GAM Run 05-03

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REQUESTOR:

Mr. Neil Hudgins on behalf of the Coastal Bend Groundwater Conservation District and the Coastal Plains Groundwater Conservation District.

DESCRIPTION OF REQUEST:

What is the water budget of Matagorda and Wharton counties under wet, dry, and predicted pumping conditions?

METHODS:

We used the historic and predictive models for the Groundwater Availability Model (GAM) for the central Gulf Coast aquifer (Waterstone and Parsons, 2003; Chowdhury and others, 2004) to determine the water budgets for Matagorda and Wharton counties. The historic model simulates groundwater flow through the central Gulf Coast aquifer during the period 1980 through 2000. We extracted water budget data from the GAM for zones representing Matagorda and Wharton counties for the wettest year (1992), the driest year (1988), and the predictive period (2005 through 2012). The water budget reported for 1988 is the average of the monthly water budgets for that year. Similarly, the water budget for the predictive period is the average for the years 2005 through 2012.

PARAMETERS AND ASSUMPTIONS:

- See Chowdhury and others (2004) for assumptions and limitations of the GAM. The root mean squared error for this model is 21 ft.
- Chowdhury and others (2004) calibrated the steady-state model to 1980 hydrologic conditions.
- The GAM has pumping based on water demand estimates from the 2001 regional water plans and the 2002 State Water Plan.
- Assumed average recharge conditions.
- The GAM assumes that pumping in the Evangeline aquifer only occurs in the upper part of the Evangeline aquifer.

RESULTS

Tables 1, 2, and 3 contain water-budget data for wet and dry conditions and for the 2005 to 2012 predictive period for each layer that constitutes the GAM in Matagorda and

Wharton Counties. These layers, the Chicot aquifer, Evangeline aquifer, Burkeville confining unit, and Jasper aquifer, constitute Layers 1 through 4 in the model.

Table 1. Average water budgets for Matagorda and Wharton counties for 1988, the driest year during the 1980 through 2000 transient run (values expressed in acre-feet/year).

(a) Matagorda County

Chicot Aquifer			
Flow Term	In	Out	In - Out
Storage	30,025	7,745	22,280
Constant Head	0	0	0
Horizontal Exchange	12,956	21,678	-8,722
Exchange (Upper)	0	0	0
Exchange (Lower)	1	9,062	-9,061
Wells	0	38,673	-38,673
Drains	0	461	-461
Recharge	12,681	0	12,681
Evapotranspiration	0	3,620	-3,620
Reservoirs	797	0	797
Head-Dependent Boundaries	108	6,274	-6,166
Stream Leakage	64,938	33,993	30,946
Sum	121,506	121,506	1
Evangeline Aquifer			
Storage	3,409	2,327	1,082
Constant Head	0	0	0
Horizontal Exchange	1,916	6,580	-4,664
Exchange (Upper)	9,062	1	9,061
Exchange (Lower)	372	0	372
Wells	0	5,852	-5,852
Drains	0	0	0
Recharge	0	0	0
Evapotranspiration	0	0	0
Reservoirs	0	0	0
Head-Dependent Boundaries	0	0	0
Stream Leakage	0	0	0
Sum	14,760	14,760	0

Table 1. (continued)

Burkeville Confining System			
Flow Term	In	Out	In - Out
Storage	371	0	371
Constant Head	0	0	0
Horizontal Exchange	9	8	1
Exchange (Upper)	0	372	-372
Exchange (Lower)	0	0	0
Wells	0	0	0
Drains	0	0	0
Recharge	0	0	0
Evapotranspiration	0	0	0
Reservoirs	0	0	0
Head-Dependent Boundaries	0	0	0
Stream Leakage	0	0	0
Sum	381	381	0

(b) Wharton County

Chicot Aquifer			
Flow Term	In	Out	In - Out
Storage	80,362	36,114	44,248
Constant Head	0	0	0
Horizontal Exchange	29,770	18,245	11,525
Exchange (Upper)	0	0	0
Exchange (Lower)	9	38,816	-38,806
Wells	0	129,920	-129,920
Drains	0	134	-134
Recharge	13,329	0	13,329
Evapotranspiration	0	381	-381
Reservoirs	536	0	536
Head-Dependent Boundaries	0	0	0
Stream Leakage	119,779	20,174	99,605
Sum	243,785	243,783	2

Table 1. (continued)

Evangeline Aquifer			
Flow Term	In	Out	In - Out
Storage	33,139	24,240	8,899
Constant Head	0	0	0
Horizontal Exchange	27,884	3,805	24,079
Exchange (Upper)	38,816	9	38,806
Exchange (Lower)	3,681	9	3,672
Wells	0	75,456	-75,456
Drains	0	0	0
Recharge	0	0	0
Evapotranspiration	0	0	0
Reservoirs	0	0	0
Head-Dependent Boundaries	0	0	0
Stream Leakage	0	0	0
Sum	103,519	103,519	0
Burkeville Confining System			
Storage	2,513	55	2,458
Constant Head	0	0	0
Horizontal Exchange	42	23	19
Exchange (Upper)	9	3,681	-3,672
Exchange (Lower)	1,194	0	1,194
Wells	0	0	0
Drains	0	0	0
Recharge	0	0	0
Evapotranspiration	0	0	0
Reservoirs	0	0	0
Head-Dependent Boundaries	0	0	0
Stream Leakage	0	0	0
Sum	3,759	3,759	0
Jasper Aquifer			
Storage	1,186	0	1,186
Constant Head	0	0	0
Horizontal Exchange	212	203	9
Exchange (Upper)	0	1,194	-1,194
Exchange (Lower)	0	0	0
Wells	0	0	0
Drains	0	0	0
Recharge	0	0	0
Evapotranspiration	0	0	0
Reservoirs	0	0	0
Head-Dependent Boundaries	0	0	0
Stream Leakage	0	0	0
Sum	1,398	1,398	0

Table 1. (continued)

(c) Net water budget

Flow Term	Matagorda County	Wharton County
Storage	23,733	56,790
Constant Head	0	0
Horizontal Exchange	-13,384	35,633
Exchange (Upper)	8,689	33,940
Exchange (Lower)	-8,689	-33,940
Wells	-44,524	-205,377
Drains	-461	-134
Recharge	12,681	13,329
Evapotranspiration	-3,620	-381
Reservoirs	797	536
Head-Dependent Boundaries	-6,166	0
Stream Leakage	30,946	99,605

Table 2. Water budgets for Matagorda and Wharton counties for 1992, the wettest year during the 1980 through 2000 transient run (values expressed in acre-feet/year).

(a) Matagorda County

Chicot Aquifer			
Flow Term	In	Out	In - Out
Storage	0	25,777	-25,777
Constant Head	0	0	0
Horizontal Exchange	12,655	26,152	-13,497
Exchange (Upper)	0	0	0
Exchange (Lower)	0	8,525	-8,525
Wells	0	25,864	-25,864
Drains	0	805	-805
Recharge	25,798	0	25,798
Evapotranspiration	0	3,887	-3,887
Reservoirs	644	0	644
Head-Dependent Boundaries	40	10,775	-10,735
Stream Leakage	87,789	25,141	62,648
Sum	126,926	126,926	0
Evangeline Aquifer			
Storage	17	569	-552
Constant Head	0	0	0
Horizontal Exchange	1,472	5,915	-4,443
Exchange (Upper)	8,525	0	8,525
Exchange (Lower)	319	0	319
Wells	0	3,849	-3,849
Drains	0	0	0
Recharge	0	0	0
Evapotranspiration	0	0	0
Reservoirs	0	0	0
Head-Dependent Boundaries	0	0	0
Stream Leakage	0	0	0
Sum	10,333	10,333	0

Table 2. (continued)

Burkeville Confining System			
Flow Term	In	Out	In - Out
Storage	319	0	319
Constant Head	0	0	0
Horizontal Exchange	9	9	0
Exchange (Upper)	0	319	-319
Exchange (Lower)	0	0	0
Wells	0	0	0
Drains	0	0	0
Recharge	0	0	0
Evapotranspiration	0	0	0
Reservoirs	0	0	0
Head-Dependent Boundaries	0	0	0
Stream Leakage	0	0	0
Sum	328	328	0

(b) Wharton County

Chicot Aquifer			
Flow Term	In	Out	In - Out
Storage	2	80,217	-80,215
Constant Head	0	0	0
Horizontal Exchange	30,268	20,793	9,474
Exchange (Upper)	0	0	0
Exchange (Lower)	0	37,465	-37,465
Wells	0	112,037	-112,037
Drains	0	223	-223
Recharge	27,864	0	27,864
Evapotranspiration	0	410	-410
Reservoirs	536	0	536
Head-Dependent Boundaries	0	0	0
Stream Leakage	207,636	15,159	192,477
Sum	266,305	266,304	0

Table 2. (continued)

Evangeline Aquifer			
Flow Term	In	Out	In - Out
Storage	957	122	835
Constant Head	0	0	0
Horizontal Exchange	26,863	3,329	23,534
Exchange (Upper)	37,465	0	37,465
Exchange (Lower)	3,158	0	3,158
Wells	0	64,993	-64,993
Drains	0	0	0
Recharge	0	0	0
Evapotranspiration	0	0	0
Reservoirs	0	0	0
Head-Dependent Boundaries	0	0	0
Stream Leakage	0	0	0
Sum	68,443	68,443	0
Burkeville Confining System			
Storage	1,967	6	1,961
Constant Head	0	0	0
Horizontal Exchange	44	22	22
Exchange (Upper)	0	3,158	-3,158
Exchange (Lower)	1,176	0	1,176
Wells	0	0	0
Drains	0	0	0
Recharge	0	0	0
Evapotranspiration	0	0	0
Reservoirs	0	0	0
Head-Dependent Boundaries	0	0	0
Stream Leakage	0	0	0
Sum	3,186	3,186	0
Jasper Aquifer			
Storage	1,159	0	1,159
Constant Head	0	0	0
Horizontal Exchange	216	199	17
Exchange (Upper)	0	1,176	-1,176
Exchange (Lower)	0	0	0
Wells	0	0	0
Drains	0	0	0
Recharge	0	0	0
Evapotranspiration	0	0	0
Reservoirs	0	0	0
Head-Dependent Boundaries	0	0	0
Stream Leakage	0	0	0
Sum	1,374	1,374	0

Table 2. (continued)

(c) Net water budget

Flow Term	Matagorda County	Wharton County
Storage	-26,010	-76,261
Constant Head	0	0
Horizontal Exchange	-17,940	33,047
Exchange (Upper)	8,206	33,131
Exchange (Lower)	-8,206	-33,131
Wells	-29,713	-177,030
Drains	-805	-223
Recharge	25,798	27,864
Evapotranspiration	-3,887	-410
Reservoirs	644	536
Head-Dependent Boundaries	-10,735	0
Stream Leakage	62,648	192,477

Table 3. Water budgets for Matagorda and Wharton counties averaged over the period 2005 through 2012 (values expressed in acre-feet/year).

(a) Matagorda County

Chicot Aquifer			
Flow Term	In	Out	In - Out
Storage	3,666	6	3,660
Constant Head	0	0	0
Horizontal Exchange	11,079	18,990	-7,911
Exchange (Upper)	0	0	0
Exchange (Lower)	2	8,217	-8,215
Wells	0	29,635	-29,635
Drains	0	180	-180
Recharge	17,316	0	17,316
Evapotranspiration	0	3,393	-3,393
Reservoirs	795	0	795
Head-Dependent Boundaries	238	5,549	-5,311
Stream Leakage	61,623	28,749	32,874
Sum	94,718	94,718	0
Evangeline Aquifer			
Storage	170	0	170
Constant Head	0	0	0
Horizontal Exchange	1,753	4,973	-3,220
Exchange (Upper)	8,217	2	8,215
Exchange (Lower)	308	0	308
Wells	0	5,509	-5,509
Drains	0	0	0
Recharge	0	0	0
Evapotranspiration	0	0	0
Reservoirs	0	0	0
Head-Dependent Boundaries	0	0	0
Stream Leakage	0	0	0
Sum	10,448	10,484	-36

Table 3. (continued)

Burkeville Confining System			
Flow Term	In	Out	In - Out
Storage	310	0	310
Constant Head	0	0	0
Horizontal Exchange	8	10	-1
Exchange (Upper)	0	308	-308
Exchange (Lower)	0	0	0
Wells	0	0	0
Drains	0	0	0
Recharge	0	0	0
Evapotranspiration	0	0	0
Reservoirs	0	0	0
Head-Dependent Boundaries	0	0	0
Stream Leakage	0	0	0
Sum	318	318	0

(b) Wharton County

Chicot Aquifer			
Flow Term	In	Out	In - Out
Storage	17,932	674	17,258
Constant Head	0	0	0
Horizontal Exchange	31,497	19,235	12,262
Exchange (Upper)	0	0	0
Exchange (Lower)	0	37,620	-37,620
Wells	0	107,878	-107,878
Drains	0	9	-9
Recharge	18,759	0	18,759
Evapotranspiration	0	260	-260
Reservoirs	536	0	536
Head-Dependent Boundaries	0	0	0
Stream Leakage	113,221	16,272	96,949
Sum	181,946	181,948	-1

Table 3. (continued)

Evangeline Aquifer			
Flow Term	In	Out	In - Out
Storage	243	12	230
Constant Head	0	0	0
Horizontal Exchange	28,719	3,766	24,953
Exchange (Upper)	37,620	0	37,620
Exchange (Lower)	3,192	0	3,192
Wells	0	66,038	-66,038
Drains	0	0	0
Recharge	0	0	0
Evapotranspiration	0	0	0
Reservoirs	0	0	0
Head-Dependent Boundaries	0	0	0
Stream Leakage	0	0	0
Sum	69,773	69,816	-42
Burkeville Confining System			
Storage	1,372	55	1,317
Constant Head	0	0	0
Horizontal Exchange	50	19	31
Exchange (Upper)	0	3,192	-3,192
Exchange (Lower)	1,844	0	1,844
Wells	0	0	0
Drains	0	0	0
Recharge	0	0	0
Evapotranspiration	0	0	0
Reservoirs	0	0	0
Head-Dependent Boundaries	0	0	0
Stream Leakage	0	0	0
Sum	3,266	3,266	0
Jasper Aquifer			
Storage	1,870	0	1,870
Constant Head	0	0	0
Horizontal Exchange	203	228	-26
Exchange (Upper)	0	1,844	-1,844
Exchange (Lower)	0	0	0
Wells	0	0	0
Drains	0	0	0
Recharge	0	0	0
Evapotranspiration	0	0	0
Reservoirs	0	0	0
Head-Dependent Boundaries	0	0	0
Stream Leakage	0	0	0
Sum	2,072	2,073	0

Table 3. (continued)

(c) Net water budget

Flow Term	Matagorda County	Wharton County
Storage	4,139	20,675
Constant Head	0	0
Horizontal Exchange	-11,132	37,221
Exchange (Upper)	7,907	32,583
Exchange (Lower)	-7,907	-32,583
Wells	-35,144	-173,916
Drains	-180	-9
Recharge	17,316	18,759
Evapotranspiration	-3,393	-260
Reservoirs	795	536
Head-Dependent Boundaries	-5,311	0
Stream Leakage	32,874	96,949

Total recharge in Matagorda County, based on the GAM, is approximately 12,700, 25,800, and 17,300 acre-feet per year for the driest year, wettest year, and the predictive period, respectively (Tables 1, 2, and 3). Total recharge in Wharton County, based on the GAM, is approximately 13,300, 27,900, and 18,800 acre-feet per year for the driest year, wettest year, and the predictive period, respectively (Tables 1, 2, and 3). These recharge values lie within the range of previous recharge estimates of 6,200 to 25,000 acre-feet per year for Matagorda County and 5,800 to 23,000 acre-feet per year for Wharton County (Dutton and Richter, 1990).

REFERENCES:

Chowdhury, A. H., Wade, S., Mace, R. E., and Ridgeway, C., 2004, Groundwater availability model of the Central Gulf Coast aquifer system: Numerical simulations through 1999: Texas Water Development Board, draft report, 108 p.

Dutton, A. R. and Richter, B. C., 1990, Regional hydrogeology of the gulf coast aquifer in Matagorda and Wharton counties, Texas – Development of a numerical flow model to estimate the impact of water management strategies: Report prepared for the Lower Colorado River Authority under contract (88-89) 0910, Bureau of Economic Geology, University of Texas at Austin, 118 p.

Waterstone Environmental Hydrology and Engineering, Inc., and Parsons Engineering Science, Inc., 2003, Groundwater availability of the central Gulf Coast aquifer: Numerical simulations to 2050 central Gulf Coast, Texas: prepared for the Texas Water Development Board, unpublished report, 156 p.