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

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1.0 Introduction

LCRA is proposing to pump up to 10,000 acre feet of water per year[1] from the Simsboro Aquifer in Bastrop county, Texas. LCRA's pumping would affect groundwater levels and the discharge of groundwater to the Colorado River.

The effects of LCRA'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)[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

LCRA's pumping would affect the 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[4] and unconfined[5] (recharge zone) portions of the aquifers. These effects are discussed below.

2.1 Simsboro Aquifer

LCRA's pumping would reduce hydraulic heads in the Simsboro Aquifer. The effects would extend to both the confined and unconfined portions of the 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 LCRA's pumping would not be limited to the Simsboro Aquifer. The pumping would induce leakage from the Calvert Bluff and Hooper aquifers. This leakage

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[1] LCRA 2014a
[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.

would reduce water levels in the Calvert Bluff and Hooper aquifers. The position of these aquifers relative to the Simsboro is shown in figure 1.

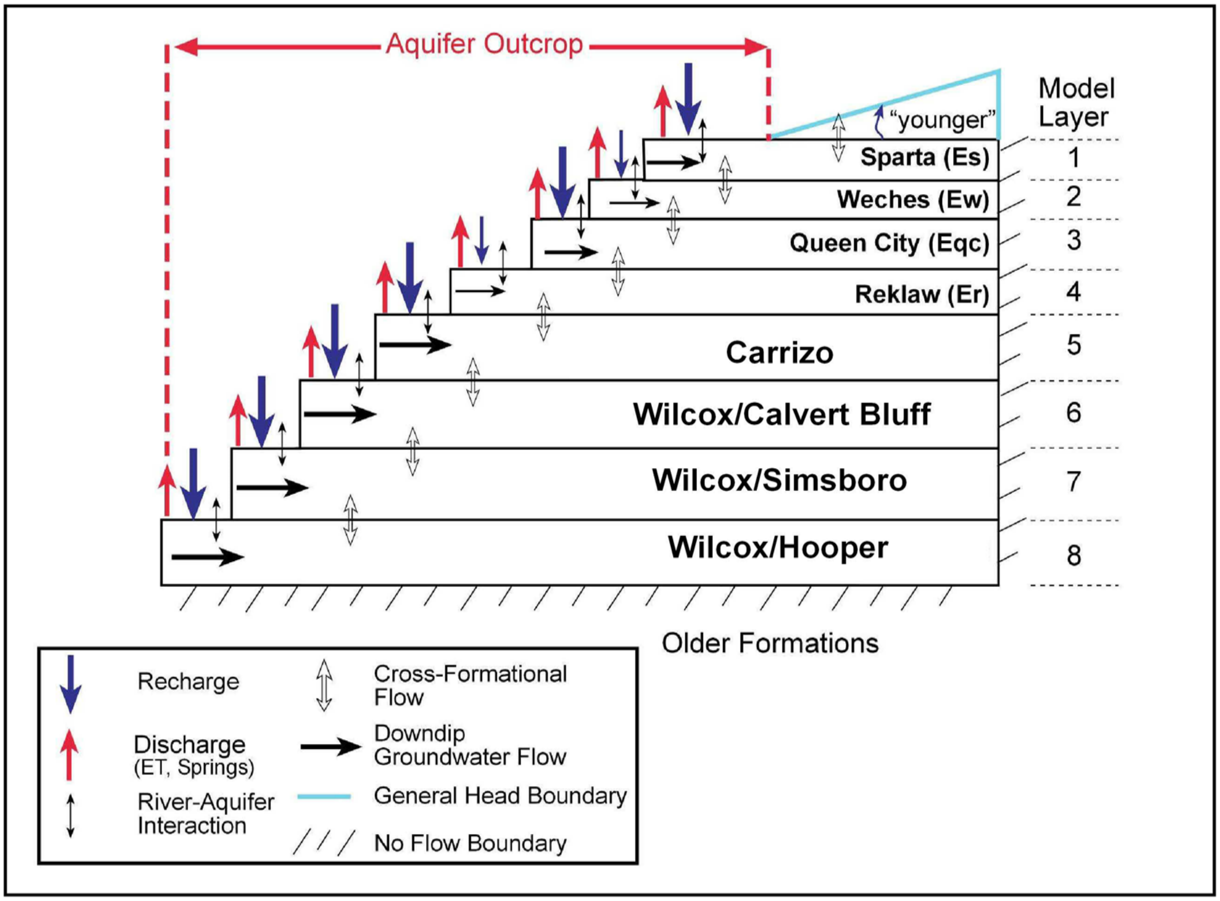

Figure 1
Geologic Units Represented in the GAM
(adapted from TWDB, 2004, figure 5.1)

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

[6] See, for example, Davis and DeWiest 1966, pages 224 – 229; and Freeze and Cherry, 1979, pages 320 – 324.
[7] Thornhill 2009, page 8.

Table 1 shows the effects of LCRA's pumping on the Calvert Bluff, Simsboro, and Hooper aquifers. It should be noted that the drawdowns shown in table 1 would be in addition to the drawdowns due to baseline pumping (table 2).

Table 1
GAM Predicted Drawdowns in 2060 due to LCRA Pumping of 10,000 acre-feet per year[8]

Aquifer (model Layer)	Maximum drawdown (ft)[9]	Average drawdown throughout LPGCD (ft)	Average Drawdown in Bastrop County (ft)	Average Drawdown in Lee County (ft)
Calvert Bluff (6)	10	5	6	5
Simsboro (7)	146	24	33	13
Hooper (8)	9	6	6	7

Table 2
GAM Predicted Drawdowns in 2060 due to Baseline Pumping[10]

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

[8] Drawdowns calculated by comparing GAM runs for baseline pumping (well file run50.wel), and baseline pumping plus LCRA pumping of 10,000 acre-feet per year (well file run52.wel).
[9] Drawdown for cell (33, 92). This cell is the location of the LCRA well that pumps at the highest rate (4000 acre feet per year). The other three wells pump at a rate of 2000 acre feet per year.
[10] Drawdowns for new baseline pumping (well file run50.wel).

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).

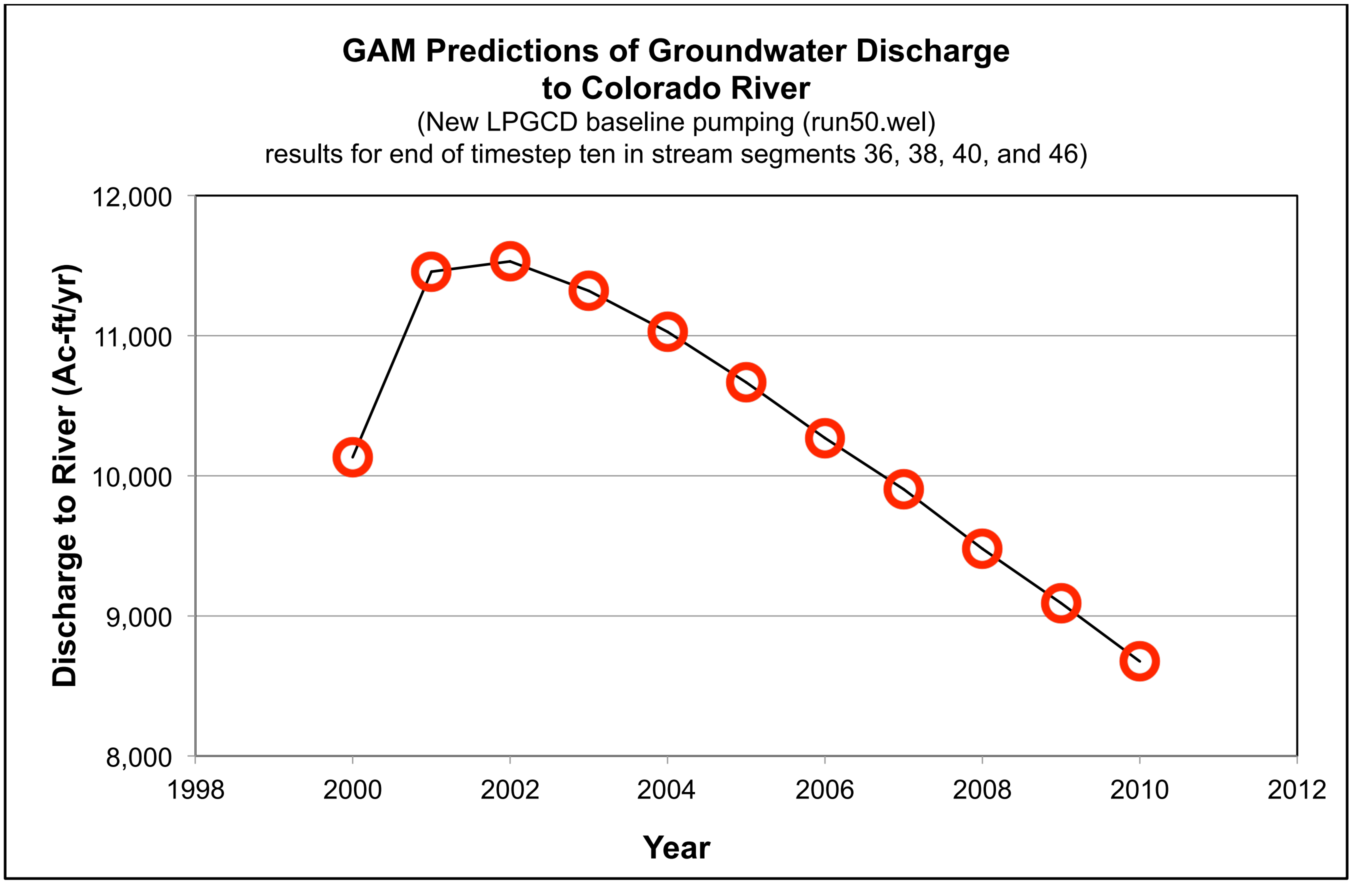

Figure 2
GAM Predicted Discharges to Colorado River
(note: this simulation used the new LPGCD baseline pumping file (RUN50.wel), no additional pumping)

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 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.

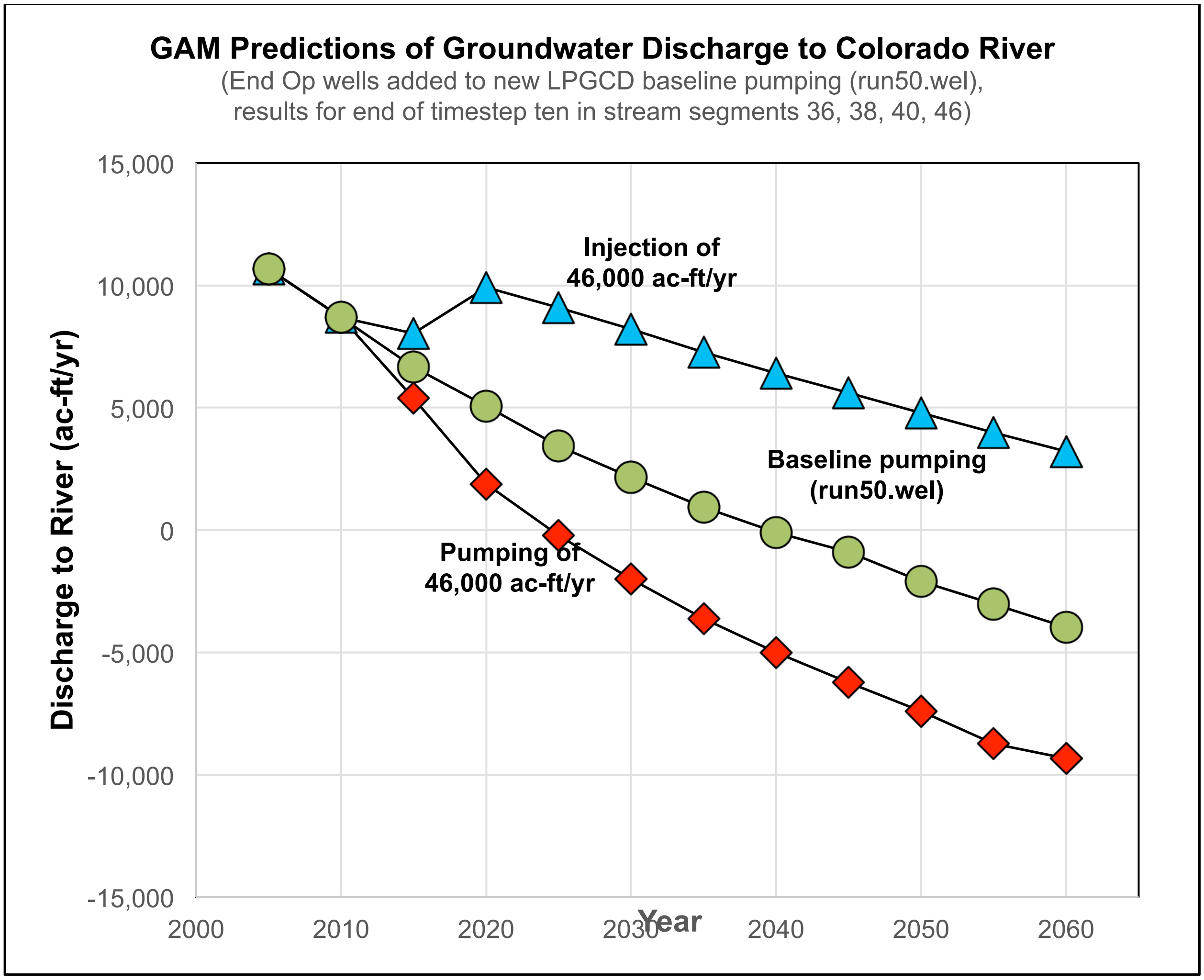

Figure 3
GAM Predicted Effects of Varying Pumping Rates and Pumping Duration

3.2.2 Pumping duration

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

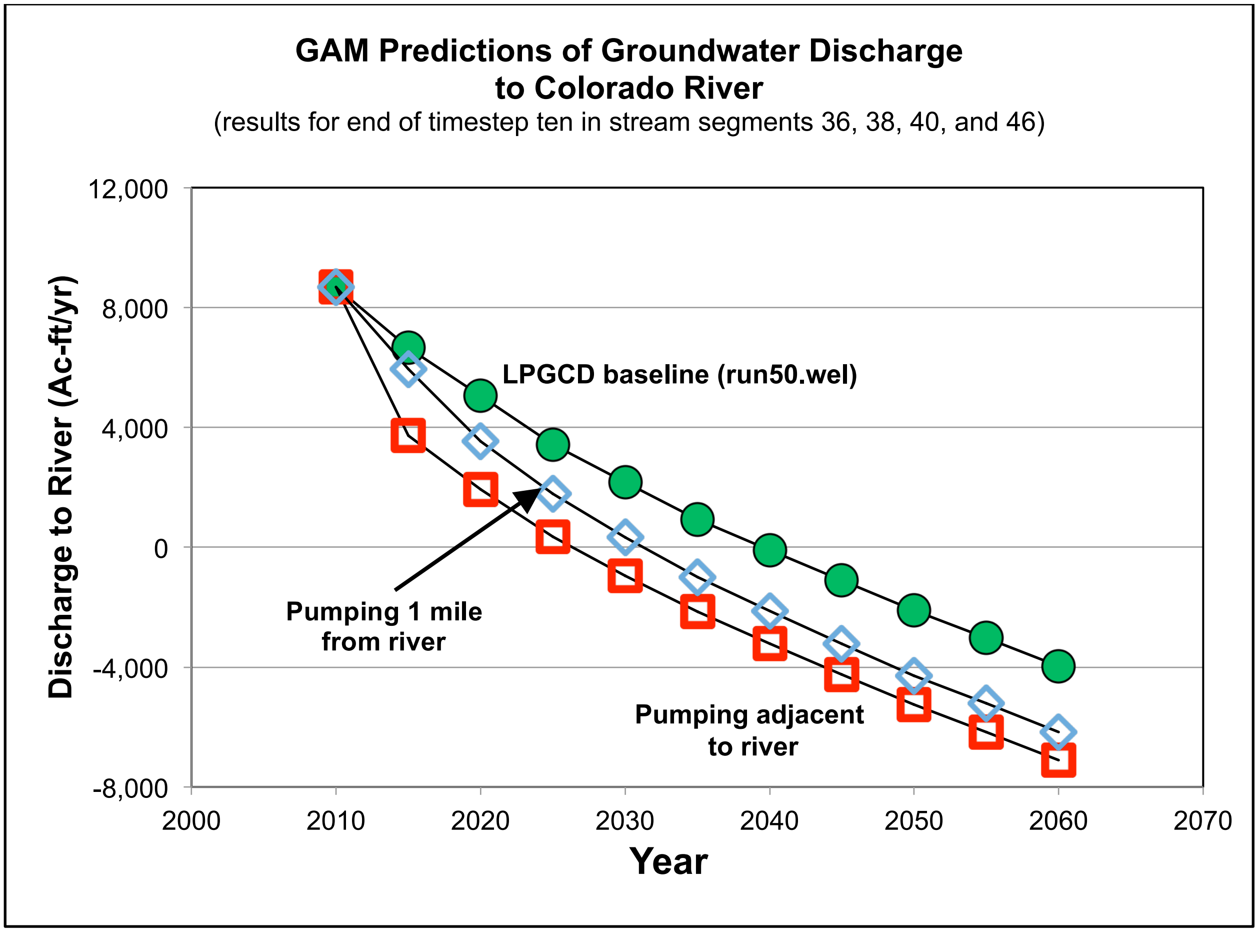

Figure 4
GAM Predicted Effects of Pumping Distance
(note: these simulations used the new LPGCD baseline pumping file (RUN50.wel))

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 LCRA'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 LCRA's pumping would decrease groundwater discharge to the Colorado River.

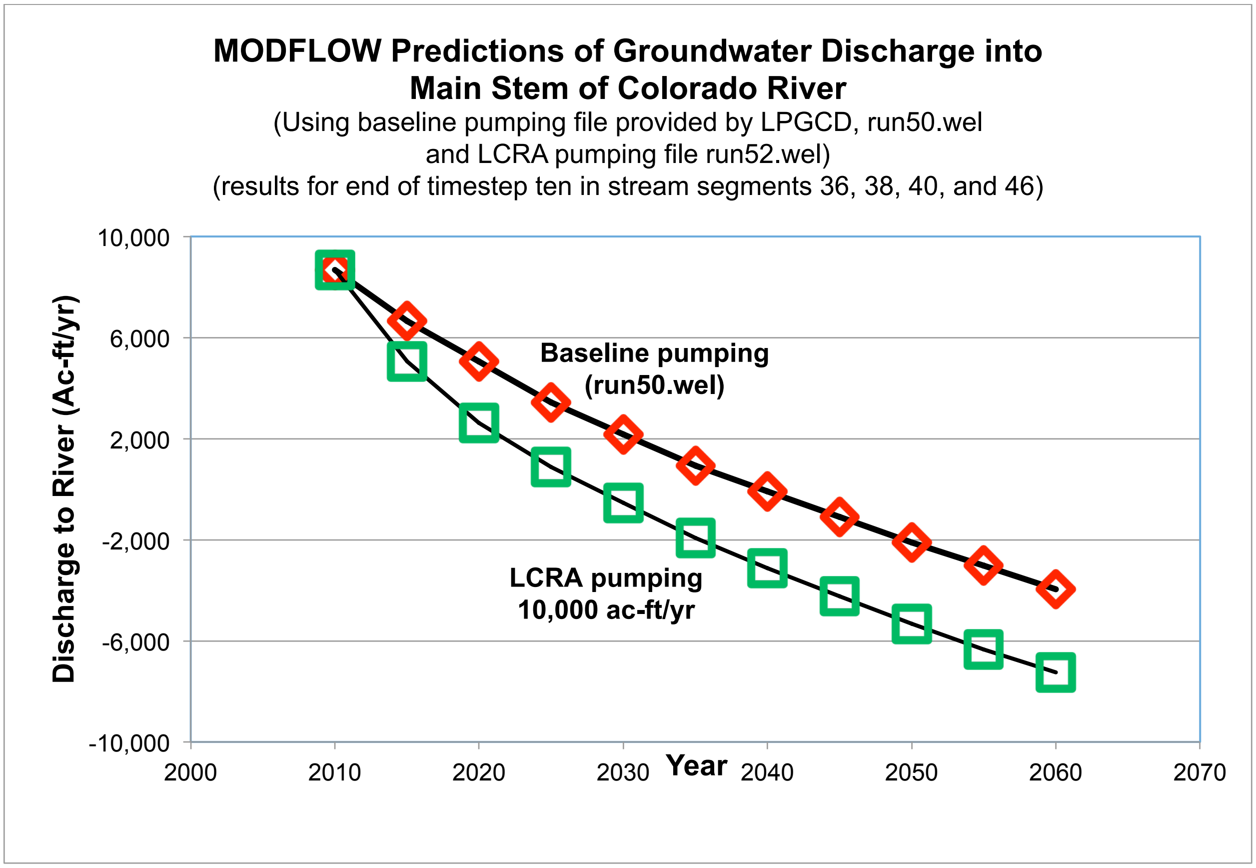

Figure 5
Effects of LCRA's Proposed Pumping on Colorado River

The effects of LCRA's proposed pumping can be compared to the effects of LCRA's pumping combined with pumping by End Op and Forestar (figure A-1)[15]. As expected, the decline in the discharge of groundwater to the Colorado is accelerated for the combined pumping. As stated above, while the trend in the decline is reasonable, the amount of decline predicted by the GAM is not reliable.

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[15] Maximum proposed pumping for LCRA = 10,000 ac-ft/yr, End Op = 56,000 ac-ft/yr, Forestar = 45,000 ac-ft/yr.

4.0 Conclusions

LCRA's proposed pumping would:

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

LCRA (Lower Colorado River Authority), 2014a, letter to Joe Cooper, Lost Pines Groundwater Conservation District, dated November 21, 2014.

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

Thornhill (Thornhill Group, Inc.), 2009, *A Report of Results of Drilling and Testing Programs to Verify Ground-Water Supplies in the Simsboro Aquifer – Proposed End Op, LP Well Fields in Bastrop and Lee Counties, Texas*, April 15, 2009.

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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