# GAM Run 09-013

**by Mr. Eric Aschenbach**
Texas Water Development Board
Groundwater Availability Modeling Section
(512) 463-1708
August 6, 2009

## EXECUTIVE SUMMARY:

Texas Water Code, Section 36.1071, Subsection (h), states that, in developing its groundwater management plan, groundwater conservation districts shall use groundwater availability modeling information provided by the Executive Administrator of the Texas Water Development Board in conjunction with any available site-specific information provided by the district for review and comment to the Executive Administrator. Information derived from groundwater availability models that shall be included in the groundwater management plan includes:

(1) the annual amount of recharge from precipitation to the groundwater resources within the district, if any;
(2) for each aquifer within the district, the annual volume of water that discharges from the aquifer to springs and any surface water bodies, including lakes, streams, and rivers; and
(3) the annual volume of flow into and out of the district within each aquifer and between aquifers in the district.

The purpose of this model run is to provide information to Wes-Tex Groundwater Conservation District for its groundwater management plan. The groundwater management plan for Wes-Tex Groundwater Conservation District is due for approval by the Executive Administrator of the Texas Water Development Board before February 15, 2010.

This report discusses the method, assumptions, and results from model runs using the groundwater availability models for the Dockum Aquifer and the Edwards-Trinity (Plateau) Aquifer. Table 1 summarizes the groundwater availability model data required by the statute, and Figure 1 shows the area of each model from which the values in Table 1 were extracted.

The Blaine Aquifer is also present in the Wes-Tex Groundwater Conservation District. However, a groundwater availability model for the Blaine Aquifer within the district is not currently available. If the district would like information for the Blaine Aquifer, they may request it from the Groundwater Technical Assistance Section of the Texas Water Development Board.

## METHODS:

We ran the groundwater availability models for the Dockum Aquifer, and the Edwards-Trinity (Plateau) Aquifer and (1) extracted water budgets for each year of the 1980 through 1997 period for the Dockum and the 1980 through 2000 period for the Edwards-Trinity (Plateau) and (2) averaged the annual water budget values for recharge, surface water outflow, inflow to the district, outflow from the district, net inter-aquifer flow (upper), and net inter-aquifer flow (lower).

## PARAMETERS AND ASSUMPTIONS:

***Groundwater availability model for the Dockum Aquifer***

- We used version 1.01 of the groundwater availability model for the Dockum Aquifer. See Ewing and others (2008) for assumptions and limitations of the groundwater availability model.

- The model includes three layers representing: geologic units overlying the Dockum Aquifer including the Ogallala, Edwards-Trinity (High Plains), Edwards-Trinity (Plateau), Pecos Valley, and Rita Blanca aquifers (Layer 1), the upper portion of the Dockum Aquifer (Layer 2), and the lower portion of the Dockum Aquifer (Layer 3).

- The aquifers represented in Layer 1 of the groundwater availability model are only included in the model for the purpose of more accurately representing flow between these units and the Dockum Aquifer. This model is not intended to explicitly simulate flow in these overlying units (Ewing and others, 2008).

- The upper portion of the Dockum Aquifer, represented by Layer 2 of the groundwater availability model, is not present within the district. Therefore, no results are presented in Table 1 for this portion of the aquifer.

- The mean absolute error (a measure of the difference between simulated and measured water levels during model calibration) in the entire model between 1980 and 1997 is 69.6 feet for the lower portion of the Dockum Aquifer (Ewing and others, 2008). This represents 3.0 percent of the hydraulic head drop across the model area for this portion of the Dockum Aquifer.

- The MODFLOW Drain package was used to simulate both evapotranspiration and springs. However, there are no spring cells defined in the portion of the model grid that covers the district. Therefore, all flows determined by the Drain package for the district are considered to be evapotranspiration and are not included in the results for the surface water outflow shown in Table 1.

- The Dockum Aquifer is underlain by Permian-age sediments. Vertical flow between the Dockum Aquifer and the underlying Permian was assumed to be negligible and a no-flow boundary was set at the base of the Dockum Aquifer (Ewing and others, 2008).

- We used Groundwater Vistas version 5 (Environmental Simulations, Inc., 2007) as the interface to process model output.

***Groundwater availability model for the Edwards-Trinity (Plateau) Aquifer***

- We used version 1.01 of the groundwater availability model for the Edwards-Trinity (Plateau) Aquifer. See Anaya and Jones (2004) for assumptions and limitations of this model.

- The Edwards-Trinity (Plateau) Aquifer model includes two layers representing the Edwards Group and equivalent limestone hydrostratigraphic units (Layer 1) and the undifferentiated Trinity Group hydrostratigraphic units (Layer 2).

- The Edwards Group and equivalent limestone hydrostratigraphic units (Layer 1) are believed to be present in Nolan County, but they are not saturated. Therefore, no results are presented in Table 1 for this portion of the aquifer.

- The Edwards-Trinity (Plateau) Aquifer model assumes a no-flow boundary between the undifferentiated Trinity Group hydrostratigraphic units (Layer 2) and any underlying formations.

- The root mean square error (a measure of the difference between simulated and measured water levels) of the Edwards-Trinity (Plateau) groundwater availability model for the period of 1980 through 2000 is 143 feet, or six percent of the range of measured water levels (Anaya and Jones, 2004).

- We used Groundwater Vistas Version 5 (Environmental Simulations, Inc. 2007) as the interface to process model output.

## RESULTS:

A groundwater budget summarizes the amount of water entering and leaving the aquifer according to the groundwater availability model. Selected components were extracted from the groundwater budget for the aquifers located within the district and averaged over the duration of the calibration and verification portion of the model runs (1980 through 1997 for the Dockum and 1980 through 2000 period for the Edwards-Trinity (Plateau) in the district, as shown in Table 1. The components of the modified budgets shown in Table 1 include:

- Precipitation recharge—This is the areally distributed recharge sourced from precipitation falling on the outcrop areas of the aquifers (where the aquifer is exposed at land surface) within the district.

- Surface water outflow—This is the total water exiting the aquifer (outflow) to surface water features such as streams, reservoirs, and drains (springs).

- Flow into and out of district—This component describes lateral flow within the aquifer between the district and adjacent counties.

- Flow between aquifers—This describes the vertical flow, or leakage, between aquifers or confining units. This flow is controlled by the relative water levels in each aquifer or confining unit and aquifer properties of each aquifer or confining unit that define the amount of leakage that occurs. “Inflow” to an aquifer from an overlying or underlying aquifer will always equal the “Outflow” from the other aquifer.

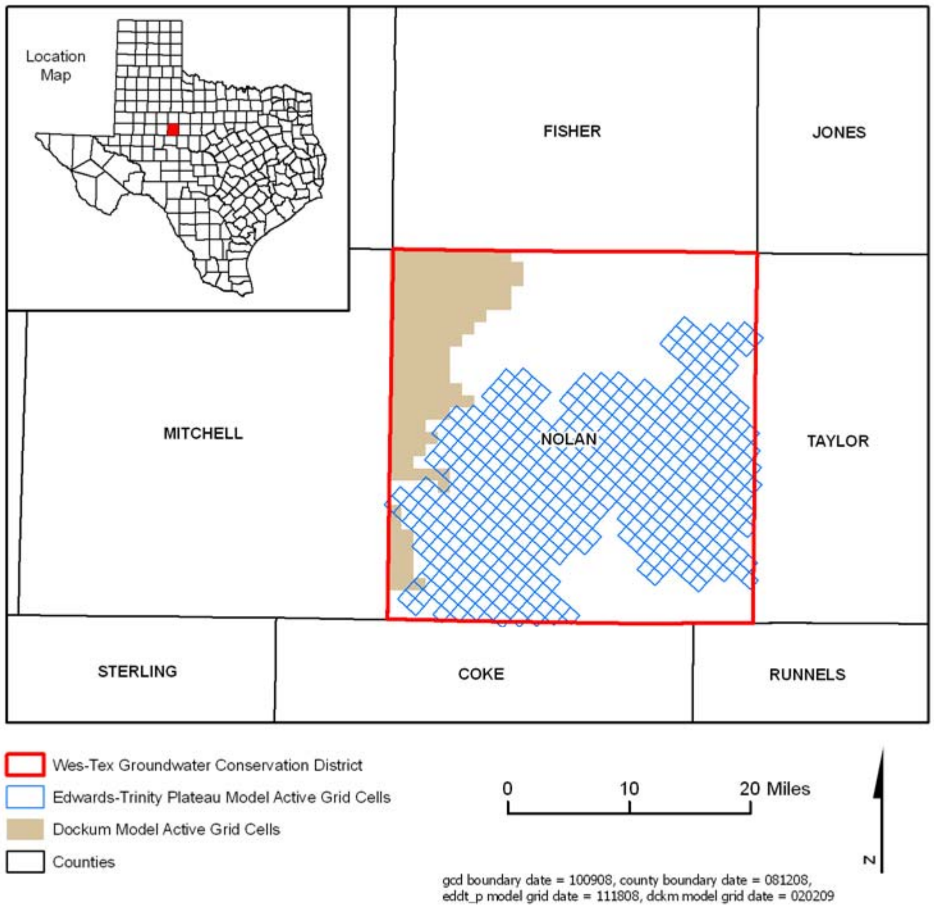
The information needed for the district’s management plan is summarized in Table 1. It is important to note that sub-regional water budgets are not exact. This is due to the size of the model cells and the approach used to extract data from the model. To avoid double accounting, a model cell that straddles a political boundary, such as district or county boundaries, is assigned to one side of the boundary based on the location of the centroid of the model cell. For example, if a cell contains two counties, the cell is assigned to the county where the centroid of the cell is located (see Figure 1).

Table 1: Summarized information needed for Wes-Tex Groundwater Conservation District's groundwater management plan. All values are reported in acre-feet per year. All numbers are rounded to the nearest 1 acre-foot.

| **Management Plan requirement** | **Aquifer or confining unit** | **Results** |
|---|---|---|
| Estimated annual amount of recharge from precipitation to the district | undifferentiated Edwards-Trinity aquifers | 11,480 |
| | Lower portion of the Dockum Aquifer | 7,135 |
| Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers | undifferentiated Edwards-Trinity aquifers | 10,840 |
| | Lower portion of the Dockum Aquifer | 516 |
| Estimated annual volume of flow into the district within each aquifer in the district | undifferentiated Edwards-Trinity aquifers | 214 |
| | Lower portion of the Dockum Aquifer | 84 |
| Estimated annual volume of flow out of the district within each aquifer in the district | undifferentiated Edwards-Trinity aquifers | 1,199 |
| | Lower portion of the Dockum Aquifer | 321 |
| Estimated net annual volume of flow between each aquifer in the district | Between Edwards and associated limestones and the undifferentiated Trinity Group* | 0 |
| | Between overlying units and the lower portion of the Dockum Aquifer* | 0 |

*Note: As previously discussed under the "Parameters and Assumptions" section of this report, only Layer 3 of the Dockum Aquifer is represented and Layer 2 of the Edwards-Trinity (Plateau) Aquifer is saturated in the district for the respective groundwater availability models. Therefore, this term is zero due to the absence of any overlying units or saturated layer for each model.

Figure 1: Area of the groundwater availability model for the Dockum Aquifer and the Edwards-Trinity (Plateau) Aquifer from which the information in Table 1 was extracted (the aquifer extent within the Wes-Tex Groundwater Conservation District boundary).



## 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., http://www.twdb.state.tx.us/gam/eddt_p/eddt_p.htm.

Environmental Simulations, Inc., 2007, Guide to Using Groundwater Vistas Version 5, 381 p.

Ewing, J.E., Jones, T.L., Yan, T., Vreugdenhil, A.M., Fryar, D.G., Pickens, J.F., Gordon, K., Nicot, J.P., Scanlon, B.R., Ashworth, J.B., and Beach, J., 2008, Groundwater Availability Model for the Dockum Aquifer – Final Report: contract report to the Texas Water Development Board, 510 p., http://www.twdb.state.tx.us/gam/dckm/dckm.htm.


---


Cynthia K. Ridgeway is Manager of the Groundwater Availability Modeling Section and is responsible for oversight of work performed by employees under her direct supervision. The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G., on August 6, 2009.