Supplement

Effects of Vista Ridge Pumping and Additional Pumping by End Op, Forestar, and LCRA on Groundwater and Surface Water in the Lost Pines and Post Oak Savannah Groundwater Conservation Districts

George Rice
January 26, 2016

Introduction

This is a supplement to the report of September 22, 2015.[1] That report examined the effects of Vista Ridge pumping in the Lost Pines Groundwater Conservation District (LPGCD), and the Post Oak Savannah Groundwater Conservation District (POSGCD).[2] This supplement examines the effects of pumping by Vista Ridge, plus additional pumping by End Op L.P. (End Op), Forestar Real Estate Group (Forestar), and the Lower Colorado River Authority (LCRA).[3] The additional pumping would intensify the effects that would be caused by Vista Ridge pumping alone.

The effects of the pumping were estimated using the *Central Queen City and Sparta Groundwater Availability Model* (GAM).[4] The input files used to generate the results presented in this supplement were provided by LPGCD,[5] or are modifications of LPGCD-provided files.

Part 1 examines the effects of pumping that has been approved by LPGCD and POSGCD. Part 2 examines the effects of approved pumping plus pumping that has been requested by End Op and Forestar, but not yet approved, or approved only conditionally.[6] Part 3 examines the effects of pumping on flow in the Colorado and Brazos rivers.

---

[1] Rice 2015: *Effects of Vista Ridge Pumping on Groundwater and Surface Water in the Lost Pines and Post Oak Savannah Groundwater Conservation Districts*.

[2] Please refer to the earlier report (Rice 2015) for background information.

[3] Pumping by LCRA has already begun. Pumping by Vista Ridge (SAWS 2014), End Op (LPGCD and End Op 2015) and Forestar (LPGCD and Forestar 2015) will probably begin within the next few years.

[4] TWDB 2004; and LPGCD 2013. The GAM is based on the MODFLOW computer code developed by the U.S. Geological Survey (TWDB 2004, page 6-1).

[5] LPGCD 2013.

[6] End Op and the LPGCD have agreed to a settlement framework that, if finalized, would allow End Op to ramp-up pumping to 46,000 acre-feet per year (Austin American Statesman, September 10, 2015). Forestar has been given a permit that allows it to initially pump 12,000 acre-feet per year, and gives provisional approval to increase pumping to 20,000 and 28,500 acre-feet per year, but only when certain conditions are met (LPGCD and Forestar 2015; and Austin American Statesman, December 22, 2015).

Part 1

Effects of Currently Approved Pumping: Baseline plus Vista Ridge (50,000 acre-feet/year), End Op (25,000 acre-feet/year), Forestar (12,000 acre-feet/year), and LCRA (6,500 acre-feet/year)

Pumping that is currently approved by LPGCD and POSGCD is shown in table 1.

Table 1
Currently Approved Pumping Projects[7]

Entity	Pumping Rate (ac-ft/yr)	Pumping Period[8]	Source aquifer and county
Vista Ridge	35,000	2020 - 2060	Simsboro, Burleson
Vista Ridge	15,000	2020 - 2060	Carrizo, Burleson
End Op	25,000	2018 - 2060	Simsboro, Bastrop (25%) and Lee (75%)
Forestar	12,000	2017 - 2060	Simsboro, Lee
LCRA	6,500	2015 - 2060	Simsboro, Bastrop

Projected pumping from the Simsboro Aquifer in the LPGCD and POSGCD is depicted in figure 1. This figure shows baseline pumping[9] and baseline plus approved pumping projects. Pumping is projected to increase from approximately 57,000 acre-feet per year in 2010, to approximately 167,000 acre-feet per year in 2060.

The maximum and average drawdowns caused by the pumping are given in tables 2 and 3, respectively.[10] Figure 2 is a map of drawdowns in the Simsboro Aquifer.[11]

[7] Pumping rates and periods are based on final or preliminary agreements between pumpers and groundwater districts (SAWS 2014, LPGCD and End Op 2015, and LPGCD and Forestar 2015). LPGCD and End Op are currently negotiating a permit. Thus, the rate that will finally be permitted is not known. The value of 25,000 acre-feet per year is based on the settlement framework (LPGCD and End Op 2015).
[8] Estimated dates for the commencement and duration of pumping periods simulated in the GAM.
[9] Baseline pumping is an estimate of the amount of past, present, and future pumping. It does not include proposed projects by Vista Ridge, End Op, Forestar, or LCRA. Baseline pumping from the Simsboro in 2000 is approximately 11,300 acre-feet per year in the LPGCD and 12,200 acre-feet per year in the POSGCD. For 2060, baseline pumping is 40,400 acre-feet per year in the LPGCD and 48,500 acre-feet per year in the POSGCD. Baseline pumping values taken from the file Run50.wel (LPGCD, 2013).
[10] The values in these tables do not include drawdowns due to baseline pumping.
[11] The GAM is the best tool available for estimating drawdowns in the LPGCD and the POSGCD. However, there is evidence that the manner in which faults are represented in the GAM causes the model to over-estimate drawdowns on the side of the fault where pumping takes place, and under-estimate drawdowns on the other side of the fault (Young, S., 2015). An updated GAM is being developed. Major purposes of the update are to improve the representation of faults, and to improve estimates of groundwater/surface water interaction (Young, S., and Harden, B., 2015). The updated GAM is scheduled to be released in December, 2017 (Young, S., and Harden, B., 2015).

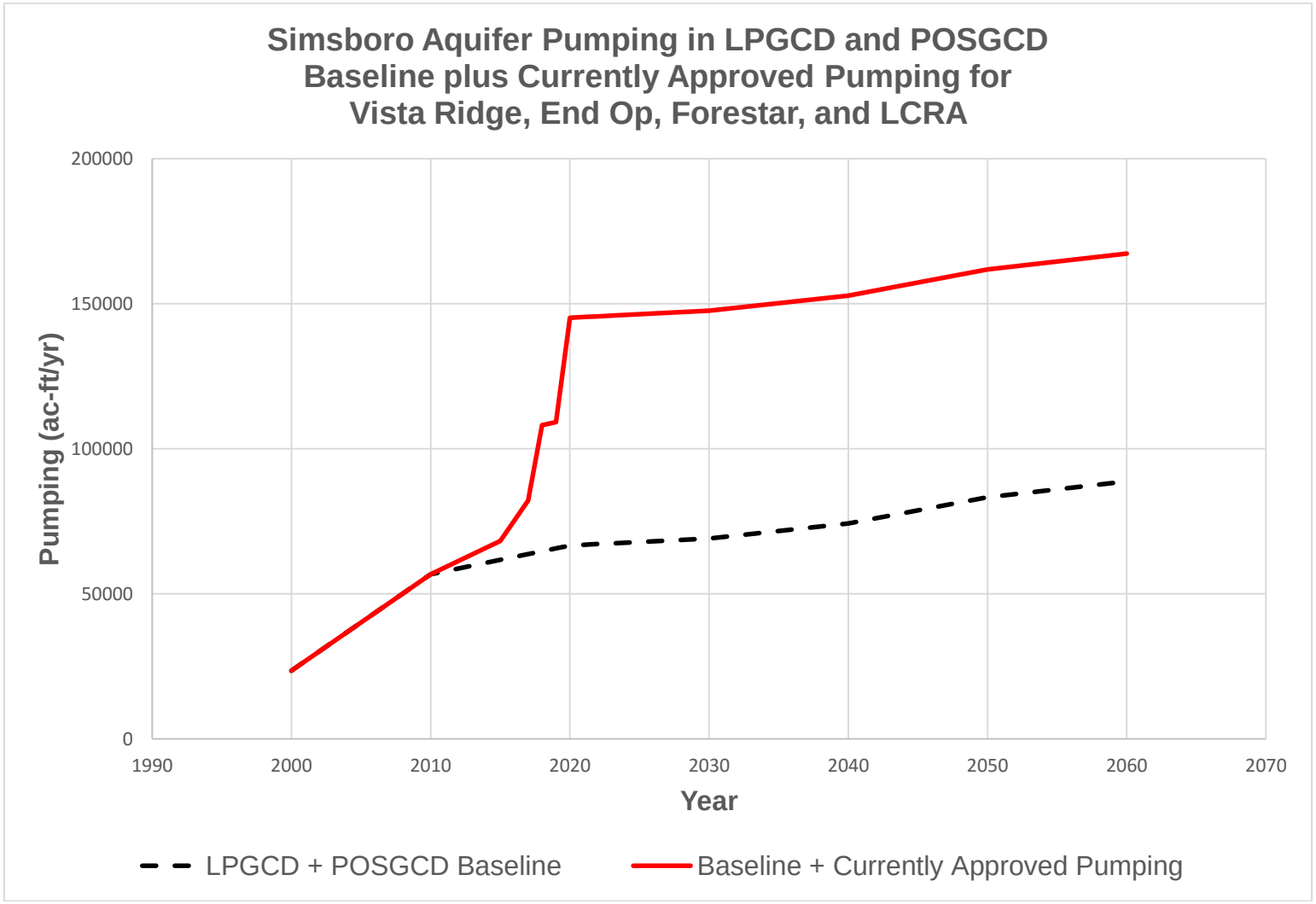

Figure 1
Projected Simsboro Aquifer pumping, Part 1

Table 2
GAM Predictions of Maximum Drawdowns in 2060
Due to Currently Approved Pumping

Aquifer	Maximum drawdown (ft)[12]
Hooper	145
Simsboro	572
Calvert Bluff	135
Carrizo	223
Queen City	30

Table 3
GAM Predictions of Average Drawdowns in the Simsboro Aquifer in 2060
Due to Currently Approved Pumping

County or GCD[13]	Average drawdown (ft)
Bastrop	124
Lee	315
Burleson	250
Milam	70
LPGCD	213
POSGCD	178

The LPGCD and the POSGCD have adopted Desired Future Conditions (DFCs) for the aquifers in their districts. The DFCs are average drawdowns that occur between the years 2000 and 2060.[14] The goal is to keep average drawdowns less than the DFC. The DFCs adopted for the Simsboro Aquifer by the LPGCD and the POSGCD are 237 feet and 300 feet, respectively.[15] Tables 4 and 5 shows GAM predictions of average drawdowns from 2000 to 2060 in the LPGCD and the POSGCD.

[12] Drawdowns at Vista Ridge wellfield.
[13] GCD: Groundwater Conservation District.
[14] GMA 12, 2010, appendix B, first page.
[15] GMA 12, 2010, appendix B, Table B-1.

Table 4
GAM Predictions of Average Simsboro Drawdowns in LPGCD
Due to Currently Approved Pumping[16]

Year	GCD	DFC (ft)	Baseline drawdown (ft)[17]	Drawdown due to additional pumping (ft)	Baseline plus Additional drawdown (ft)
2000	LPGCD		0 (34)	0	0
2010	LPGCD	237	27	0	27
2020	LPGCD	237	85	149	234
2030	LPGCD	237	130	186	316
2040	LPGCD	237	158	196	354
2050	LPGCD	237	186	205	391
2060	LPGCD	237	209	213	422

The GAM predicts that the LPGCD Simsboro DFC will be exceeded soon after 2020. Pumping in the LPGCD is projected to increase from 11,300 acre-feet per year in 2000 to 71,700 acre-feet per year in 2020.

Table 5
GAM Predictions of Average Simsboro Drawdowns in POSGCD
Due to Currently Approved Pumping[18]

Year	GCD	DFC (ft)	Baseline drawdown (ft)[19]	Drawdown due to additional pumping (ft)	Baseline plus Additional drawdown (ft)
2000	POSGCD		0 (73)	0	0
2010	POSGCD	300	41	0	41
2020	POSGCD	300	119	124	243
2030	POSGCD	300	181	159	340
2040	POSGCD	300	218	166	384
2050	POSGCD	300	254	172	426
2060	POSGCD	300	279	178	457

The GAM predicts that the POSGCD Simsboro DFC will be exceeded between 2020 and 2030. Pumping in the POSGCD is projected to increase from 12,200 acre-feet per year in 2000 to 73,500 acre-feet per year in 2020.

[16] Baseline plus Vista Ridge (35,000 (Simsboro)), End Op (25,000), Forestar (12,000), LCRA (6500) (all values in acre-feet per year).
[17] Drawdown since year 2000. Drawdowns from the beginning of simulation (1975) to 2000 were 34 feet and 73 feet in the LPGCD and POSGCD, respectively.
[18] Baseline plus Vista Ridge (35,000 (Simsboro)), End Op (25,000), Forestar (12,000), LCRA (6500) (all values in acre-feet per year).
[19] Drawdown since year 2000. Drawdowns from the beginning of simulation (1975) to 2000 were 34 feet and 73 feet in the LPGCD and POSGCD, respectively.

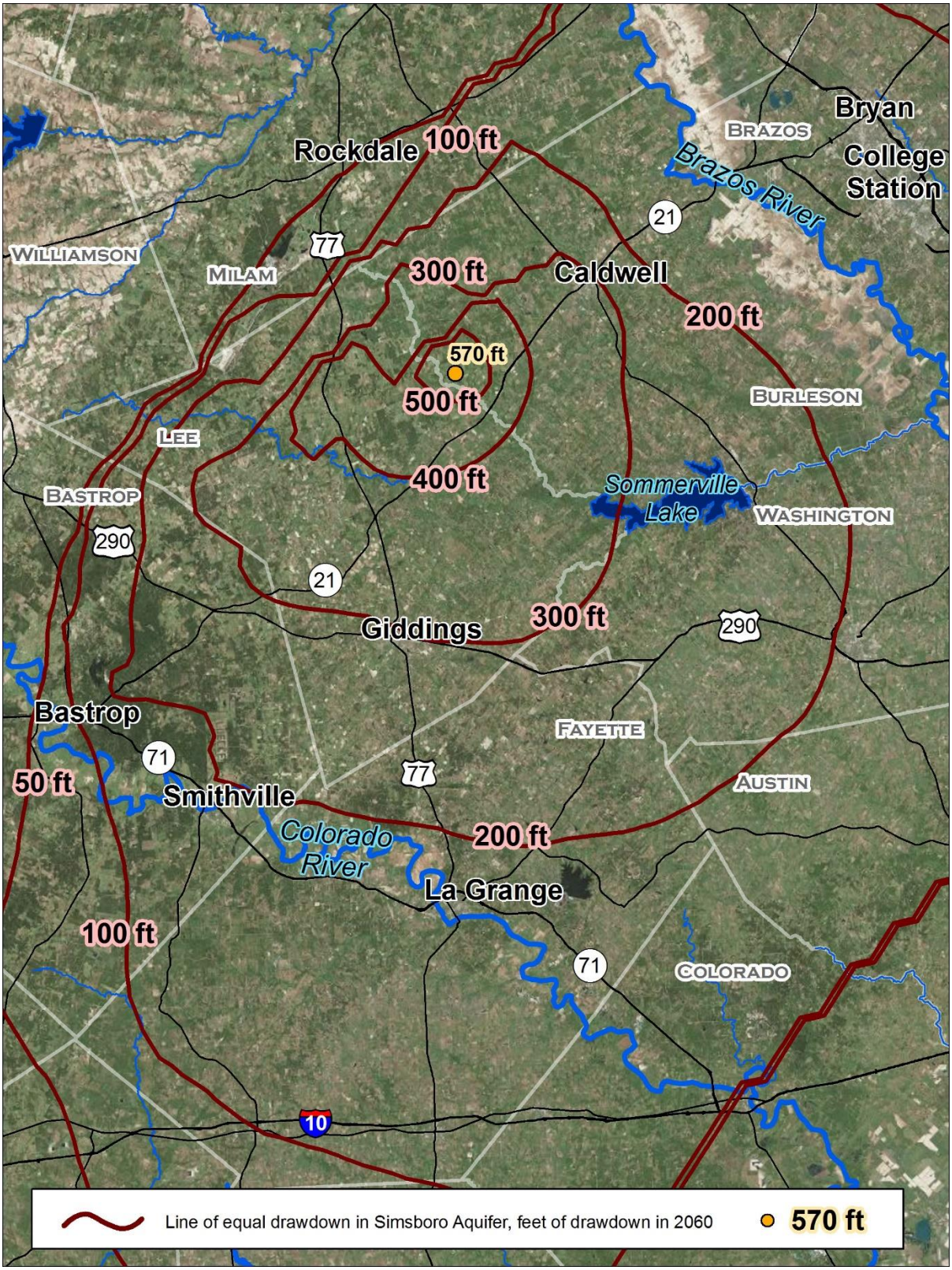

Figure 2
GAM Prediction of Drawdowns in the Simsboro Aquifer in 2060
Due to Pumping by Vista Ridge (35,000) plus End Op (25,000),
Forestar (12,000), and LCRA (6500) (all values in acre-feet per year)

Part 2

Effects of Currently and Conditionally Approved Pumping: Baseline plus Vista Ridge (50,000 acre-feet/year), End Op (46,000 acre-feet/year), Forestar (28,500 acre-feet/year), and LCRA (6,500 acre-feet/year)

Pumping that is currently or conditionally approved by LPGCD and POSGCD is shown in table 6. Conditionally approved pumping is 37,500 acre-feet per year greater than currently approved pumping.

Table 6
Currently and Conditionally Approved Pumping[20]

Entity	Pumping Rate (ac-ft/yr)	Pumping Period[21]	Source aquifer and county
Vista Ridge	35,000	2020 - 2060	Simsboro, Burleson
Vista Ridge	15,000	2020 - 2060	Carrizo, Burleson
End Op	25,000	2018 - 2019	Simsboro, Bastrop (25%) and Lee (75%)
End Op	36,000	2020 - 2022	Simsboro, Bastrop (25%) and Lee (75%)
End Op	46,000	2023 - 2060	Simsboro, Bastrop (25%) and Lee (75%)
Forestar	12,000	2017 - 2019	Simsboro, Lee
Forestar	20,000	2020[22] - 2022	Simsboro, Lee
Forestar	28,500	2023 - 2060	Simsboro, Lee
LCRA	6,500	2015 - 2060	Simsboro, Bastrop

Projected pumping from the Simsboro Aquifer in the LPGCD and POSGCD is depicted in figure 3. This figure shows baseline pumping, and baseline plus currently and conditionally approved pumping. Pumping is projected to increase from approximately 57,000 acre-feet per year in 2010, to approximately 205,000 acre-feet per year in 2060.

---

[20] Pumping rates and periods are based on final or preliminary agreements between pumpers and groundwater districts (SAWS 2014, LPGCD and End Op 2015, and LPGCD and Forestar 2015). End Op pumping rates are based on a preliminary settlement framework between LPGCD and End Op (LPGCD and End Op 2015). The End Op Permit is still under negotiation. Forestar pumping rates are based on the permit issued by LPGCD. The permit allows Forestar to pump 12,000 acre-feet per year, and gives provisional approval to increase pumping to 20,000 and 28,500 acre-feet per year, but only when certain conditions are met (LPGCD and Forestar 2015; and Austin American Statesman, December 22, 2015).

[21] Estimated dates for the commencement and duration of pumping are based on agreements between the GCDs and the pumpers (SAWS 2014, LPGCD and End Op 2015, and LPGCD and Forestar 2015).

[22] The most recent available version of the permit contains a new provision (Special condition (3)(c)(i)). This provision would not allow Forestar to pump at a rate of 20,000 acre-feet per year until December 2020. In the GAM simulation, Forestar pumping of 20,000 acre-feet per year begins in January 2020. This new provision would also cause the date at which Forestar could begin pumping at a rate of 28,500 acre-feet per year to be delayed for about a year; from January 2023 to December 2023. The net effect of this change would be to reduce the total amount of pumping between 2017 and 2060 by 16,500 acre-feet. This is approximately 0.2% of the total amount of pumping that would occur during this period (8,120,000 acre-feet).

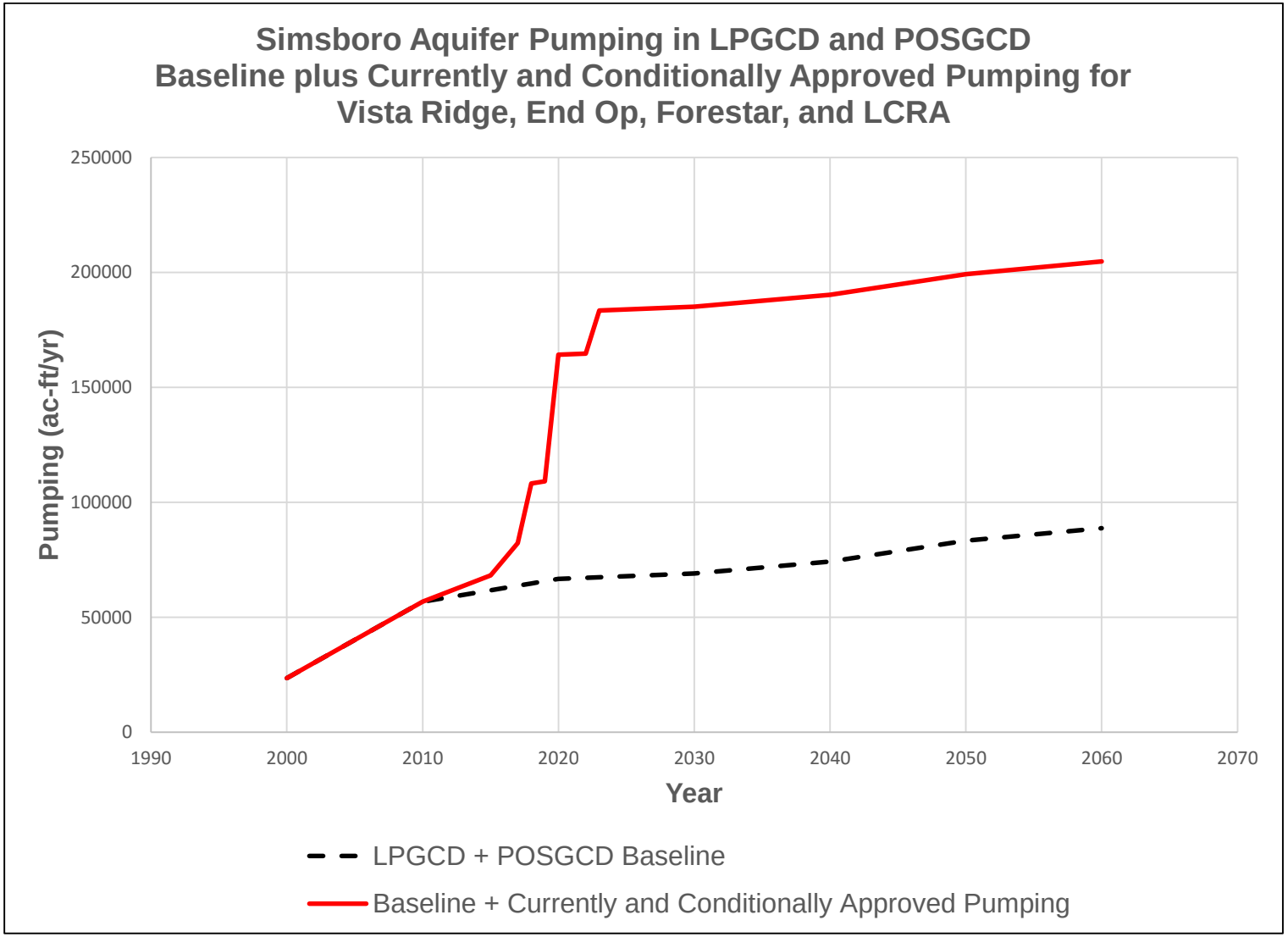

Figure 3
Projected Simsboro Aquifer pumping, Part 2

The maximum and average drawdowns caused by the pumping are given in tables 7 and 8, respectively.[23] Figure 4 is map of drawdowns in the Simsboro Aquifer.

Table 7
GAM Predictions of Maximum Drawdowns in 2060
Due to Currently and Conditionally Approved Pumping

Aquifer	Maximum drawdown (ft)[24]
Hooper	197
Simsboro	687
Calvert Bluff	172
Carrizo	229
Queen City	31

Table 8
GAM Predictions of Average Drawdowns in the Simsboro Aquifer
Due to Currently and Conditionally Approved Pumping

County or GCD[25]	Average drawdown (ft)
Bastrop	173
Lee	437
Burleson	328
Milam	103
LPGCD	296
POSGCD	238

Tables 9 and 10 show the average Simsboro Aquifer drawdowns in the LPGCD and POSGCD from 2000 to 2060.

[23] The values in these tables do not include drawdowns due to baseline pumping.
[24] Drawdowns at Vista Ridge wellfield.
[25] GCD: Groundwater Conservation District.

Table 9
GAM Predictions of Average Simsboro Drawdowns in LPGCD
Due to Currently and Conditionally Approved Pumping

Year	GCD	DFC (ft)	Baseline drawdown (ft)[26]	Drawdown due to additional pumping (ft)	Baseline plus Additional drawdown (ft)
2000	LPGCD		0 (34)	0	0
2010	LPGCD	237	27	0	27
2020	LPGCD	237	85	175	260
2030	LPGCD	237	130	252	382
2040	LPGCD	237	158	269	427
2050	LPGCD	237	186	283	469
2060	LPGCD	237	209	296	505

The GAM predicts that the LPGCD Simsboro DFC will be exceeded in 2020. Projected pumping in the LPGCD will increase from 11,300 acre-feet per year in 2000 to 90,700 acre-feet per year in 2020.

Table 10
GAM Predictions of Average Simsboro Drawdowns in POSGCD, 2000 - 2060
Due to Currently and Conditionally Approved Pumping

Year	GCD	DFC (ft)	Baseline drawdown (ft)[27]	Drawdown due to additional pumping (ft)	Baseline plus Additional drawdown (ft)
2000	POSGCD	300	0 (73)	0	0
2010	POSGCD	300	41	0	41
2020	POSGCD	300	119	142	261
2030	POSGCD	300	181	209	390
2040	POSGCD	300	218	220	438
2050	POSGCD	300	254	230	484
2060	POSGCD	300	279	238	517

The GAM predicts that the POSGCD Simsboro DFC will be exceeded between 2020 and 2030. Pumping in the POSGCD is projected to increase from 12,200 acre-feet per year in 2000 to 73,500 acre-feet per year in 2020.

[26] Drawdown since year 2000. Drawdown from the beginning of simulation (1975) to 2000 was 34 feet in the LPGCD.
[27] Drawdown since year 2000. Drawdown from the beginning of simulation (1975) to 2000 was 73 feet in the POSGCD.

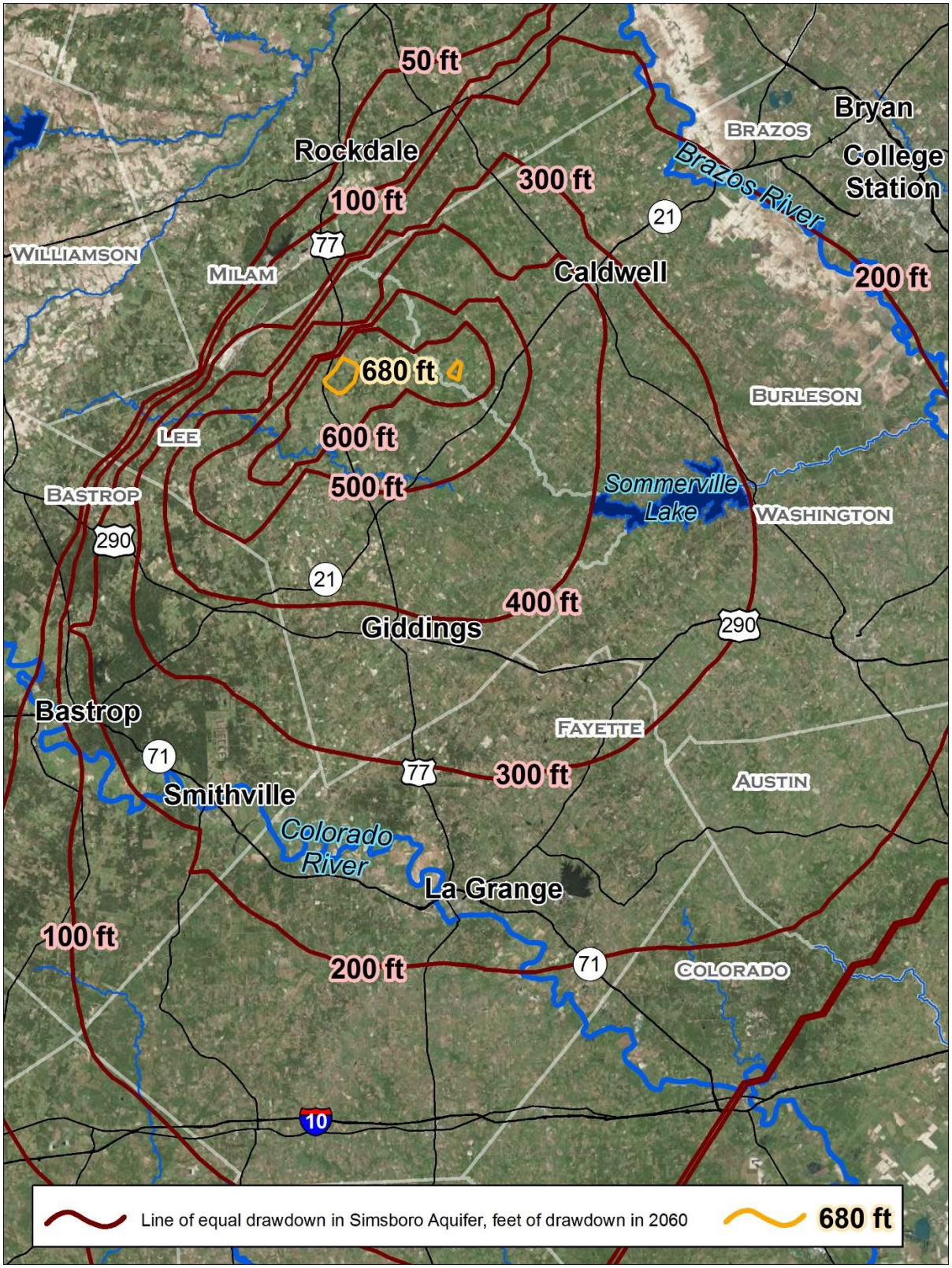

Figure 4
GAM Prediction of Drawdowns in the Simsboro Aquifer in 2060
Due to Pumping by Vista Ridge (35,000) plus End Op (46,000),
Forestar (28,500), and LCRA (6500) (all values in acre-feet per year)

Part 3

Effects of Pumping on Groundwater Discharge to the Colorado and Brazos Rivers

Groundwater discharge contributes to the flow of both the Colorado and Brazos rivers. The GAM predicts that groundwater discharges to the Colorado and Brazos rivers will decrease as a result of groundwater pumping. The decreases due to the pumping examined in part 2 of this supplement are shown in figures 5 and 6.[28]

Although the GAM predicts the amount of groundwater discharge to the rivers over time, as well as trends in groundwater discharge, there is reason to believe that 1) the amount of discharge predicted by the GAM is not reliable, and 2) the trend predicted by the GAM is probably reliable.[29] The basis for these claims is presented in appendix 1 of the earlier report.[30]

Conclusions

Additional pumping by End Op, Forestar, and LCRA would increase the effects caused by Vista Ridge pumping alone. It would:

- Reduce hydraulic heads in the Hooper, Simsboro, Calvert Bluff, Carrizo, and Queen City aquifers.
- Where these aquifers are confined, the reduced heads would cause water levels in wells to decline.
- Where these aquifers are unconfined (recharge areas), the reduced heads would cause dewatering of portions of the aquifers.
- Result in the LPGCD and POSGCD exceeding their adopted Simsboro Aquifer DFCs before 2060.
- Reduce groundwater discharge to the Colorado and Brazos rivers, thereby reducing the amount of water flowing in these streams.

[28] The results for the Colorado River and its tributaries are for the end of time step ten in stream segments 36 through 48. The results for the Brazos River and its tributaries are for the end of time step ten in stream segments 49, 50, 51, 52, 53, 55, 56, 57, 58, 59, 60.

[29] According to simulations by Huang et al., groundwater pumping in the region represented by the GAM will continue to reduce the discharge of groundwater to streams. Over a 50 year period, the percentage of pumped groundwater derived from streams will increase from about 18% to 24% (Huang et al., 2012, page 10 and figure 8).

[30] Rice 2015.

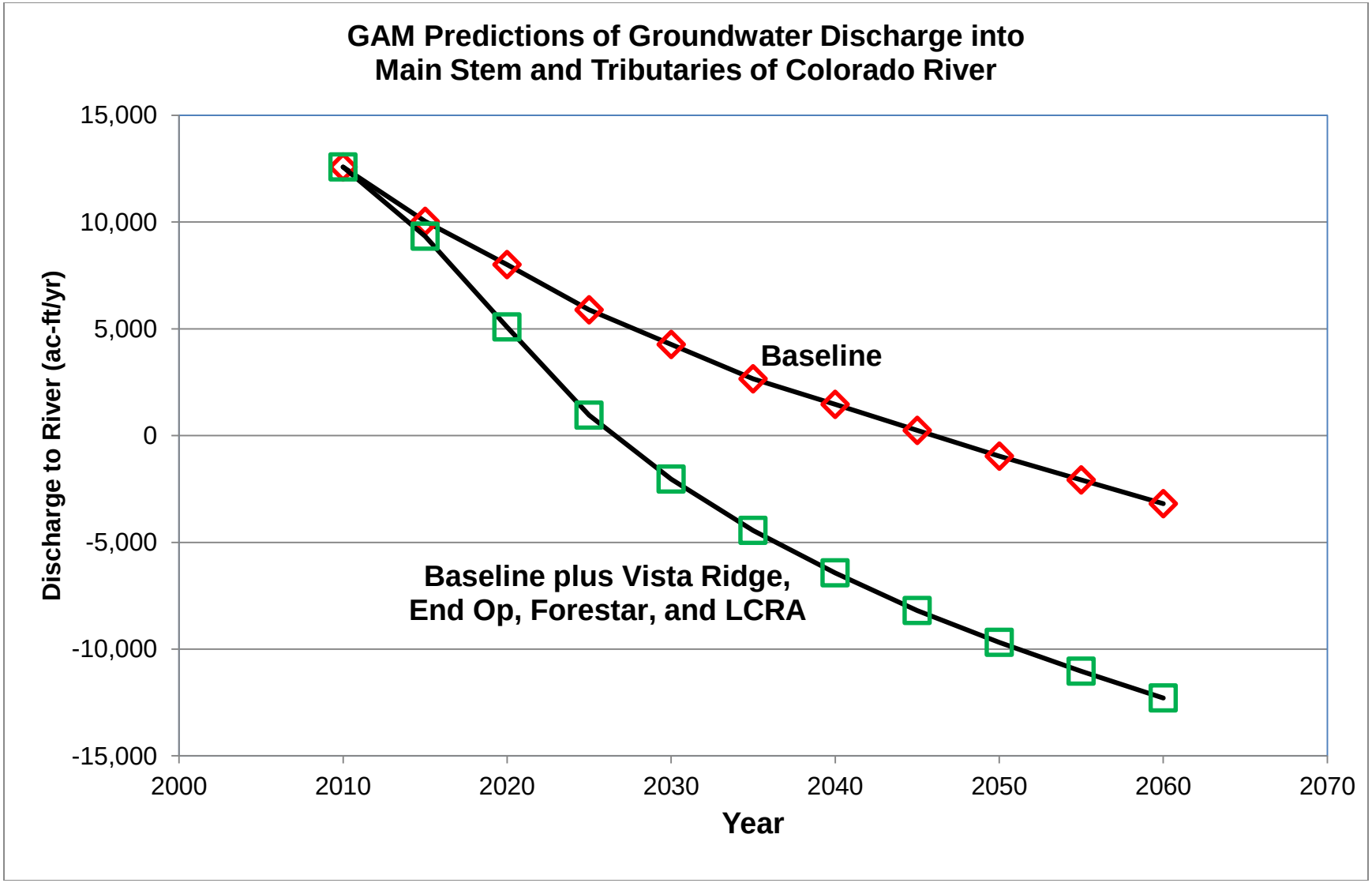

Figure 5
GAM Prediction of Groundwater Discharge to Colorado River and its Tributaries

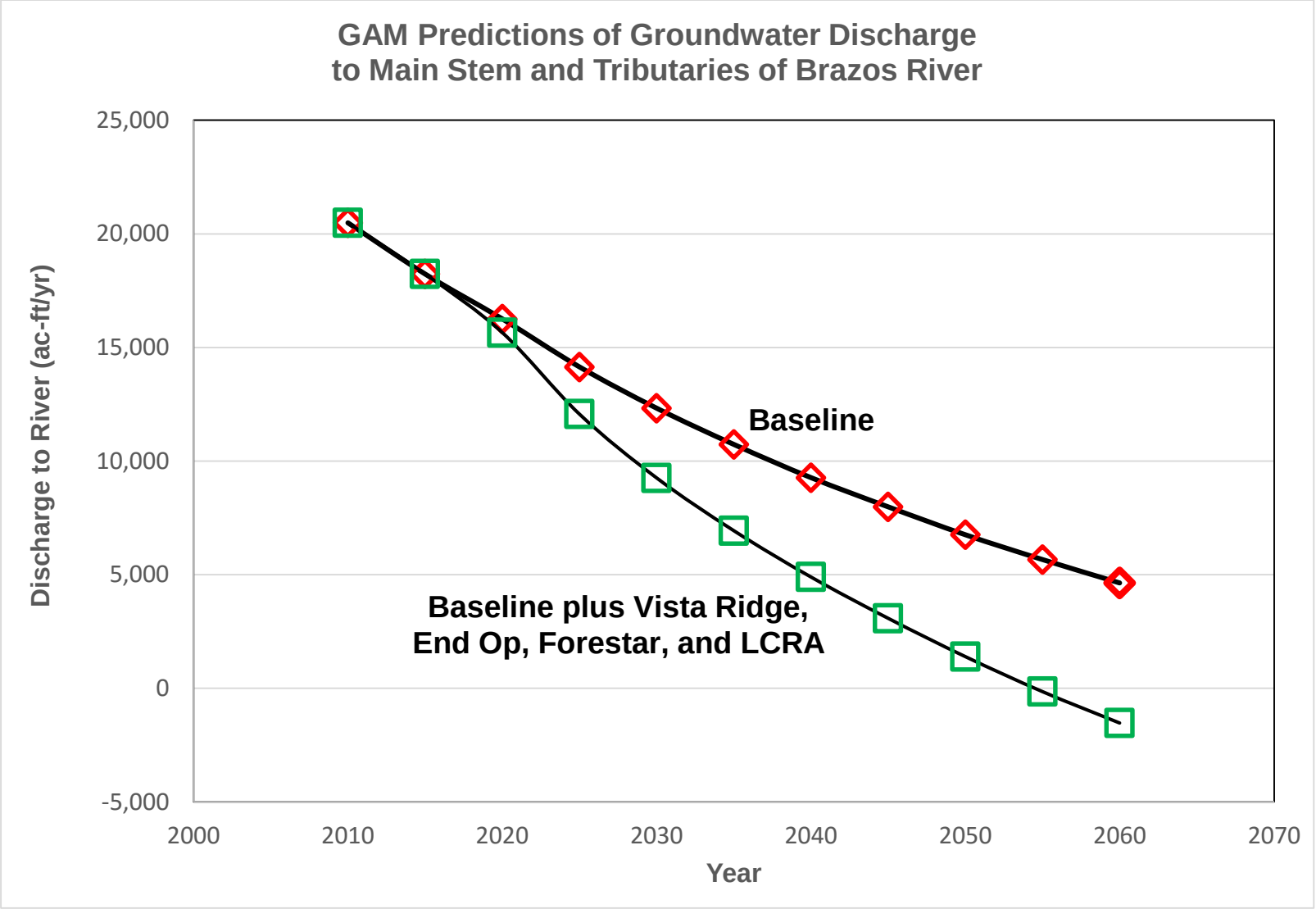

Figure 6
GAM Prediction of Groundwater Discharge to Brazos River and its Tributaries

5.0 References

GMA 12, 2010, (Groundwater Management Area 12), *Resolution to Adopt Desired Future Conditions for Aquifer(s) in Groundwater Management 12*, August 11, 2010.

Huang et al., 2012, Yun Huang, Bridget R. Scanlon, Jean-Philippe Nicot, Robert C. Reedy, Alan R. Dutton, Van A. Kelley, Neil E. Deeds, *Sources of groundwater pumpage in a layered aquifer system in the Upper Gulf Coastal Plain, USA,* in Hydrogeology Journal, v. 20, pages 783–796, 13 April, 2012.

LPGCD, 2013, (Lost Pines Groundwater Conservation District), input, output, and summary files related to LPGCD's GAM runs.

LPGCD and End Op, 2015, Confidential Settlement Framework Subject to Rule 408, TRCP.

LPGCD and Forestar, 2015, Draft *Lost Pines Groundwater Conservation District Operation Permit, District Well Number: 5933122,* December 2015.

Rice, G., 2015, *Effects of Vista Ridge Pumping on Groundwater and Surface Water in the Lost Pines and Post Oak Savannah Groundwater Conservation Districts*, September 22, 2015.

SAWS, 2014, (San Antonio Water System), *Draft Vista Ridge Regional Supply Project Water Transmission and Purchase Agreement*, September 21, 2014.

TWDB, 2004, (Texas Water Development Board), *Groundwater Availability Models for the Queen City and Sparta Aquifers*, October, 2004.

Young, Steven, 2015, *Comments Regarding Predictive Simulations 1 through 4 and Preliminary Evaluation of Potential DFCs for the Simsboro Aquifer*, presentation given at Milano Civic Center, Milam, TX, March 27, 2015.

Young, S., and Harden, B, 2015*, Effect of Faults on Groundwater Flow in the Carrizo-Wilcox Aquifer in Central Texas: Update the Central GAM for Sparta, Queen City, Carrizo-Wilcox Aquifers*, Stakeholder Meeting #1, November 20, 2015, Milano Civic Center.