Technical Memorandum

To:	Groundwater Management Area 15
From:	Michael R. Keester, P.G.
Reviewed By:	Andrew Donnelly, P.G. – Daniel B. Stephens & Associates, Inc.
Date:	December 10, 2021
Project:	2021 Joint Planning
Subject:	Groundwater Availability Modeling Technical Elements

The purpose of this memo is to meet the requirements of "Desired Future Condition Submission Packet Checklist - Groundwater Availability Modeling Technical Elements (part 4)" checklist. All modeling was conducted at the direction of Groundwater Management Area (GMA) 15 members. If there are technical questions regarding the modeling, please contact myself or Mr. Donnelly.

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Description of Desired Future Condition (DFC)

As described in Section 2 of the Explanatory Report, for the Gulf Coast Aquifer System the adopted DFCs are expressed as average drawdown for each county and the entire GMA from January 1, 2020 through December 31, 2080. The DFC for GMA 15 shall not exceed an average drawdown of 13 feet for the Gulf Coast Aquifer System. DFCs for each county within the GMA shall not exceed the values specified in Table 1.

In addition to the adopted DFCs in Table 1, the GMA 15 members also established DFC evaluation factors. For the Gulf Coast Aquifer System and each county in GMA 15 except Goliad County, the evaluation factor is three feet above or below the adopted DFC (that is, ±3 feet the value shown in Table 1). For Goliad County, the evaluation factors vary for each hydrogeologic unit of the Gulf Coast Aquifer System as follows:

- Chicot: ±17 feet
- Evangeline: ±36 feet
- Burkeville: ±14 feet
- Jasper: ±7 feet

Table 1. Adopted DFCs for each county in GMA 15 expressed as average drawdown from January 1, 2000 through December 31, 2080.

County	Aquifer	DFC
Aransas	Gulf Coast Aquifer System	0
Bee	Gulf Coast Aquifer System	7
Calhoun	Gulf Coast Aquifer System	5
Colorado	Chicot & Evangeline	17
	Jasper	25
De Witt	Gulf Coast Aquifer System	17
Fayette	Gulf Coast Aquifer System	44
Goliad	Chicot	-4
	Evangeline	-2
	Burkeville	7
	Jasper	14
Jackson	Gulf Coast Aquifer System	15
Karnes	Gulf Coast Aquifer System	22
Lavaca	Gulf Coast Aquifer System	18
Matagorda	Chicot & Evangeline	11
Refugio	Gulf Coast Aquifer System	5
Victoria	Gulf Coast Aquifer System	5
Wharton	Chicot & Evangeline	15

Modeling Approach

GAM version: The central Gulf Coast GAM developed and documented by Chowdhury and others (2004).

Stress periods: 81 stress periods of 365.25 days each. The first stress period begins on January 1, 2000 and the last stress period (81) ends on December 31, 2080. The first stress period corresponds to the end of the calibration period.

Recharge: Average recharge applied throughout the predictive period

Predictive pumping: Details on the modifications to the predictive pumping are documented in the technical memorandums in Appendix 3 of the Explanatory Report.

Version of TWDB "model grid" file: "glfc_c_grid_poly062620.csv" available at http://www.twdb.texas.gov/groundwater/models/gam/gam_grids/glfc_c.zip as of the date of this technical memorandum.

Evaluation method: To extract data from the model and calculate average drawdown we used a script written using the Julia programming language available at https://julialang.org/. The script is named "Calc_avg_dd_GMA15_2019_001_v1.jl" and is included with the modeling files. We calculated average drawdown for each county and for GMA 15 as a whole with the following assumptions:

- Calculations only occur within the active aquifer footprint as defined in the "model grid" file (AQ_Active[#] == 1; where [#] is the layer number)
- Drawdown for each layer = starting head – head for the stress period of interest
  - For the DFCs, the stress period of interest = 81
  - Starting head = simulated head at the end of the calibration period (12/31/1999)
  - If a cell goes dry, it is not included in the calculations
- Drawdown for the Gulf Coast Aquifer System or for a combination of layers calculated by:
  - For each layer, multiplying the average drawdown by the number of active cells in the stress period to get the total drawdown
  - For the GCAS, dividing the sum of the total drawdown for each layer (1, 2, 3, and 4) by the sum of the number of active cells for each layer
  - For the combined Chicot and Evangeline (Chic./Evan.), dividing the sum of the total drawdown for layers 1 and 2 by the sum of the number of active cells for layers 1 and 2
- Average drawdown = sum of drawdown in each model cell within area of interest divided by the number of model cells within the area of interest

Results: Summarized below. Also, see Appendix 3.5 in Explanatory Report.

Table 2. Abbreviated summary of the pumping input values for portions of counties located within GMA 15.

County	Aquifer	2020	2030	2040	2050	2060	2070	2080
Aransas	GCAS	1,544	1,544	1,544	1,544	1,544	1,544	1,544
Bee	GCAS	8,015	8,015	8,015	8,015	8,015	8,015	8,015
Calhoun	GCAS	7,575	7,575	7,575	7,575	7,575	7,575	7,575
Colorado	Chic./Evan.	71,716	71,716	71,716	71,716	71,716	71,716	71,716
	Jasper	919	919	919	919	919	919	919
De Witt	GCAS	18,060	18,060	18,060	18,060	18,060	18,060	18,060
Fayette	GCAS	7,187	7,453	7,756	8,101	8,496	8,947	8,947
Goliad	Chicot	419	422	426	4209	433	436	436
	Evangeline	5,000	5,061	5,122	5,182	5,243	5,304	5,304
	Burkeville	425	452	479	506	533	560	560
	Jasper	254	343	432	522	611	700	700
Jackson	GCAS	90,604	90,604	90,604	90,604	90,604	90,604	90,604
Karnes	GCAS	11,388	11,388	4,003	4,003	4,003	4,003	4,003
Lavaca	GCAS	20,627	20,627	20,627	20,627	20,627	20,627	20,627
Matagorda	Chic./Evan.	38,881	38,881	38,881	38,881	38,881	38,881	38,881
Refugio	GCAS	5,863	5,863	5,863	5,863	5,863	5,863	5,863
Victoria	GCAS	60,044	60,044	60,044	60,044	60,044	60,044	60,044
Wharton	Chic./Evan.	181,413	181,413	181,413	181,413	181,413	181,413	181,413

Table 3. Calculated simulated average drawdown from January 1, 2000 through December 31, 2080.

County	Chicot	Evangeline	Chic./Evan.	Burkeville	Jasper	GCAS
Aransas	0	6	0	—	—	0
Bee	1	8	6	8	6	6
Calhoun	-1	10	3	3	—	3
Colorado	12	26	20	24	28	23
DeWitt	0	5	4	16	34	20
Fayette	—	11	11	43	54	44
Goliad	-4	-2	-3	7	14	5
Jackson	15	20	18	14	22	17
Karnes	—	0	0	22	27	23
Lavaca	7	7	7	17	32	18
Matagorda	5	17	9	16	—	10
Refugio	0	7	3	3	—	3
Victoria	-4	6	1	5	8	3
Wharton	15	12	13	24	27	19