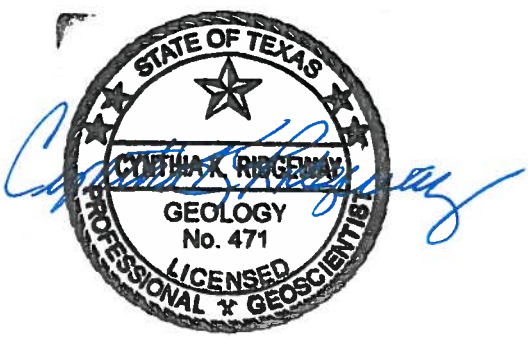
GAM Run 10-047 MAG: Groundwater Management Area 16 Model Runs to Estimate Drawdowns under Assumed Future Pumping for The Gulf Coast Aquifer

by Mohammad Masud Hassan, P.E.
Texas Water Development Board
Groundwater Availability Modeling Section

Edited and finalized by Marius Jigmond to reflect statutory changes
effective September 1, 2011
(512) 463-8499

December 8, 2011



Cynthia K. Ridgeway, the Manager of the Groundwater Availability Modeling Section and Interim Director of the Groundwater Resources Division, is responsible for oversight of work performed by employees under her direct supervision. The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G. 471 on December 8, 2011.

This page is intentionally blank.

GAM RUN 10-047 MAG: GROUNDWATER MANAGEMENT AREA 16 MODEL RUNS TO ESTIMATE DRAWDOWNS UNDER ASSUMED FUTURE PUMPING FOR THE GULF COAST AQUIFER

by Mohammad Masud Hassan, P.E.
Texas Water Development Board
Groundwater Availability Modeling Section

Edited and finalized by Marius Jigmond to reflect statutory changes
effective September 1, 2011
(512) 463-8499

December 8, 2011

EXECUTIVE SUMMARY:

The modeled available groundwater for the Gulf Coast Aquifer as a result of the desired future condition adopted by the members of Groundwater Management Area 16 is approximately 358,100 acre-feet per year. This is summarized by county, regional water planning area, and river basin as shown in Table 1 for use in the regional water planning process. Modeled available groundwater is summarized by county, regional water planning area, river basin, and groundwater conservation district in tables 2 through 5. The estimates were extracted from Groundwater Availability Modeling (GAM) Run 09-008, Scenario 10, which Groundwater Management Area 16 used as the basis for developing their desired future condition for the Gulf Coast Aquifer.

REQUESTOR:

Mr. Scott Bledsoe III of Live Oak Underground Water Conservation District on behalf of Groundwater Management Area 1

DESCRIPTION OF REQUEST:

In a letter dated May 30, 2010 and received September 2, 2010, Mr. Scott Bledsoe provided the Texas Water Development Board (TWDB) with the desired future condition of the Gulf Coast Aquifer adopted by the members of Groundwater Management Area (GMA) 16. The desired future condition for the

Gulf Coast Aquifer in Groundwater Management Area 16, as shown in Resolution No. R2010-001, is as follows:

> *"[…]*
>
> *The authorized voting representatives of the [Groundwater Management Area] 16 Districts hereby establish a desired future condition of the Gulf Coast [Aquifer] of a [Groundwater Management Area]-wide average drawdown of approximately 94 feet through 2060 consistent with scenario 10 of GAM [Run] 09-008 by the vote reflected in the above recitals.*
>
> *The authorized voting representatives of the [Groundwater Management Area] 16 Districts hereby decline to establish a desired future condition of the Carrizo-Wilcox, and the Yegua-Jackson aquifer slivers, finding them to not be relevant for purposes of [Groundwater Management Area] 16 joint planning at this time by the vote reflected in the above recitals.*
>
> *[…]"*

In response to receiving the adopted desired future condition, the Texas Water Development Board has estimated the modeled available groundwater for the Gulf Coast Aquifer within Groundwater Management Area 16.

METHODS:

The Texas Water Development Board previously completed several predictive groundwater availability model simulations of the Gulf Coast Aquifer to assist the members of Groundwater Management Area 16 in developing a desired future condition. The location of Groundwater Management Area 16, the Gulf Coast Aquifer, and the groundwater availability model cells that represent the aquifer are shown in Figure 1. As described in Resolution No. R2010-001, the management area considered Scenario 10 of Groundwater Availability Modeling (GAM) Run 09-008 when developing a desired future condition for the Gulf Coast Aquifer (Hutchison, 2010). Since the above desired future condition is met in Scenario 10 of GAM Run 09-008, the modeled available groundwater for Groundwater Management Area 16 presented here was taken directly from this simulation. This was then divided by county, regional water planning area, river basin, and groundwater conservation district (Figure 2).

PARAMETERS AND ASSUMPTIONS:

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

- We used the Groundwater Management Area 16 numerical groundwater flow model, version 1.0 for these predictive simulations (Hutchison and others, 2011).

- The groundwater flow model encompasses the footprint of Groundwater Management Area 16 and its underlying aquifer systems. The Groundwater Management Area 16 model includes portions of the Gulf Coast, Yegua-Jackson, Queen City, Sparta, and Carrizo-Wilcox aquifer systems. Layers 1 through 4 represent the Gulf Coast Aquifer System which is comprised of the Chicot Aquifer, Evangeline Aquifer, Burkeville Confining System, and Jasper Aquifer in descending order. Layer 5 is a bulk representation of the Yegua-Jackson Aquifer System, and Layer 6 is a bulk representation of the Queen-City, Sparta, and Carrizo-Wilcox aquifers (Hutchison and others, 2011).

- Please refer to GAM Run 09-008 (Hutchison, 2011) for the model parameters, assumptions, and methods used for the predictive simulation.

Modeled Available Groundwater and Permitting

As defined in Chapter 36 of the Texas Water Code, "modeled available groundwater" is the estimated average amount of water that may be produced annually to achieve a desired future condition. This is distinct from "managed available groundwater," shown in the draft version of this report dated June 7, 2011, which was a permitting value and accounted for the estimated use of the aquifer exempt from permitting. This change was made to reflect changes in statute by the 82nd Texas Legislature, effective September 1, 2011.

Groundwater conservation districts are required to consider modeled available groundwater, along with several other factors, when issuing permits in order to manage groundwater production to achieve the desired future condition(s). The other factors districts must consider include annual precipitation and production patterns, the estimated amount of pumping exempt from permitting, existing permits, and a reasonable estimate of actual groundwater production under existing permits. The estimated amount of pumping exempt from permitting, which the Texas Water Development Board is now required to develop after soliciting input from applicable groundwater conservation districts, will be provided in a separate report.

RESULTS:

The modeled available groundwater for the Gulf Coast Aquifer in Groundwater Management Area 16 consistent with the above desired future condition is approximately 358,100 acre-feet per year. This has been divided by county, regional water planning area, and river basin for each decade between 2010 and 2060 for use in the regional water planning process (Table 1). The modeled available groundwater for the Gulf Coast Aquifer is also summarized by county, regional water planning area, river basin, and groundwater conservation district as shown in tables 2 through 5. In Table 5, the modeled

available groundwater both excluding and including areas outside of a groundwater conservation district is shown.

LIMITATIONS:

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

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

A key aspect of using the groundwater model to evaluate the impacts of future pumping is the need to make assumptions about the location in the aquifer where future pumping will occur. In this case, as noted, pumping in each county is evenly distributed. This assumption was necessary, in part, due to the generally large increases in pumping as compared to historic pumping. There is a fair degree of uncertainty in many of these estimates due to the large increases in pumping in areas that had not historically been stressed. As actual pumping changes in the future, it will be necessary to evaluate the amount of that pumping as well as its location in the context of the assumptions associated with this analysis. Evaluating the amount and location of future pumping is as important as evaluating the changes in groundwater levels, spring flows, and other metrics that describe the impacts of that pumping. This analysis does not assess the possible impacts of pumping such as reduced water quality or land surface subsidence.

In addition, certain assumptions have been made regarding future precipitation, recharge, and streamflow in evaluating the impacts of future pumping. Those assumptions also need to be considered and compared to actual future data.

Given these limitations, users of this information are cautioned that the results should not be considered a definitive, permanent prediction of the changes in groundwater storage, streamflow and spring flow. Because the application of the groundwater model was designed to address regional scale questions, the

results are most effective on a regional scale. The TWDB makes no warranties or representations relating to the actual conditions of any aquifer at a particular location or at a particular time.

It is important for groundwater conservation districts to monitor future groundwater pumping and overall conditions of the aquifer. Because of the limitations of the groundwater model and the assumptions in this analysis, it is important that the groundwater conservation districts work with the TWDB to refine this analysis in the future given the reality of how the aquifer responds to the actual amount and location of pumping now and in the future.

REFERENCES:

Harbaugh, A.W., Banta, E.R., Hill, M.C., and McDonald, M.G., 2000, MODFLOW-2000, The U.S. Geological Survey modular ground-water model-user guide to modularization concepts and the ground-water flow process: U.S. Geological Survey Open-File Report 00-92, 121 p.

Hutchison, W.R., Hill, M.E., Anaya, R., Hasan, M.M., Oliver, W., Jigmond, M., Wade, S., and Aschenbach, E., 2011. Groundwater Management Area 16 Groundwater Flow Model: Texas Water Development Board.

Hutchison, W.R., 2011. Draft GAM Run 09-08: Groundwater Management Area 16 Model Runs to Estimate Drawdowns under Assumed Future Pumping for the Gulf Coast Aquifer, June 10, 2011, 45p.

National Research Council, 2007. Models in Environmental Regulatory Decision Making. Committee on Models in the Regulatory Decision Process, National Academies Press, Washington D.C., 287 p.

Wilson, J.D. and Naff, R.L., 2004, The U.S. Geological Survey modular ground-water model-GMG linear equation solver package documentation: U.S. Geological Survey Open-File Report 2004-1261, 47 p.

TABLE 1: MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER IN GROUNDWATER MANAGEMENT AREA 16. RESULTS ARE IN ACRE-FEET PER YEAR AND ARE DIVIDED BY COUNTY, REGIONAL WATER PLANNING AREA, AND RIVER BASIN.

County	Regional Water Planning Area	River Basin	Year					
			2010	2020	2030	2040	2050	2060
Bee	N	Nueces	762	762	762	762	762	762
		San Antonio-Nueces	9,898	9,898	9,898	9,898	9,898	9,898
Brooks	N	Nueces-Rio Grande	15,595	15,595	15,595	15,595	15,595	15,595
Cameron	M	Nueces-Rio Grande	48,576	48,576	48,576	48,576	48,576	48,576
		Rio Grande	1,984	1,984	1,984	1,984	1,984	1,984
Duval	N	Nueces	364	364	364	364	364	364
		Nueces-Rio Grande	13,699	13,699	13,699	13,699	13,699	13,699
Hidalgo	M	Nueces-Rio Grande	38,941	38,941	38,941	38,941	38,941	38,941
		Rio Grande	2,985	2,985	2,985	2,985	2,985	2,985
Jim Hogg	M	Nueces-Rio Grande	20,836	20,836	20,836	20,836	20,836	20,836
		Rio Grande	3,578	3,578	3,578	3,578	3,578	3,578
Jim Wells	N	Nueces	3,962	3,962	3,962	3,962	3,962	3,962
		Nueces-Rio Grande	23,924	23,924	23,924	23,924	23,924	23,924
Kenedy	N	Nueces-Rio Grande	51,778	51,778	51,778	51,778	51,778	51,778
Kleberg	N	Nueces-Rio Grande	50,701	50,701	50,701	50,701	50,701	50,701
Live Oak	N	Nueces	11,377	11,377	11,377	11,377	11,377	11,377
		San Antonio-Nueces	57	57	57	57	57	57
McMullen	N	Nueces	510	510	510	510	510	510
Nueces	N	Nueces	946	946	946	946	946	946
		Nueces-Rio Grande	7,884	7,884	7,884	7,884	7,884	7,884

County	Regional Water Planning Area	River Basin	Year					
			2010	**2020**	**2030**	**2040**	**2050**	**2060**
		San Antonio-Nueces	179	179	179	179	179	179
San Patricio	**N**	Nueces	3,868	3,868	3,868	3,868	3,868	3,868
		San Antonio-Nueces	15,145	15,145	15,145	15,145	15,145	15,145
Starr	**M**	Nueces-Rio Grande	3,079	3,079	3,079	3,079	3,079	3,079
		Rio Grande	4,447	4,447	4,447	4,447	4,447	4,447
Webb	**M**	Nueces	82	82	82	82	82	82
		Nueces-Rio Grande	2,445	2,445	2,445	2,445	2,445	2,445
		Rio Grande	475	475	475	475	475	475
Willacy	**M**	Nueces-Rio Grande	20,013	20,013	20,013	20,013	20,013	20,013
Total			**358,090**	**358,090**	**358,090**	**358,090**	**358,090**	**358,090**

TABLE 2: MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SUMMARIZED BY COUNTY IN GROUNDWATER MANAGEMENT AREA 16 FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR. NOTE THAT THE PUMPING AMOUNT SHOWN IN THE TABLE BELOW FOR BEE COUNTY REPRESENTS ONLY THE PORTION OF THE COUNTY WITHIN GROUNDWATER MANAGEMENT AREA 16.

County	Year					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Bee	10,660	10,660	10,660	10,660	10,660	10,660
Brooks	15,595	15,595	15,595	15,595	15,595	15,595
Cameron	50,560	50,560	50,560	50,560	50,560	50,560
Duval	14,063	14,063	14,063	14,063	14,063	14,063
Hidalgo	41,926	41,926	41,926	41,926	41,926	41,926
Jim Hogg	24,414	24,414	24,414	24,414	24,414	24,414
Jim Wells	27,886	27,886	27,886	27,886	27,886	27,886
Kenedy	51,778	51,778	51,778	51,778	51,778	51,778
Kleberg	50,701	50,701	50,701	50,701	50,701	50,701
Live Oak	11,434	11,434	11,434	11,434	11,434	11,434
McMullen	510	510	510	510	510	510
Nueces	9,009	9,009	9,009	9,009	9,009	9,009
San Patricio	19,013	19,013	19,013	19,013	19,013	19,013
Starr	7,526	7,526	7,526	7,526	7,526	7,526
Webb	3,002	3,002	3,002	3,002	3,002	3,002
Willacy	20,013	20,013	20,013	20,013	20,013	20,013
Total	**358,090**	**358,090**	**358,090**	**358,090**	**358,090**	**358,090**

TABLE 3: MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SUMMARIZED BY REGIONAL WATER PLANNING AREA IN GROUNDWATER MANAGEMENT AREA 16 FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR.

Regional Water Planning Area	Year					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
M	147,441	147,441	147,441	147,441	147,441	147,441
N	210,649	210,649	210,649	210,649	210,649	210,649
Total	**358,090**	**358,090**	**358,090**	**358,090**	**358,090**	**358,090**

TABLE 4: MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SUMMARIZED BY RIVER BASIN IN GROUNDWATER MANAGEMENT AREA 16 FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR.

River Basin	Year					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Nueces	21,871	21,871	21,871	21,871	21,871	21,871
Nueces-Rio Grande	297,471	297,471	297,471	297,471	297,471	297,471
Rio Grande	13,469	13,469	13,469	13,469	13,469	13,469
San Antonio-Nueces	25,279	25,279	25,279	25,279	25,279	25,279
Grand Total	**358,090**	**358,090**	**358,090**	**358,090**	**358,090**	**358,090**

TABLE 5: MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) IN GROUNDWATER MANAGEMENT AREA 16 FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR. UWCD REFERS TO UNDERGROUND WATER CONSERVATION DISTRICT. ASRCD REFERS TO AQUIFER STORAGE & RECOVERY CONSERVATION DISTRICT.

Groundwater Conservation District	Year					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Bee GCD	10,600	10,600	10,600	10,600	10,600	10,600
Brush Country GCD	68,846	68,846	68,846	68,846	68,846	68,846
Corpus Christi ASRCD	2,526	2,526	2,526	2,526	2,526	2,526
Duval County GCD	14,063	14,063	14,063	14,063	14,063	14,063
Kenedy County GCD	97,335	97,335	97,335	97,335	97,335	97,335
Live Oak UGCD	11,434	11,434	11,434	11,434	11,434	11,434
Mcmullen GCD	510	510	510	510	510	510
Red Sands GCD	584	584	584	584	584	584
San Patricio GCD	18,367	18,367	18,367	18,367	18,367	18,367
Starr County GCD	7,526	7,526	7,526	7,526	7,526	7,526
Total (excluding non-district areas)	**231,791**	**231,791**	**231,791**	**231,791**	**231,791**	**231,791**
No District	126,299	126,299	126,299	126,299	126,299	126,299
Total (including non-district areas)	**358,090**	**358,090**	**358,090**	**358,090**	**358,090**	**358,090**

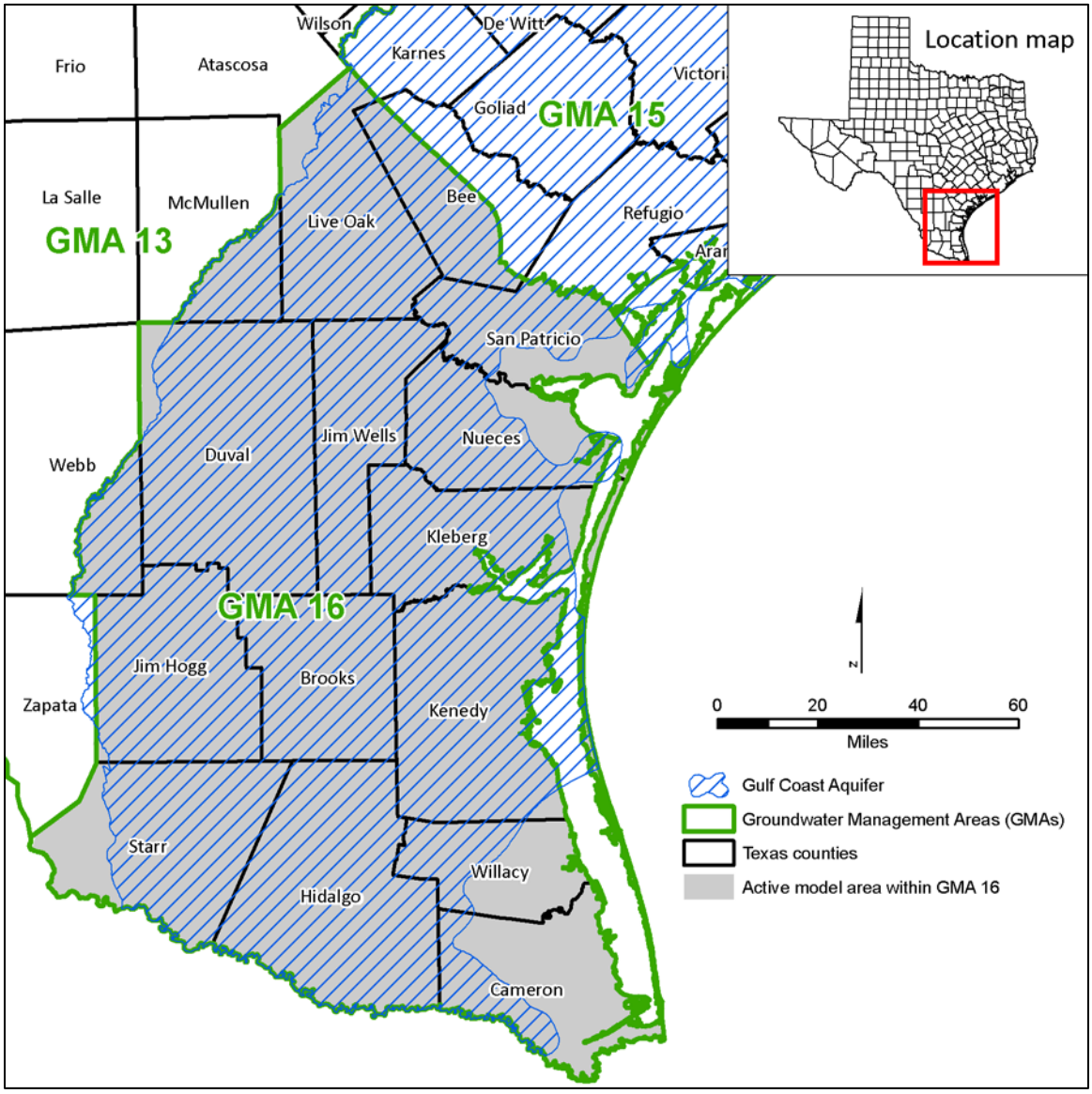


FIGURE 1: MAP SHOWING THE AREAS COVERED BY THE GROUNDWATER MODEL FOR GROUNDWATER MANAGEMENT AREA 16 WHICH INCLUDES THE GULF COAST AQUIFER.

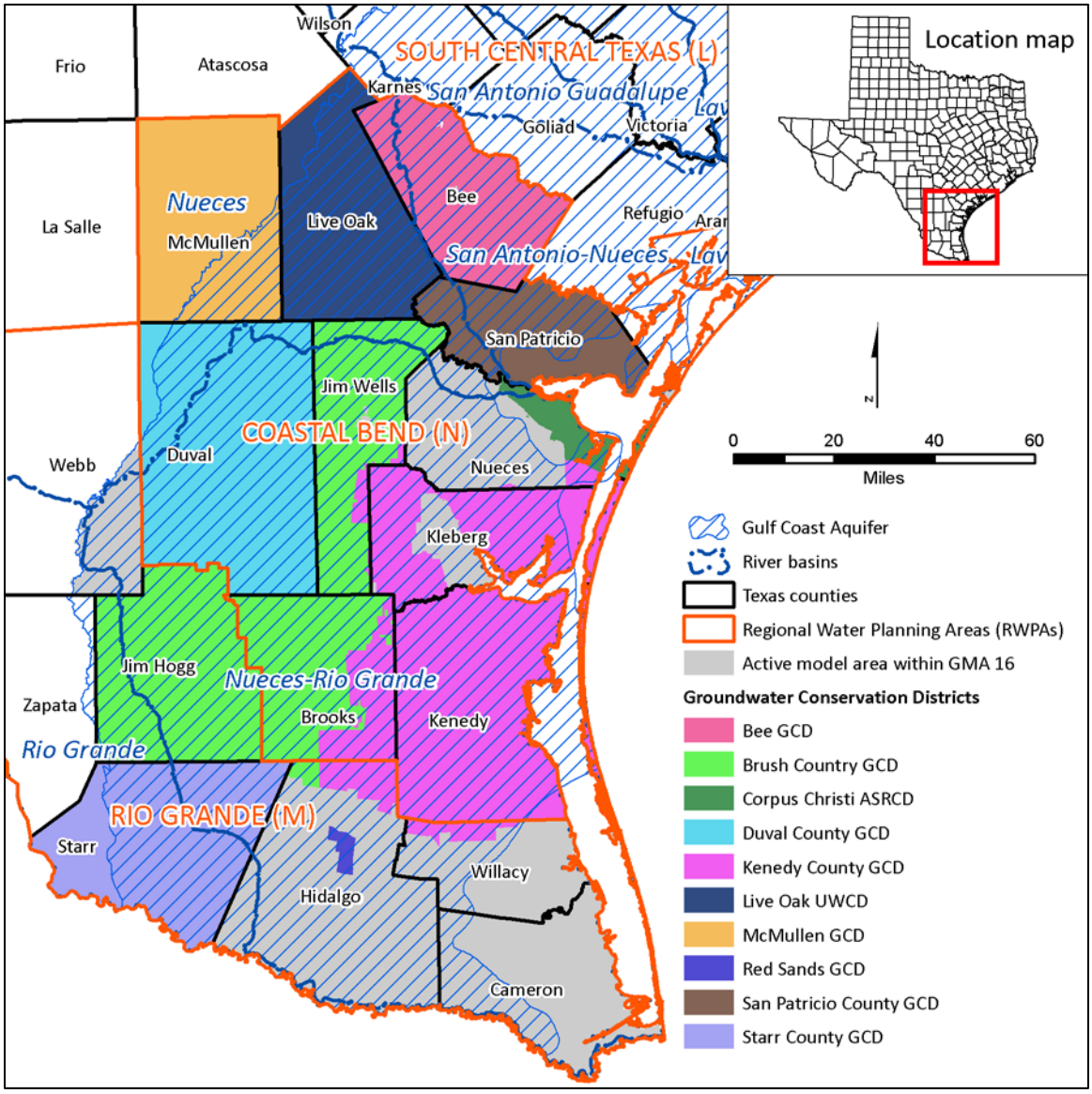


FIGURE 2: MAP SHOWING REGIONAL WATER PLANNING AREAS (RWPAS), GROUNDWATER CONSERVATION DISTRICTS (GCDS), COUNTIES, AND RIVER BASINS IN GROUNDWATER MANAGEMENT AREA 16.