.
[38] Previously included in Title 31, Texas Administrative Code, Section 356.2(8)

of the aquifer in the groundwater management area (multiple desired future conditions for the same aquifer in a groundwater management area need to be physically compatible)."

Upon passage of Senate Bill 660 in 2011[39], the TWDB made significant revisions to the rules contained in Title 31, Texas Administrative Code Chapter 356 to be consistent with the new statutes. During this process, reference to the need for a DFC to be physically possible or physically compatible was removed, under the rationale that the reference to consideration of feasibility of achieving a DFC included in Texas Water Code Section 36.108(d)(8) equated to a DFC being physically possible or physically compatible.

During the TWDB's review of multiple petitions regarding the reasonableness of adopted DFCs in groundwater management areas from 2010 - 2011, the evaluation of whether or not an adopted DFC was physically possible was based on whether or not the DFC(s) could reasonably be simulated using the TWDBs adopted groundwater availability model for the aquifer(s) in question. This was a valid approach because if an adopted DFC was not physically possible, then under the physical laws of hydrology, as incorporated in the mathematical calculations executed during model simulations, the model would not execute the prescribed simulation successfully.

There have been and continue to be many potential DFC scenarios considered in GMAs across Texas that are not physically possible. One example is GMA 9, where petitions filed in 2009 challenged DFCs approved for the Edwards Group of the Edwards Trinity (Plateau) Aquifer. Following a hearing, the TWDB determined the DFC for Kerr County to be unreasonable because more than 100 percent of the modeled available groundwater (MAG) would be produced through exempt-use wells making it unfeasible to achieve the adopted DFC.

During this round of joint planning in GMA 8, a number of DFC options were modeled using the TWDB's updated Northern Trinity and Woodbine GAM. One of these scenarios, Northern Trinity and Woodbine GAM Run 2, also referred to as the "Highest Practicable Run" was executed in an effort to better understand potential "bookends" of DFC options for GMA 8. However, after execution and analysis of GAM Run 2 results, it was determined that this DFC option was not physically possible, or feasible. For comparison purposes only, a TERS approach was taken to quantify potential estimates of MAG, however, it was clearly stated in GMA discussions on this point that the option was not feasible from a hydrologic perspective. For GMA 8 District Representatives, this was an important point during the consideration of DFC options in that it helped to better understand that certain management goals, while being potentially laudable, may not be feasible due to the specifics of hydrologic conditions on a local or regional basis.

The DFCs and resulting estimates of modeled available groundwater initially presented during the February 17, 2016 GMA 8 meeting, referred to as the Northern Trinity and

[39] Act of May 29, 2011, 82nd Leg., R.S., ch. 1233, 2011 Tex. Gen. Laws 3287.

Woodbine GAM Run 10, and utilized throughout the remainder of the joint-planning process in GMA 8, were successfully simulated and corresponding potential estimates of MAG were produced. Therefore, utilizing the approach taken by the TWDB during the first round of joint planning that concluded on September 1, 2010, the adopted DFCs for the Northern Trinity and Woodbine aquifers in GMA 8 are physically possible, and thus are feasible.

A common definition of feasibility is "capable of being accomplished or brought about; possible." Using this definition, it becomes important to consider the potential estimates of MAG resulting from proposed DFCs with respect to both historic use, current and projected supplies, projected water demands, and available regulatory framework necessary to achieve proposed DFCs. All of these elements were considered by GMA 8 District Representatives to confirm this finding of feasibility.

3.2.9 Other relevant information considered

Texas Water Code Section 36.108(d)(8) requires District Representatives in a GMA to consider any other information relevant to the specific desired future condition. Although there were multiple discussions regarding the complexity of the joint-planning process as amended by Senate Bill 660[40], as GMA 8 District Representatives worked through the considerations process required in Texas Water Code Section 36.108(d)(1)–(8), no additional information was identified for inclusion in this explanatory report.

4.0 OTHER DESIRED FUTURE CONDITIONS CONSIDERED

During this round of joint planning in GMA 8, the new requirement for GMAs to address other DFC options that were considered but not adopted (Texas Water Code Section 36.108(d–3)(4)) led the District Representatives to develop and adopt, by resolution, administrative procedures that clearly prescribed the process for recognizing any suggested proposals for DFCs as official "options" that would then need to be addressed in the Explanatory Report. The administrative procedures (see Appendix OO) clearly articulate the procedures for any suggested proposals for DFCs to be designated as official options eligible for consideration under the statutory criteria. Pursuant to the administrative procedures, once designated as an official DFC option, the GMA 8 District Representatives considered the nine factors set forth in Texas Water Code Section 36.108(d)(1–9) with respect to the DFC option.

Following the process prescribed in the adopted administrative procedures, GMA 8 District Representatives only designated one set of DFC options for the aquifers in the Northern Trinity, Woodbine, Edwards (BFZ), and Llano Uplift aquifer systems. After consideration of the nine factors on the approved set of DFC options, this set of DFC options was ultimately adopted as the final DFCs for the relevant aquifers in GMA 8 (see Appendix D). There were

[40] Act of May 29, 2011, 82nd Leg., R.S., ch. 1233, 2011 Tex. Gen. Laws 3287.

no other DFC options considered during this round of joint planning by GMA 8 District Representatives.

5.0 RECOMMENDATIONS BY ADVISORY COMMITTEES AND RELEVANT PUBLIC COMMENTS

The nature of the joint-planning process described in Texas Water Code Section 36.108(d) is that policy and technical decisions made by District Representatives in a GMA be made in an open and transparent process. In accordance with Texas Water Code Section 36.108(d-3) and (d-4), this section of the Explanatory Report discusses recommendations made by advisory committees and other relevant comments. In addition, relevant comments received during the public comment period by the GCDs during the joint-planning process are discussed, along with whether the comments were or were not incorporated into the DFCs ultimately adopted on January 31, 2017.

Beginning in early 2012, in response to a number of comments and concerns received regarding the adequacy and technical issues with groundwater science available at the time in GMA 8, North Texas GCD, Northern Trinity GCD, Prairielands GCD, and Upper Trinity GCD, launched an unprecedented project designed to produce a comprehensive update to the Northern Trinity and Woodbine Aquifers Groundwater Availability Model (Northern Trinity and Woodbine Aquifer GAM). Throughout project execution, all GCDs in GMA 8 were invited and encouraged to participate in the Northern Trinity and Woodbine Aquifer GAM update in one or more of three principle ways; (1) with financial support, (2) by making available any relevant hydrologic, geologic, and water use information collected by the GCDs, and (3) by participation in an official stakeholder advisory group referred to as the Northern Trinity and Woodbine Aquifer GAM Technical Advisory Committee (TAC). In addition, the TWDB and the U.S. Geological Survey were also designated participants in the TAC. Most GCDs in GMA 8 provided technical information for use in the Northern Trinity and Woodbine Aquifer GAM update. All GCDs in GMA 8 were represented on this TAC, which held routine project update meetings, and reviewed and provided comments on draft reports. This project was approved by the Executive Administrator of the TWDB on November 21, 2014 (see Appendix C). The Final Northern Trinity and Woodbine Aquifer GAM Report by Kelley and others (2015)[41], is included in its entirety in Appendixes I, J, and K.

The Northern Trinity and Woodbine Aquifer GAM update was executed by a technical team led by INTERA, Inc., and supported by the Bureau of Economic Geology at the University of Texas at Austin and LBG-Guyton Associates. Numerous comments were received from the TAC on the different components of the Northern Trinity and Woodbine Aquifer GAM Model

[41] Kelley, -V.A., Ewing, J., Jones, T. L., Young, S. C., Deeds, N., and Hamlin, S., 2014, Updated groundwater availability model of the Northern Trinity and Woodbine Aquifers: - Final Report: Prepared for the North Texas Groundwater Conservation District, Northern Trinity Groundwater Conservation District, Prairielands Groundwater Conservation District, and Upper Trinity Groundwater Conservation District by INTERA, Inc., The Bureau of Economic Geology, and LBG-Guyton Associates, Volumes I, II, and III, variously paginated.

Report. All comments and responses to comments are included as appendices in the Northern Trinity and Woodbine Aquifer GAM Final Model Report which are included in this Explanatory Report as Appendix K.

Upon completion in 2014 and formal acceptance and adoption by the TWDB, the Northern Trinity and Woodbine Aquifer GAM update became the official groundwater availability model for the Northern Trinity and Woodbine aquifers in GMA 8. North Texas GCD, Northern Trinity GCD, Prairielands GCD, and Upper Trinity GCD invested over three years and almost $2 million dollars of local funds in order to ensure that the GCDS in GMA 8 have the best groundwater science that can be developed in order to ensure that future joint-planning decisions made during the adoption of statements of DFCs will be based on sound science.

In response to comments received prior to and throughout execution of this project, the Northern Trinity and Woodbine Aquifer GAM update was developed as follows:

- The calibration period has been extended to pre-1900 and from 1999 through 2012.
- The Northern Trinity and Woodbine Aquifer GAM has been successfully calibrated to both steady-state and transient conditions (1890-2012) consistent with GAM standards from predevelopment to 2012. As part of this effort, 706 transient hydrographs and more than 27,000 individual water level measurements were used for transient calibration targets.
- Efforts in developing the Conceptual Model included development of the first comprehensive hydrostratigraphic framework for the Northern Trinity and Woodbine aquifers from the Colorado River through the Antlers in Oklahoma.
- To construct the hydrostratigraphic framework, 1,498 geophysical logs were assembled and analyzed.
- The Northern Trinity and Woodbine Aquifer GAM is a significant step forward in our understanding of the Northern Trinity and Woodbine aquifers.
- The Northern Trinity and Woodbine Aquifer GAM successfully reproduces the important aquifer dynamics that govern sustainability and a policy definition of availability.
- As a result of the unprecedented level of effort devoted to data collection, analysis, and archiving, the geodatabase constructed to support the Northern Trinity and Woodbine Aquifer GAM will serve as a good foundation for planning and future improvements.
- The Northern Trinity and Woodbine Aquifer GAM was developed in a public process in multiple forums.
- The Northern Trinity and Woodbine Aquifer GAM offers advantages that include a refined grid that provides better placement of wells, rivers, and other hydraulic boundaries.

- The Northern Trinity and Woodbine Aquifer GAM calibration period now extends through the major water level decline period, which helps constrain aquifer storativity.
- The Northern Trinity and Woodbine Aquifer GAM calibration is improved from the previous model.
- The Northern Trinity and Woodbine Aquifer GAM incorporated GCD pumping data including metered data and wells.

The Northern Trinity and Woodbine Aquifer GAM TAC were appointed to this advisory committee at the beginning of the project to assist in the development of scientific tools to be utilized in the development and evaluation of potential DFCs pursuant to Texas Water Code Section 36.1081. With the exception of this advisory committee, GMA 8 received little to no public participation or comments throughout the majority of the joint-planning process. Only within the 90-day public comment period did GCDs in GMA 8 receive any substantive comments from the public.

The GCDs in GMA 8 each prepared a Summary Report inclusive of all relevant comments received during the 90-day public comment period regarding the proposed DFCs, any suggested revisions to the proposed DFCS, and the basis for the revisions. The GCDs' Summary Reports were submitted to GMA 8 for further review by the District Representatives at a joint-planning meeting held September 29, 2016. The 11 Summary Reports are presented in their entirety in Appendix PP.

The only substantive comment received requesting a modification to the proposed DFCs was received from the Upper Trinity GCD. This request was to discretize DFCs for relevant aquifers within the Upper Trinity GCD on the basis of "outcrop DFCs" and "Subcrop DFCs" within the boundaries of the District. GMA 8 District Representatives, after discussion, voted unanimously to make the requested modification to the proposed DFCs.

6.0 AQUIFERS CLASSIFIED AS NON-RELEVANT FOR THE PURPOSES OF JOINT PLANNING

TWDB allows for classification of aquifers, including major or minor aquifers as designated by TWDB, as non-relevant for the purposes of joint planning.

> The districts in a groundwater management area may, as part of the process for adopting and submitting desired future conditions, propose classification of a portion or portions of a relevant aquifer as non-relevant if the districts determine that aquifer characteristics, groundwater demands, and current groundwater uses do not warrant adoption of a desired future condition. In such a case no desired future condition is required. The districts must submit

the following documentation to the agency related to the portion of the relevant aquifer proposed to be classified as non-relevant.[42]

District Representatives in GMA 8 have adopted DFCs for the Trinity, Woodbine, Edwards (BFZ), Marble Falls, Hickory and Ellenburger – San Saba aquifers. The Nacatoch, Blossom and Brazos River Alluvium aquifers were classified as non-relevant for the purposes of joint planning, and therefore DFCs were not adopted for these aquifers.

In a guidance document titled "How Will the Texas Water Development Board Support Development of Desired Future Conditions Statements and Review Desired Future Conditions Submittals?" TWDB indicates that districts must submit three items to classify aquifers as non-relevant. Each of these are discussed below for the Nacatoch, Blossom and Brazos River Alluvium aquifers.

6.1.1 Location of the aquifers

The Nacatoch, Blossom, and Brazos River Alluvium aquifers in GMA 8 are shown in Figure 6 and in more detail in Figure 18, Figure 19, and Figure 20. The Nacatoch and Blossom aquifers are in northeastern GMA 8. The portion of the Brazos River Alluvium Aquifer in GMA 8 is limited to a narrow strip along the Brazos River in McLennan and Falls counties. The full extent of these aquifers within GMA 8 are designated as non-relevant for joint planning purposes.

[42] Title 31, Texas Administrative Code Section 356.31(b).

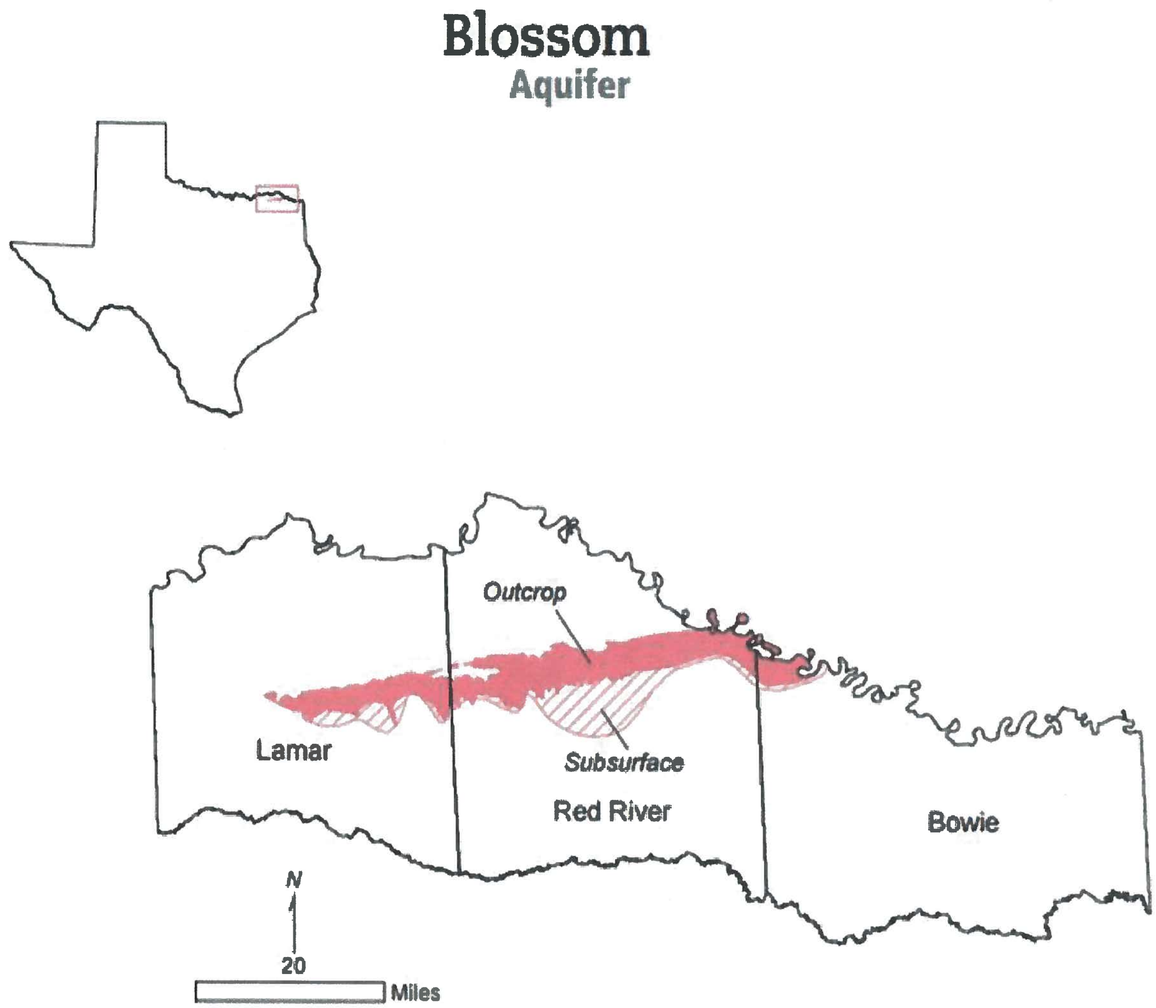

Figure 18. Location of the Blossom Aquifer in GMA 8. Reproduced from George and others (2011[43]).

[43] George, P. G., Mace, R. E., and Petrossian, R., 2011, Aquifers of Texas: Texas Water Development Board, Report 380, 172 p.

Figure 19 Location of the Brazos River Aquifer in Texas. Southern boundary for Brazos River Alluvium Aquifer in GMA 8 is county boundary between Milam and Robertson counties. Reproduced from George and others (2011).[44]

[44] *Id.*

Figure 20. Location of the Nacatoch Aquifer in GMA 8. Reproduced from George and others (2011).[45]

6.1.2 Aquifer characteristics

The aquifer characteristics, groundwater demands, current groundwater uses and total estimated recoverable storage are presented above in Sections 3.2.1 and 3.2.3. Notably, the water use from the aquifer is relatively small. Table 25 shows the TWDB Water Use Survey Groundwater Pumpage Estimates for each of these aquifers between 2007 and 2011.

45 *Id.*

Table 25. TWDB Groundwater Pumpage Estimates for Non-Relevant Aquifers

Aquifer	2007	2008	2009	2010	2011	Average
Blossom	5,409	10,666	9,128	8,421	3,522	7,429
Brazos River Alluvium	2,536	7,308	9,539	8,304	7,555	7,048
Nacatoch	2,664	2,901	2,509	4,801	3,656	3,306

Regarding any potential impact these aquifers could have on the DFCs adopted for other aquifers in GMA 8, as shown in Figure 5 and Figure 6, the Blossom and Nacatoch aquifers are outside of the extent of the other aquifers in GMA 8 which have DFCs. This includes the far down-dip areas of the Trinity and Woodbine aquifers. The Brazos River Alluvium Aquifer is present over the confined portion of the Trinity Aquifer in McLennan and Falls counties, but is separated from the Trinity Aquifer by the Washita/Fredericksburg group. For these reasons, designating these aquifers as non-relevant for the purposes of joint planning will not have any significant impact on desired future conditions for other aquifers in GMA 8.

6.1.3 Explanation of why aquifers are non-relevant for joint planning

As shown in Figure 2 and Figure 6, the Nacatoch and Blossom aquifers in far eastern GMA 8 exist entirely outside the boundaries of any groundwater conservation district. That is, there is no administrative entity to manage and monitor progress toward any desired future condition set for these aquifers. For the Nacatoch, Blossom, and Brazos River Alluvium aquifers, the water use is limited (Table 25) compared to other aquifers such as the Trinity, Woodbine and Edwards (Balcones Fault Zone). As shown in Table 17, Table 18, and Table 19, the total estimated recoverable storage for these aquifers is also relatively small. After considering these facts and determining that a non-relevant designation for these aquifers will not affect the desired future conditions for other aquifers in the GMA, the districts in GMA 8 have determined that these aquifers are non-relevant for joint planning.