Evaluation of Drawdowns Resulting from Baseline Pumping and Potential Pumping from the Simsboro Aquifer in Bastrop and Lee Counties, Texas

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1.0 Introduction

This is an evaluation of drawdowns caused by pumping in the Simsboro Aquifer in Bastrop and Lee counties, Texas through 2060. The pumping considered here is the baseline pumping anticipated by the Lost Pines Groundwater Conservation District (LPGCD, 40,370 ac-ft/yr[1]), plus potential pumping of about 110,000 ac-ft/yr. The purpose of the simulation is to estimate the impact of significant additional pumping on other aquifers and on discharge to the Colorado River.

The effects of the pumping was evaluated using the LPGCD's version of the *Central Queen City and Sparta Groundwater Availability Model* (GAM)[2]. The input files used to generate the results presented in this report were provided by the LPGCD[3], or are modifications of LPGCD-provided files. Figure 1 shows the geologic units represented in the GAM.

2.0 Effects on groundwater

The pumping would create a cone of depression (region of reduced hydraulic heads) that extends to both the confined[4] and unconfined[5] (recharge zone) portions of the Carrizo, Calvert Bluff, Simsboro, and Hooper aquifers.

2.1 Simsboro Aquifer

The pumping would reduce hydraulic heads in both the confined and unconfined portions of the Simsboro Aquifer. Where the aquifer is confined, the reduction in heads would reduce water levels in wells that draw water from the aquifer. Where the aquifer is unconfined, the reduction in heads would dewater portions of the aquifer.

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[1] LPGCD 2013, sum of simulated pumping from Simsboro Aquifer in Bastrop and Lee counties in 2060, MODFLOW input file run50.wel. Total permitted pumping in the Simsboro aquifer in the Lost Pines GCD as of April 2013 was around 53,564 ac-ft/yr.(per Environmental Stewardship).
[2] 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).
[3] LPGCD 2013.
[4] 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.
[5] 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.

2.2 Leakage from the Carrizo, Calvert Bluff, and Hooper aquifers

The effects of the pumping would not be limited to the Simsboro Aquifer. The pumping would induce leakage from the Carrizo, Calvert Bluff, and Hooper aquifers. This leakage would reduce hydraulic heads in the aquifers. Where the aquifers are confined, the reduction in heads would reduce water levels in wells that draw water from the aquifers. Where the aquifers are unconfined, the reduction in heads would dewater portions of the aquifers. The position of these aquifers relative to the Simsboro is shown in figure 1.

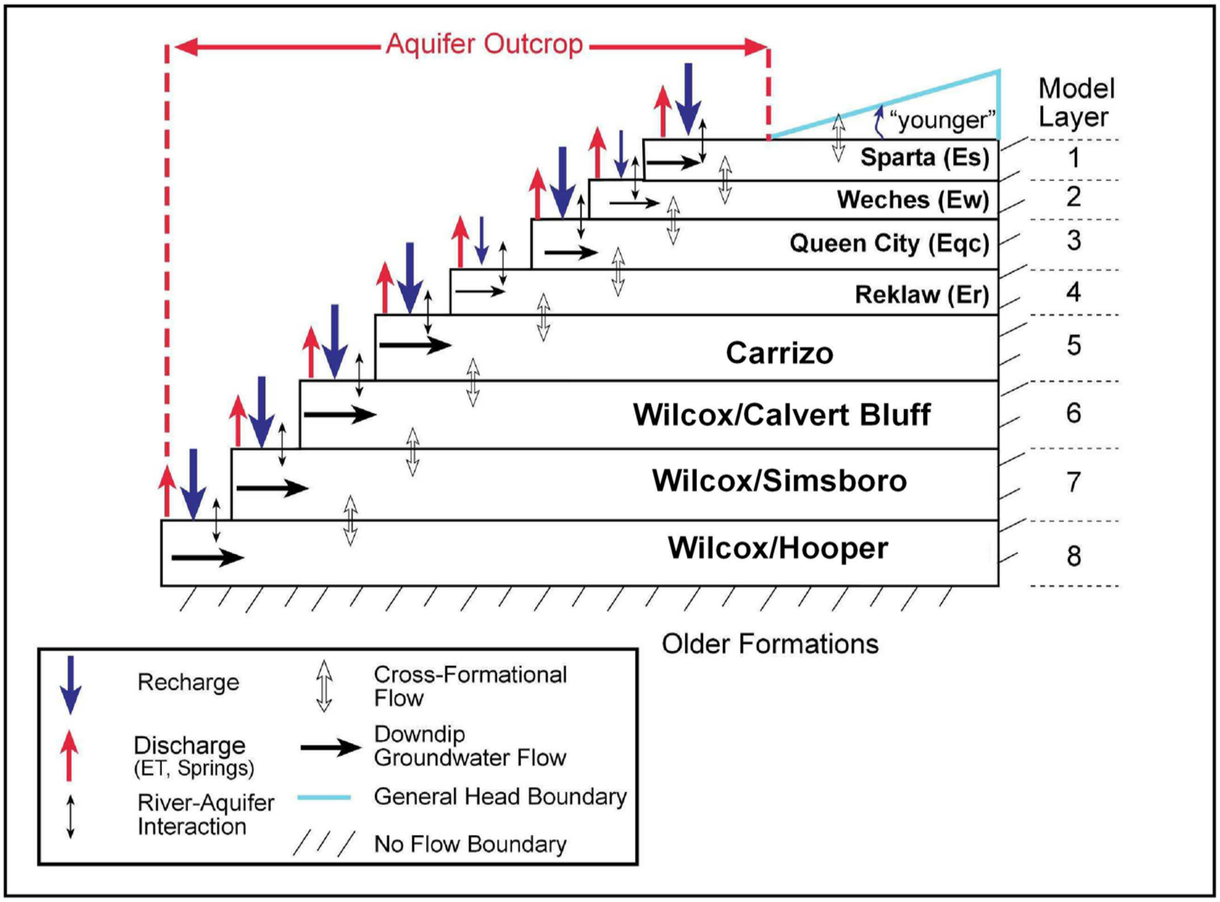

Figure 1
Geologic Units Represented in the GAM
(adapted from TWDB, 2004, figure 5.1)

Leakage is a common and well-known phenomenon that is discussed in standard hydrology texts[6]. In figure 1, leakage (cross-formational flow) between geologic units is indicated by double-headed arrows. In a 2009 pump-test conducted in Lee County, it

[6] See, for example, Davis and DeWiest 1966, pages 224 – 229; and Freeze and Cherry, 1979, pages 320 – 324.

was estimated that 22% of the water pumped from the Simsboro was derived from leakage from adjacent aquifers[7].

2.3 Predicted Drawdowns

Table 1 shows the effects of baseline pumping only (40,370 ac-ft/yr). Table 2 shows the effects of baseline pumping, plus potential pumping (110,000 ac-ft/yr), totalling 150,370 ac-ft/yr..

Table 1
GAM Predicted Drawdowns in 2060 due to Baseline Pumping Only[8]

Aquifer (model Layer)	Average drawdown throughout LPGCD (ft)	Average Drawdown in Bastrop County (ft)	Average Drawdown in Lee County (ft)
Carrizo (5)	60	50	68
Calvert Bluff (6)	99	60	140
Simsboro (7)	241	147	349
Hooper (8)	137	88	195

Table 2
GAM Predicted Drawdowns in 2060 due to Baseline Pumping Plus Potential Pumping

Aquifer (model Layer)	Maximum drawdown (ft)[9]	Average drawdown throughout LPGCD (ft)	Average Drawdown in Bastrop County (ft)	Average Drawdown in Lee County (ft)
Carrizo (5)	70[10]	71	56	83
Calvert Bluff (6)	334	167	106	231
Simsboro (7)	1107	513	355	692
Hooper (8)	379	230	156	328

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7 Thornhill 2009, page 8.
8 Drawdowns for baseline pumping, (well file run50.wel).
9 Maximum drawdown for MODFLOW grid cell (36, 118). This is where the maximum drawdown occurs in the Simsboro Aquifer.
10 The discrepancy between the maximum drawdown and the average throughout the LPGCD and Lee County is due to the fact that drawdowns in the Carrizo are primarily due to pumping in the Carrizo itself. That is, drawdowns in the Carrizo caused by pumping in the Carrizo are much larger than drawdowns in the Carrizo caused by pumping in the Simsboro.

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[11] in Bastrop County[12]. 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[13], [14]

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.

[11] The Wilcox Aquifer consist of three parts: the Calvert Bluff, Simsboro, and Hooper aquifers.
[12] Saunders 2009.
[13] Saunders 2009, page 3.
[14] 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).

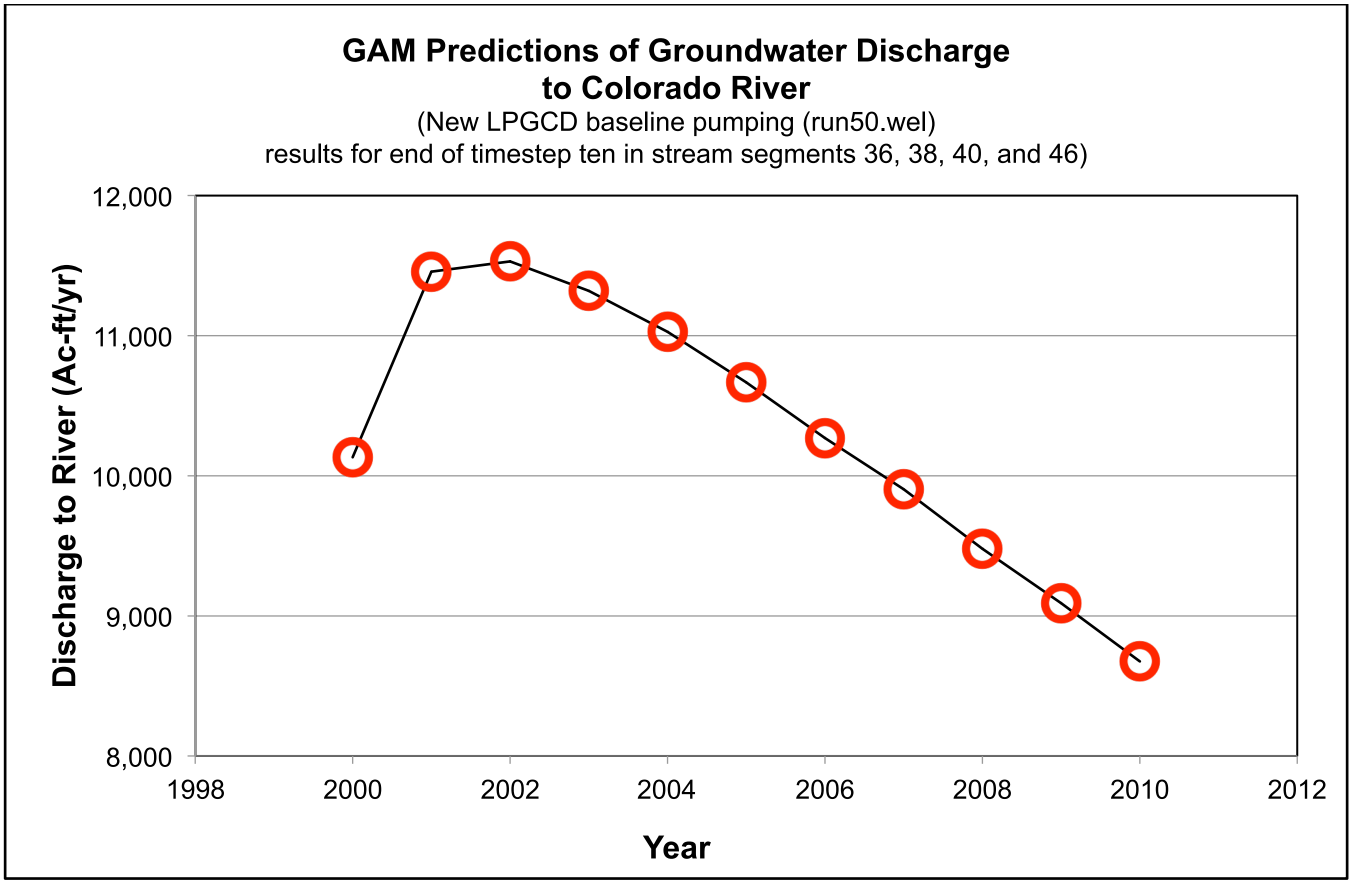

Figure 2
GAM Predicted Discharges to Colorado River
(note: this simulation used the new LPGCD baseline pumping file (RUN50.wel), no additional pumping)

3.2 GAM predictions of discharge trends

The answer to the second question (can the GAM reliably predict trends in the discharge) 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 about 45,000 acre-feet per year over baseline pumping rates, and more discharge when water is injected at a rate of about 45,000 acre-feet per year over baseline rates.

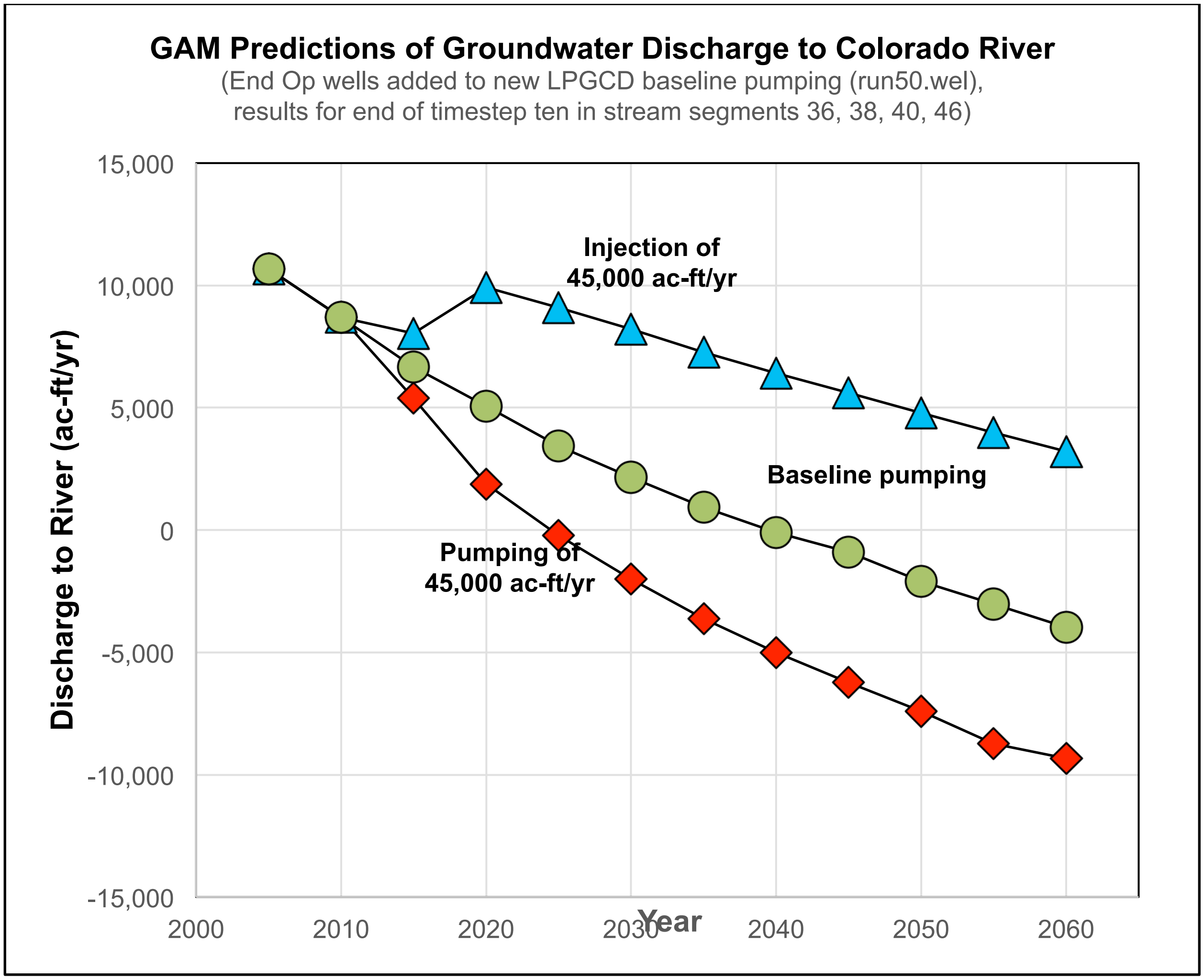

Figure 3
GAM Predicted Effects of Varying Pumping Rates and Pumping Duration

3.2.2 Pumping duration

GAM predictions are consistent with expectations regarding the effect of pumping duration. That is, longer pumping durations 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.

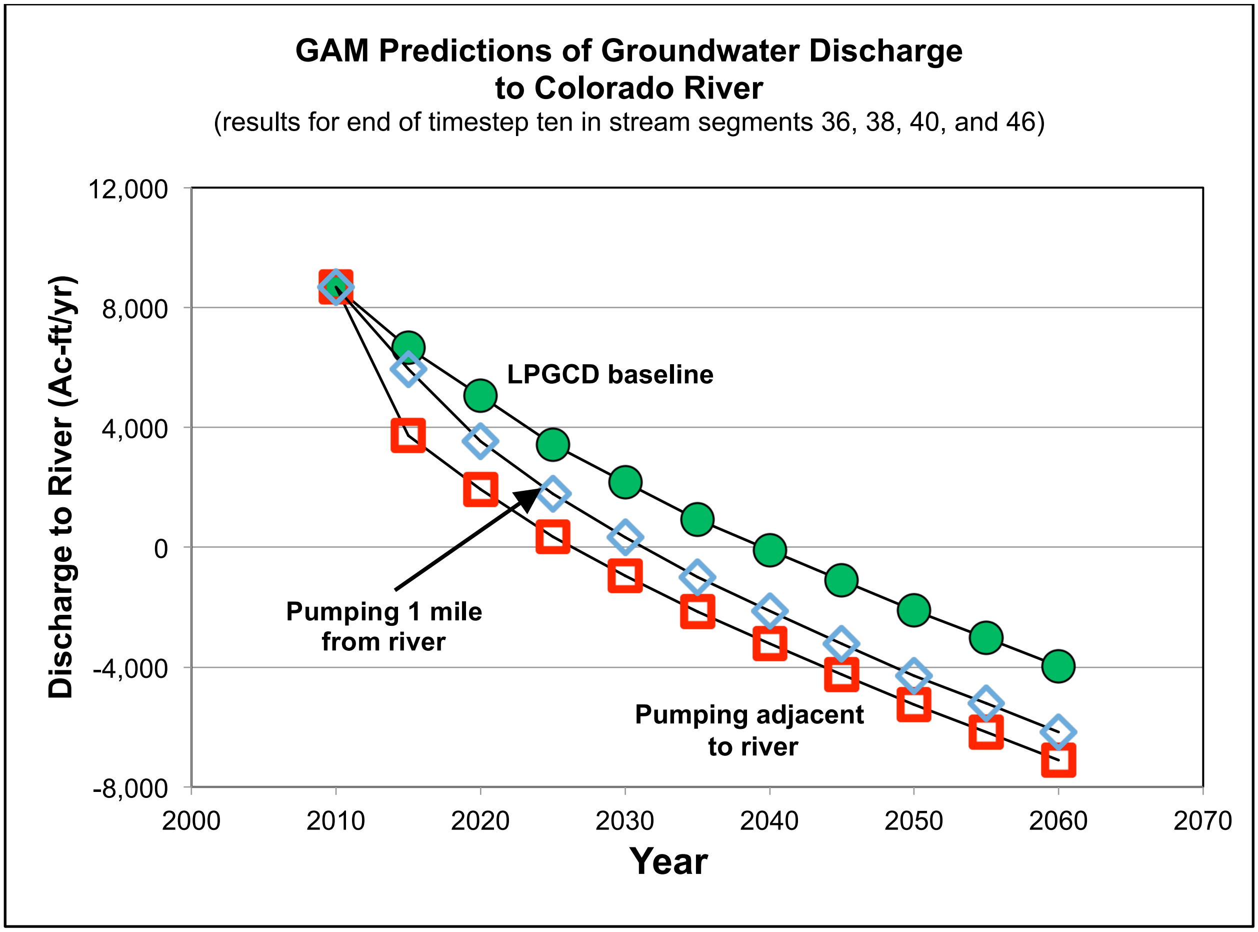

Figure 4
GAM Predicted Effects of Pumping Distance
(note: these simulations used the new LPGCD baseline pumping file (RUN50.wel))

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 baseline plus potential 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 baseline, plus potential pumping would decrease groundwater discharge to the Colorado River.

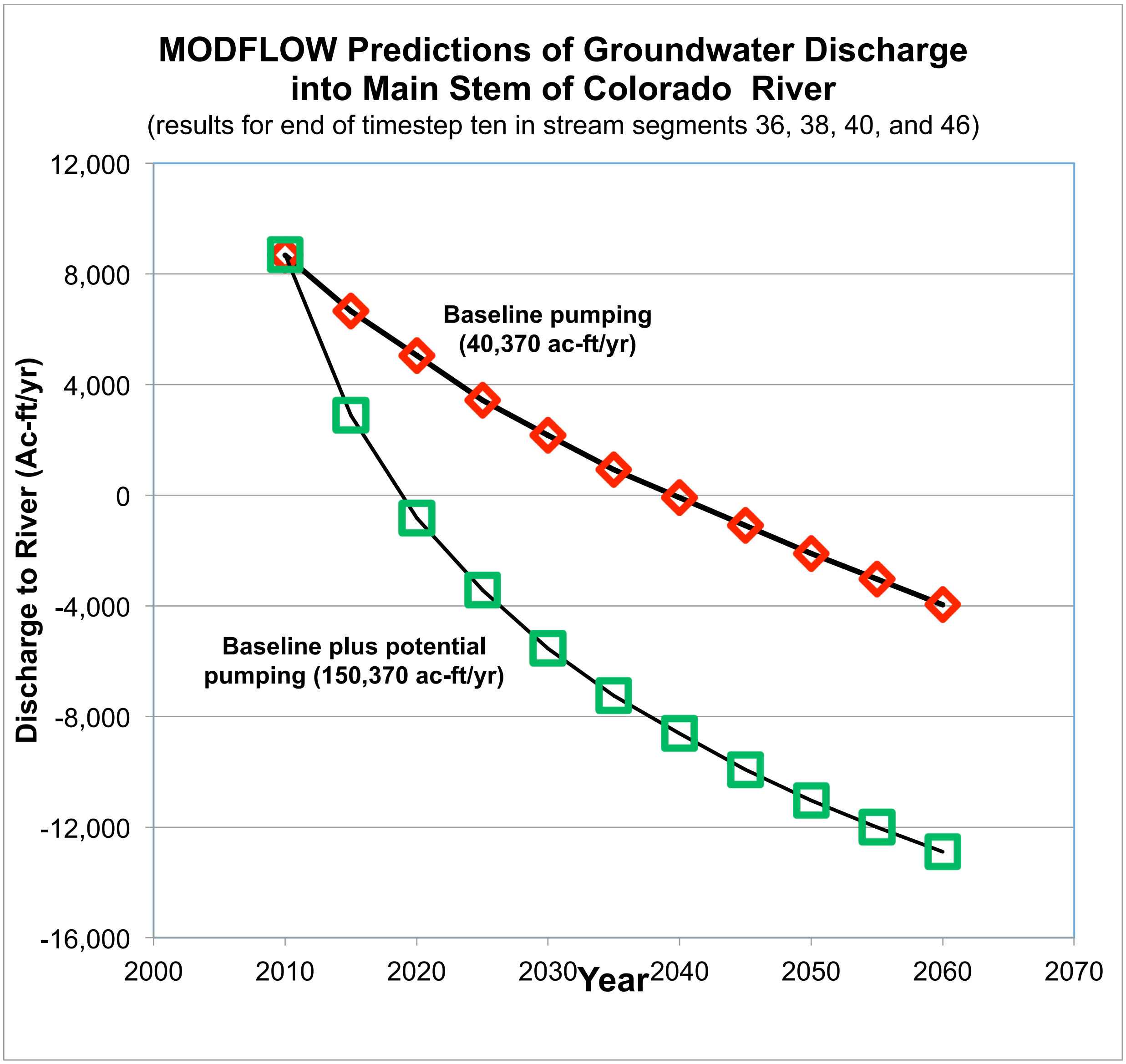

Figure 5
Effects of Baseline and Potential Pumping on Colorado River

4.0 Conclusions

Baseline pumping, plus potential pumping would:

- Reduce hydraulic heads in the Carrizo, Calvert Bluff, Simsboro, and Hooper aquifers.
    - The reduced heads in the confined portions of these aquifers would cause water levels in wells to decline.
    - The reduced heads in the unconfined portion of these aquifers (recharge area) would cause dewatering of portions of the aquifer.
- 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*.

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

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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