

# GAM run 03-27

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Groundwater Availability Modeling Section  
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## REQUESTOR:

Mr. Mike Mahoney, Evergreen Underground Water Conservation District

## DESCRIPTION OF REQUEST:

Mr. Mahoney requested the following information from the Southern Carrizo-Wilcox aquifer Groundwater Availability Model (GAM) for the Evergreen Underground Water Conservation District (UWCD):

- Recharge,
- Water budget, and
- Total storage in the Carrizo aquifer above 4,000 feet depth.

## METHODS:

To address the request, we:

- Ran the predictive model (2000 – 2050) under average recharge conditions for the Southern Carrizo-Wilcox aquifer Groundwater Availability Model (Deeds and others, 2003) and queried the budget files for each aquifer layer in Atascosa, Frio, Karnes, and Wilson counties for 2050.
- Estimated storage by calculating layer thickness for each model cell with bottom elevation greater than 4,000 feet depth in the Carrizo aquifer (thickness = layer 3 top elevation minus layer 3 bottom elevation), multiplying by cell area (1 mi<sup>2</sup>) and specific yield, and summing all of the model cells within Atascosa, Frio, Karnes, and Wilson counties.

## PARAMETERS AND ASSUMPTIONS:

None: Data request.

## RESULTS:

### Recharge and Water budget

Table 1 shows the 2050 water budget for the Southern Carrizo-Wilcox GAM model in Atascosa, Frio, Karnes, and Wilson counties. Recharge values from the model are shown

in bold text in the table. Karnes County has zero direct recharge because there is no outcrop in that county. However, TWDB rules concerning groundwater management plan certification define recharge as "The addition of water from precipitation or runoff by seepage or infiltration to an aquifer from the land surface, streams, or lakes directly into a formation or indirectly by way of leakage from another formation." Leakage into the aquifers is listed in the columns "upper Z-flow in and lower Z-flow in" (Table 1).

It should be noted that layer 1, representing the Queen City aquifer, was put in as a boundary condition to help constrain the model. Therefore, the recharge values for layer 1 may not be representative of the Queen City aquifer, and we do not recommend using layer 1 recharge values.

### **Aquifer Storage**

The total volume of storage in the Carrizo aquifer is shown for Atascosa, Frio, Karnes, and Wilson counties in Table 2.

### **DISCUSSION:**

An estimate of total useable groundwater is required for the groundwater conservation district management plan. Total useable groundwater is equivalent to groundwater availability discussed on the TWDB GAM webpage <http://www.twdb.state.tx.us/gam/UsingGAM.htm>. It is up to the district to determine how they wish to define total useable groundwater or groundwater availability. The definition might be based on how the district envisions the future condition of their aquifer. Possibilities include (but are not limited to):

- If the district wants the aquifer to remain in the same state as it is now, then they might consider a conservative estimate of availability or useable groundwater such as recharge.
- If they want to completely deplete the aquifer in 50 years, then they might consider total storage divided by 50 as the yearly availability or useable storage.
- If they want to allow partial depletion, they might divide a percentage of the total storage by a certain number of years.
- If they want to allow a certain drawdown over a certain period of time, the model can be run to determine what pumping level will give that amount of drawdown. This pumping amount then could be considered the limit of useable storage.

For the first three bullets listed above, there is sufficient information in this report to estimate useable storage. However, bullet four would require several additional GAM runs.

**REFERENCES:**

Deeds, N., Kelley, V., Fryar, D., and Jones, T., 2003, Groundwater Availability Model for the Southern Carrizo-Wilcox Aquifer: Final Report prepared for the Texas Water Development Board.

**Table 1. Atascosa, Frio, Karnes, and Wilson counties flow budgets for the Southern Carrizo-Wilcox aquifer model for 2050 with average recharge conditions. Flows are in acre-feet per year.**

County	Lyr	Storage	X-flow in	X-flow out	upper		lower		Wells	Recharge	ET	GHB	Stream	Total		% diff
					Z-flow in	Z-flow out	Z-flow in	Z-flow out						In	Out	
<b>Atascosa</b>	1	-8,043	2,480	-1,686	0	0	4,985	-1,777	-208	<b>*5,866</b>	-87	-2,090	562	13,894	-13,891	0
	2	-1,172	485	-253	1,777	-4,985	4,639	-1,988	-362	<b>1,809</b>	0	0	50	8,761	-8,760	0
	3	-1,463	18,410	-10,102	1,988	-4,639	1,955	-945	-16,129	<b>9,762</b>	-180	0	1,345	33,459	-33,457	0
	4	-270	276	-572	945	-1,955	1,263	-79	-11	<b>403</b>	0	0	0	2,887	-2,887	0
	5	-2,945	962	-630	79	-1,263	691	-777	-288	<b>3,570</b>	0	0	602	5,904	-5,903	0
	6	-1,122	3,504	-2,486	777	-691	0	0	-111	<b>129</b>	0	0	0	4,411	-4,411	0
	All	-15,015	26,118	-15,730	5,566	-13,533	13,533	-5,566	-17,110	<b>21,539</b>	-266	-2,090	2,559	69,315	-69,310	0
<b>Frio</b>	1	-26,567	410	-2,930	0	0	63	-12,930	-327	<b>*42,633</b>	-5,315	6,754	-1,809	49,860	-49,895	0
	2	-6,804	206	-1,306	12,930	-63	741	-13,456	-99	<b>7,607</b>	0	0	243	21,728	-21,728	0
	3	-6,472	12,805	-21,141	13,456	-741	2,848	-1,314	-5,161	<b>5,411</b>	0	0	309	34,828	-34,830	0
	4	-68	244	-591	1,314	-2,848	2,648	-591	-108	<b>0</b>	0	0	0	4,205	-4,205	0
	5	-528	1,337	-650	591	-2,648	2,063	-75	-89	<b>0</b>	0	0	0	3,991	-3,991	0
	6	-621	5,072	-2,462	75	-2,063	0	0	-1	<b>0</b>	0	0	0	5,147	-5,147	0
	All	-41,059	20,074	-29,081	28,365	-8,362	8,362	-28,365	-5,786	<b>55,651</b>	-5,315	6,754	-1,256	119,759	-119,795	0
<b>Karnes</b>	1	-24	843	-1,093	0	0	3,313	0	-819	<b>0</b>	0	-2,219	0	4,155	-4,155	0
	2	-12	117	-205	0	-3,313	3,414	0	-1	<b>0</b>	0	0	0	3,530	-3,530	0
	3	21	6,397	-2,940	0	-3,414	267	-87	-246	<b>0</b>	0	0	0	6,686	-6,686	0
	4	-26	9	-50	87	-267	248	0	0	<b>0</b>	0	0	0	344	-344	0
	5	-147	144	-123	0	-248	375	0	0	<b>0</b>	0	0	0	519	-519	0
	6	-706	2,049	-968	0	-375	0	0	0	<b>0</b>	0	0	0	2,049	-2,049	0
	All	-894	9,558	-5,379	87	-7,617	7,617	-87	-1,066	<b>0</b>	0	-2,219	0	17,262	-17,262	0
<b>Wilson</b>	1	-765	314	-2,334	0	0	1,918	-13,263	-1,484	<b>*35,486</b>	-3,330	-1,011	-15,611	37,718	-37,798	0
	2	228	16	-295	13,263	-1,918	1,817	-18,016	-835	<b>4,593</b>	-55	0	1,202	21,120	-21,118	0
	3	972	7,748	-17,672	18,016	-1,817	954	-231	-18,323	<b>7,575</b>	-82	0	2,860	38,126	-38,125	0
	4	-165	44	-20	231	-954	1,023	-5	-337	<b>184</b>	0	0	0	1,482	-1,482	0
	5	-138	2,524	-1,008	5	-1,023	929	-407	-2,214	<b>3,108</b>	-32	0	-1,743	6,566	-6,565	0
	6	-446	4,722	-3,377	407	-929	0	0	-376	<b>0</b>	0	0	0	5,129	-5,129	0
	All	-314	15,368	-24,705	31,922	-6,640	6,640	-31,922	-23,570	<b>50,946</b>	-3,500	-1,011	-13,292	104,876	-104,954	0

Notes:

1. Layer 1: \*Queen City aquifer (see text for discussion of recharge rates for this layer)
2. Layer 2: Reklaw unit
3. Layer 3: Carrizo aquifer
4. Layer 4: Upper Wilcox aquifer
5. Layer 5: Middle Wilcox aquifer
6. Layer 6: Lower Wilcox aquifer
7. All: sum of layers 1,2, 3, 4, 5, and 6
8. **GHB** refers to flow into or out of the top of the Queen City.
9. **ET** refers to groundwater extraction due to evapotranspiration.
10. **X-flow in** refers to lateral flow into the county.
11. **X-flow out** refers to lateral flow out of the county.
12. **upper - Z-flow in** refers to flow into the layer from the layer above.
13. **upper - Z-flow out** refers to flow out of the layer into the layer above.
14. **lower - Z-flow in** refers to flow into the layer from the layer below.
15. **lower - Z-flow out** refers to flow out of the layer into the layer below.
16. **Wells** is for pumping input.
17. A negative sign refers to flow out of the layer in the county.
18. A positive sign refers to flow into the layer in the county.
19. The numbers are rounded to the nearest 1 acre-ft.

**Table 2. Total Carrizo aquifer storage based on Southern Carrizo-Wilcox Groundwater Availability Model**

<b>County</b>	<b>Average Thickness feet</b>	<b>Total Area (mi<sup>2</sup>)</b>	<b>Total Storage acre-ft</b>
<b>Atascosa</b>	744	1,059	126,000,000
<b>Frio</b>	452	1,123	81,000,000
<b>Karnes</b>	797	109	14,000,000
<b>Wilson</b>	680	775	84,000,000
<b>Total</b>	NA	1,943	305,000,000

Notes:

- Based on specific yield of 0.25
- Total storage rounded to the nearest 1,000,000 acre-ft
- NA – not applicable



