Evaluation of End Op's Proposal to Pump Groundwater from the Simsboro Aquifer

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1.0 Introduction

End Op is proposing to pump between 30,000 and 46,000 acre feet of water per year from the Simsboro Aquifer in Bastrop and Lee counties, Texas. End Op's pumping would affect groundwater levels and the discharge of groundwater to the Colorado River.

The effects of End Op's pumping were estimated using the Lost Pines Groundwater Conservation District's (LPGCD) version of the *Central Queen City and Sparta Groundwater Availability Model* (GAM)[1]. The input files used to generate the results presented in this report were provided by the LPGCD[2]. Figure 1 shows the geologic units represented in the GAM.

2.0 Effects on groundwater

End Op's pumping would affect the Carrizo, Calvert Bluff, Simsboro, and Hooper aquifers. The pumping would create a cone of depression (region of reduced hydraulic heads) that extends to both the confined[3] and unconfined[4] (recharge zone) portions of the aquifers.

Where the aquifers are confined, the reduced heads would cause water levels in wells to decline. Where the aquifers are unconfined, the reduced heads would cause dewatering of the affected portions of the aquifers. These effects are discussed below.

[1] 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).

[2] LPGCD 2013. Note: the author added End Op's proposed pumping to LPGCD's new baseline pumping file (RUN50.wel). Beginning in 2015 (stress period 41) and continuing through 2060 (stress period 86) simulated pumpage of 255, 734 ft^3/day (for the 30,000 acre-feet simulation) and 392,212 ft^3/day (for the 46,000 acre-feet simulation) was added to each of the fourteen model cells that represent the locations of End Op's proposed wells.

[3] A confined aquifer is buried below geologic units that have a relatively low hydraulic conductivity. When a well taps a confined aquifer, the water level in the well will rise above the top of the aquifer.

[4] Unconfined aquifers are usually exposed at land surface. The water level in a well tapping an unconfined aquifer represents the position of the water table in the aquifer.

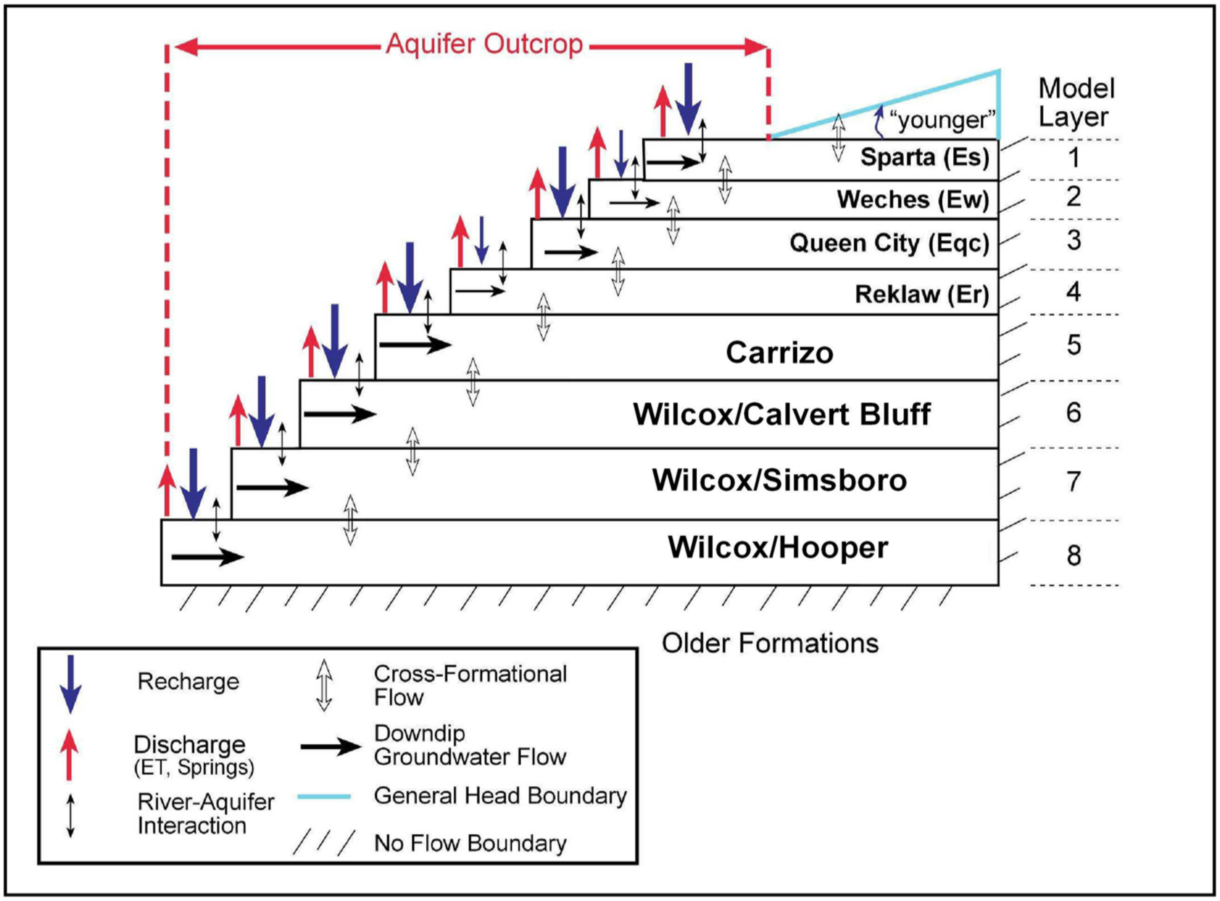

Figure 1
Geologic Units Represented in the GAM
(adapted from TWDB, 2004, figure 5.1)

2.1 Simsboro Aquifer

End Op's pumping would reduce hydraulic heads in the Simsboro Aquifer. The effects would extend to both the confined and unconfined portions of the Simsboro Aquifer. Where the aquifer is confined, the reduction in heads will reduce water levels in wells that draw water from the aquifer. Where the aquifer is unconfined, the reduction in heads will dewater portions of the aquifer.

2.2 Leakage from other aquifers

The effects of End Op's pumping would not be limited to the Simsboro Aquifer. The pumping would induce leakage from the Carrizo, Calvert Bluff, and Hooper aquifers. The position of these aquifers relative to the Simsboro is shown in figure 1.

Leakage is a common and well-known phenomenon that is discussed in standard hydrology texts[5]. In figure 1, leakage (cross-formational flow) between geologic units is indicated by double-headed arrows. In a pump test conducted in 2009, End Op's hydrologist estimated that 22% of the water pumped from the Simsboro was derived from leakage from adjacent aquifers[6].

Tables 1 and 2 show the effects of End Op's pumping on the Carrizo, Calvert Bluff, Simsboro, and Hooper aquifers. It should be noted that the drawdowns shown in tables 1 and 2 would be in addition to the drawdowns due to baseline pumping (table 3).

Table 1
GAM Predicted Drawdowns in 2060 due to End Op Pumping of 30,000 acre-feet per year[7]

Aquifer (model Layer)	Maximum drawdown (ft)	Average drawdown throughout LPGCD (ft)	Average Drawdown in Bastrop County (ft)	Average Drawdown in Lee County (ft)
Carrizo (5)	4	2	1	3
Calvert Bluff (6)	29	16	13	19
Simsboro (7)	270	74	76	71
Hooper (8)	32	22	18	28

Table 2
GAM Predicted Drawdowns in 2060 due to End Op Pumping of 46,000 acre-feet per year[8]

Aquifer (model Layer)	Maximum drawdown (ft)	Average drawdown throughout LPGCD (ft)	Average Drawdown in Bastrop County (ft)	Average Drawdown in Lee County (ft)
Carrizo (5)	5	3	2	4
Calvert Bluff (6)	44	24	20	28
Simsboro (7)	413	111	114	108
Hooper (8)	48	33	27	40

[5] See, for example, Davis and DeWiest 1966, pages 224 – 229; and Freeze and Cherry, 1979, pages 320 – 324.
[6] Thornhill 2009, page 8.
[7] Drawdowns calculated by comparing GAM runs for baseline pumping (well file RUN50.wel) and baseline pumping plus End Op pumping of 30,000 acre-feet per year.
[8] Drawdowns calculated by comparing GAM runs for baseline pumping (well file RUN50.wel) and baseline pumping plus End Op pumping of 46,000 acre-feet per year.

Table 3
GAM Predicted Drawdowns in 2060 due to Baseline Pumping[9]

Aquifer (model Layer)	Maximum drawdown (ft)	Average drawdown throughout LPGCD (ft)	Average Drawdown in Bastrop County (ft)	Average Drawdown in Lee County (ft)
Carrizo (5)	111	60	50	68
Calvert Bluff (6)	211	99	60	140
Simsboro (7)	507	241	147	349
Hooper (8)	261	134	88	195

3.0 Effects on groundwater discharges to Colorado River

The GAM simulates the effects of groundwater pumping on groundwater discharges to the Colorado River. There are two questions regarding the simulations. First, can the GAM accurately predict the amount of discharge that will occur? Second, can the GAM reliably predict trends in the discharge?

3.1 GAM predictions of amount of discharge

The answer to the first question appears to be no. Groundwater discharges to the Colorado River have been measured for the Carrizo-Wilcox Aquifer[10] in Bastrop County[11]. The measurements ranged from about 22,000 to 36,000 acre-feet per year (table 4).

Table 4
Measured Groundwater Discharge to the Colorado River
From the Carrizo-Wilcox Aquifer in Bastrop County[12], [13]

Year	Discharge (cfs)	Discharge (ac-ft/yr)	Remarks
1918	36	26,060	USGS
2005	50	36,200	LCRA
2008	30	21,720	Saunders

However, between the years 2000 to 2010, the GAM predicts groundwater discharges between 8,000 and 12,000 acre-feet per year (figure 2). Clearly, these predictions are inaccurate.

[9] Drawdowns for new baseline pumping (well file RUN50.wel).
[10] The Wilcox Aquifer consist of three parts: the Calvert Bluff, Simsboro, and Hooper aquifers.
[11] Saunders 2009.
[12] Saunders 2009, page 3.
[13] Note: modeling performed by the TWDB estimated the discharge to the Colorado River to be approximately 45,000 acre-feet per year (TWDB/LCRA, 1989, page 45).

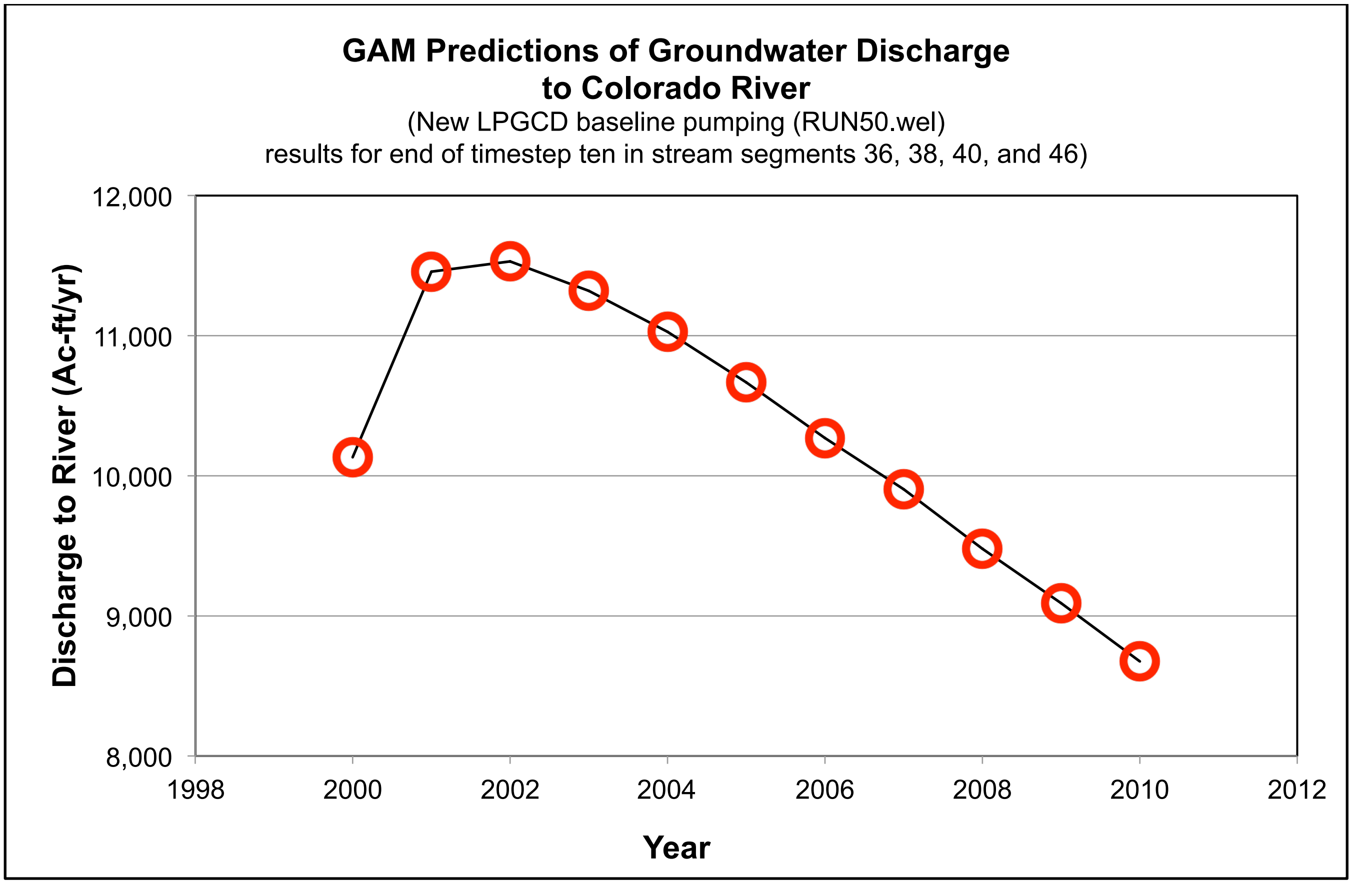

Figure 2
GAM Predicted Discharges to Colorado River
(note: this simulation used the new LPGCD baseline pumping file (RUN50.wel), no additional pumping)

3.2 GAM predictions of discharge trends

The answer to the second questions appears to be yes. This is because GAM results are consistent with what groundwater discharges would be expected to do in response to pumping. That is, we would expect the following:

- Pumping rates: higher groundwater pumping rates should result in less discharge to the river.
- Duration of pumping: longer durations should result in less discharge to the river.
- Distance of pumping: pumping closer to the river should have a greater effect than pumping farther from the river.

3.2.1 Pumping rates

GAM predictions are consistent with expectations regarding the effect of pumping rates. Figure 3 shows that the GAM predicts less discharge to the river when pumping is increased by 46,000 acre-feet per year over baseline pumping rates, and more discharge when water is injected at a rate of 46,000 acre-feet per year over baseline rates.

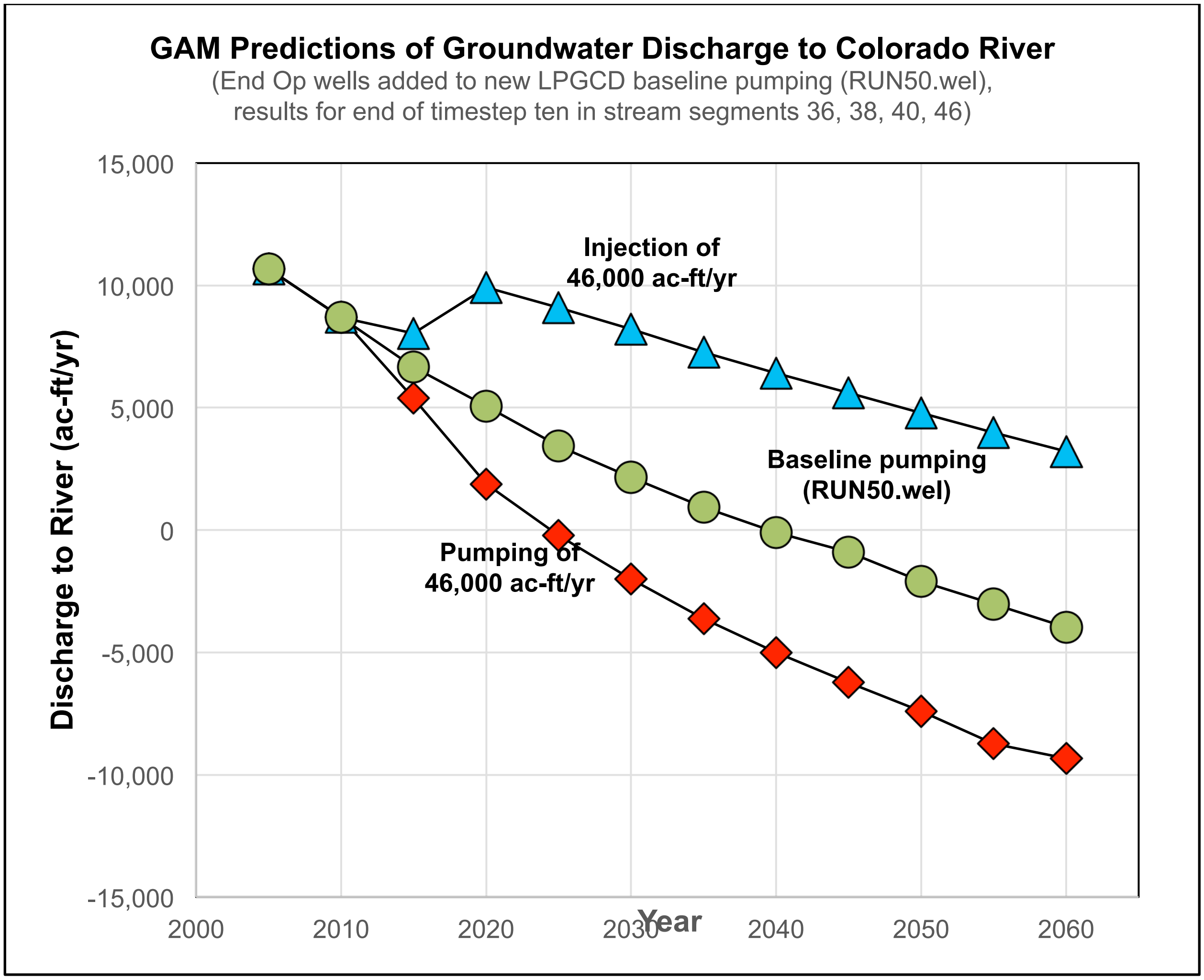

Figure 3
GAM Predicted Effects of Varying Pumping Rates and Pumping Duration

3.2.2 Pumping duration

GAM predictions are consistent with expectations regarding the effect of pumping duration. That is, longer pumping times result in less discharge to the river (figure 3).

3.2.2 Distance of Pumping

GAM predictions are consistent with expectations regarding the effect of distance. Figure 4 illustrates the effects of pumping from four wells at a rate of 3400 acre-feet per year over baseline rates. The GAM predicts less discharge due to pumping wells that are adjacent to the river than for pumping wells that are approximately one mile from the river.

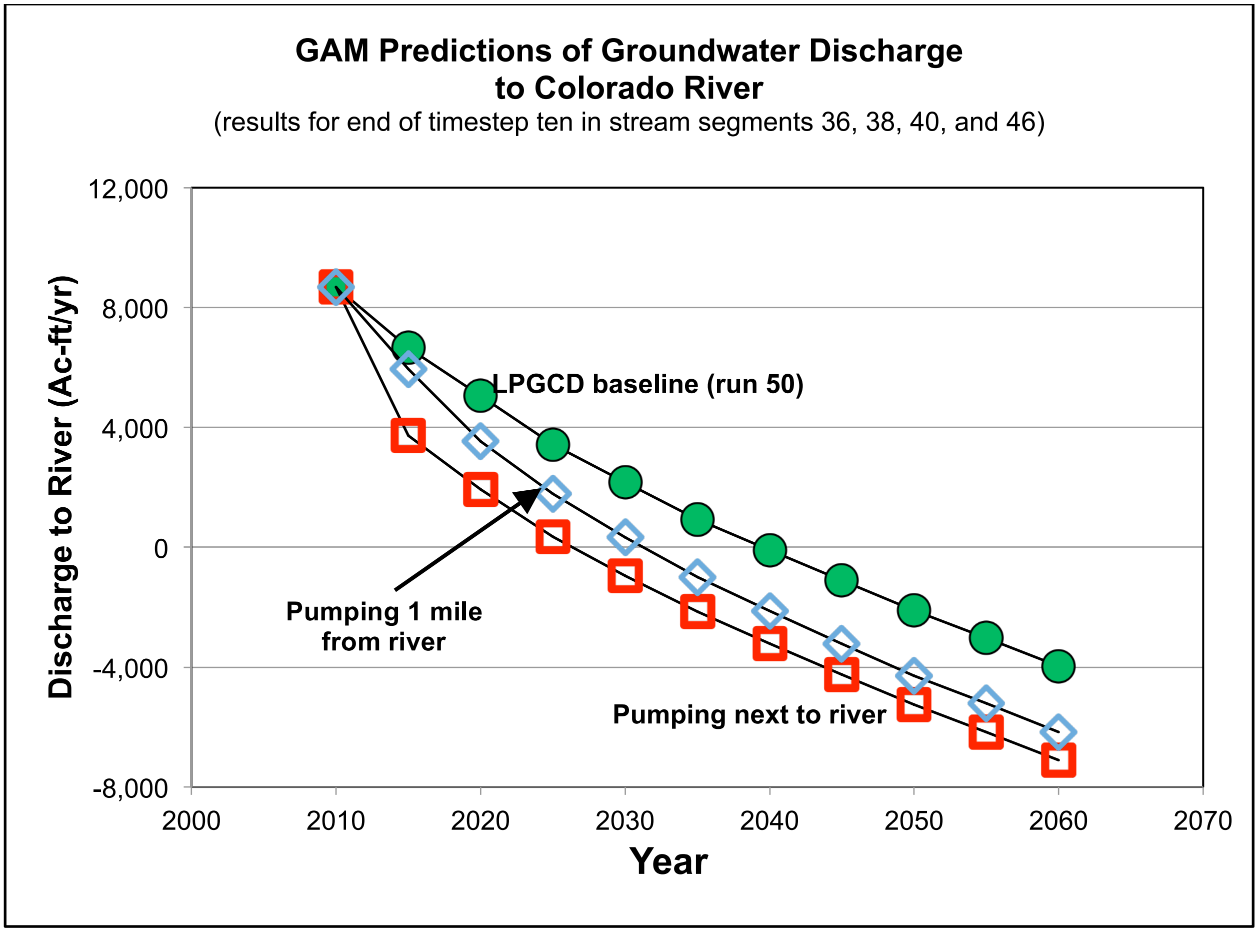

Figure 4
GAM Predicted Effects of Pumping Distance
(note: these simulations used the new LPGCD baseline pumping file (RUN50.wel))

The results presented above indicate that the GAM can reliably predict how pumping will affect trends in the discharge of groundwater to the Colorado River.

3.3 Effects of End Op's proposed pumping on discharges to the Colorado River

As shown above, the GAM does not accurately predict the effect of pumping on the amount of groundwater discharged to the Colorado River. It does, however, reliably predict the trends in groundwater discharge resulting from pumping.

Figure 5 shows that End Op's pumping would decrease groundwater discharge to the Colorado River.

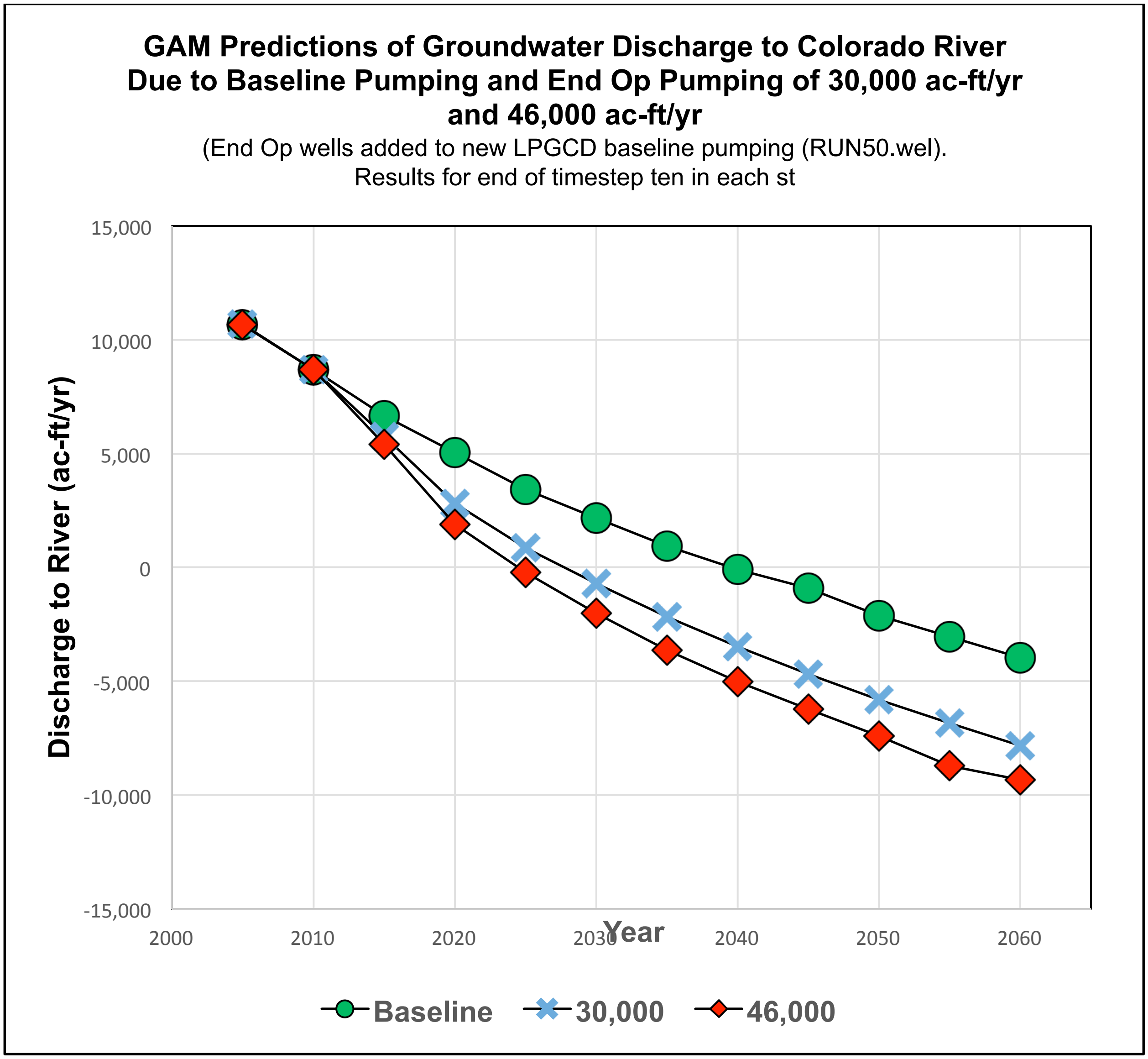

Figure 5
Effects of End Op's Proposed Pumping on Colorado River

4.0 Conclusions

End Op's proposed pumping would:

- Reduce hydraulic heads in the Carrizo, Calvert Bluff, Simsboro, and Hooper aquifers.
    - Where these aquifers are confined, the reduced heads would cause water levels in wells to decline.
    - Where these aquifers are unconfined (i.e., recharge areas), the reduced heads would cause dewatering of portions of the aquifers.
- Reduce groundwater discharge to the Colorado River, thereby reducing the amount of water flowing in the river.

5.0 References

Davis, S.N., and DeWiest, R.J.M., 1966, *Hydrogeology*.

Freeze, R.A., and Cherry, J.A., 1979, *Groundwater*.

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Saunders, G.P., 2009, *Low-Flow Gain-Loss Study of the Colorado River in Bastrop County, Texas*.

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TWDB/LCRA (Texas Water Development Board and Lower Colorado River Authority), 1989, *A Digital Model of the Carrizo-Wilcox Aquifer within the Colorado River Basin of Texas,* January, 1989.

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