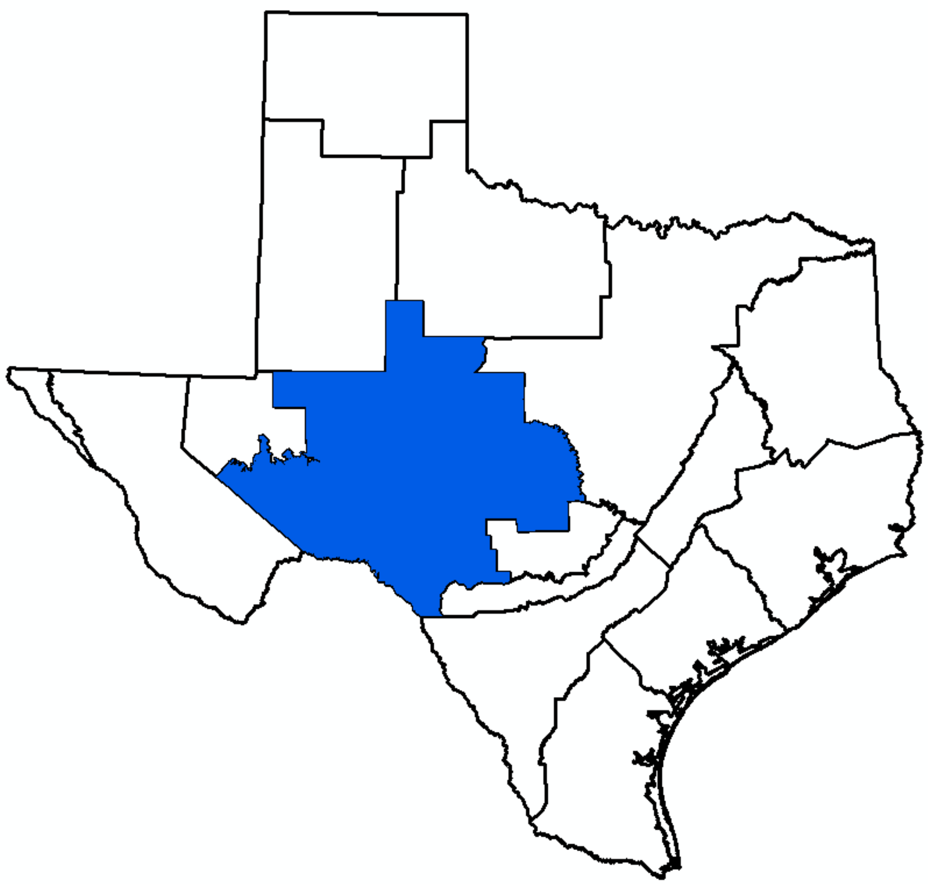
GMA 7 Explanatory Report - Final

Aquifers of the Llano Uplift Region (Ellenburger-San Saba, Hickory, Marble Falls)



Prepared for:

Groundwater Management Area 7

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1.0 Groundwater Management Area 7

Groundwater Management Area 7 is one of sixteen groundwater management areas in Texas and covers that portion of west Texas that is underlain by the Edwards-Trinity (Plateau) Aquifer (Figure 1).

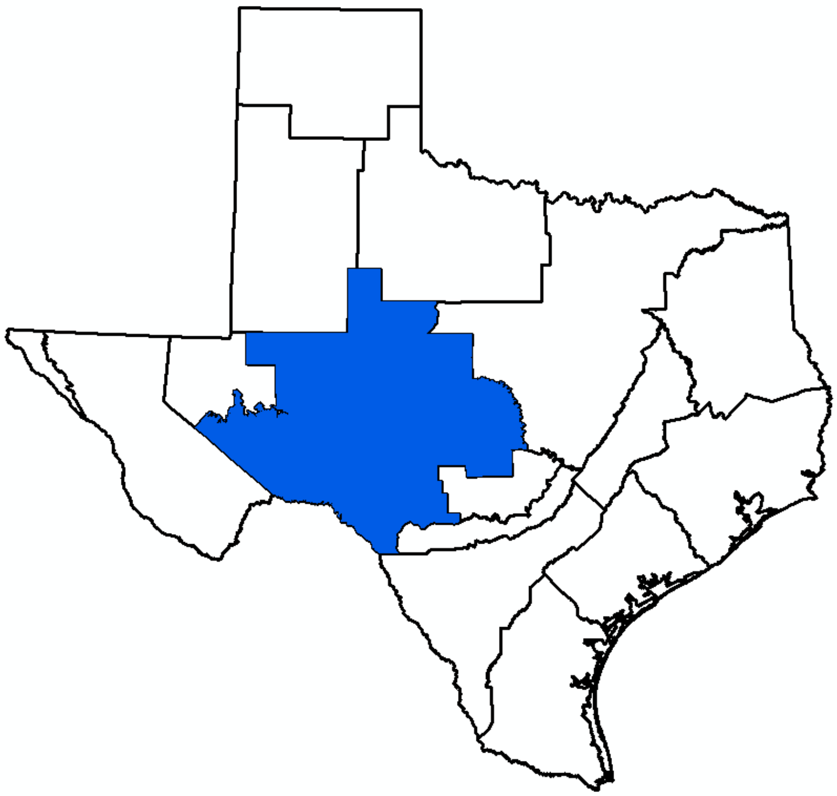

Figure 1. Groundwater Management Area 7

Groundwater Management Area 7 covers all or part of the following counties: Coke, Coleman, Concho, Crockett, Ector, Edwards, Gillespie, Glasscock, Irion, Kimble, Kinney, Llano, Mason, McCulloch, Menard, Midland, Mitchell, Nolan, Pecos, Reagan, Real, Runnels, San Saba, Schleicher, Scurry, Sterling, Sutton, Taylor, Terrell, Tom Green, Upton, and Uvalde (Figure 2).

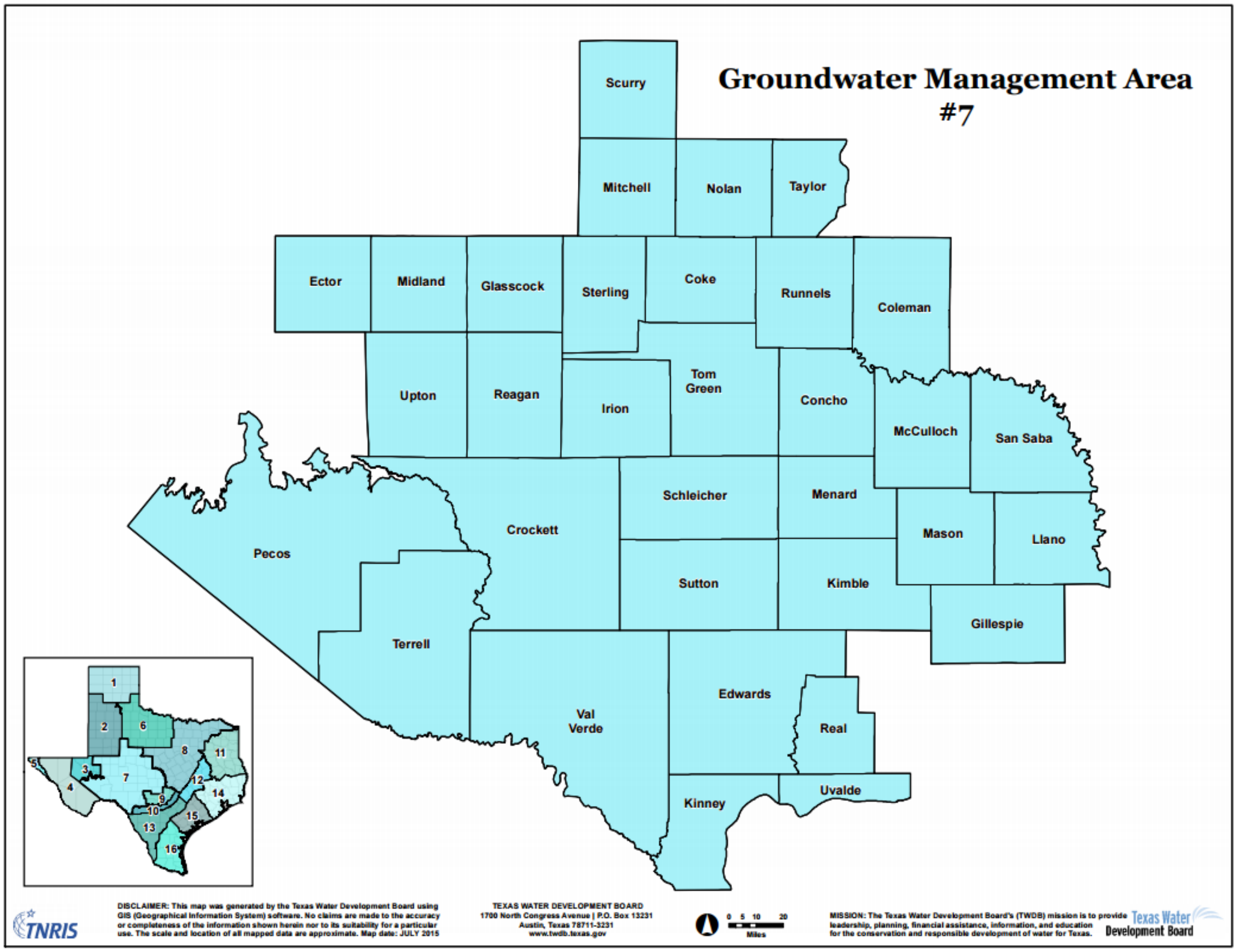

Figure 2. GMA 7 Counties (from TWDB)

There are 20 groundwater conservation districts in Groundwater Management Area 7: Coke County Underground Water Conservation District, Crockett County Groundwater Conservation District, Glasscock Groundwater Conservation District, Hickory Underground Water Conservation District No. 1, Hill County Underground Water Conservation District, Irion County Water Conservation District, Kimble County Groundwater Conservation District, Kinney County Groundwater Conservation District, Lipan-Kickapoo Water Conservation District, Lone Wolf Groundwater Conservation District, Menard County Underground Water District, Middle Pecos Groundwater Conservation District, Plateau Underground Water Conservation and Supply District, Real-Edwards Conservation and Reclamation District Santa Rita Underground Water Conservation District, Sterling County Underground Water Conservation District, Sutton County Underground Water Conservation District, Terrell County Groundwater Conservation District, Uvalde County Underground Water Conservation District, and Wes-Tex Groundwater Conservation District (Figure 3).

The Edwards Aquifer Authority is also partially inside of the boundaries of GMA 7, but are exempt from participation in the joint planning process.

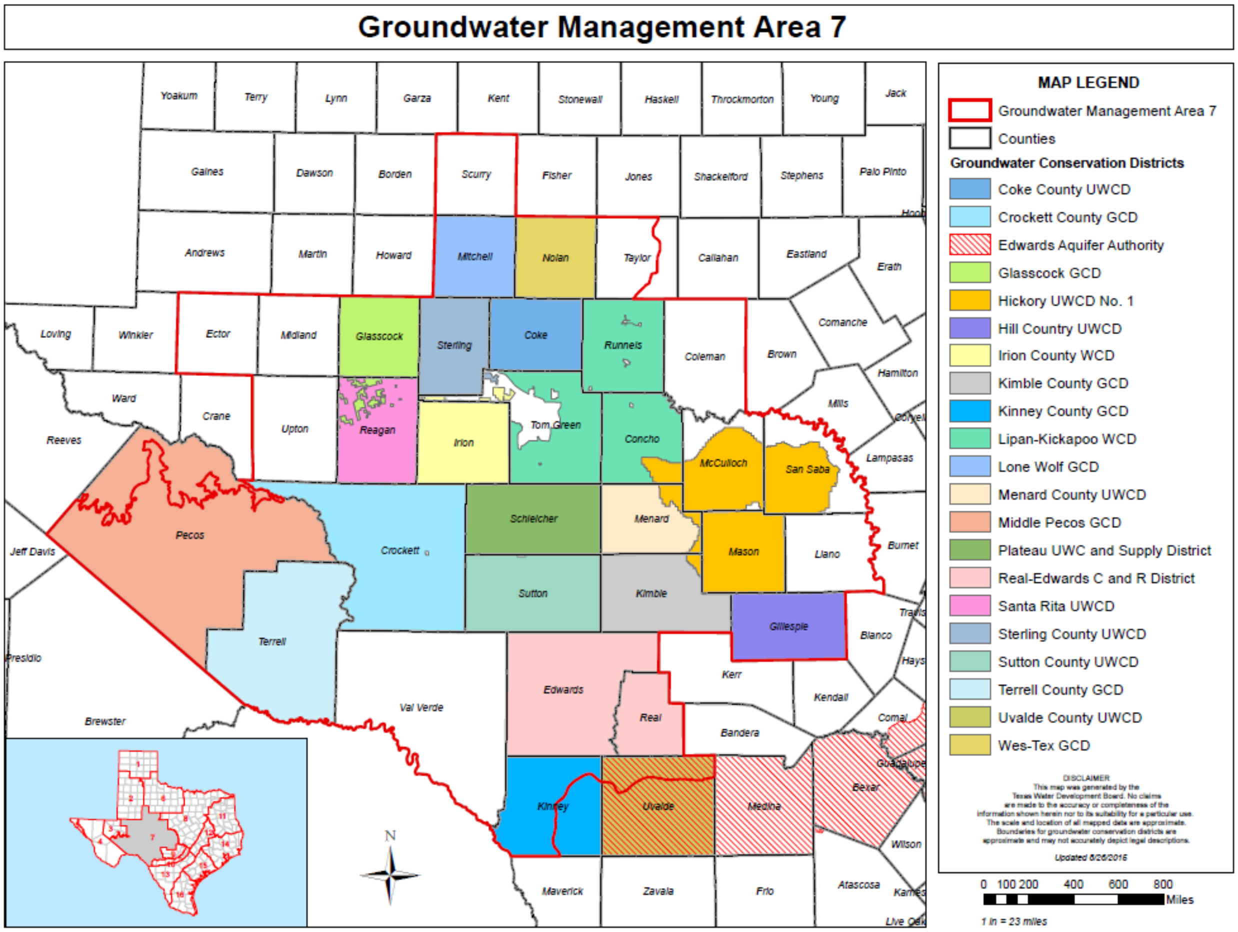

Figure 3. Groundwater Conservation Districts in GMA 7 (from TWDB)

The explanatory report covers the aquifers of the Llano Uplift (Ellenburger-San Saba, Hickory, and Marble Falls). As described in George and others (2011):

> **The Ellenburger–San Saba Aquifer** *is a minor aquifer that is found in parts of 15 counties in the Llano Uplift area of Central Texas. The aquifer consists of the Tanyard, Gorman, and Honeycut formations of the Ellenburger Group and the San Saba Limestone Member of the Wilberns Formation. The aquifer consists of a sequence of limestone and dolomite that crop out in a circular pattern around the Llano Uplift and dip radially into the subsurface away from the center of the uplift to depths of approximately 3,000 feet. Regional block faulting has significantly compartmentalized the aquifer. The maximum thickness of the aquifer is about 2,700 feet. Water is held in fractures, cavities, and solution channels and is commonly under confined conditions. The aquifer is highly permeable in places, as indicated by wells that yield as much as 1,000 gallons per minute and springs that issue from the aquifer, maintaining the base flow of streams in the area. Water produced from the aquifer is inherently hard and usually has less than 1,000 milligrams per liter of total dissolved solids. Fresh to slightly saline water extends downdip to depths of approximately 3,000 feet. Elevated concentrations of radium and radon also occur in the aquifer. Most of the groundwater is used for municipal purposes, and the remainder*

for irrigation and livestock. A large portion of water flowing from San Saba Springs, which is the water supply for the city of San Saba, is thought to be from the Ellenburger–San Saba and Marble Falls aquifers. The regional water planning groups, in their 2006 Regional Water Plans, recommended several water management strategies that use the Ellenburger–San Saba Aquifer, including the development of a new well field in Llano County to supply the city of Llano, additional pumping from existing wells, temporary overdrafts, and the reallocation of supplies from users with surpluses to users with needs.

The Hickory Aquifer, *a minor aquifer found in the central part of the state, consists of the water-bearing parts of the Hickory Sandstone Member of the Riley Formation. The Hickory Aquifer reaches a maximum thickness of 480 feet, and freshwater saturated thickness averages about 350 feet. Although the groundwater is generally fresh, with total dissolved solids concentrations of less than 1,000 milligrams per liter, the upper portion of the aquifer typically contains iron in excess of the state's secondary drinking water standards. Of greater concern is naturally occurring radioactivity: gross alpha radiation, radium, and radon are commonly found in excess of the state's primary drinking water standards. The groundwater is used for irrigation throughout its extent and for municipal supply in the cities of Brady, Mason, and Fredericksburg. Slight water level fluctuations occur seasonally in irrigated areas. The regional water planning groups, in their 2006 Regional Water Plans, recommended several water management strategies that use the Hickory Aquifer, including constructing new wells, pumping additional water from existing wells, and maintaining existing supplies through supplemental or replacement wells. In addition, the Region F Regional Water Planning Group recommended treating water from the aquifer and distributing it as drinking water through a bottled water program in Concho and McCulloch counties.*

The Marble Falls Aquifer*, a minor aquifer, occurs in several separated outcrops along the northern and eastern flanks of the Llano Uplift region of Central Texas. The subsurface extent of the aquifer is unknown. Groundwater occurs in fractures, solution cavities, and channels in the limestone of the Marble Falls Formation of the Bend Group. The aquifer is highly permeable in places, as indicated by wells that yield as much as 2,000 gallons per minute. Maximum thickness of the formation is 600 feet. Where underlying beds are thin or absent, the Marble Falls Aquifer may be hydraulically connected to the Ellenburger–San Saba Aquifer. Numerous large springs issue from the aquifer and provide a significant part of the base flow to the San Saba River in McCulloch and San Saba counties and to the Colorado River in San Saba and Lampasas counties. Because the limestone beds composing this aquifer are relatively shallow, the aquifer is susceptible to pollution by surface uses and activities. For example, some wells in Blanco County have produced water with high nitrate concentrations. In the subsurface, groundwater becomes highly mineralized; however, the water produced from this aquifer is suitable for most purposes and generally contains less than 1,000 milligrams per liter of total dissolved solids. Water from the aquifer is used for municipal, agricultural, and industrial uses, and no significant water level declines have occurred in wells measured by the TWDB. The regional water planning groups, in their 2006 Regional Water Plans, recommended drilling new wells in Burnet County as a water management strategy using the Marble Falls Aquifer.*

2.0 Desired Future Condition History

2.1 2010 Desired Future Conditions

GMA 7 adopted a desired future condition for the Ellenburger-San Saba Aquifer on July 29, 2010 as follows:

> *".. through the year 2060:*
>
> 1) *Total net decline in water levels within Hickory UWCD No. 1, Hill Country UWCD, Kimble County GCD, and Menard County UWD at the end of the fifty-year period shall not exceed 5 feet below 2010 water levels in the aquifer;*
> 2) *The Ellenburger-San Saba Aquifer is not relevant for joint planning purposes in all other areas of GMA 7.*

The desired future condition was developed after considering a water budget analysis was that was completed by the Texas Water Development Board (Thorkildsen and Backhouse, 2010a). A groundwater model of the aquifer was not available at the time of the initial desired future condition.

GMA 7 adopted a desired future condition for the Hickory Aquifer on July 29, 2010 as follows:

> *".. through the year 2060:*
>
> 1) *Total net decline in water levels within Hickory UWCD No. 1, Hill Country UWCD, Kimble County GCD, and Menard County UWD, Llano County and the unprotected areas in McCulloch and San Saba counties at the end of the fifty-year period shall not exceed seven (7) feet below 2010 water levels in the aquifer;*
> 2) *The Hickory Aquifer is not relevant for joint planning purposes in all other areas of GMA 7.*

The desired future condition was developed after considering a water budget analysis was that was completed by the Texas Water Development Board (Thorkildsen and Backhouse, 2010b). A groundwater model of the aquifer was not available at the time of the initial desired future condition.

GMA 7 adopted a desired future condition for the Marble Falls Aquifer on July 29, 2010 as follows:

> *".. through the year 2060:*
>
> 3) *Total net decline in water levels in San Saba County at the end of the fifty-year period shall not exceed seven (7) feet below 2010 water levels in the aquifer;*
> 4) *The Marble Falls Aquifer is not relevant for joint planning purposes in all other areas of GMA 7.*

The desired future condition was developed after considering a water budget analysis was that was completed by the Texas Water Development Board (subsequently documented in Wuerch and Backhouse, 2011). A groundwater model of the aquifer was not available at the time of the initial desired future condition.

2.2 2016 Desired Future Conditions

In 2016, the Texas Water Development Board released the groundwater availability model (GAM) for the aquifers of the Llano Uplift region. This model was used as a tool to set the desired future conditions. Documentation of the GAM runs is presented in Technical Memorandum 16-02.

On April 21, 2016, the groundwater conservation districts in Groundwater Management Area 7 voted on proposed desired future conditions for the aquifers of the Llano Uplift region that were based on Scenario 3 in Technical Memorandum 16-02. At a meeting on September 22, 2016, the groundwater conservation districts in Groundwater Management Area 7 voted final approval of these desired future conditions for the aquifers in the Llano Uplift region as follows:

Ellenberger-San Saba Aquifer:

a) Total net drawdowns of aquifer levels shall not exceed drawdowns in 2070, as compared with 2011 aquifer levels, respectively as follows:

County	GCD	Drawdown (feet)
Gillespie	Hill Country UWCD	8
Mason	Hickory UWCD	14
McCulloch	Hickory UWCD	29
Menard	Menard UWD & Hickory UWCD	46
Kimble	Kimble County GCD & Hickory UWCD	18
San Saba	Hickory UWCD	5

(Reference: Scenario 3, GMA 7 Technical Memo 16-02)

b) The Ellenburger-San Saba Aquifer is not relevant for joint planning purposes in all other areas in GMA 7.

Hickory Aquifer:

a) Total net drawdown of aquifer levels shall not exceed drawdowns in 2070, as compared with 2011 aquifer levels, respectively as follows:

County	GCD	Drawdown (feet)
Concho	Hickory UWCD	53
Gillespie	Hill Country UWCD	9
Kimble	Kimble County GCD Hickory UWCD	18
Llano	-	13
Mason	Hickory UWCD	17
McCulloch	Hickory UWCD	29
Menard	Menard UWD and Hickory UWCD	46
San Saba	Hickory UWCD	6

(Reference: Scenario 3 GMA 7 Technical Memo 16-02, 4-14-2016)

b) The Hickory Aquifer is not relevant for joint planning purposes in all areas of GMA 7 outside the boundaries of the Hickory UWCD No.1, Hill Country UWCD, Kimble County GCD, Menard UWD and Llano County.

Marble Falls Aquifer:

After reviewing the results of the model simulations in Technical Memo 16-02, the groundwater conservation districts in Groundwater Management Area 7 classified the Marble Falls Aquifer as not relevant for purposes of joint planning.

2.3 Third Round Desired Future Conditions

After review and discussion, the groundwater conservation districts in Groundwater Management Area 7 found that the desired future conditions approved in 2016 would remain unchanged.

The resolution that documents the adoption of the desired future condition for the Capitan Reef Complex Aquifer is presented in Appendix A and was adopted on August 19, 2021 by a 14-0 vote at a properly noticed meeting of Groundwater Management Area 7.

3.0 Policy Justification

As developed more fully in this report, the proposed desired future condition was adopted after considering:

- Aquifer uses and conditions within Groundwater Management Area 7
- Water supply needs and water management strategies included in the 2012 State Water Plan
- Hydrologic conditions within Groundwater Management Area 7 including total estimated recoverable storage, average annual recharge, inflows, and discharge
- Other environmental impacts, including spring flow and other interactions between groundwater and surface water
- The impact on subsidence
- Socioeconomic impacts reasonably expected to occur
- The impact on the interests and rights in private property, including ownership and the rights of landowners and their lessees and assigns in Groundwater Management Area 7 in groundwater as recognized under Texas Water Code Section 36.002
- The feasibility of achieving the desired future condition
- Other information

In addition, the proposed desired future condition provides a balance between the highest practicable level of groundwater production and the conservation, preservation, protection, recharging, and prevention of waste of groundwater in Groundwater Management Area 7.

There is no set formula or equation for calculating groundwater availability. This is because an estimate of groundwater availability requires the blending of policy and science. Given that the tools for scientific analysis (groundwater models) contain limitations and uncertainty, policy provides the guidance and defines the bounds that science can use to calculate groundwater availability.

As developed more fully below, many of these factors could only be considered on a qualitative level since the available tools to evaluate these impacts have limitations and uncertainty.

4.0 Technical Justification

The process of using the groundwater model in developing desired future conditions revolves around the concept of incorporating many of the elements of the nine factors (e.g. current uses and water management strategies in the regional plan). For the Llano Uplift region and its associated aquifers (Ellenburger-San Saba, Hickory, and Marble Falls), five scenarios were completed, and the results discussed prior to adopting a desired future condition.

Some critics of the process asserted that the districts were "reverse-engineering" the desired future conditions by specifying pumping (e.g., the modeled available groundwater) and then adopting the resulting drawdown as the desired future condition. However, it must be remembered that among the input parameters for a predictive groundwater model run is pumping, and among the outputs of a predictive groundwater model run is drawdown. Thus, an iterative approach of running several predictive scenarios with models and then evaluating the results is a necessary (and time-consuming) step in the process of developing desired future conditions.

One part of the reverse-engineering critique of the process has been that "science" should be used in the development of desired future conditions. The critique plays on the unfortunate name of the groundwater models in Texas (Groundwater Availability Models) which could suggest that the models yield an availability number. This is simply a mischaracterization of how the models work (i.e. what is a model input and what is a model output).

The critique also relies on a fairly narrow definition of the term *science* and fails to recognize that the adoption of a desired future condition is primarily a policy decision. The call to use science in the development of desired future conditions seems to equate the term *science* with the terms *facts* and *truth*. Although the Latin origin of the word means knowledge, the term *science* also refers to the application of the scientific method. The scientific method is discussed in many textbooks and can be viewed as a means to quantify cause-and-effect relationships and to make useful predictions.

In the case of groundwater management, the scientific method can be used to understand the relationship between groundwater pumping and drawdown, or groundwater pumping and spring flow. A groundwater model is a tool that can be used to run "experiments" to better understand the cause-and-effect relationships within a groundwater system as they relate to groundwater management.

Much of the consideration of the nine statutory factors involves understanding the effects or the impacts of a desired future condition (e.g. groundwater-surface water interaction and property rights). The use of the models in this manner in evaluating the impacts of alternative futures is an effective means of developing information for the groundwater conservation districts as they develop desired future conditions.

5.0 Factor Consideration

Senate Bill 660, adopted by the legislature in 2011, changed the process by which groundwater conservation districts within a groundwater management area develop and adopt desired future conditions. The new process includes nine steps as presented below:

- The groundwater conservation districts within a groundwater management area consider nine factors outlined in the statute.
- The groundwater conservation districts adopt a "proposed" desired future condition
- The "proposed" desired future condition is sent to each groundwater conservation district for a 90-day comment period, which includes a public hearing by each district
- After the comment period, each district compiles a summary report that summarizes the relevant comments and includes suggested revisions. This summary report is then submitted to the groundwater management area.
- The groundwater management area then meets to vote on a desired future condition.
- The groundwater management area prepares an "explanatory report".
- The desired future condition resolution and the explanatory report are then submitted to the Texas Water Development Board and the groundwater conservation districts within the groundwater management area.
- Districts then adopt desired future conditions that apply to that district.

The nine factors that must be considered before adopting a proposed desired future condition are:

1. Aquifer uses or conditions within the management area, including conditions that differ substantially from one geographic area to another.
2. The water supply needs and water management strategies included in the state water plan.
3. Hydrological conditions, including for each aquifer in the management area the total estimated recoverable storage as provided by the executive administrator (of the Texas Water Development Board), and the average annual recharge, inflows and discharge.
4. Other environmental impacts, including impacts on spring flow and other interactions between groundwater and surface water.
5. The impact on subsidence.
6. Socioeconomic impacts reasonably expected to occur.
7. The impact 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 Section 36.002 (of the Texas Water Code).
8. The feasibility of achieving the desired future condition.
9. Any other information relevant to the specific desired future condition.

In addition to these nine factors, statute requires that the desired future condition provide a balance between the highest practicable level of groundwater production and the conservation, preservation, protection, recharging, and prevention of waste of groundwater and control of subsidence in the management area.

5.1 Groundwater Demands and Uses

County-level groundwater demands and uses from 2000 to 2012 for the aquifers in the Llano Uplift region are presented in Appendix B. Data were obtained from the Texas Water Development Board historic pumping database:

http://www.twdb.state.tx.us/waterplanning/waterusesurvey/historical-pumpage.asp

These data, and a comparison to current modeled available groundwater numbers were discussed at the GMA 7 meeting of December 18, 2014 in San Angelo, Texas, and reviewed again at the GMA 7 meeting of January 19, 2020.

5.2 Groundwater Supply Needs and Strategies

The 2016 Region F Plan lists county-by-county shortages and strategies. Shortages are identified when current supplies (e.g. existing wells) cannot meet future demands. Strategies are then recommended (e.g. new wells) to meet the future demands. Of note is the strategy associated with the new Hickory Aquifer wells for the City of San Angelo. As documented in Technical Memorandum 16-02, pumping from these wells was specifically included in the simulations.

5.3 Hydrologic Conditions, including Total Estimated Recoverable Storage

The groundwater budget for the Ellenburger-San Saba Aquifer for the calibration period of the model (1981 to 2010) is presented alongside the groundwater budget for Scenario 3 from 2011 to 2070 in Table 1.

The groundwater budget for the Hickory Aquifer for the calibration period of the model (1981 to 2010) is presented alongside the groundwater budget for Scenario 3 from 2011 to 2070 in Table 2.

The total estimated recoverable storage estimates from the TWDB (Jones and others, 2013) are summarized as follows:

- Table 3: Ellenburger-San Saba Aquifer
- Table 4: Hickory Aquifer
- Table 5: Marble Falls Aquifer

Table 1. Groundwater Budget for Ellenburger-San Saba Aquifer

	1980-2010	2011-2070	Difference
Inflow			
Recharge from Rainfall	80,410	81,865	1,455
Inflow from Overlying Formations	40,448	43,944	3,496
Total Inflow	120,858	125,810	4,951
Outflow			
Pumping	16,008	19,021	3,013
Spring Discharge	11	9	-2
Discharge to Surface Water	35,714	24,803	-10,911
Outflow to Underlying Formations	57,987	68,828	10,842
Outflow to GMA 8	9,269	9,791	522
Outflow to GMA 9	3,879	3,552	-327
	122,867	126,004	3,137
Inflow-Outflow	-2,008	-194	1,814
Model Estimated Storage Change	-2,008	-183	1,825
Model Error	0	-11	-11

Table 2. Groundwater Budget of Hickory Uplift Aquifers in GMA 7
All Values in AF/yr except as noted

	1981 to 2010	2010 to 2070	Difference
Inflow			
Recharge from Rainfall	15,397	14,415	-982
Inflow from Overlying Formations	55,683	65,905	10,222
Total	71,081	80,321	9,240
Outflow			
Pumping	29,222	37,783	8,561
Springs and Discharge to Surface Water	20,802	20,118	-684
Outflow to Underlying Formations	13,083	13,337	254
Outflow to GMA 8	1,737	1,727	-10
Outflow to GMA 9	7,170	6,748	-422
Total	72,015	79,714	7,698
Inflow - Outflow	-935	607	1,542
Model Estimate of Storage Change	-935	607	1,542
Model Error	0	0	0

Table 3. Total Estimated Recoverable Storage – Ellenburger-San Saba Aquifer

County	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Coleman	1,400,000	350,000	1,050,000
Concho	62,000	15,500	46,500
Gillespie	6,500,000	1,625,000	4,875,000
Kimble	6,000,000	1,500,000	4,500,000
Llano	350,000	87,500	262,500
Mason	1,900,000	475,000	1,425,000
McCulloch	16,000,000	4,000,000	12,000,000
Menard	1,600,000	400,000	1,200,000
San Saba	20,000,000	5,000,000	15,000,000
Total	53,812,000	13,453,000	40,359,000

Table 4. Total Estimated Recoverable Storage – Hickory Aquifer

County	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Coleman	1,500,000	375,000	1,125,000
Concho	2,800,000	700,000	2,100,000
Gillespie	7,200,000	1,800,000	5,400,000
Kimble	5,900,000	1,475,000	4,425,000
Llano	1,000,000	250,000	750,000
Mason	5,400,000	1,350,000	4,050,000
McCulloch	8,500,000	2,125,000	6,375,000
Menard	4,500,000	1,125,000	3,375,000
San Saba	7,500,000	1,875,000	5,625,000
Total	44,300,000	11,075,000	33,225,000

Table 5. Total Estimated Recoverable Storage – Marble Falls Aquifer

County	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Kimble	2,400	600	1,800
Llano	2,100	525	1,575
Mason	5,300	1,325	3,975
McCulloch	33,000	8,250	24,750
San Saba	144,000	36,000	108,000
Total	186,800	46,693	140,078

5.4 Other Environmental Impacts, including Impacts on Spring Flow and Surface Water

Tables 1, 2, 3 above includes groundwater budget estimates of spring flow and surface water impacts for each aquifer.

5.5 Subsidence

Subsidence is not an issue in any of the aquifers of the Llano Uplift region in GMA 7. Applying the maximum drawdown to the recently released subsidence tool on the Texas Water Development board website, the Total Weighted Risk for the Ellenburger-San Saba Aquifer is 2.66 and is 3.44 for the Hickory Aquifer. As noted in the tool, a risk score of 0 is low risk and a risk score of 10 is high risk. Predicted subsidence using the tool is 0.02 feet for the Hickory Aquifer and 0.00 feet for the Ellenburger-San Saba Aquifer from 2010 to 2070.

5.6 Socioeconomic Impacts

The Texas Water Development Board prepared reports on the socioeconomic impacts of not meeting water needs for each of the Regional Planning Groups during development of the 2021 Regional Water Plans. Because the development of this desired future condition used the State Water Plan demands and water management strategies as an important foundation, it is reasonable to conclude that the socioeconomic impacts associated with this proposed desired future condition can be evaluated in the context of not meeting the listed water management strategies. Groundwater Management Area 3 is covered by Regional Planning Group F. The socioeconomic impact report for Regions F is included in Appendix C.

5.7 Impact on Private Property Rights

The impact on the interests and rights in private property, including ownership and the rights of landowners and their lessees and assigns in Groundwater Management Area 3 in groundwater is recognized under Texas Water Code Section 36.002.

The desired future conditions adopted by GMA 7 are consistent with protecting property rights of landowners who are currently pumping groundwater and landowners who have chosen to conserve groundwater by not pumping. All current and projected uses (as defined in the 2015 Region F plan) can be met based on the simulations. In addition, the pumping associated with achieving the desired future condition (the modeled available groundwater) will cause impacts to exiting well owners and to surface water. However, as required by Chapter 36 of the Water Code, GMA 7 considered these impacts and balanced them with the increasing demand of water in the GMA 7 area, and concluded that, on balance and with appropriate monitoring and project specific review during the permitting process, the desired future condition is consistent with protection of private property rights.

5.8 Feasibility of Achieving the Desired Future Condition

Groundwater levels are routinely monitored by the districts and by the TWDB in GMA 7. Evaluating the monitoring data is a routine task for the districts, and the comparison of these data with the model results that were used to develop the DFCs is covered in each district's management plan. These comparisons will be useful to guide the update of the DFCs that are required every five years.

5.9 Other Information

GMA 7 did not consider any other information in developing these DFCs.

6.0 Discussion of Other Desired Future Conditions Considered

There were 5 GAM scenarios completed that included a range of future pumping scenarios. Results of these scenarios were originally presented at the GMA 7 meeting of March 17, 2016. The model results were summarized in GMA 7 Technical Memorandum 16-02. In addition, the details of the analysis contained in Technical Memorandum 16-02 were presented at the Hickory UWCD No. 1 Board meeting on April 14, 2016.

After review and discussion, the groundwater conservation districts found that Scenario 3, which includes all San Angelo pumping in the Hickory Aquifer was a reasonable scenario as a basis for the desired future condition.

7.0 Discussion of Other Recommendations

Public comments were invited, and each district held a public hearing on the proposed desired future condition for aquifers within their boundaries. The four GCDs in GMA 7 that had DFCs proposed in the Ellenburger-San Saba and Hickory aquifers held public hearings as follows:

Groundwater Conservation District	Date of Public Hearing	Number of Comments Received
Hickory UWCD No. 1	6/10/2021	None
Hill Country UWCD	6/8/2021	None
Kimble County GCD	3/22/2021	None
Menard County UWD	4/14/2021	None

8.0 References

George, P.G., Mace, R.E., and Petrossian, R., 2011. Aquifers of Texas. Texas Water Development Board Report 380, July 2011, 182p.

Jones, I.C., Bradley, R., Boghici, R., Kohlrenken, W., Shi, J., 2013. GAM Task 13-030: Total Estimated Recoverable Storage for Aquifers in Groundwater Management Area 7. Texas Water Development Board, Groundwater Resources Division, October 2, 2013, 53 p.

Shi, J., Boghici, R., Kohlrenken, W., and Hutchison, W., 2016. Numerical Model Report: Minor Aquifers of the Llano Uplift Region of Texas (Marble Falls, Ellenburger-San Saba, and Hickory). Texas Water Development Board report, November 4, 2016, 435p.

Thorkildsen, D., and Backhouse, S., 2010a. GTA Aquifer Assessment 08-08. Groundwater Management Area 7, Ellenburger-San Saba Aquifer, Evaluation of Draft Desired Future Conditions. Texas Water Development Board, Groundwater Technical Assistance Section, August 31, 2010, 13p.

Thorkildsen, D., and Backhouse, S., 2010b. GTA Aquifer Assessment 08-07. Groundwater Management Area 7, Hickory Aquifer, Evaluation of Draft Desired Future Conditions. Texas Water Development Board, Groundwater Technical Assistance Section, August 31, 2010, 18p.

Wuerch, D., and Backhouse, S., 2011. GTA Aquifer Assessment 10-12MAG. Groundwater Management Area 7, Marble Falls Aquifer, Modeled Available Groundwater Estimates. Texas Water Development Board, Groundwater Technical Assistance Section, November 1, 2011, August 31, 2010, 10p.