GAM Run 05-37

by Andrew C. A. Donnelly, P.G.
Texas Water Development Board
Groundwater Availability Modeling Section
(512) 463-3132
November 18, 2005

REQUESTOR:

Mr. Scott Holland on behalf of the Sterling County Underground Water Conservation District (UWCD).

DESCRIPTION OF REQUEST:

Mr. Holland requested a Groundwater Availability Model (GAM) run using the GAM for the Edwards-Trinity (Plateau) and Cenozoic Pecos Alluvium aquifers. Mr. Holland requested that we provide water budgets for Sterling County from a baseline simulation for use in the District's Management Plan, due in December 2005.

METHODS:

To determine the water budgets for Sterling County, we used the GAM for the Edwards-Trinity (Plateau) and Cenozoic Pecos Alluvium aquifer systems. We ran the model for the transient calibration and verification period (1980 through 2000) using estimated historic recharge and pumpage from the original GAM model. We extracted annual water budgets from the GAM for an area that corresponds to Sterling County. We then took the average value for each of the water budget components for the 20-year simulation and reported the results.

PARAMETERS AND ASSUMPTIONS:

- See Anaya and Jones (2004) for assumptions and limitations of the GAM.
- The root mean squared error (a measure of the difference between simulated and actual water levels during model calibration) in the entire Edwards-Trinity (Plateau) and Cenozoic Pecos Alluvium GAM for the period of 1990 to 2000 is 143 feet, or six percent of the range of measured water levels (Anaya and Jones, 2004).
- The model includes two layers, representing the Edwards and associated limestones (Layer 1) and undifferentiated Trinity units (Layer 2) in the Sterling County UWCD area. The active model cells in the model are shown in Figures 1 and 2.
- We used estimated historic recharge and pumpage included in the transient calibration simulation.

- The GAM uses drains to simulate discharge to springs and seeps mostly along the northern and eastern margins of the aquifer. Drains are included in both the Edwards and Trinity layers of the model within Sterling County (Figures 1 and 2).

- The GAM uses general-head boundaries (GHB) to simulate cross-formational flow between the Edwards-Trinity (Plateau) and Cenozoic Pecos Alluvium aquifers and both overlying and underlying aquifers, including the Ogallala, Edwards (Balcones Fault Zone), Dockum, Capitan Reef, Rustler, and Hickory aquifers. A general-head boundary was included in Sterling County for the Trinity layer to simulate interaction with the underlying Dockum aquifer.

- Recharge was distributed in the GAM based on a percent of annual precipitation and aquifer outcrop. For Sterling County, recharge was calibrated at two percent of annual precipitation.

- The GAM uses streams to simulate the interaction between the aquifer(s) and major intermittent streams flowing in the region. Flow both from the stream to the aquifer and from the aquifer to the stream is allowed, and the direction of flow is determined by the water levels in the aquifer and stream during each stress period in the simulation. No major streams within Sterling County were included in the model.

- The GAM includes pumpage representing rural domestic, municipal, industrial, irrigation, and livestock uses.

RESULTS:

Water budgets for Sterling County are presented in Tables 1, 2, and 3. These tables show the average annual flow, in acre-feet, of water into (Inflow) and out of (Outflow) each aquifer in the GAM for the Edwards-Trinity (Plateau) aquifer in Sterling County for the years 1980 to 1999, 2010, and 2020, respectively. The components of the budgets shown in Tables 1 to 3 include:

- Springs and seeps—This is water that drains from an aquifer if water levels are above the elevation of the spring or seep. This component is always shown as "Outflow", or discharge, from an aquifer. Springs and seeps are modeled in the GAM for the Edwards-Trinity (Plateau) aquifer using the MODFLOW Drain package, and are found along the margins of the aquifer, primarily in the northern and eastern parts of the modeled region.

- Wells—This is water produced from wells in each aquifer. In the GAM for the Edwards-Trinity (Plateau) aquifer, this component is always shown as "Outflow" from an aquifer, because all wells included in the GAM produce (rather than inject) water. Wells are modeled in the GAM for the Edwards-Trinity (Plateau) aquifer using the MODFLOW Well package.

- Recharge—This component simulates areally distributed recharge due to precipitation falling on the outcrop areas of aquifers. Recharge is always shown as "Inflow" into an aquifer. This component does not include runoff from precipitation events that may later recharge an aquifer as stream losses, which is included in the model using the stream package, described above. Recharge is modeled in the GAM for the Edwards-Trinity (Plateau) aquifer using the MODFLOW Recharge package.

- Cross-formational flow between the Dockum Aquifer—This is water that flows between the Edwards-Trinity (Plateau) aquifer and the underlying Dockum aquifer. This component of the budget is shown both as "Inflow" and "Outflow" based on water levels in the Edwards-Trinity (Plateau) aquifer and in the adjacent Dockum aquifer. Cross-formational flow is modeled in the GAM for the Edwards-Trinity (Plateau) aquifer using the MODFLOW General-Head Boundary (GHB) package.

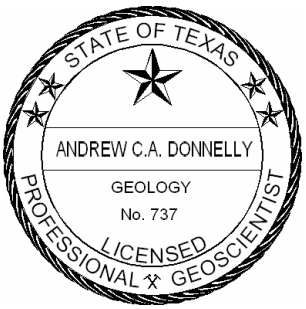
- Storage—This component is water stored in the aquifer. The storage component that is included in "Inflow" is water that is removed from storage in the aquifer (that is, water levels decline). The storage component that is included in "Outflow" is water that is added back into storage in the aquifer (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 county-wide 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 between counties—This component describes lateral flow within an aquifer between Sterling and adjacent counties.

It is important to note that sub-regional water budgets for individual counties, such as Sterling County, are not exact. This is due to the one-mile spacing of the model grid and because we assumed each model cell is assigned to a single county. The water budgets for an individual cell containing a county boundary are assigned to either one county or the other and therefore very minor variations in the county-wide budgets may be observed.

REFERENCES:

Anaya, R., and Jones, I., 2004, Groundwater availability model for the Edwards-Trinity (Plateau) and Cenozoic Pecos Alluvium aquifer systems, Texas: Texas Water Development Board, GAM Report, 208 p.



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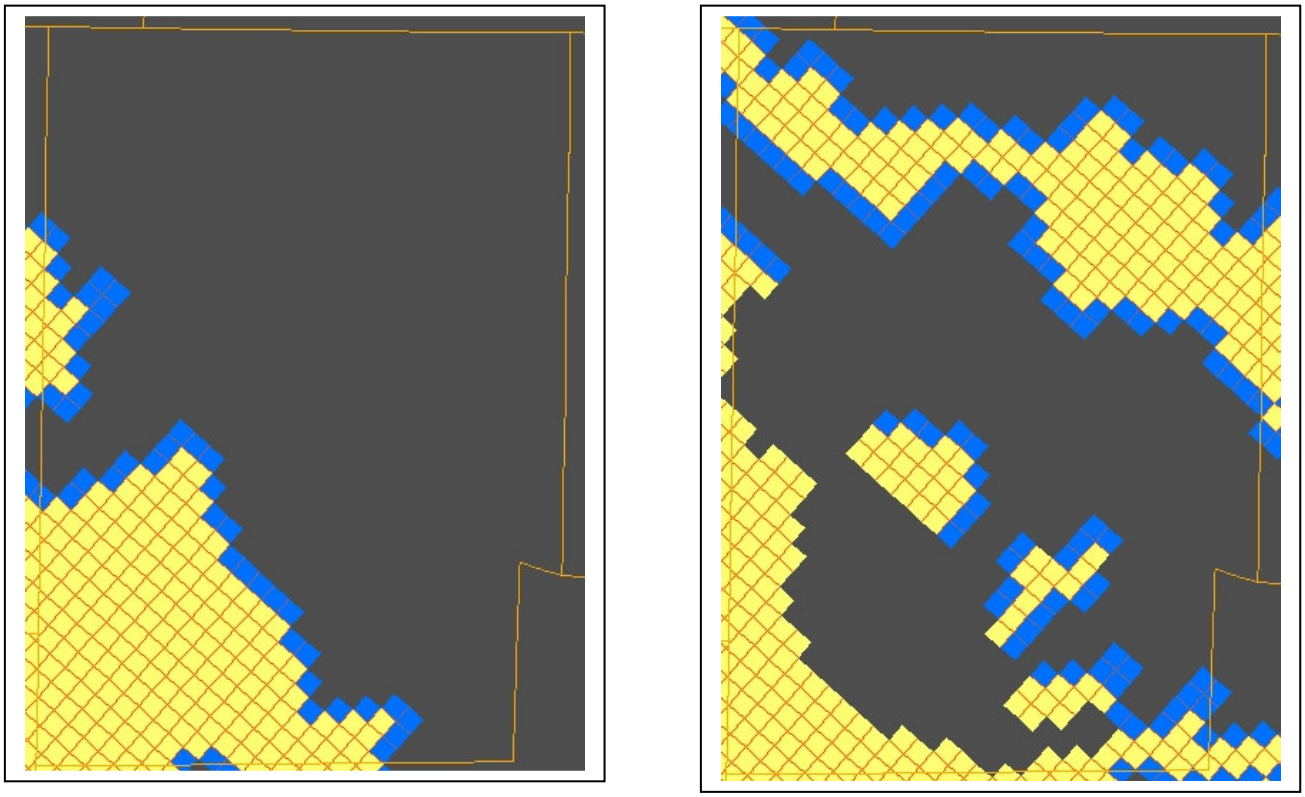

Edwards **Trinity**

Figure 1. Model cells included in the GAM for the Edwards-Trinity (Plateau) aquifer in Sterling County for Layer 1 (Edwards) and Layer 2 (Trinity). Inactive (no-flow) areas are gray. Active cells are yellow. Active cells that contain drains (springs and seeps) are blue.

Table 1. **Summary of average annual water budgets for Sterling County for 1980 to 1999. Flows reported in acre-feet per year. Values are probably only accurate to two significant figures.**

Edwards and Trinity Layers		
	Inflow	**Outflow**
Springs and Seeps*	0	6,183
Cross-formational flow between the Dockum Aquifer**	135	1,312
Wells	0	522
Recharge	10,335	0
Storage	954	632
Lateral flow from Coke County	216	494
Lateral flow from Glasscock County	889	1,418
Lateral flow from Howard County	0	2
Lateral flow from Reagan County	296	655
Lateral flow from Tom Green County	307	1,914

*Springs and seeps were modeled using the MODFLOW drain package
**Flow to the Dockum was modeled using the MODFLOW GHB package

Table 2. **Summary of average annual water budgets for Sterling County for 2010. Flows reported in acre-feet per year. Values are probably only accurate to two significant figures.**

Edwards and Trinity Layers		
	Inflow	**Outflow**
Springs and Seeps*	0	5,810
Cross-formational flow between the Dockum Aquifer**	109	1,291
Wells	0	1,013
Recharge	10,539	0
Storage	1	197
Lateral flow from Coke County	197	480
Lateral flow from Glasscock County	889	919
Lateral flow from Howard County	0	6
Lateral flow from Reagan County	252	506
Lateral flow from Tom Green County	212	1,979

*Springs and seeps were modeled using the MODFLOW drain package
**Flow to the Dockum was modeled using the MODFLOW GHB package

Table 3. Summary of average annual water budgets for Sterling County for 2020. Flows reported in acre-feet per year. Values are probably only accurate to two significant figures.

Edwards and Trinity Layers		
	Inflow	**Outflow**
Springs and Seeps*	0	5,886
Cross-formational flow between the Dockum Aquifer**	56	1,300
Wells	0	987
Recharge	10,539	0
Storage	1	81
Lateral flow from Coke County	202	485
Lateral flow from Glasscock County	890	881
Lateral flow from Howard County	0	5
Lateral flow from Reagan County	252	427
Lateral flow from Tom Green County	160	2,029

*Springs and seeps were modeled using the MODFLOW drain package

**Flow to the Dockum was modeled using the MODFLOW GHB package