Texas Water Development Board
Report 374

Aquifers of the Upper Coastal Plains of Texas

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October 2009

Chapter 8

Low-Flow Gain-Loss Study of the Colorado River in Bastrop County, Texas

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A field investigation was conducted in November 2008 as a follow-up to previous gain-loss studies of the lower Colorado River in Texas. Previous studies conducted by the Lower Colorado River Authority (LCRA) of groundwater-surface water interaction between the Carrizo-Wilcox Aquifer and the Colorado River provided valuable information, but the results were inconclusive. The 2008 LCRA study was a more detailed investigation of gains and losses in river flow upstream and downstream from the outcrops of two productive aquifer units: the Simsboro Sand and Carrizo Sand.

8.1
STUDY AREA

The lower Colorado River flows through Bastrop County, Texas, in a meandering channel within a broad alluvial floodplain (Figure 8-1). Outcrops of the Simsboro Sand and Carrizo Sand are exposed along the banks of the river and underneath the alluvium associated with the river. The Simsboro Sand is exposed in a 70-foot cliff at Powell Bend upstream from the town of Bastrop (Figure 8-2). The Carrizo Sand underlies the Colorado River between Bastrop and the Colovista Country Club measurement site shown on Figure 8-1. At some locations, small seeps and springs may be found along the banks of the river, but most groundwater-surface water interaction occurs through the river alluvium.

8.2
PREVIOUS STUDIES

Earlier low-flow investigations by the U.S. Geological Survey in 1918 found that the Colorado River gained about 36 cubic feet per second across the outcrop of the Carrizo-Wilcox Aquifer (TBWE, 1960). A study conducted by LCRA of streamflow hydrographs during low-flow conditions in 1999 found data suggesting a possible gain in river flow of 59 cubic feet per second between gaging stations at Bastrop and Smithville, based upon the U.S. Geological Survey streamgage readings (Saunders, 2005). A field investigation conducted by LCRA in November 2005 also produced data suggesting a possible net gain in river flow from Utley to Smithville of 50 cubic feet per second (Saunders, 2006).

8.3
METHODS

This study was conducted according to the methods for low-flow investigations and gain-loss studies recommended by the U.S. Geological Survey (Riggs, 1972; Slade and others, 2002). Conditions of steady river flow, dry weather, and minimal tributary inflows, discharges, and withdrawals were ideal for a low-flow investigation during an ongoing dry period in late November 2008. The field investigation was conducted November 24–25, 2008. Although river flow is continuously monitored at gaging stations at Bastrop and Smithville, flow measurements for this study were taken at four mainstem locations, as well as on any tributaries between Utley and Smithville in which flow was present. Streamflow was measured using acoustic Doppler velocity meters and portable cut-throat flumes. Best efforts

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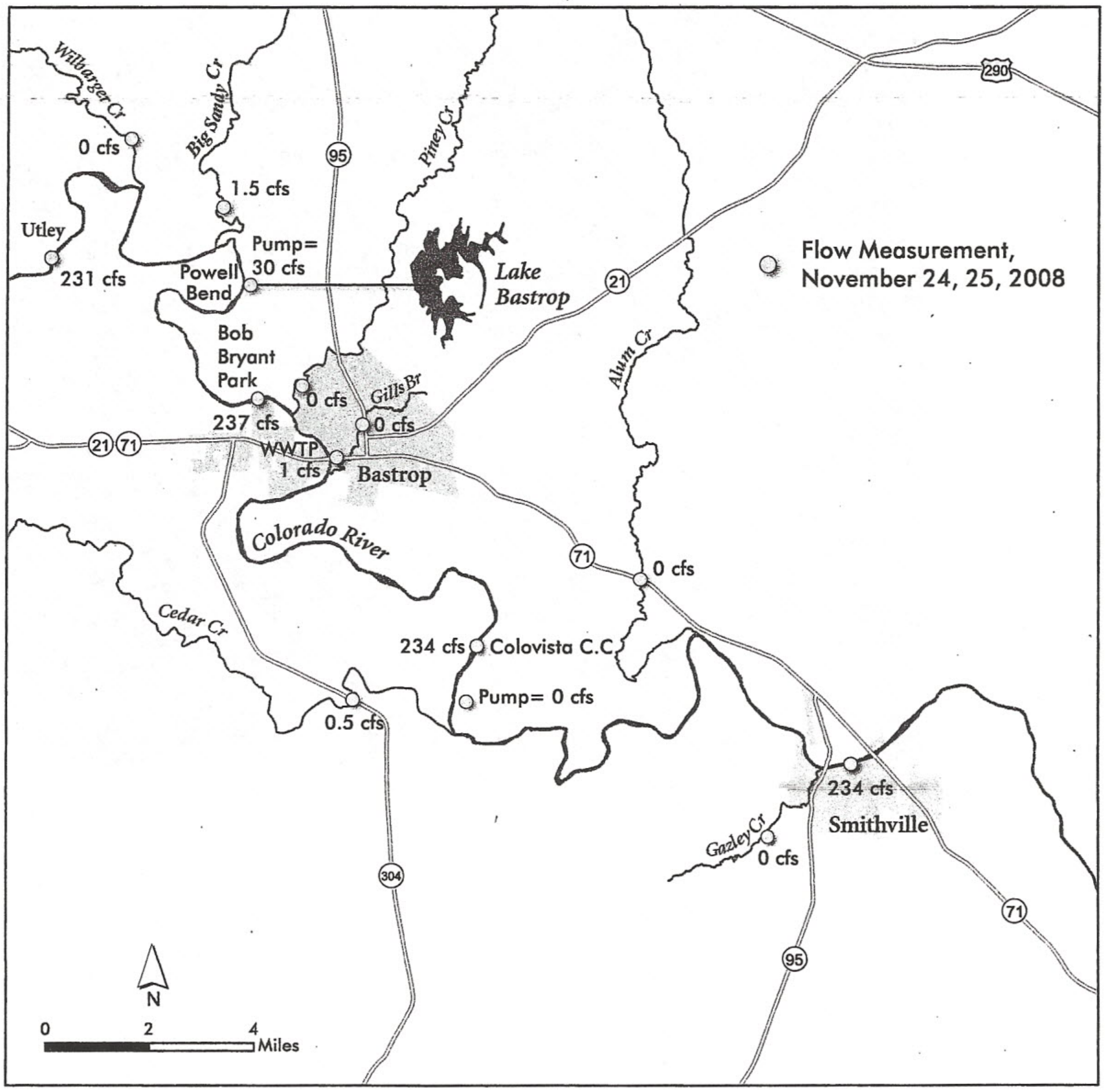

Figure 8-1. Low-flow measurements in the reach of the Colorado River from Utley to Smithville, Bastrop County, Texas, November 24–25, 2008 (LCRA graphic).
cfs = cubic feet per second

were made to maximize the accuracy of streamflow measurements; however, the estimated error associated with this type of measurement is 5 percent or better (Rantz, 1982). Furthermore, although flow measurements were not taken continuously for the two-day period of this study, the river was considered to be in a near-steady flow condition so that estimates of gains and losses could be estimated. In order to complete the estimates, all known discharges and withdrawals were verified by observation and by checking with the plant operators.

8.4 RESULTS

Results of data collection are shown in Table 8-1. The data are arranged in

Figure 8-2. Outcrop of the Simsboro Sand Formation along the Colorado River at Powell Bend, Bastrop County, Texas (LCRA photo).

order from upstream to downstream to indicate gain-loss relationships.

River flow measurements at Utley, Bob Bryant Park upstream from Bastrop, Colovista Country Club downstream from Bastrop, and Smithville were remarkably consistent, ranging between 231 and 237 cubic feet per second. There was a relatively large withdrawal of water at Powell Bend to supplement Lake Bastrop (30 cubic feet per second) during the field investigation. Tributary inflows were negligible at Wilbarger Creek (0 cubic feet per second); Big Sandy Creek (1.5 cubic feet per second); Piney Creek (0 cubic feet per second); Gills Branch (0 cubic feet per second); Alum Creek (0 cubic feet per second); Cedar Creek (0.5 cubic feet per second); and Gazley Creek (0 cubic feet per second). The City of Bastrop wastewater treatment plant was discharging (1 cubic foot per second) during the field investigation.

Although there was no significant increase in river flow between the mainstem measurement sites, the relatively large withdrawal of water at Powell Bend for Lake Bastrop (30 cubic feet per second) factors into the analysis. Considering differences in measured river flow, tributary inflows, and the withdrawal at Powell Bend, the data suggests a net gain between Utley and Bastrop of 30 cubic feet per second. Such a gain would most likely be attributable to groundwater contribution from the Simsboro Sand to the Colorado River.

Downstream from Bastrop, the data indicate no increase in river flow nor any significant withdrawals or discharges. Therefore, there was no apparent gain in river flow attributable to the Carrizo Sand during the field investigation.

Table 8-1. Results of data collection, November 24–25, 2008.

Mainsteam	Off-channel	Type	Flow (cfs)	Inflow (-) or outflow (+) (cfs)	Net gain-loss (cfs)
Colorado River at Utley		River flow	231		
	Wilbarger Creek	Tributary		0	
	Big Sandy Creek	Tributary		-1.5	
	Sim Gideon pumping station	Withdrawal		+30	
Colorado River at Bob Bryant Park		River flow	237		(237–231) -1.5 + 30 = 34.5
	Piney Creek	Tributary		0	
	City of Bastrop WWTP	Discharge		-1	
	Gills Branch	Tributary		0	
Colorado River at Colovista Country Club		River flow	234		(234–237) -1 = -4
	Colovista Country Club pump	Withdrawal		0	
	Cedar Creek	Tributary		-0.5	
	Alum Creek	Tributary		0	
	Gazley Creek	Tributary		0	
Colorado River at Smithville		River flow	234		(234–234) - 0.5 = -.5
				Net gain	+30

cfs = cubic feet per second; WWTP = wastewater treatment plant

8.5 CONCLUSIONS

As shown in Table 8-1, the total net gain to the Colorado River from the Carrizo-Wilcox Aquifer in Bastrop County was estimated to be 30 cubic feet per second during the November 2008 low-flow event. This compares to the U.S. Geological Survey 1918 estimate of 36 cubic feet per second and the LCRA estimate of 50 cubic feet per second in November 2005.

Thus, the potential groundwater contribution of flow to the Colorado River from the Carrizo-Wilcox Aquifer may be significant, particularly when compared to more well-known sources such as Barton Springs in Austin, which was flowing at 19 cubic feet per second during the field investigation in November 2008. Contributions to the base flow from these sources can be important during critical low-flow conditions.

Although groundwater flow in sand aquifers is generally considered to be slow and steady, it is possible that groundwater contributions to the lower Colorado River may be variable from one time period to another. However, a study of groundwater-surface water interaction prepared as part of development of the central Carrizo-Wilcox groundwater availability model indicated that base flow rates of rivers crossing the aquifer outcrop have not decreased over time, and seasonal variability in base flow for perennial streams may not fluctuate significantly (Dutton and others, 2003). In addition, flow from bedrock aquifers through the alluvium to the river is a complicated system and requires further data and analysis. As demands on groundwater resources increase with future growth in Central Texas, groundwater-surface water interactions may need to be periodically monitored to assess water availability in the decades to come.

8.6 REFERENCES

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