Memorandum

Date:	Tuesday, May 29, 2018
Project:	2021 Brazos G Regional Water Plan
To:	Executive Director, Texas Water Development Board
Cc:	Brazos G RWPG Thomas Barnett, Texas Water Development Board Sarah Backhouse, Texas Water Development Board Stephen Hamlin, Brazos River Authority Alan Day, Brazos Valley GCD Gary Westbrook, Chair, Groundwater Management Area 12 Dave Coleman, City of College Station
From:	David D. Dunn, P.E.
Subject:	Request to utilize a MAG Peak Factor for the Carrizo-Wilcox Aquifer in Brazos County

On April 9, 2018, the Brazos G Regional Water Planning Group (BGRWPG) took action to request use of Modeled Available Groundwater (MAG) Peak Factors for the Carrizo-Wilcox Aquifer in Brazos County in developing the 2021 Brazos G Regional Water Plan. This memorandum documents the request by the BGRWPG and the process by which the requested MAG Peak Factors were developed and approved by the Brazos Valley GCD and GMA-12, and presents supporting technical information demonstrating that use of the MAG Peak Factors will not cause the Desired Future Conditions (DFCs) within Groundwater Management Area (GMA)-12 to be exceeded.

Justification for MAG Peak Factors in the Carrizo-Wilcox Aquifer

The water demands used in the planning process are defined as "dry-year" demands, or water demands that will occur in abnormally dry or drought years without drought restrictions in place. The overall goal of the planning process is to produce a regional water plan that will fully supply the projected dry-year demands through a repeat of drought of record hydrology without shortages. This is a rational approach when comparing surface water supplies with water demands, because the basis of supply for surface water sources is dry, drought-of-record conditions. For some groundwater systems sensitive to annual hydrologic variability, such as the Northern Edwards Aquifer, this is also a rational approach, as the MAG by necessity is based upon dry or drought-of-record conditions which would occur simultaneously with the increased, dry-year demands. However, supplies from some aquifer systems, such as the Carrizo-Wilcox Aquifer, are not sensitive to annual or short-term fluctuations in hydrology. This has resulted in an overly conservative approach to planning for groundwater supplies. The methodology effectively assumes that the dry-year demands will occur in each year of the planning horizon (2020 – 2070), because the MAG is pumped annually in the modeling process used to determine the MAG. In actuality, water demands for most water use types only infrequently reach the level of the dry-year demands upon which the planning is based.

With the realization that demands in many years will be substantially less than the dry-year demands, the BGRWPG desires to use a MAG Peak Factor to increase the planning supplies from specific aquifers to values greater than the MAG. This would be accomplished by multiplying a MAG Peak Factor (greater than 100 percent) by the MAG in each decade to represent the available groundwater to be used for planning purposes. However, the bottom line is that these adjustments to the MAG must honor the approved DFCs.

Development of MAG Peak Factors for the Carrizo-Wilcox Aquifer in Brazos County

The methodology for determining MAG Peak Factors is based on developing an annual pumping pattern that reflects actual annual variation in pumping from the aquifer over a 10-year period, while not exceeding the 10-year volume that would be pumped by the MAG over that 10-year period. An underlying assumption is that this annual variability in pumping will be exhibited by users in future years. This annual pumping pattern can be repeated each decade from 2020 through 2070, adjusted each decade so that the total volume pumped does not exceed the MAG pumping for that decade. The largest annual pumping volume divided by the MAG at the start of the decade will determine the MAG Peak Factor for that decade. The annual pumping volumes thus derived can be inputted into the Groundwater Availability Model (GAM) that was used to develop the MAG to determine if that pumping pattern will cause the DFCs to be violated. If the total volume of the annual pumping over a 10-year period will be limited to the total MAG volume over that period, it is unlikely that the DFCs will be violated.

The Brazos Valley GCD provided records of annual pumping from permitted wells and estimates of pumping from exempt wells (domestic and livestock wells) for the 10-year period of 2008 through 2017 for the Carrizo and Simsboro Aquifers, which together with the Hooper and Calvert Bluff formations comprise the Carrizo-Wilcox Aquifer. HDR summarized those data and developed a 10-year annual pumping pattern. For each decade from 2020 through 2070, the 10-year annual pumping pattern was adjusted such that its total volume pumped was equal to the total MAG volume pumped in that decade in the GAM. Pumping patterns were developed separately for the Carrizo and Simsboro Aquifers, as shown in Figure 1.[1]

The City of College Station provided funding for WSP USA, Inc. (WSP) to perform a modeling analysis to verify that the proposed pumping patterns would not violate DFCs. Pumping in the GAM was replaced with the "MPF Pumping" (MAG Peak Factor Pumping) patterns shown in Figure 1, and the GAM was run to determine if drawdown from that pumping in the Brazos County GCD and all GCDs associated with GMA-12 would violate the DFCs within GMA-12. Only the pumping in Brazos County was modified to match the patterns in Figure 1; pumping used to determine the MAG was retained in all other counties. The attached memorandum from WSP further documents the modeling process. The GAM files developed have been provided to TWDB staff for their review via a separate transmittal.

Figure 2 illustrates the overall MAG Peak Factor pumping for the combined Carrizo-Wilcox Aquifer in Brazos County. The resulting MAG Peak Factors are presented in Table 1.

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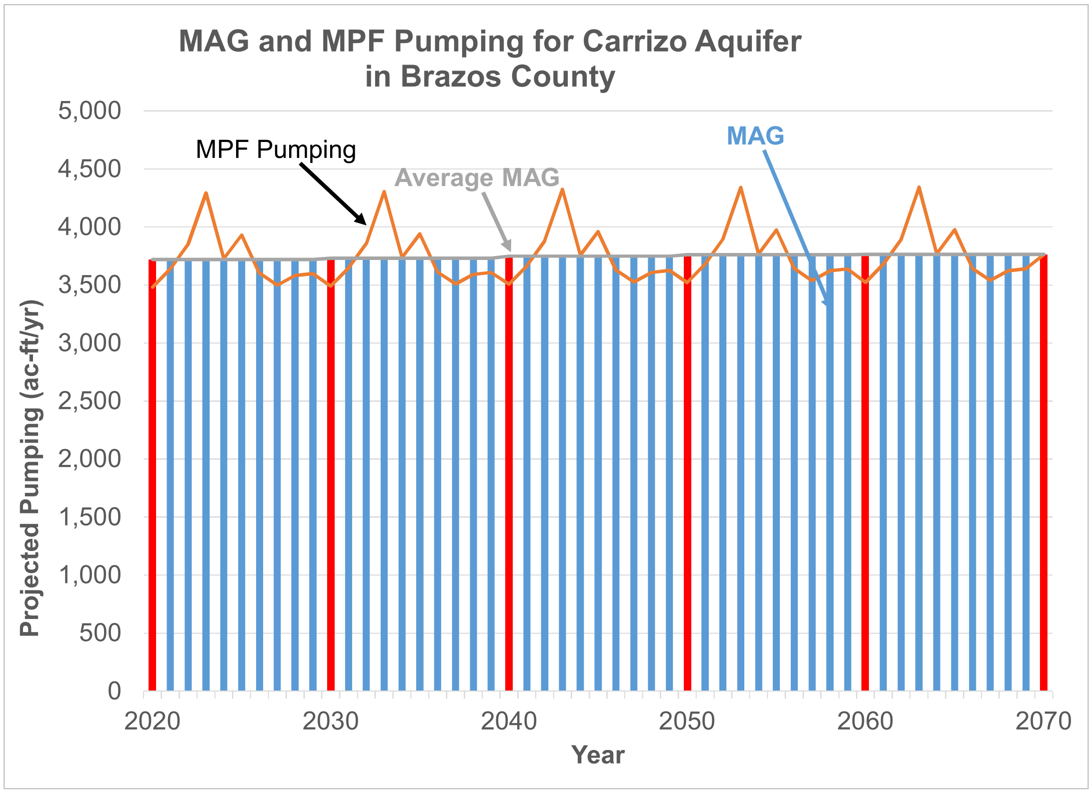
[1] Brazos Valley GCD reported no pumping from the Hooper and Calvert Bluff formations in Brazos County, so no pumping patterns were established for those formations.



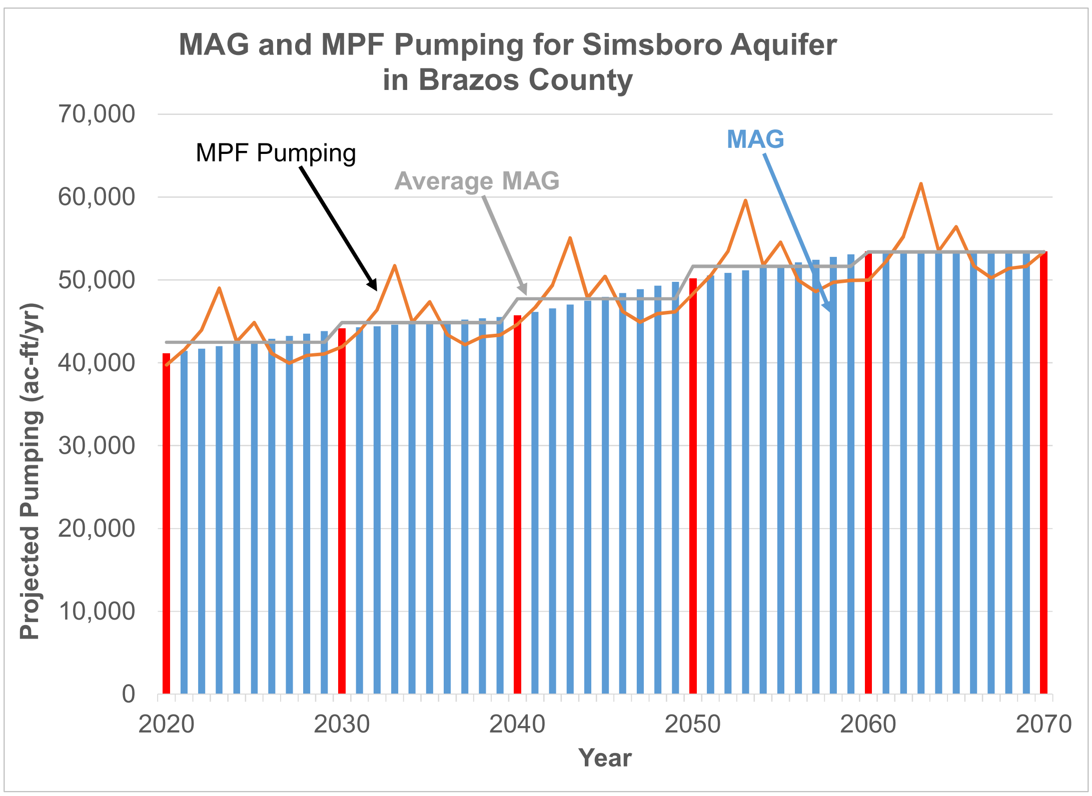


Figure 1. MAG and MPF Pumping Patterns for the Carrizo and Simsboro Aquifers in Brazos County

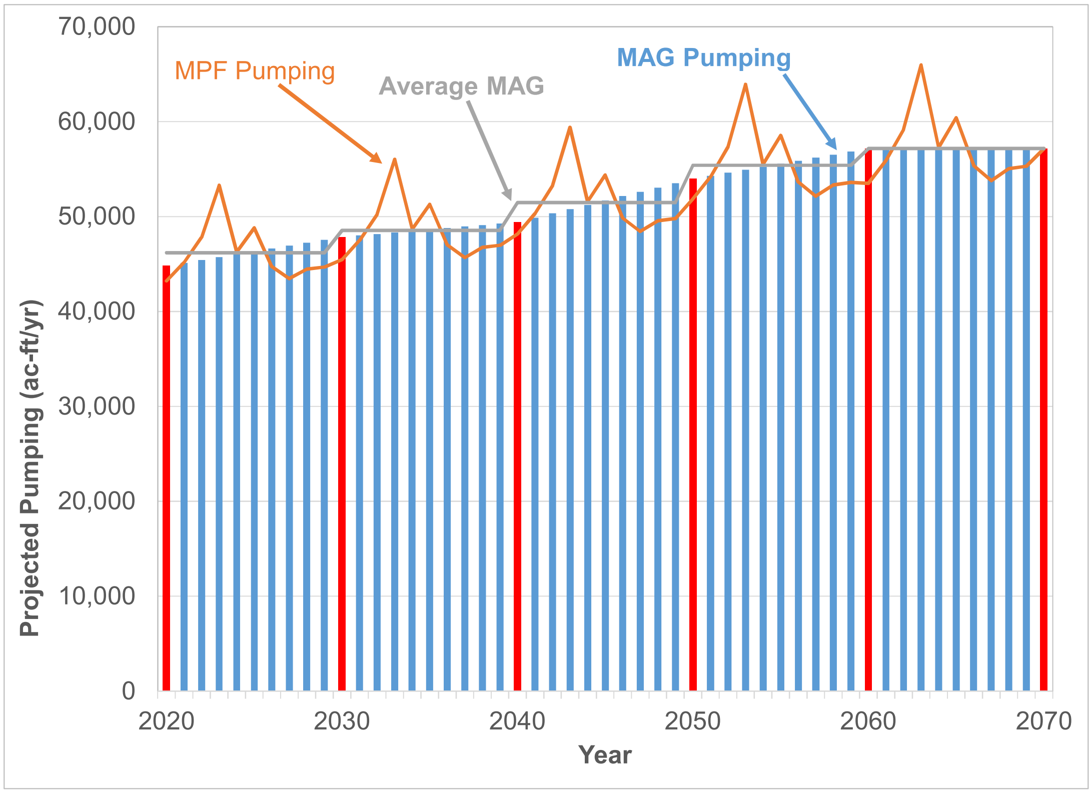


Figure 2. Pumping patterns from the Carrizo-Wilcox Aquifer in Brazos County used to determine MAG Peak Factors

Table 1. Proposed MAG Peak Factors – Carrizo-Wilcox Aquifer, Brazos County, Brazos River Basin

Decade	MAG Peak Factor
2020	1.19
2030	1.17
2040	1.20
2050	1.18
2060	1.15
2070	1.15

Coordination with Brazos Valley GCD and GMA-12

The Brazos Valley GCD approved the requested MAG Peak Factors on May 10, 2018, and the representatives of GMA-12 approved them on May 11, 2018. Letters from Brazos Valley GCD and GMA-12 affirming their support of the MAG Peak Factors are attached.

Utilization of MAG Peak Factors for the Carrizo-Wilcox Aquifer in Brazos County will not prevent the Brazos Valley GCD from managing groundwater resources to achieve the DFCs adopted by the GCD and by GMA-12. This is because the Brazos Valley GCD has sufficient rules and policies in place to monitor groundwater levels in relation to the DFCs and to take action to enforce pumping limitations in order to achieve the DFCs. Please see the attached letter from the Brazos Valley GCD explaining the District's policies and pro-active monitoring program.

Attachments

1. Memorandum from WSP USA, Inc. summarizing the modeling process used to determine that the proposed MAG Peak Factors will not violate the DFCs.
2. Model files developed by WSP USA, Inc. (under separate transmittal)
3. Letter from the Brazos Valley GCD in support of the proposed MAG Peak Factors.
4. Letter from GMA-12 in support of the proposed MAG Peak Factors.
5. Letter from the Brazos Valley GCD describing the District's monitoring plan and regulations to ensure that DFCs are attained.

May 25, 2018

Mr. David M. Coleman, P.E.
Director, Water Services Department
City of College Station
1601 Graham Road
College Station, Texas 77845

Subject: Results of MAG Peak Factor Groundwater Flow Modeling

Dear Mr. Coleman:

The Texas Water Development Board (TWDB) has added an option to regional water planning regarding groundwater supply assessment using a modeled available groundwater (MAG) Peak Factor or MPF. Region G has done a statistical analysis of pumping from the Carrizo and Simsboro aquifers in Brazos County over the past decade and incorporated that into the estimates of future pumping from the aquifers for the period from 2020 through 2069, as represented in the decadal MAGs developed by the TWDB as part of groundwater management area (GMA) planning. Our firm has completed groundwater flow modeling for a MPF of about 1.2, as represented in a scenario developed by Region G for the two aquifers. An objective of the modeling was to evaluate whether the MPF is a consideration for water resources planning by the City of College Station. One of those considerations was to determine whether the MPF pumping for the Carrizo and Simsboro aquifers had any effect on the desired future conditions (DFCs) in 2070 for the Brazos Valley Groundwater Conservation District (GCD), Mid-East Texas GCD, Post Oak Savannah GCD and Lost Pine GCD. The DFCs for 2070 were developed as part of the 2017 cycle of planning performed by Groundwater Management Area 12 (GMA 12).

GROUNDWATER FLOW MODELING TASKS

The effort to develop results regarding whether the MPF had any effect on DFCs included the following sequence of work.

- Development by Region G of a scenario of potential future variations in pumping from the Carrizo and Simsboro aquifers in Brazos County based on variations in pumping from the two aquifers over the past 10 years. Two illustrations of the variations in pumping

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developed by Region G are attached. A table also is attached that shows the variations in pumping from the two aquifers in a tabular form for 2020 through 2069.

- The pumping that was represented during that period for the two aquifers was inputted to the well file for the regional groundwater model with the MPF pumping replacing the pumping for the two aquifers that was in simulation PS 12 that was used to develop the DFCs for GMA 12 that were submitted to the TWDB in September of 2017. As shown on the attached figures, the pumping varies from year to year and the variation in pumping was spread over the county by adjusting the pumping in each model cell with pumping, by the percentage change in pumping represented by the MPF pumping compared to the average MAG pumping shown on the two figures. The results of this approach were that the total amount of groundwater withdrawal over the planning period from 2020 to 2070 for the MPF pumping was the same as for the average MAG pumping. For the period 2000 through 2019 pumping as represented in the PS 12 simulation was used in the MPF simulation.

- The simulation was performed using the Regional Queen City / Sparta Groundwater Availability Model developed by the TWDB, the same model that was used in the GMA 12 planning effort in 2017. The results of the GMA 12 effort regarding MAGs and DFCs is documented in TWDB GAM Run 17-030 MAG: Modeled Available Groundwater for the Carrizo-Wilcox, Queen City, Sparta, Yegua-Jackson, and Brazos River Alluvium Aquifers in Groundwater Management Area 12 released by the TWDB on December 1, 2017. The results of the MPF simulation show that the utilization of the MPF pumping did not result in any increase in the DFCs for GCDs within GMA 12 nor for GMA 12 in total for the Carrizo, Calvert Bluff, Simsboro and Hooper aquifers. A table providing results from the two simulations is attached. The methodology utilized to calculate the DFCs was the same as was used during the last cycle of GMA 12 water planning. If there is any variation in the DFCs, the results were that the DFCs were slightly lower for the MPF pumping compared to the average MAG, but were so close that the differences are inconsequential.

- As provided yesterday, the modeling files are available via a link that has been provided to you and David Dunn with HDR. The files will be transmitted to the TWDB by Region G.

Our firm has appreciated the opportunity to be of service during the study and believe that the results add some flexibility for the consideration of future water resources planning and development of water supply projects for the City of College Station.

Sincerely,

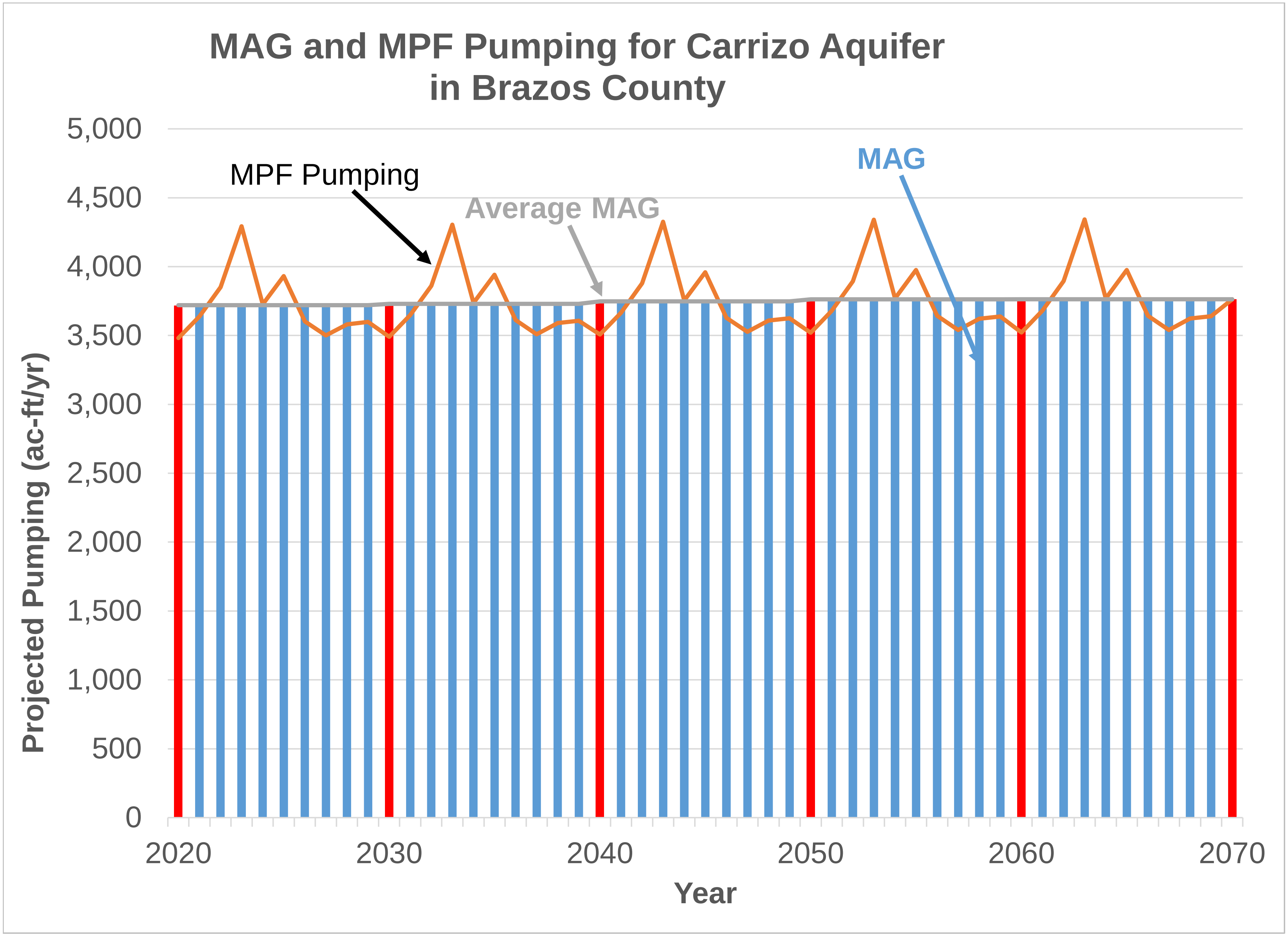
W. John Seifert, Jr., P.E.
Senior Supervising Engineer

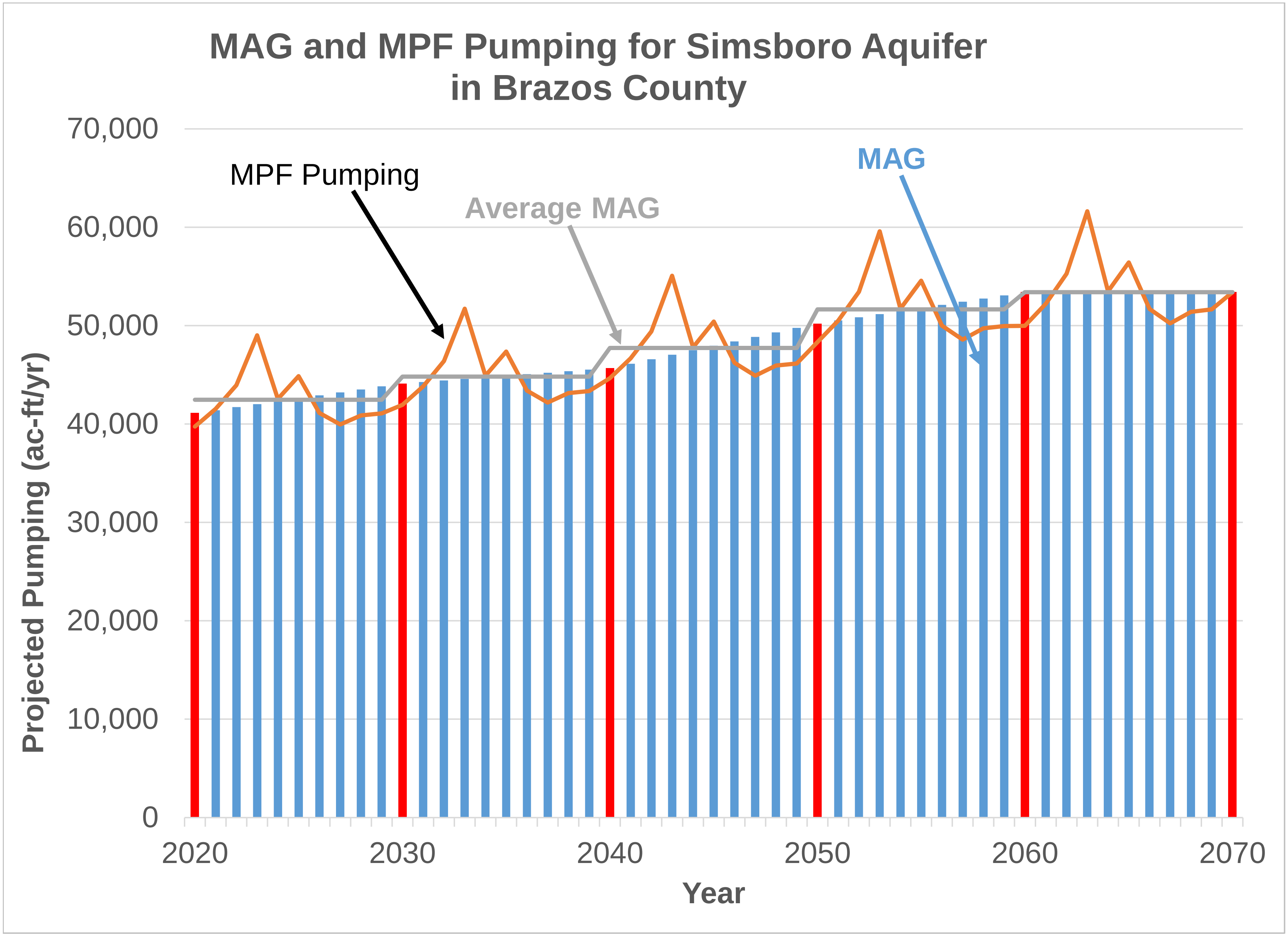
STATE OF TEXAS
WILLIAM J. SEIFERT, JR.
49994
LICENSED
PROFESSIONAL ENGINEER

WSP USA, Inc.
F-2263

5/25/2018

WJS/lks
Attachements


MAG and MPF Pumping for Carrizo Aquifer
in Brazos County
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Projected Pumping (ac-ft/yr)
MPF Pumping
Average MAG
MAG
2020
2030
2040
2050
2060
2070
Year



MAG and MPF Pumping for Simsboro Aquifer in Brazos County
MPF Pumping
Average MAG
MAG
Projected Pumping (ac-ft/yr)
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
2020
2030
2040
2050
2060
2070
Year

All values in acre-feet/year

Total Carrizo-Wilcox Aquifer (initial pattern)

Year	MAG	MPF Pumping Pattern	Average MAG
2020	44832	48413	51733
2021	45133	50590	51733
2022	45434	53546	51733
2023	45735	59700	51733
2024	46036	51822	51733
2025	46337	54658	51733
2026	46638	50089	51733
2027	46939	48672	51733
2028	47240	49802	51733
2029	47541	50037	51733
2030	47844	48413	51733
2031	48001	50590	51733
2032	48158	53546	51733
2033	48315	59700	51733
2034	48472	51822	51733
2035	48629	54658	51733
2036	48786	50089	51733
2037	48943	48672	51733
2038	49100	49802	51733
2039	49257	50037	51733
2040	49418	48413	51733
2041	49873	50590	51733
2042	50328	53546	51733
2043	50783	59700	51733
2044	51238	51822	51733
2045	51693	54658	51733
2046	52148	50089	51733
2047	52603	48672	51733
2048	53058	49802	51733
2049	53513	50037	51733
2050	53969	48413	51733
2051	54289	50590	51733
2052	54609	53546	51733
2053	54929	59700	51733
2054	55249	51822	51733
2055	55569	54658	51733
2056	55889	50089	51733
2057	56209	48672	51733
2058	56529	49802	51733
2059	56849	50037	51733
2060	57167	48413	51733
2061	57167	50590	51733
2062	57167	53546	51733
2063	57167	59700	51733
2064	57167	51822	51733
2065	57167	54658	51733
2066	57167	50089	51733
2067	57167	48672	51733
2068	57167	49802	51733
2069	57167	50037	51733
2070	57167	57167	51733

Carrizo Aquifer

Year	MAG	MPF Pumping Pattern	Average MAG	MPF Pumping		
2020	3717	48413	3720	3,481	**Cum Diff**	(0.00)
2021	3717.7	50590	3720	3,638	**Adj. Factor**	0.071911
2022	3718.4	53546	3720	3,851	**MPF**	1.155
2023	3719.1	59700	3720	4,293		
2024	3719.8	51822	3720	3,727		
2025	3720.5	54658	3720	3,930		
2026	3721.2	50089	3720	3,602		
2027	3721.9	48672	3720	3,500		
2028	3722.6	49802	3720	3,581		
2029	3723.3	50037	3720	3,598		
2030	3724	48413	3730	3,490	**Cum Diff**	(0.00)
2031	3725.3	50590	3730	3,647	**Adj. Factor**	0.072098
2032	3726.6	53546	3730	3,861	**MPF**	1.156
2033	3727.9	59700	3730	4,304		
2034	3729.2	51822	3730	3,736		
2035	3730.5	54658	3730	3,941		
2036	3731.8	50089	3730	3,611		
2037	3733.1	48672	3730	3,509		
2038	3734.4	49802	3730	3,591		
2039	3735.7	50037	3730	3,608		
2040	3737	48413	3748	3,507	**Cum Diff**	(0.00)
2041	3739.4	50590	3748	3,665	**Adj. Factor**	0.072445
2042	3741.8	53546	3748	3,879	**MPF**	1.157
2043	3744.2	59700	3748	4,325		
2044	3746.6	51822	3748	3,754		
2045	3749	54658	3748	3,960		
2046	3751.4	50089	3748	3,629		
2047	3753.8	48672	3748	3,526		
2048	3756.2	49802	3748	3,608		
2049	3758.6	50037	3748	3,625		
2050	3761	48413	3762	3,520	**Cum Diff**	0.00
2051	3761.2	50590	3762	3,679	**Adj. Factor**	0.072718
2052	3761.4	53546	3762	3,894	**MPF**	1.154
2053	3761.6	59700	3762	4,341		
2054	3761.8	51822	3762	3,768		
2055	3762	54658	3762	3,975		
2056	3762.2	50089	3762	3,642		
2057	3762.4	48672	3762	3,539		
2058	3762.6	49802	3762	3,621		
2059	3762.8	50037	3762	3,639		
2060	3763	48413	3763	3,522	**Cum Diff**	0.00
2061	3763	50590	3763	3,680	**Adj. Factor**	0.072739
2062	3763	53546	3763	3,895	**MPF**	1.154
2063	3763	59700	3763	4,343		
2064	3763	51822	3763	3,769		
2065	3763	54658	3763	3,976		
2066	3763	50089	3763	3,643		
2067	3763	48672	3763	3,540		
2068	3763	49802	3763	3,623		
2069	3763	50037	3763	3,640		
2070	3763	57167	3763	3,763		

Simsboro Aquifer

Year	MAG	MPF Pumping Pattern	Average MAG	MPF Pumping		
2020	41115	48413	42470	39,745	**Cum Diff**	0.00
2021	41416.2	50590	42470	41,532	**Adj. Factor**	0.820955
2022	41717.4	53546	42470	43,959	**MPF**	1.192
2023	42018.6	59700	42470	49,011		
2024	42319.8	51822	42470	42,544		
2025	42621	54658	42470	44,872		
2026	42922.2	50089	42470	41,121		
2027	43223.4	48672	42470	39,958		
2028	43524.6	49802	42470	40,885		
2029	43825.8	50037	42470	41,078		
2030	44120	48413	44828	41,951	**Cum Diff**	(0.00)
2031	44277.4	50590	44828	43,838	**Adj. Factor**	0.866534
2032	44434.8	53546	44828	46,399	**MPF**	1.173
2033	44592.2	59700	44828	51,732		
2034	44749.6	51822	44828	44,906		
2035	44907	54658	44828	47,363		
2036	45064.4	50089	44828	43,404		
2037	45221.8	48672	44828	42,176		
2038	45379.2	49802	44828	43,155		
2039	45536.6	50037	44828	43,359		
2040	45681	48413	47729	44,666	**Cum Diff**	-
2041	46136.1	50590	47729	46,675	**Adj. Factor**	0.922603
2042	46591.2	53546	47729	49,402	**MPF**	1.206
2043	47046.3	59700	47729	55,079		
2044	47501.4	51822	47729	47,811		
2045	47956.5	54658	47729	50,428		
2046	48411.6	50089	47729	46,212		
2047	48866.7	48672	47729	44,905		
2048	49321.8	49802	47729	45,947		
2049	49776.9	50037	47729	46,164		
2050	50208	48413	51647	48,333	**Cum Diff**	0.00
2051	50527.8	50590	51647	50,506	**Adj. Factor**	0.998341
2052	50847.6	53546	51647	53,457	**MPF**	1.187
2053	51167.4	59700	51647	59,601		
2054	51487.2	51822	51647	51,736		
2055	51807	54658	51647	54,567		
2056	52126.8	50089	51647	50,006		
2057	52446.6	48672	51647	48,591		
2058	52766.4	49802	51647	49,719		
2059	53086.2	50037	51647	49,954		
2060	53404	48413	53404	49,977	**Cum Diff**	0
2061	53404	50590	53404	52,224	**Adj. Factor**	1.032302
2062	53404	53546	53404	55,276	**MPF**	1.154
2063	53404	59700	53404	61,628		
2064	53404	51822	53404	53,496		
2065	53404	54658	53404	56,424		
2066	53404	50089	53404	51,707		
2067	53404	48672	53404	50,244		
2068	53404	49802	53404	51,411		
2069	53404	50037	53404	51,653		
2070	53404	53404	53404	53,404		

Total Carrizo-Wilcox Aquifer (final)

Year	MAG	MPF Pumping	Average MAG		
2020	44832	43,226	46190		
2021	45133	45,170	46190		
2022	45434	47,809	46190	**MPF**	1.189
2023	45735	53,304	46190		
2024	46036	46,270	46190		
2025	46337	48,802	46190		
2026	46638	44,723	46190		
2027	46939	43,458	46190		
2028	47240	44,467	46190		
2029	47541	44,676	46190		
2030	47844	45,442	48558		
2031	48001	47,485	48558		
2032	48158	50,260	48558	**MPF**	1.171
2033	48315	56,036	48558		
2034	48472	48,642	48558		
2035	48629	51,304	48558		
2036	48786	47,015	48558		
2037	48943	45,685	48558		
2038	49100	46,746	48558		
2039	49257	46,966	48558		
2040	49418	48,173	51477		
2041	49873	50,340	51477		
2042	50328	53,281	51477	**MPF**	1.202
2043	50783	59,404	51477		
2044	51238	51,565	51477		
2045	51693	54,387	51477		
2046	52148	49,841	51477		
2047	52603	48,431	51477		
2048	53058	49,555	51477		
2049	53513	49,789	51477		
2050	53969	51,853	55409		
2051	54289	54,185	55409		
2052	54609	57,351	55409	**MPF**	1.185
2053	54929	63,942	55409		
2054	55249	55,504	55409		
2055	55569	58,542	55409		
2056	55889	53,648	55409		
2057	56209	52,131	55409		
2058	56529	53,341	55409		
2059	56849	53,593	55409		
2060	57167	53,498	57167		
2061	57167	55,904	57167		
2062	57167	59,171	57167	**MPF**	1.154
2063	57167	65,971	57167		
2064	57167	57,265	57167		
2065	57167	60,399	57167		
2066	57167	55,350	57167		
2067	57167	53,785	57167		
2068	57167	55,033	57167		
2069	57167	55,293	57167		
2070	57167	57,167	57167		

Results of MAG Peak Factor Modeling

January 2000 through December 2069 Average Drawdown, ft

Entity / Scenario	Aquifer: Carrizo	Calvert Bluff	Simsboro	Hooper
Brazos Valley GCD				
MAG	60	125	295	207
MPF	60	123	290	205
Mid-East Texas GCD				
MAG	80	89	138	125
MPF	80	89	136	124
Lost Pines GCD				
MAG	68	109	252	181
MPF	68	109	250	181
Post Oak Savannah GCD				
MAG	66	149	322	206
MPF	66	147	318	205
GMA-12				
MAG	75	114	228	168
MPF	75	113	226	167

MAG = Results from GMA-12 simulation used to develop DFCs for 2017 cycle of GMA planning.

MPF = Results from simulation using pumping from the Simsboro Aquifer modified in Brazos County by a peaking factor of about 1.2 provided by Region G.

BRAZOS VALLEY GROUNDWATER CONSERVATION DISTRICT

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May 11, 2018

Wayne Wilson
c/o Stephen Hamlin
Brazos G Regional Water Planning Group Coordinator
4600 Cobbs Drive
Waco, TX 76710

Dear Wayne,

The Brazos Valley Groundwater Conservation District met on Thursday, May 10, 2018 discuss and possibly adopt a 1.2 or 1.3 MAG Peaking Factor for the Carrizo-Wilcox Aquifer within Brazos County for use during the currently state water planning cycle.

Item 4 - Discussion and possible action on the approval of a 1.30 Modeled Available Groundwater Peaking Factor for Brazos County in response to a proposed groundwater project for the City of College Station.

Following a unanimous vote, the Board adopted a 1.20 MAG Peaking Factor in the Carrizo-Wilcox Aquifer in Brazos for use during the current state water planning cycle in Region G. If you have any questions concerning this matter, please do not hesitate to contact me at your convenience.

Best regards,

Alan M. Day
General Manager

Post Oak Savannah Groundwater Conservation District

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Gary Westbrook, General Manager

May 17, 2018

Mr. Wayne Wilson, Chairman
Brazos G Regional Water Planning Group
c/o Mr. Stephen Hamlin, Brazos G Coordinator
4600 Cobbs Drive
Waco, TX 76710

Sent via email to stephen.hamlin@Brazos.org

Dear ~~Chairman Wilson~~ Wayne,

Groundwater Management Area 12 met on Friday, May 11, 2018, at the offices of the Post Oak Savannah GCD offices, and, during the course of the meeting, considered agenda item 6, "Discussion and possible action on the approval of a 1.30 Modeled Available Groundwater Peaking Factor for Brazos County in response to a proposed groundwater project for the City of College Station."

After receiving presentations, and following discussion on this item, the voting representatives of GMA 12 voted unanimously to approve a 1.2 Modeled Available Groundwater Peaking Factor for Brazos County in response to a proposed groundwater project for the City of College Station in the current cycle of regional water planning.

Please do not hesitate to contact me for further information.

Sincerely,

Gary Westbrook
General Manager
Post Oak Savannah GCD

BRAZOS VALLEY GROUNDWATER CONSERVATION DISTRICT
P.O. BOX 528 · HEARNE, TX 77859 · (979)279-9350 · FAX: (979)279-0035
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May 26, 2018

Larry French
Director, Groundwater Division
Texas Water Development Board
1700 North Congress Avenue
Austin, Texas 78701

Dear Larry,

The Brazos Valley Groundwater Conservation District Board of Directors recently approved a Modeled Available Groundwater Peaking Factor for the Carrizo and Simsboro aquifers in Brazos County for use in the 5th cycle of state water planning. It has been brought to my attention that the Texas Water Development Board needs:

"documentation (for example, monitoring plans) of how the temporary availability increase will not prevent the associated GCD(s) from managing groundwater resources to achieve the DFC(s)…."

The District has numerous rules and policy in place to enforce and take action based on aquifer response to pumping:

- District Rule 7.2 (Actions Based on Aquifer Response to Pumping) details trigger levels and actions available to the Board of Directors to keep the District compliant with the adopted DFC(s). The details of the rule can be viewed on pages 21-25 of the District Rules.

  https://brazosvalleygcd.org/wp-content/uploads/2012/12/BVGCD-Rules-Adopted-11-9-17-1.pdf

- The District maintains a robust monitoring well network of 157 wells which are measured quarterly. Fifty-six (56) of the wells screen the Simsboro Aquifer. Twelve (12) of those wells have been designated as "DFC" wells. Ten (10) of the wells have water level data dating back to 1999 (the beginning point for the DFC(s)). Beginning water levels for the remaining two (2) wells were interpolated. The DFC wells were chosen for spatial diversity. District DFCs are based on the average artesian reduction across the entire two-county district. The proposed groundwater projects envisioned as water strategies by the City of College Station will be in the Simsboro Aquifer.

- All water level measurements are available for public viewing on the District website.

  https://brazosvalleygcd.halff.com/portal1/Map.aspx

- A strict water level measurement protocol was adopted by the Board in order to validate all data collected. The District will base any curtailment of pumping on data collected by District staff. The adopted protocol provides reliable data collection allowing the Board to make informed decisions and assuring permit holders that any reductions are based on high quality information. A copy of the adopted protocol is enclosed.

If you have any questions concerning this matter, please feel free to contact me at 979-279-9350 (office) or 817-774-6412 (cell).

Best regards,

Alan M. Day
General Manager

Adopted August 11, 2016

Brazos Valley GCD
Steel Tape Measuring Protocol

1. The well where the static water level is to be measured should not be pumped for 24 hours, if possible, prior to taking the static water-level measurements. If the well has been pumped less than 24 hours prior to taking the water-level measurement, record in the official record how long the pump has been off prior to taking the measurement, if known. Confirm and indicate in the official record that no non-exempt well completed in the same aquifer within a ½ mile radius to the well being measured is being actively pumped at the time of taking the water-level measurement. Unless this can be confirmed, no water-level measurement should be taken. Obtain permission to collect measurement at a later time.

2. If well is equipped with a submersible pump, confirm and record in the official record that the pump is not in operation. Unless it is determined that the pump is not operational, no water-level measurement should be taken or recorded. Obtain permission to collect measurement at a later time.

3. Identify a port or opening in the pump discharge head or casing or in the pump foundation (surface casing vent pipe) that provides access for the steel tape to the annulus between the surface casing and the pump column assembly, water-level measuring pipe or open casing if the well is not equipped with a pump.

4. Measure and record the height of the opening above ground level and this will become the measuring point. Describe the measuring point in the official record for the well, and use the same measuring point each time when measuring the water level. If not possible, record the height of the measuring point above land surface each time the static water-level is measured.

5. Prior to taking the water-level measurement, review previous water-level measurements to estimate the current water level depth.

6. Use carpenter’s chalk to coat the lowest 15-30 feet of the steel tape.

7. Lower the steel tape in the annulus between the pump column and casing, down the open casing if not equipped with a pump or down a water-level measuring pipe until the depth of the tape is 10 feet lower than the last recorded static water level. Record the length of tape installed in the well with the footage marker exactly at the measuring point. Refer to this length as the “hold”. Retract the steel tape and record the length of the tape to the nearest hundredth of a foot that is wet. This measurement is called the “cut”. Record both measurements. Remove the wet chalk on the tape.

8. Wait 5 minutes after initial measurement, re-chalk tape and lower the tape 1-2 feet deeper than the hold depth for the previous measurement. Retract the tape and record the cut length. Subtract the cut length from the hold length to calculate the depth to water. The

difference between the two measurements should be no greater than 0.02 feet. If the difference in depth to water is greater than 0.02 feet, note in the field log and schedule for water-level measurement at a future date.

9. Subtract the measuring point height from the measured depth to water to obtain depth of water below land surface and record in the official record.

10. Record date and time of measurement.

11. Remove the chalk from the steel tape and clean the lowest 30 feet with Clorox bleach wipes, bleach wipes with an equivalent percentage sodium hypochlorite or a minimum 0.5% sodium hypochlorite solution (NaOCl and water) before measuring the water level in another well.

12. Replace cap on any port in discharge head or casing. Leave the well and pump in same condition as observed on arrival.

Adopted August 11, 2016

Brazos Valley GCD
Pressure Transducer Utilization Protocol

1) Select and purchase all equipment best suited for long term monitoring needs (static water-level and well depth). The equipment needed for the transducer includes pressure transducer, cable, adapters for computer and software.

2) Install manufacturer supplied software to computer(s) that will be used to interface with the transducers.

3) Install transducer onto cable and follow manufacturer's instructions.

4) Use an open-ended pipe perforated at its bottom and extending to at least the transducer setting or open casing void of a pump to provide protective housing for the transducer.

5) Measure the water level in the water-level measuring pipe or open casing with a steel tape following the steel tape measuring protocol.

6) Connect transducer cable to computer allowing software to establish signal to transducer.

7) Input correct settings for data recording task. Start with a data collection frequency of one measurement per hour. After signal established and transducer programmed, disconnect transducer from computer.

8) Install transducer in well at a depth deemed suitable to capture all anticipated water levels. Secure transducer and cable following manufacturer's recommendations to keep unit stable. Reconnect transducer to computer and program the pressure transducer so that water level measured is the same as the water level measured with the steel tape. Use ground level as the depth datum.

9) Record water level data for two months and download data. Measure water level in the well with a steel tape and record depth to water. Compare depth to water measured with the steel tape with the depth to water measured with the pressure transducer. Record both readings in the official record. Both readings should be within 1.0 foot of each other.

10) If pressure transducer and steel tape depth to water measurements are within 1.0 foot of each other after the first two months of data collection, record measurements in the official record and resume data collection. Repeat Step 9. If the water level measurements are not within 1.0 foot of each other, recalibrate or replace transducer and reinstall the recalibrated or new transducer. Record the transducer equipment change and any transducer depth setting change in the official record.

11) Program transducer to collect water-level data at least once per day and resume data collection. Repeat Steps 9 and 10.

Adopted August 11, 2016

Brazos Valley GCD
Airline Measuring Protocol

1. The well where the static water-level is to be measured should not be pumped for 24 hours, if possible, prior to taking the static water-level measurement. If the well has been pumped less than 24 hours prior to taking the water-level measurement, record in the official record how long the pump had been off prior to taking the measurement, if known. Confirm and indicate in the official record that no non-exempt well completed in the same aquifer within a ½ mile radius to the well being measured is being actively pumped at the time of taking the water-level measurement. Unless this can be confirmed, no water-level measurement should be taken. Obtain permission to collect measurement at a later time.

2. Prior to taking the water-level measurement, review previous measurements regarding how deep the water level may be encountered and records showing the depth setting of the air line.

3. Measure and record the height of the base of the pump discharge head above ground level, and this will become the measuring point. Describe the measuring point in the records for the well, and use the same measuring point each time when measuring the depth to water.

4. Determine the manufacturer of the gauge to be used, the serial number, and the date last calibrated. Record this in the official record.

5. Check and record depth of air line setting below ground level or below pump base based on air line setting data from well owner and/or pump setting contractor.

6. If well is equipped with a submersible pump, confirm and record in the official record that the pump is not in operation. Unless it is determined that the pump is not operational, no water-level measurement should be taken or recorded. Obtain permission to collect measurement for a later time.

7. Use an air or nitrogen source with adequate pressure to blow air out the bottom of the air line.

8. Open the valve on the air supply.

9. Attach the air hose nozzle to the valve on the air line.

10. The needle on the pressure gauge should rise to the approximate pressure at bottom of air line as the water has been purged from the bottom of the air line.

11. Remove the air hose nozzle, and then the needle on the pressure gauge will slowly descend and stabilize at the current water-level pressure. If this does not occur, have a

spare, quality pressure gauge available that can be installed and used on a temporary basis. Repeat Steps 7-10.

12. Record the measurement from the pressure gauge in units provided on the gauge. If the pressure gauge only has psi readings, multiply the psi reading by 2.31 to convert the reading to feet of water.

13. The recorded measurement in Item 12 is how many feet of water are above the bottom of the air line. Subtract the measurement from the depth setting of the air line to convert the measurement to depth to water below land surface. (Example: If air line is installed to a depth of 400 feet below land surface and the pressure gauge reading is 150 feet above the bottom of the air line, the depth to water from land surface is = 400’-150’= 250’ below land surface). If the air line setting is depth below the pump base, subtract the measuring point from the depth to water reading to calculate depth to water below land surface.

14. Only record data if the air gauge pressure holds constant for five minutes.

15. Record date and time of measurement.

Adopted August 11, 2016

Brazos Valley GCD
E-line Measuring Protocol

1. The well where the static water level is to be measured should not be pumped for 24 hours, if possible, prior to taking the static water-level measurements. If the well has been pumped less than 24 hours prior to taking the water-level measurement, record in the official record how long the pump has been off prior to taking the measurement, if known. Confirm and indicate in the official record that no non-exempt well completed in the same aquifer within a ½ mile radius to the well being measured is being actively pumped at the time of taking the water-level measurement. Unless this can be confirmed, no water-level measurement should be taken. Obtain permission to collect measurement at a later time.

2. If well is equipped with a submersible pump, confirm and record in the official record that the pump in not in operation. Unless it is determined that the pump in not operational, no water-level measurement should be taken or recorded. Obtain permission to collect measurement at a later time.

3. Identify a port or opening in the pump discharge head or in the pump foundation (surface casing vent pipe) that provides access for the e-line to the annulus between the surface casing and the pump column assembly, water-level measuring pipe or open casing if the well is not equipped with a pump.

4. Measure and record the height of the opening above ground level and this will become the measuring point. Describe the measuring point in the official record for the well, and use the same measuring point each time when measuring the water level. If not possible, record the height of the measuring point above land surface each time the water level is measured.

5. Prior to taking the water-level measurement, review previous water-level measurements to estimate the current water level depth.

6. Turn on power to the e-line and adjust sensitivity of sound meter to about halfway. If light used to detect water level, no need to adjust sound level.

7. Lower the e-line into the well until the e-line signals it has encountered the water level in the well. Retract the e-line about one foot above where the e-line signaled water encountered and slowly lower again until the water level is encountered again.

8. Hold the electric line with a fingertip at the measuring point when the water is encountered. Using the 0.01 feet markings on the electric line, determine depth to water to the nearest 0.01 of a foot and record in the official record.

9. Retract the e-line about 5 feet, wait five minutes and repeat the process to ensure an accurate reading has been made of a stable water level. If both measurements are not within 0.05-foot of each other, note in the field log and schedule for water-level measurement at a future date.

10. Subtract the measuring point height from the measured depth to water obtained in Step 8 to determine depth of water from land surface, and record in the official record.

11. Record date and time of measurement.

12. Retract the e-line from the well and clean the lower 20 feet with Clorox bleach wipes, bleach wipes with an equivalent percentage sodium hypochlorite or a minimum 0.5% sodium hypochlorite in solution (NaOCl and water) prior to measuring the water level in the next well.

13. Replace cap on any port in discharge head or casing. Leave the well and pump in same condition as observed on arrival.