GAM Run 08-19

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September 23, 2008

EXECUTIVE SUMMARY:

We ran the groundwater availability model for the southern part of the Gulf Coast Aquifer for a 60-year predictive simulation using pumpage specified by members of Groundwater Management Area 16 along with average recharge and evapotranspiration rates. The results of this model run indicate water-level declines in excess of 1,000 feet in the Chicot and Evangeline aquifers within Groundwater Management Area 16 in response to the specified pumpage. The Jasper Aquifer was not evaluated for the southern part of the Gulf Coast Aquifer groundwater availability model because there is no pumpage assigned to this aquifer in this model run.

REQUESTOR:

Mr. Scotty Bledsoe from the Live Oak Underground Water Conservation District (on behalf of Groundwater Management Area 16).

DESCRIPTION OF REQUEST:

Mr. Bledsoe asked us to run a model simulation using the groundwater availability model for the southern part of the Gulf Coast Aquifer. This baseline model run would be a 60-year simulation using initial water levels from the end of the historic calibration model run and average recharge. Each year of the model runs would use pumpage specified by the members of Groundwater Management Area 16.

This model run is one of multiple model runs that will aid Groundwater Management Area 16 in developing their desired future conditions for the southern portion of the Gulf Coast Aquifer. Other previously completed model runs for this portion of the Gulf Coast Aquifer are GAM runs 07-11 (Donnelly, 2007a), 07-28 (Donnelly, 2007b), 07-33 (Donnelly 2007c), and 07-34 (Donnelly, 2007d).

METHODS:

We averaged recharge rates and evapotranspiration rates for the historic calibration runs, representing 1981 through 1999. We then used these averages for each year of the 60-year predictive simulation along with the specified pumpage. We then evaluated the resulting water levels and drawdown and described them in the results section below.

PARAMETERS AND ASSUMPTIONS:

The groundwater availability model for the southern part of the Gulf Coast Aquifer was used for this simulation. The parameters and assumptions for this model are described below:

- We used Version 2.01 of the groundwater availability model for the southern part of the Gulf Coast Aquifer.
- See Chowdhury and Mace (2007) for assumptions and limitations of the groundwater availability model for the southern part of the Gulf Coast Aquifer.
- The mean absolute error (a measure of the difference between simulated and actual water levels during model calibration) in the entire model for 2000 is 15.3 feet (Chowdhury and Mace, 2007).
- The model includes four layers representing: the Chicot Aquifer (Layer 1), the Evangeline Aquifer (Layer 2), the Burkeville Confining Unit (Layer 3), and the Jasper Aquifer (Layer 4).
- Recharge and evapotranspiration rates are averages from the 1981 through 1999 calibration time period.
- Pumpage used for each year of the 60-year predictive simulation is shown in Table 1. The methodology for the addition of pumpage was identical to that done for GAM Run 07-33 (Donnelly, 2007b). Pumpage was added to the baseline pumpage from GAM Run 07-11 (Donnelly, 2007a) in the Chicot and Evangeline aquifers (Figures 1 and 2).

Table 1. Summary of pumpage used in this model run. Pumpage is expressed in acre-feet per year. Pumpage in Jim Hogg, Brooks, and Kenedy counties represents only the pumpage located in the active portion of the model.

County	GAM Run 07-11 baseline pumpage	GAM Run 07-28 specified pumpage	GAM Run 07-33 specified pumpage	GAM Run 07-34 specified pumpage	GAM Run 08-19 total pumpage (acre-feet/year)	Chicot pumpage (acre-feet/year)	Evangeline pumpage (acre-feet/year)
Brooks	389	50,389	15,556	25,669	50,325	10,065	40,260
Cameron	2,832	89,679	89,653	89,653	105,228	104,700	528
Hidalgo	20,325	52,538	27,883	32,920	168,821	33,764	135,057
Jim Hogg	38	4,880	4.880	4,880	4,880	0	4,880
Kenedy	199	51,744	15,500	25,700	207,520	41,504	166,016
Starr	394	7,600	7,600	7,600	7,600	0	7,600
Willacy	28	48,029	14,502	24,153	83,648	16,730	66,918

RESULTS:

Included in the results are estimates of the water budgets after running the model for 60 years. The components of the water budget are described below.

- Wells—water produced from wells in each aquifer. This component is always shown as "Outflow" from the water budget, because all wells included in the model produce (rather than inject) water. Wells are simulated in the model using the MODFLOW Well package.

- Recharge—simulates areally distributed recharge due to precipitation falling on the outcrop areas of aquifers. Recharge is always shown as "Inflow" in the water budget.

- Vertical Leakage (Upward or Downward)—describes the vertical flow, or leakage, between two aquifers. This flow is controlled by the water levels in each aquifer and hydraulic properties of each aquifer that define the amount of leakage that can occur. "Inflow" to an aquifer from an overlying or underlying aquifer will always equal to "Outflow" from the other aquifer.

- Storage—water stored in the aquifer. The storage component that is included in "Inflow" is water that is removed from storage in the aquifer (that is, water levels decline). The storage component that is included in "Outflow" is water that is added back into storage in the aquifer (that is, water levels increase). This component of the budget is often seen as water both going into and out of the aquifer because this is a regional budget, and water levels will decline in some areas (water is being removed from storage) and will rise in others (water is being added to storage).

- Lateral flow—describes lateral flow within an aquifer between a county and adjacent counties.

- Evapotranspiration—water that flows out of an aquifer due to direct evaporation and plant transpiration. This component of the budget will always be shown as "Outflow". Evapotranspiration is modeled in the model using the MODFLOW Evapotranspiration (EVT) package.

- Rivers and Streams—water that flows between streams and rivers and an aquifer. The direction and amount of flow depends on the water level in the stream or river and the aquifer. In areas where water levels in the stream or river are above the water level in the aquifer, water flows into the aquifer and is shown as "Inflow" in the budget. In areas where water levels in the aquifer are above the water level in the stream or river, water flows out of the aquifer and into the stream and is shown as "Outflow" in the budget. Rivers and streams are modeled in the model for the southern part of the Gulf Coast Aquifer using the MODFLOW River package

The results of this model run are described for the Chicot Aquifer (layer 1 in the model) and the Evangeline Aquifer (layer 2). The Burkeville Confining Unit (layer 3) is not discussed because this is not a major source of water in the region. There also is no pumpage from this Burkeville

Confining Unit layer in the model. The Jasper Aquifer is not discussed because it is not used, and therefore, has no assigned pumpage in this model run.

Initial water levels (which are from the end of the transient calibration run — the end of 1999) for the Chicot and Evangeline aquifers are shown in Figures 3 and 4, respectively. These figures show the starting water levels for this 60-year predictive model run, and show that water-level elevations decrease as groundwater flows down-dip towards the coast.

Water levels at the end of the 60-year predictive simulation using the specified pumpage for the Chicot and Evangeline aquifers are shown in Figures 5 and 6, respectively. Water-level changes over the 60-year predictive simulation for the Chicot and Evangeline aquifers are shown in Figures 7 and 8, respectively. These figures indicate that water-level declines due to pumpage over the 60-year model run are in excess of 200 feet and 1,000 feet in the Chicot and Evangeline aquifers, respectively. Table 2 shows average water-levels declines for the Chicot and Evangeline aquifers in each county in the model.

Table 2. Average water-level changes by county and aquifer located in the groundwater availability model for the southern portion of the Gulf Coast Aquifer. Negative values indicate an average lowering of water levels between 1999 and 2060 while a positive value indicates an increase in water levels.

County	Average Water Level Change (feet)	
	Chicot Aquifer (Layer 1)	Evangeline Aquifer (Layer 2)
Brooks	-118	-818
Cameron	-12.0	-43.8
Hidalgo	-60.4	-285
Jim Hogg	-83.1	-272
Kenedy	-109	-281
Starr	-77.6	-300
Willacy	-47.9	-136

Figure 7 indicates water-level decline throughout the model area in the Chicot Aquifer, largely due to the increase in pumpage. Large areas of up-dip portions of the Chicot Aquifer have gone dry during the model run (shown in black in Figure 7). Water-level declines in western Kenedy County exceed 200 feet, and in Hidalgo County water-level declines are up to 100 feet. Water-level declines decrease significantly towards the coast due to the presence of constant-head cells in the groundwater model used to represent the Gulf of Mexico and Laguna Madre. The reversal of the hydraulic gradient in the Chicot Aquifer over 60-year predictive model run suggests the potential for the occurrence of seawater intrusion along the coast.

In the Evangeline Aquifer (Figure 8), the water-level declines are even larger than in the Chicot Aquifer. The assigned pumpage results in dry cells in western Brooks and northern Hidalgo counties and parts of Starr County. These dry cells are part of a large cone-of-depression

centered around Brooks County where an approximately 40,000 acre-feet per year of additional pumpage was placed. Water-level declines exceed 1,000 feet in the cone-of-depression, and all areas in the Evangeline Aquifer show significant water-level decline associated with the specified pumpage totals. It should be noted that the model contains no pumpage from the Evangeline Aquifer in Cameron County, and consequently water-level declines there are generally less than 100 feet in this model run. The formation of the cone-of-depression in the Evangeline Aquifer also has the potential to induce influxes of high saline groundwater.

As noted above, the results indicate a large number of cells going dry in the Chicot and Evangeline aquifers during the model simulation. Dry cells occur when the water level in a cell falls below the bottom of the cell. When this occurs, the cell is deactivated. If high pumpage is the primary factor for a cell going dry, the model is saying that the pumping may be too great for the aquifer in this area. In the groundwater availability model for the southern part of the Gulf Coast Aquifer, when the model deactivates a cell, that cell is inactive for the rest of the simulation, and it is important to identify why a cell went dry and address the causes. In reality, the aquifer will probably not go dry because pumping will become uneconomical before the aquifer is fully dewatered in any particular area. However, the model is suggesting that these areas may experience water supply problems sometime in the 60-year simulation period if pumpage is increased to the level supplied by Groundwater Management Area 16.

Water budgets are provided in Table 3. The budgets from this baseline run can be compared to future model runs to provide detail on the impact of future pumpage scenarios on these water budget components.

REFERENCES:

Chowdhury, A. H. and Mace R. E., 2007, Groundwater Resource Evaluation and Availability Model of the Gulf Coast Aquifer in the Lower Rio Grande Valley of Texas, Texas Water Development Board Report 368, 119 p.

Donnelly, A. C. A., 2007a, GAM07-11 Final Report, Texas Water Development Board GAM Run Report, April 19, 2007, 15 pp.

Donnelly, A. C. A., 2007b, GAM07-28 Final Report, Texas Water Development Board GAM Run Report, September 13, 2007, 10 pp.

Donnelly, A. C. A., 2007c, GAM07-33 Final Report, Texas Water Development Board GAM Run Report, November 30, 2007, 10 pp.

Donnelly, A. C. A., 2007d, GAM07-34 Final Report, Texas Water Development Board GAM Run Report, November 30, 2007, 10 pp.

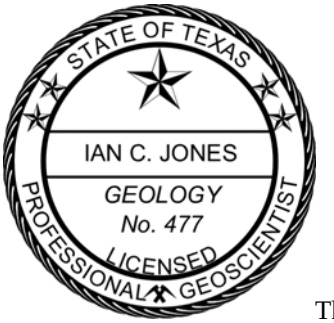

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Table 3. Water budgets for each county at the end of the 60-year predictive model run using the specified pumpage (in acre-feet per year). A dashed line indicates the aquifer does not exist or was not modeled for a particular county. Water budgets for Brooks, Jim Hogg, and Kenedy counties represent only portions of those counties located in the active portion of the model for the southern part of the Gulf Coast Aquifer.

	Brooks		Cameron		Hidalgo		Jim Hogg		Kenedy		Starr		Willacy		Non-Texas	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Chicot																
Storage	0	0	3	0	5	0	--	--	17	9	--	--	7	0	0	0
Rivers	0	0	133,979	1,854	80,146	963	--	--	0	0	--	--	10,628	0	0	0
Wells	0	0	0	104,674	0	21,906	--	--	0	34,304	--	--	0	15,297	0	0
Gulf of Mexico (Constant Head)	0	0	26,257	349	0	0	--	--	146,959	0	--	--	33,150	36	39,020	0
Recharge	0	0	7,514	0	2,220	0	--	--	6,766	0	--	--	4,254	0	0	0
Evapotranspiration	0	0	0	0	0	0	--	--	0	299	--	--	0	69	0	0
Lateral Inflow	0	0	8,557	29,813	856	60,359	--	--	20,288	1,720	--	--	33,381	17,126	0	12,785
Vertical Leakage Downward	0	0	0	39,619	0	0	--	--	0	137,697	--	--	0	48,892	0	26,235
Evangeline																
Storage	41	47	9	0	102	6	372	0	37	0	304	10	14	0	2	0
Rivers	0	0	0	0	42,760	0	0	0	0	0	1,044	18	0	0	0	0
Wells	0	13,206	0	528	0	131,028	0	4,868	0	166,016	0	6,759	0	66,917	0	0
Gulf of Mexico (Constant Head)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Recharge	1,513	0	0	0	6,760	0	2,430	0	1,480	0	3,220	0	743	0	115	0
Evapotranspiration	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0
Vertical Leakage Upward	0	0	39,619	0	58,720	0	0	0	137,697	0	0	0	48,892	0	26,235	0
Lateral Inflow	10,215	273	2,648	42,167	24,915	5,651	0	821	32,943	9,624	588	2,591	34,881	18,566	703	27,201
Vertical Leakage Downward	1,757	0	418	0	3,603	176	2,886	0	3,484	0	4,452	225	952	0	147	0

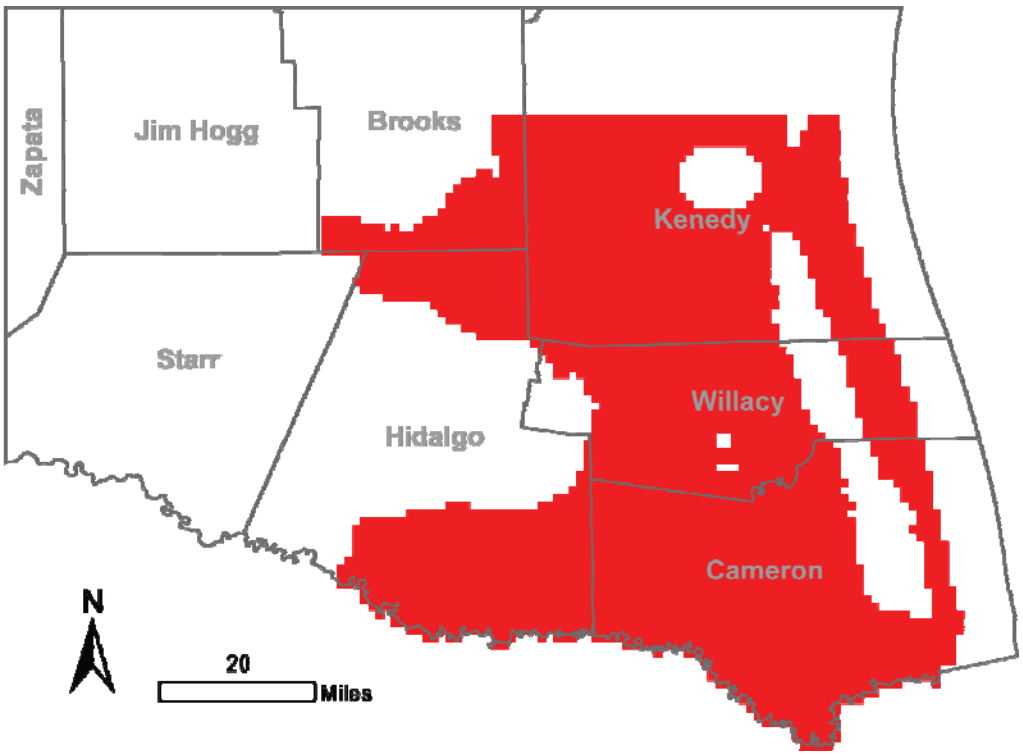

Figure 1. Areas in the Chicot Aquifer where pumpage is assigned in the predictive model run.

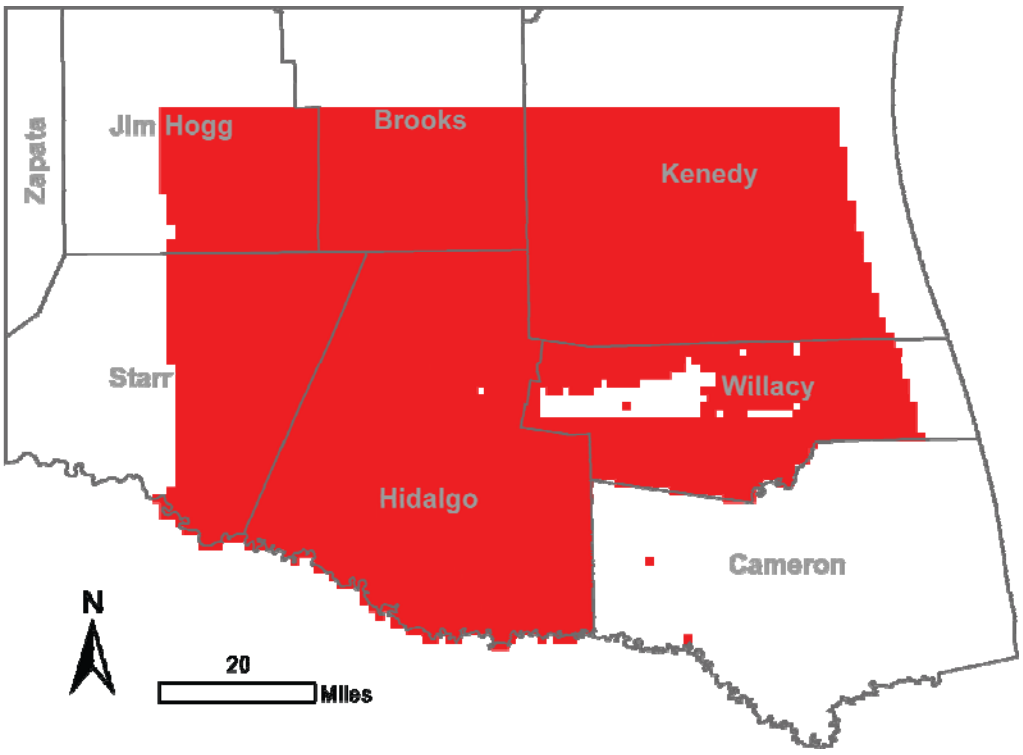

Figure 2. Areas in the Evangeline Aquifer where pumpage is assigned in the predictive model run.

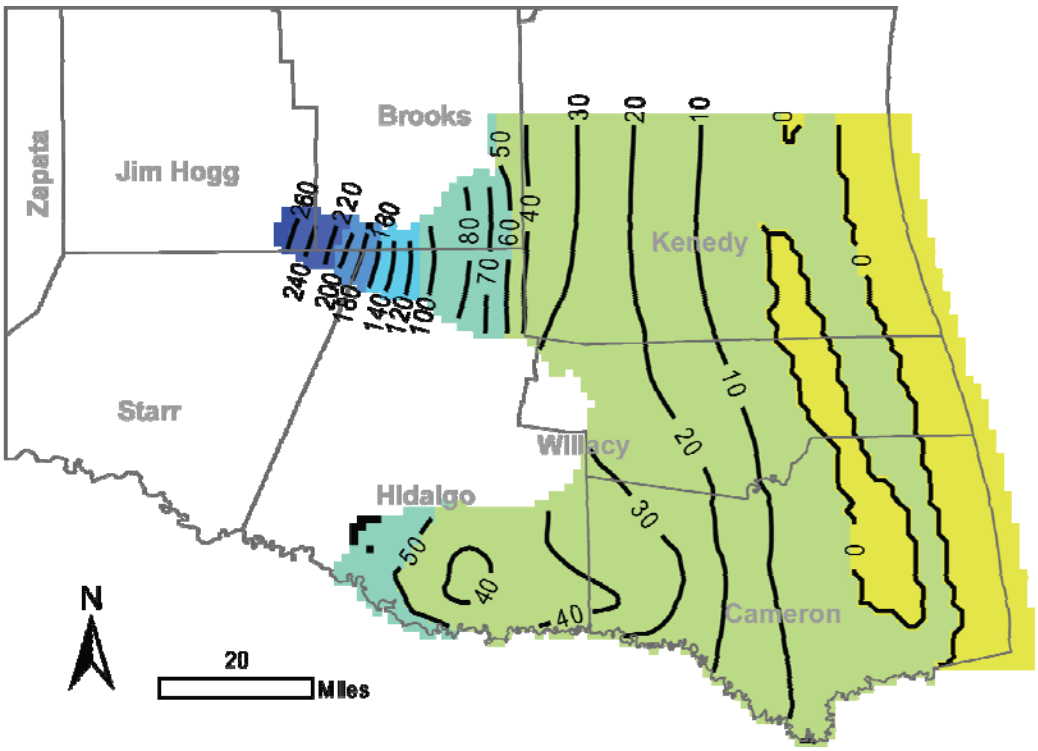

Figure 3. Initial water-level elevations for the predictive model run in the Chicot Aquifer. Water-level elevations are in feet above mean sea level. The contour interval is 10 feet.

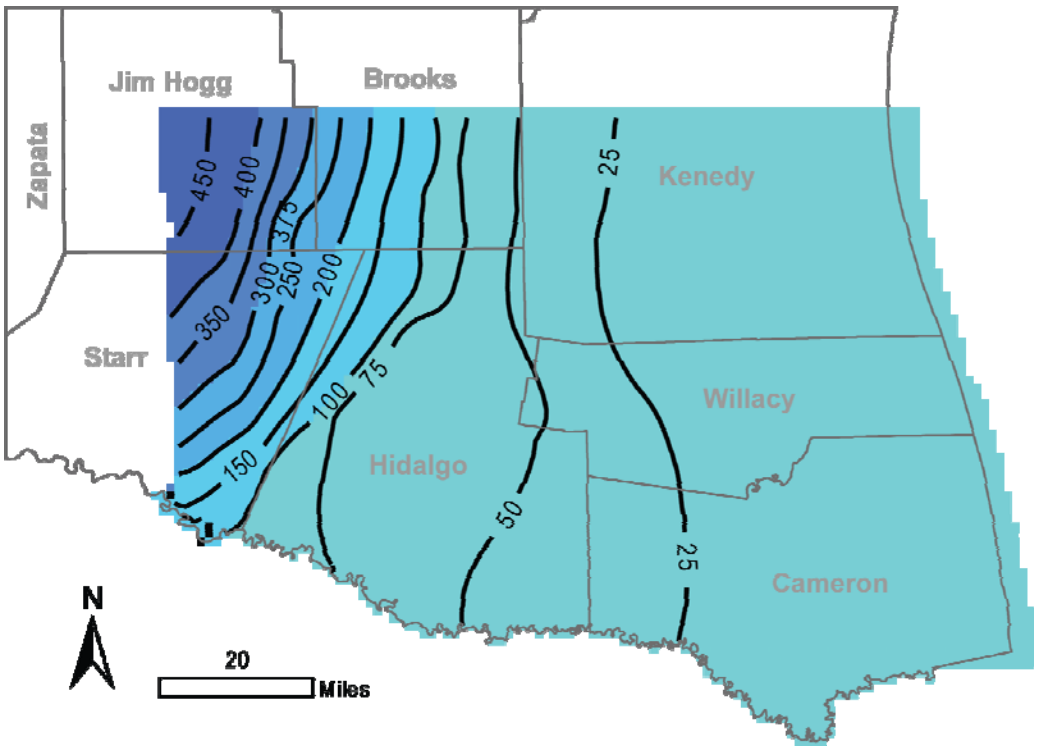

Figure 4. Initial water-level elevations for the predictive model run in the Evangeline Aquifer. Water-level elevations are in feet above mean sea level. The contour interval is 25 feet.

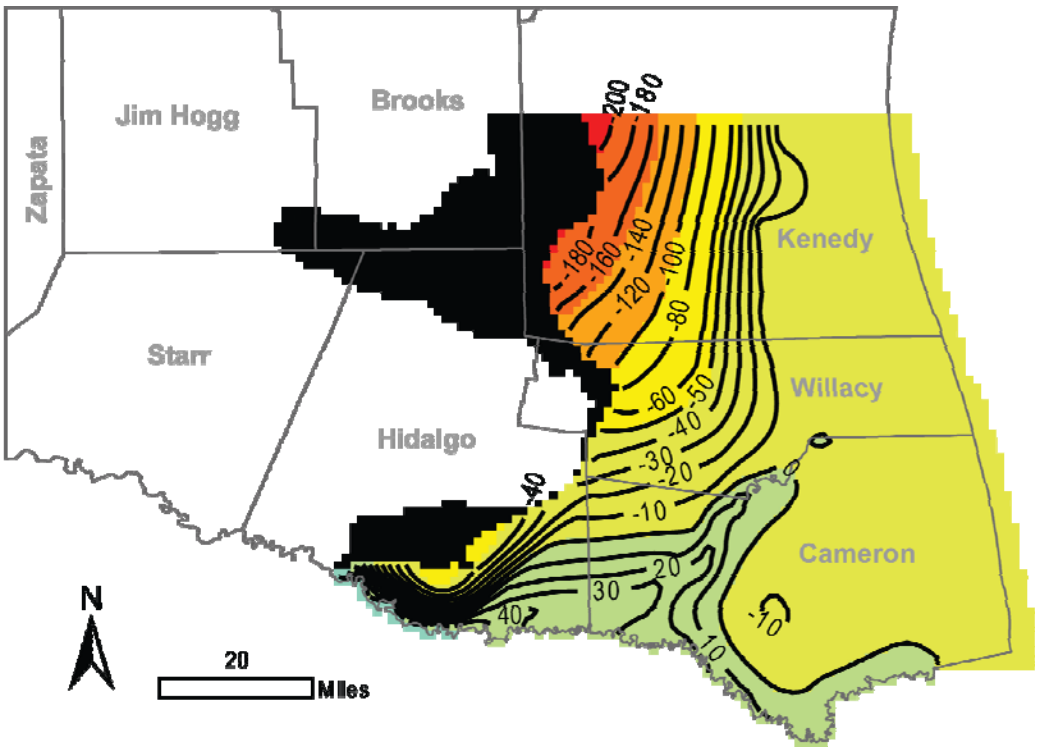

Figure 5. Water-level elevations after 60 years using the specified pumpage in the Chicot Aquifer. Water-level elevations are in feet above mean sea level. Contour interval is 10 feet. Dry cells are shown in black.

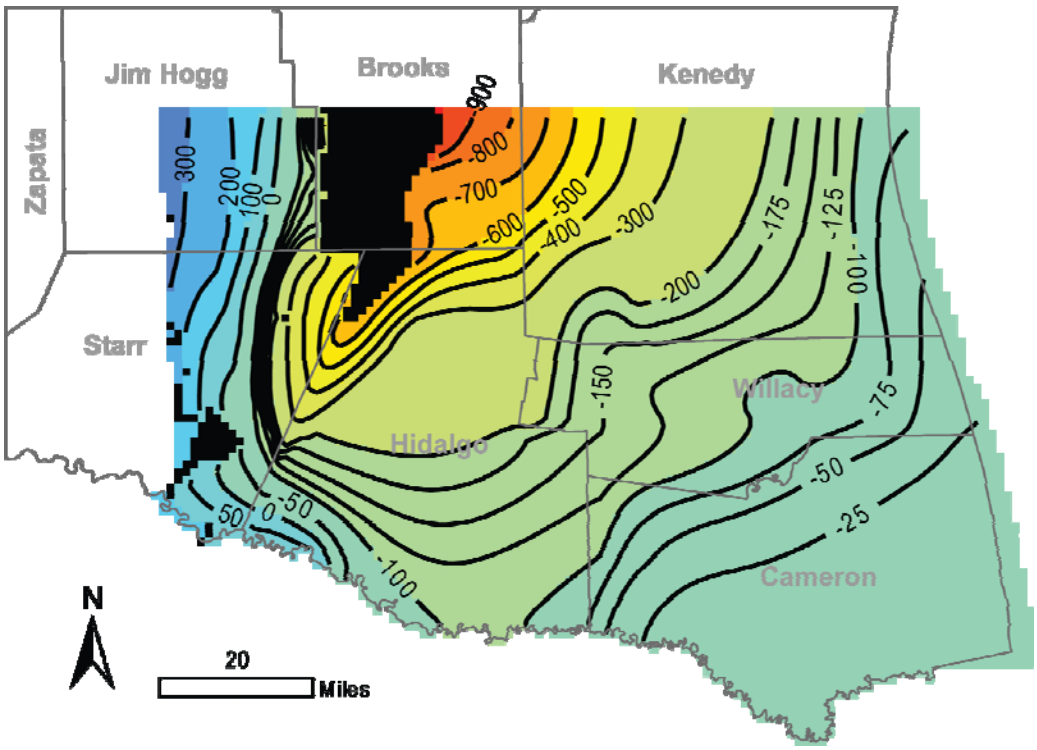

Figure 6. Water-level elevations after 60 years using the specified pumpage in the Evangeline Aquifer. Water-level elevations are in feet above mean sea level. Contour interval is 25 feet. Dry cells are shown in black.

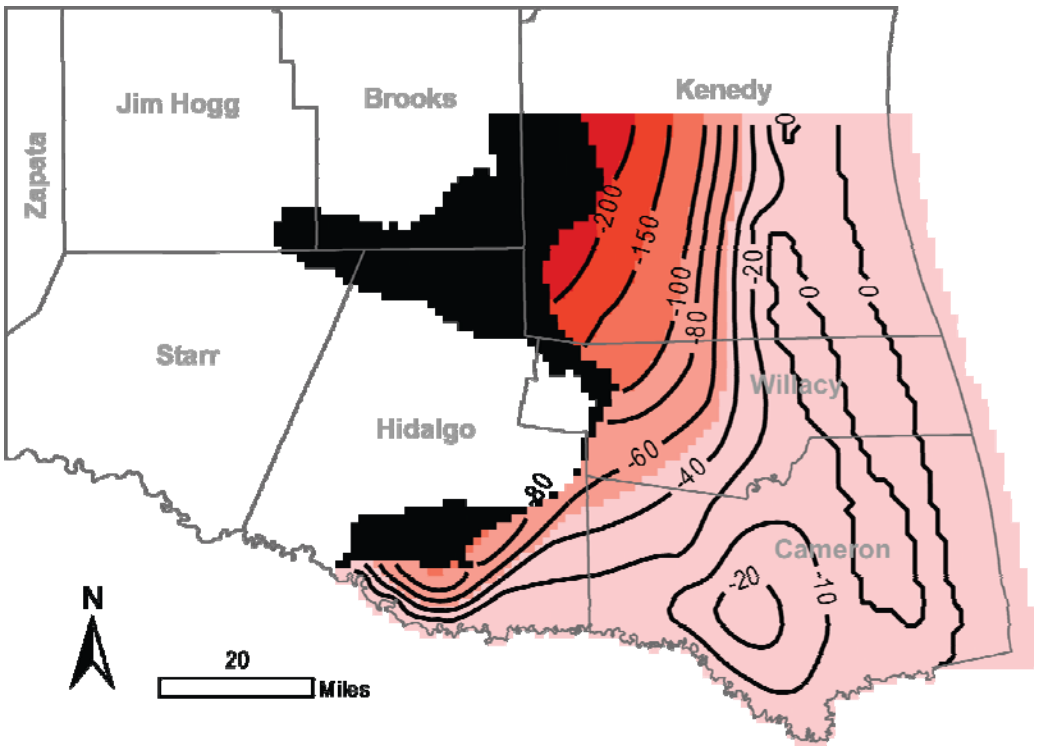

Figure 7. Water-level changes (in feet) after 60 years using the specified pumpage in the Chicot Aquifer. The contour interval is 10 feet. Areas of decreasing water levels (drawdown) are shown in red. Dry cells are shown in black.

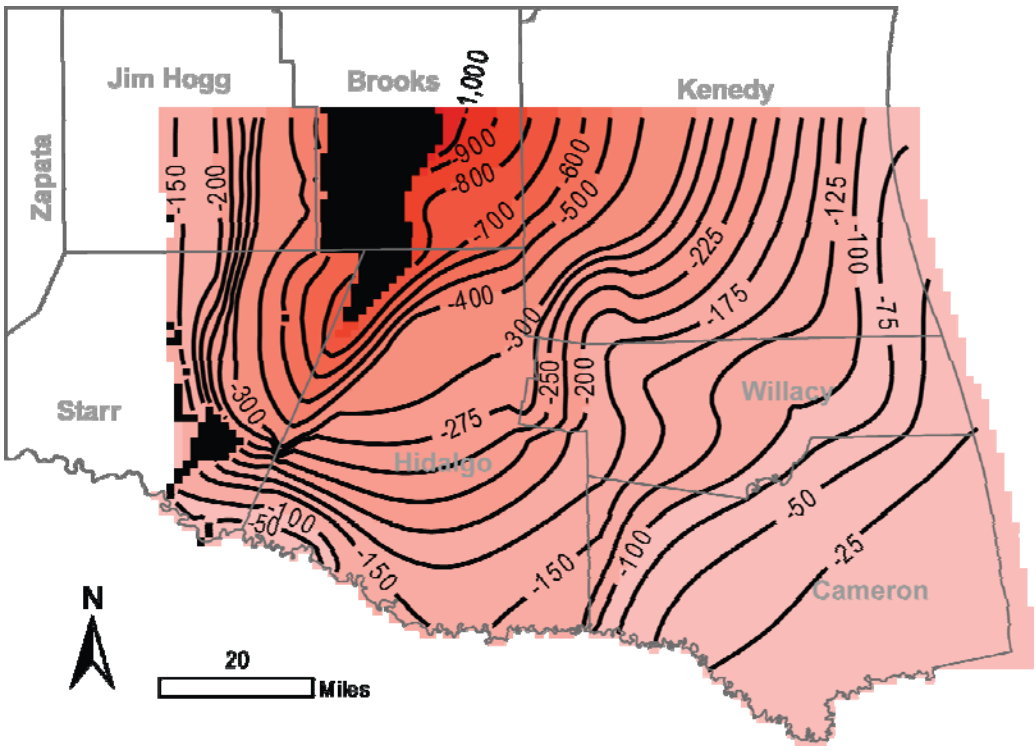

Figure 8. Water-level changes (in feet) after 60 years using the specified pumpage in the Evangeline Aquifer. The contour interval is 25 feet. Areas of decreasing water levels (drawdown) are shown in red. Dry cells are shown in black.

Appendix

Summary from GAM Run 08-17
Central Gulf Coast Aquifer Groundwater Availability Model

Table A-1. Pumpage used in the model simulation for GAM Run 08-17. Pumpage is expressed in acre-feet per year. Please note that pumpage in Jim Hogg, Brooks, Kenedy, Brazoria, Fort Bend, and Austin counties represents only the pumpage located in the active portion of the model for the central part of the Gulf Coast Aquifer.

County	GAM Run 07-12 baseline pumpage	GAM Run 08-17 total pumpage	Additional pumpage	Additional Chicot pumpage	Additional Evangeline pumpage	Additional Jasper pumpage
Aransas	1,827	1,827	0	0	0	0
Bee	4,694	18,654	13,960	6,282	7,399	279
Brooks	4,040	30,699	26,659	5,332	21,327	0
Calhoun	1,517	2,940	1,423	1,387	36	0
Colorado	33,236	47,857	14,621	7,448	6,898	275
Dewitt	4,587	15,866	11,279	3,384	6,767	1,128
Duval	7,749	14,063	6,314	338	3,585	2,390
Fayette	2,197	8,697	6,500	0	715	5,785
Goliad	6,143	12,806	6,667	706	5,961	0
Jackson	53,615	87,876	34,261	24,979	9,282	0
Jim Hogg	981	981	0	0	0	0
Jim Wells	4,761	46,304	41,530	8,306	33,224	0
Karnes	2,897	15,200	12,303	0	1,107	11,196
Kenedy	104	70,557	70,453	14,091	56,362	0
Kleberg	8,634	116,309	107,675	21,535	86,140	0
Lavaca	11,376	38,171	26,795	4,060	16,583	6,152
Live Oak	8,693	11,987	3,307	0	1,058	2,249
Matagorda	35,000	49,221	14,221	11,254	2,967	0
McMullen	29	450	421	0	4	417
Nueces	3,097	56,000	52,903	13,226	39,677	0
Refugio	1,063	28,859	27,791	6,257	21,534	0
San Patricio	3,748	16,290	12,542	6,271	6,271	0
Victoria	13,872	41,128	27,257	15,091	12,166	0
Webb	143	2,000	1,857	0	1,765	92
Wharton	180,000	182,793	2,793	1,734	1,059	0

Table A-2. Average water-level changes by county and aquifer. Negative values indicates an average lowering of water levels between 1999 and 2060 while a positive value indicates an increase in water levels. A dashed line indicates the aquifer does not exist or was not modeled for a particular county. Please note that average water-level changes in Jim Hogg, Brooks, Kenedy, Brazoria, Fort Bend, and Austin counties represents only the active portion of the model for the central part of the Gulf Coast Aquifer.

County	Average Water Level Change (feet)		
	Chicot Aquifer (Layer 1)	Evangeline Aquifer (Layer 2)	Jasper Aquifer (Layer 4)
Aransas	0.0	-25.3	--
Austin	+3.5	-3.3	-12.8
Bee	-4.8	-10.0	-6.3
Brazoria	+0.5	-11.4	-15.1
Brooks	-19.4	-175.6	-18.3
Calhoun	+0.6	-9.8	--
Colorado	-7.5	-11.6	-26.2
De Witt	-7.4	-6.4	-18.0
Duval	-5.2	-17.4	-35.0
Fayette	--	-14.4	-46.3
Fort Bend	+2.2	-3.2	-12.8
Goliad	+1.0	-4.6	-14.2
Gonzales	--	--	-15.8
Jackson	-19.0	-24.4	-27.3
Jim Hogg	+15.4	+7.8	+1.0
Jim Wells	-9.8	-133.0	-20.9
Karnes	--	-23.8	-51.6
Kenedy	-34.8	-816.1	--
Kleberg	-9.3	-706.3	-35.0
Lavaca	-13.6	-12.9	-62.1
Live Oak	-6.7	-9.5	-16.6
Matagorda	-3.8	-22.5	--
McMullen	--	--	-15.2
Nueces	-19.8	-137.7	-17.3
Refugio	-0.5	-30.5	--
San Patricio	-6.5	-29.0	-13.3
Victoria	+6.6	-0.5	-6.2
Washington	--	--	-52.0
Webb	--	-55.1	-56.9
Wharton	-15.2	-10.5	-23.0

Table A-3. Annual water budgets for each county at the end of the 60-year predictive model run using the specified pumpage in the groundwater availability model for the central part of the Gulf Coast Aquifer (in acre-feet per year). Water budgets for Jim Hogg, Brooks, Kenedy, Brazoria, Fort Bend, and Austin counties represent only the portions of those counties located in the active portion of the model.

Bee						
	GAM07-12 Baseline		GAM07-14 Availability		GAM08-17 New Pumpage	
	In	Out	In	Out	In	Out
Chicot						
Storage	0	15	1,424	0	361	0
Reservoirs (River package)	0	0	0	0	0	0
Springs (Drain package)	0	0	0	0	0	0
General Head Boundaries	0	0	0	0	0	0
Wells	0	1,383	0	9,620	0	6,934
Streams and Rivers	4,811	10,996	7,027	975	7,444	3,687
Recharge	18,921	0	18,825	0	18,825	0
Evapotranspiration	0	219	0	45	0	116
Lateral Inflow	775	8,671	972	5,568	754	8,180
Vertical Leakage Downward	937	4,160	0	12,041	0	8,466
Evangeline						
Storage	0	41	173	0	67	0
Reservoirs (River package)	0	0	0	0	0	0
Springs (Drain package)	0	0	0	0	0	0
General Head Boundaries	0	0	0	0	0	0
Wells	0	2,973	0	13,553	0	10,370
Streams and Rivers	4,008	3,783	6,758	2,190	5,681	2,645
Recharge	4,993	0	5,089	0	5,089	0
Evapotranspiration	0	2	0	0	0	0
Vertical Leakage Upward	4,160	937	12,041	0	8,466	0
Lateral Inflow	2,354	6,841	5,104	13,006	3,093	8,706
Vertical Leakage Downward	96	1,031	612	1,023	352	1,022
Jasper						
Storage	39	187	594	0	382	0
Reservoirs (River package)	0	0	0	0	0	0
Springs (Drain package)	0	0	0	0	0	0
General Head Boundaries	0	0	0	0	0	0
Wells	0	260	0	658	0	540
Streams and Rivers	94	96	159	58	145	69
Recharge	23	0	24	0	24	0
Evapotranspiration	0	0	0	0	0	0
Vertical Leakage Upward	884	148	1,152	270	1,072	206
Lateral Inflow	492	844	453	1,395	436	1,243

Table A-3. (continued)

Brooks						
	GAM07-12 Baseline		GAM07-14 Availability		GAM08-17 New Pumpage	
	In	Out	In	Out	In	Out
Chicot						
Storage	0	3	98	0	1,020	0
Reservoirs (River package)	3,431	0	3,431	0	3,431	0
Springs (Drain package)	0	0	0	0	0	0
General Head Boundaries	0	0	0	0	0	0
Wells	0	359	0	359	0	5,681
Streams and Rivers	1,073	23,128	1,349	19,705	3,838	8,184
Recharge	23,402	0	23,402	0	23,402	0
Evapotranspiration	0	1,826	0	1,763	0	866
Lateral Inflow	5,005	4,877	4,674	4,580	5,388	4,601
Vertical Leakage Downward	1,365	4,081	507	7,051	0	17,743
Evangeline						
Storage	1	3	574	0	7,433	0
Reservoirs (River package)	0	0	0	0	0	0
Springs (Drain package)	0	0	0	0	0	0
General Head Boundaries	0	0	0	0	0	0
Wells	0	3,681	0	3,681	0	25,006
Streams and Rivers	0	863	5	828	430	135
Recharge	340	0	340	0	340	0
Evapotranspiration	0	0	0	0	0	0
Vertical Leakage Upward	4,081	1,365	7,051	507	17,743	0
Lateral Inflow	2,680	1,752	3,308	7,610	5,447	11,789
Vertical Leakage Downward	808	245	1,562	214	5,542	1
Jasper						
Storage	1	208	282	58	1,708	0
Reservoirs (River package)	0	0	0	0	0	0
Springs (Drain package)	0	0	0	0	0	0
General Head Boundaries	0	0	0	0	0	0
Wells	0	0	0	0	0	0
Streams and Rivers	0	0	0	0	0	0
Recharge	0	0	0	0	0	0
Evapotranspiration	0	0	0	0	0	0
Vertical Leakage Upward	197	785	188	998	11	2,573
Lateral Inflow	1,448	655	1,399	813	1,571	717

Table A-3. (continued)

Duval						
	GAM07-12 Baseline		GAM07-14 Availability		GAM08-17 New Pumpage	
	In	Out	In	Out	In	Out
Chicot						
Storage	1	0	106	0	159	0
Reservoirs (River package)	0	0	0	0	0	0
Springs (Drain package)	0	0	0	0	0	0
General Head Boundaries	0	0	0	0	0	0
Wells	0	394	0	733	0	733
Streams and Rivers	1,544	3,215	3,451	1,230	3,118	1,459
Recharge	5,270	0	5,270	0	5,270	0
Evapotranspiration	0	34	0	17	0	16
Lateral Inflow	671	3,467	666	3,184	585	3,369
Vertical Leakage Downward	339	715	40	4,368	51	3,604
Evangeline						
Storage	72	0	859	0	577	1
Reservoirs (River package)	0	0	0	0	0	0
Springs (Drain package)	0	0	0	0	0	0
General Head Boundaries	0	0	0	0	0	0
Wells	0	4,363	0	7,949	0	7,949
Streams and Rivers	2,962	8,272	6,070	4,955	5,538	4,995
Recharge	14,506	0	14,506	0	14,506	0
Evapotranspiration	0	335	0	28	0	31
Vertical Leakage Upward	715	339	4,368	40	3,604	51
Lateral Inflow	1,410	3,973	1,769	12,000	1,292	9,690
Vertical Leakage Downward	1,001	3,384	1,032	3,632	773	3,572
Jasper						
Storage	866	0	2,131	0	2,066	0
Reservoirs (River package)	0	0	0	0	0	0
Springs (Drain package)	0	0	0	0	0	0
General Head Boundaries	0	0	0	0	0	0
Wells	0	2,892	0	5,283	0	5,283
Streams and Rivers	0	0	0	0	0	0
Recharge	189	0	189	0	189	0
Evapotranspiration	0	412	0	371	0	371
Vertical Leakage Upward	3,597	940	4,188	431	4,124	352
Lateral Inflow	2,256	2,663	2,127	2,550	2,198	2,572

Table A-3. (continued)

Jim Hogg						
	GAM07-12 Baseline		GAM07-14 Availability		GAM08-17 New Pumpage	
	In	Out	In	Out	In	Out
Chicot						
Storage	0	2	0	2	1	0
Reservoirs (River package)	0	0	0	0	0	0
Springs (Drain package)	0	0	0	0	0	0
General Head Boundaries	0	0	0	0	0	0
Wells	0	14	0	14	0	14
Streams and Rivers	0	2,024	0	2,009	0	1,288
Recharge	6,440	0	6,440	0	6,440	0
Evapotranspiration	0	443	0	442	0	410
Lateral Inflow	382	3,251	377	3,261	292	3,763
Vertical Leakage Downward	313	1,399	310	1,399	284	1,542
Evangeline						
Storage	4	42	30	17	29	12
Reservoirs (River package)	0	0	0	0	0	0
Springs (Drain package)	0	0	0	0	0	0
General Head Boundaries	0	0	0	0	0	0
Wells	0	371	0	371	0	371
Streams and Rivers	342	4,069	412	3,655	385	3,536
Recharge	7,165	0	7,165	0	7,165	0
Evapotranspiration	0	657	0	584	0	577
Vertical Leakage Upward	1,399	313	1,399	310	1,542	284
Lateral Inflow	504	1,996	321	2,037	360	2,679
Vertical Leakage Downward	549	2,514	408	2,761	407	2,428
Jasper						
Storage	11	399	51	269	92	132
Reservoirs (River package)	0	0	0	0	0	0
Springs (Drain package)	0	0	0	0	0	0
General Head Boundaries	0	0	0	0	0	0
Wells	0	594	0	594	0	594
Streams and Rivers	0	0	0	0	0	0
Recharge	155	0	155	0	155	0
Evapotranspiration	0	172	0	162	0	169
Vertical Leakage Upward	2,370	533	2,628	392	2,362	390
Lateral Inflow	1,355	2,194	865	2,284	1,016	2,341

Table A-3. (continued)

Jim Wells						
	GAM07-12 Baseline		GAM07-14 Availability		GAM08-17 New Pumpage	
	In	Out	In	Out	In	Out
Chicot						
Storage	8	0	281	0	380	0
Reservoirs (River package)	0	0	0	0	0	0
Springs (Drain package)	0	14	0	5	0	3
General Head Boundaries	0	0	0	0	0	0
Wells	0	2,257	0	13,567	0	10,553
Streams and Rivers	5,557	18,173	14,515	6,284	18,982	2,907
Recharge	25,328	0	25,328	0	25,328	0
Evapotranspiration	0	237	0	157	0	128
Lateral Inflow	3,722	9,291	3,316	8,293	3,421	8,609
Vertical Leakage Downward	568	5,212	209	15,340	2	25,912
Evangeline						
Storage	5	0	4,994	0	5,877	0
Reservoirs (River package)	562	0	562	0	562	0
Springs (Drain package)	0	0	0	0	0	0
General Head Boundaries	0	0	0	0	0	0
Wells	0	2,491	0	36,421	0	35,521
Streams and Rivers	561	4,370	1,019	3,410	3,819	731
Recharge	2,234	0	2,234	0	2,206	0
Evapotranspiration	0	8	0	5	0	2
Vertical Leakage Upward	5,212	568	15,340	209	25,912	2
Lateral Inflow	3,693	5,521	18,266	7,387	11,292	18,643
Vertical Leakage Downward	865	175	5,254	237	5,276	43
Jasper						
Storage	100	3	1,410	0	1,612	0
Reservoirs (River package)	0	0	0	0	0	0
Springs (Drain package)	0	0	0	0	0	0
General Head Boundaries	0	0	0	0	0	0
Wells	0	7	0	7	0	7
Streams and Rivers	0	0	0	0	0	0
Recharge	0	0	0	0	0	0
Evapotranspiration	0	0	0	0	0	0
Vertical Leakage Upward	132	735	245	1,971	41	1,959
Lateral Inflow	1,765	1,251	1,625	1,302	1,680	1,367

Table A-3. (continued)

Kenedy						
	GAM07-12 Baseline		GAM07-14 Availability		GAM08-17 New Pumpage	
	In	Out	In	Out	In	Out
Chicot						
Storage	1	0	110	0	3,013	0
Reservoirs (River package)	0	0	0	0	0	0
Springs (Drain package)	0	0	0	0	0	0
General Head Boundaries	0	18,999	0	17,601	693	2,686
Wells	0	41	0	41	0	14,133
Streams and Rivers	897	6,442	952	4,947	8,225	877
Recharge	25,221	0	25,221	0	25,221	0
Evapotranspiration	0	2,283	0	2,169	0	257
Lateral Inflow	4,224	2,619	3,919	2,580	4,923	1,637
Vertical Leakage Downward	214	175	0	2,859	0	22,483
Evangeline						
Storage	3	0	158	0	17,959	0
Reservoirs (River package)	0	0	0	0	0	0
Springs (Drain package)	0	0	0	0	0	0
General Head Boundaries	0	0	0	0	0	0
Wells	0	62	0	62	0	56,426
Streams and Rivers	0	0	0	0	0	0
Recharge	0	0	0	0	0	0
Evapotranspiration	0	0	0	0	0	0
Vertical Leakage Upward	175	214	2,859	0	22,483	0
Lateral Inflow	728	663	1,406	4,983	11,017	436
Vertical Leakage Downward	33	1	623	0	5,405	0
Jasper						
Storage	--	--	--	--	--	--
Reservoirs (River package)	--	--	--	--	--	--
Springs (Drain package)	--	--	--	--	--	--
General Head Boundaries	--	--	--	--	--	--
Wells	--	--	--	--	--	--
Streams and Rivers	--	--	--	--	--	--
Recharge	--	--	--	--	--	--
Evapotranspiration	--	--	--	--	--	--
Vertical Leakage Upward	--	--	--	--	--	--
Lateral Inflow	--	--	--	--	--	--

Table A-3. (continued)

Kleberg						
	GAM07-12 Baseline		GAM07-14 Availability		GAM08-17 New Pumpage	
	In	Out	In	Out	In	Out
Chicot						
Storage	6	0	431	0	1,174	0
Reservoirs (River package)	0	0	0	0	0	0
Springs (Drain package)	0	1	0	0	0	0
General Head Boundaries	0	16,786	3,803	7,454	18,493	3,669
Wells	0	948	0	5,086	0	22,497
Streams and Rivers	19,863	12,407	26,367	7,961	38,650	5,027
Recharge	4,486	0	4,486	0	4,486	0
Evapotranspiration	0	1,137	0	933	0	755
Lateral Inflow	12,640	4,515	12,126	5,964	11,081	10,119
Vertical Leakage Downward	55	1,256	0	19,816	0	31,816
Evangeline	0	0	0	0		
Storage	20	0	6,479	0	22,460	0
Reservoirs (River package)	0	0	0	0	0	0
Springs (Drain package)	0	0	0	0	0	0
General Head Boundaries	0	0	0	0	0	0
Wells	0	7,682	0	44,910	0	93,858
Streams and Rivers	0	0	0	0	0	0
Recharge	0	0	0	0	0	0
Evapotranspiration	0	0	0	0	0	0
Vertical Leakage Upward	1,256	55	19,816	0	31,816	0
Lateral Inflow	5,789	427	15,229	4,062	29,844	4,560
Vertical Leakage Downward	1,095	0	7,448	0	14,299	0
Jasper						
Storage	100	0	817	0	1,193	0
Reservoirs (River package)	0	0	0	0	0	0
Springs (Drain package)	0	0	0	0	0	0
General Head Boundaries	0	0	0	0	0	0
Wells	0	0	0	0	0	0
Streams and Rivers	0	0	0	0	0	0
Recharge	0	0	0	0	0	0
Evapotranspiration	0	0	0	0	0	0
Vertical Leakage Upward	0	431	0	1,089	0	1,649
Lateral Inflow	388	57	321	48	477	21

Table A-3. (continued)

Live Oak						
	GAM07-12 Baseline		GAM07-14 Availability		GAM08-17 New Pumpage	
	In	Out	In	Out	In	Out
Chicot						
Storage	0	0	63	0	2	0
Reservoirs (River package)	0	0	0	0	0	0
Springs (Drain package)	0	0	0	0	0	0
General Head Boundaries	0	0	0	0	0	0
Wells	0	88	0	88	0	88
Streams and Rivers	177	0	177	0	177	0
Recharge	1,194	0	1,194	0	1,194	0
Evapotranspiration	0	6	0	4	0	0
Lateral Inflow	242	190	92	301	91	280
Vertical Leakage Downward	0	1,328	0	1,133	0	1,095
Evangeline	0	0	0	0		
Storage	0	8	123	0	32	0
Reservoirs (River package)	2,634	0	2,890	0	2,835	0
Springs (Drain package)	0	5	0	0	0	0
General Head Boundaries	0	0	0	0	0	0
Wells	0	1,802	0	4,140	0	2,938
Streams and Rivers	635	8,684	1,106	5,915	905	6,435
Recharge	4,205	0	4,205	0	4,205	0
Evapotranspiration	0	68	0	38	0	44
Vertical Leakage Upward	1,328	0	1,133	0	1,095	0
Lateral Inflow	2,561	767	1,550	693	1,358	927
Vertical Leakage Downward	254	284	30	251	117	204
Jasper						
Storage	1,386	65	2,949	0	2,155	0
Reservoirs (River package)	0	0	0	0	0	0
Springs (Drain package)	0	0	0	0	0	0
General Head Boundaries	0	0	0	0	0	0
Wells	0	2,744	0	7,705	0	4,988
Streams and Rivers	441	394	997	90	654	184
Recharge	527	0	528	0	527	0
Evapotranspiration	0	56	0	39	0	46
Vertical Leakage Upward	386	949	1,151	268	606	455
Lateral Inflow	1,955	488	2,684	207	2,099	368

Table A-3. (continued)

McMullen						
	GAM07-12 Baseline		GAM07-14 Availability		GAM08-17 New Pumpage	
	In	Out	In	Out	In	Out
Chicot						
Storage	--	--	--	--	--	--
Reservoirs (River package)	--	--	--	--	--	--
Springs (Drain package)	--	--	--	--	--	--
General Head Boundaries	--	--	--	--	--	--
Wells	--	--	--	--	--	--
Streams and Rivers	--	--	--	--	--	--
Recharge	--	--	--	--	--	--
Evapotranspiration	--	--	--	--	--	--
Lateral Inflow	--	--	--	--	--	--
Vertical Leakage Downward	--	--	--	--	--	--
Evangeline						
Storage	--	--	--	--	--	--
Reservoirs (River package)	--	--	--	--	--	--
Springs (Drain package)	--	--	--	--	--	--
General Head Boundaries	--	--	--	--	--	--
Wells	--	--	--	--	--	--
Streams and Rivers	--	--	--	--	--	--
Recharge	--	--	--	--	--	--
Evapotranspiration	--	--	--	--	--	--
Vertical Leakage Upward	--	--	--	--	--	--
Lateral Inflow	--	--	--	--	--	--
Vertical Leakage Downward	--	--	--	--	--	--
Jasper						
Storage	401	0	624	0	622	0
Reservoirs (River package)	0	0	0	0	0	0
Springs (Drain package)	0	0	0	0	0	0
General Head Boundaries	0	0	0	0	0	0
Wells	0	19	0	286	0	437
Streams and Rivers	368	590	465	520	458	488
Recharge	249	0	249	0	249	0
Evapotranspiration	0	116	0	105	0	102
Vertical Leakage Upward	258	0	333	0	332	0
Lateral Inflow	205	756	190	950	195	828

Table A-3. (continued)

Nueces						
	GAM07-12 Baseline		GAM07-14 Availability		GAM08-17 New Pumpage	
	In	Out	In	Out	In	Out
Chicot						
Storage	9	0	1,217	0	4,357	0
Reservoirs (River package)	0	0	0	0	0	0
Springs (Drain package)	0	89	0	59	0	42
General Head Boundaries	91	4,039	4,137	467	7,502	251
Wells	0	1,862	0	15,935	0	15,091
Streams and Rivers	11,348	11,049	36,234	1,836	38,569	739
Recharge	4,795	0	4,795	0	4,795	0
Evapotranspiration	0	372	0	281	0	237
Lateral Inflow	8,976	6,697	10,109	5,722	13,181	6,131
Vertical Leakage Downward	1,235	2,345	5	32,198	0	45,911
Evangeline						
Storage	2	0	88	0	680	0
Reservoirs (River package)	0	0	0	0	0	0
Springs (Drain package)	0	0	0	0	0	0
General Head Boundaries	0	0	0	0	0	0
Wells	0	1,083	0	33,913	0	40,761
Streams and Rivers	0	0	0	0	0	0
Recharge	0	0	0	0	0	0
Evapotranspiration	0	0	0	0	0	0
Vertical Leakage Upward	2,345	1,235	32,198	5	45,911	0
Lateral Inflow	2,047	2,501	6,217	6,302	5,689	14,167
Vertical Leakage Downward	424	0	1,715	0	2,651	0
Jasper	0	0	0	0		
Storage	26	1	265	0	438	0
Reservoirs (River package)	0	0	0	0	0	0
Springs (Drain package)	0	0	0	0	0	0
General Head Boundaries	0	0	0	0	0	0
Wells	0	0	0	0	0	0
Streams and Rivers	0	0	0	0	0	0
Recharge	0	0	0	0	0	0
Evapotranspiration	0	0	0	0	0	0
Vertical Leakage Upward	0	330	0	567	0	700
Lateral Inflow	402	98	396	93	371	109

Table A-3. (continued)

San Patricio						
	GAM07-12 Baseline		GAM07-14 Availability		GAM08-17 New Pumpage	
	In	Out	In	Out	In	Out
Chicot						
Storage	0	63	623	0	645	0
Reservoirs (River package)	0	0	0	0	0	0
Springs (Drain package)	0	376	0	250	0	153
General Head Boundaries	30	4,366	654	2,651	1,600	2,002
Wells	0	2,404	0	3,877	0	8,705
Streams and Rivers	3,004	12,018	3,593	6,015	4,491	4,343
Recharge	12,704	0	12,704	0	12,704	0
Evapotranspiration	0	515	0	440	0	409
Lateral Inflow	7,138	3,500	4,558	3,439	6,996	2,370
Vertical Leakage Downward	1,601	1,234	44	5,503	0	8,455
Evangeline						
Storage	0	2	21	0	21	0
Reservoirs (River package)	676	0	823	0	864	0
Springs (Drain package)	0	0	0	0	0	0
General Head Boundaries	0	0	0	0	0	0
Wells	0	1,304	0	2,110	0	7,587
Streams and Rivers	0	657	0	584	0	512
Recharge	148	0	148	0	148	0
Evapotranspiration	0	13	0	10	0	10
Vertical Leakage Upward	1,234	1,601	5,503	44	8,455	0
Lateral Inflow	2,429	1,225	1,116	5,408	1,775	3,892
Vertical Leakage Downward	326	11	546	1	738	0
Jasper						
Storage	0	26	157	0	152	0
Reservoirs (River package)	0	0	0	0	0	0
Springs (Drain package)	0	0	0	0	0	0
General Head Boundaries	0	0	0	0	0	0
Wells	0	0	0	0	0	0
Streams and Rivers	0	0	0	0	0	0
Recharge	0	0	0	0	0	0
Evapotranspiration	0	0	0	0	0	0
Vertical Leakage Upward	5	315	5	320	0	436
Lateral Inflow	358	23	280	122	314	29

Table A-3. (continued)

Webb						
	GAM07-12 Baseline		GAM07-14 Availability		GAM08-17 New Pumpage	
	In	Out	In	Out	In	Out
Chicot						
Storage	--	--	--	--	--	--
Reservoirs (River package)	--	--	--	--	--	--
Springs (Drain package)	--	--	--	--	--	--
General Head Boundaries	--	--	--	--	--	--
Wells	--	--	--	--	--	--
Streams and Rivers	--	--	--	--	--	--
Recharge	--	--	--	--	--	--
Evapotranspiration	--	--	--	--	--	--
Lateral Inflow	--	--	--	--	--	--
Vertical Leakage Downward	--	--	--	--	--	--
Evangeline						
Storage	0	0	372	0	5	0
Reservoirs (River package)	0	0	0	0	0	0
Springs (Drain package)	0	0	0	0	0	0
General Head Boundaries	0	0	0	0	0	0
Wells	0	135	0	2,786	0	1,899
Streams and Rivers	0	770	79	32	7	152
Recharge	3,008	0	2,996	0	3,008	0
Evapotranspiration	0	471	0	0	0	3
Vertical Leakage Upward	--	--	--	--	--	--
Lateral Inflow	43	315	72	81	49	152
Vertical Leakage Downward	331	1,692	13	632	70	933
Jasper						
Storage	5	5	141	0	105	0
Reservoirs (River package)	0	0	0	0	0	0
Springs (Drain package)	0	0	0	0	0	0
General Head Boundaries	0	0	0	0	0	0
Wells	0	7	0	148	0	99
Streams and Rivers	0	0	0	0	0	0
Recharge	46	0	46	0	46	0
Evapotranspiration	0	88	0	59	0	67
Vertical Leakage Upward	1,680	325	651	12	934	68
Lateral Inflow	151	1,457	190	810	174	1,027