GAM Run 08-75

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EXECUTIVE SUMMARY:

Texas State Water Code, Section 36.1071, Subsection (h), states that, in developing its groundwater management plan, a groundwater conservation district 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 Middle Pecos Groundwater Conservation District for its groundwater management plan. The groundwater management plan for Middle Pecos Groundwater Conservation District is due for approval by the Executive Administrator of the Texas Water Development Board before August 18, 2009.

This report discusses the methods, assumptions, and results from model runs using the groundwater availability models for the Edwards-Trinity (Plateau) Aquifer (which also includes the Pecos Valley Aquifer) and the Dockum Aquifer. Table 1 summarizes the groundwater availability model data required by statute for Middle Pecos Groundwater Conservation District's groundwater management plan. Figure 1 shows the area of the model from which the values in Table 1 were extracted.

The Rustler and Capitan Reef aquifers also underlie the Middle Pecos Groundwater Conservation District; however, groundwater availability models for these minor aquifers have not been completed at this time. If the district would like information for the Rustler or Capitan Reef aquifers, they may request it from the Groundwater Technical Assistance Section of the Texas Water Development Board.

METHODS:

We first ran the groundwater availability models for the Edwards-Trinity (Plateau) and Dockum aquifers and extracted water budgets for each year of the 1980 through 1999 period for the Edwards-Trinity (Plateau) groundwater availability model and each year of the 1980 through 1997 period for the Dockum groundwater availability model. We then averaged the annual water budget values for recharge, surface water outflow, inflow to the district, outflow from the district, and net inter-aquifer flow for the portions of the Edwards-Trinity (Plateau), Pecos Valley, and Dockum aquifers located within the district.

PARAMETERS AND ASSUMPTIONS:

Groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers

- We used version 1.01 of the groundwater availability model for the Edwards-Trinity (Plateau) Aquifer, which includes the Pecos Valley Aquifer (formerly known as the Cenozoic Pecos Alluvium Aquifer). See Anaya and Jones (2004) for assumptions and limitations of the model.

- The groundwater availability model includes two layers, which together represent the Edwards-Trinity (Plateau) Aquifer and the Pecos Valley Aquifer. In order to separate model results for the Pecos Valley Aquifer from the Edwards-Trinity (Plateau) Aquifer, areas of the model were designated as representing either the Edwards-Trinity (Plateau) Aquifer or the Pecos Valley Aquifer based on the relative saturated thickness of each, as described below and shown in Figure 1.

- The water budget values shown in Table 1 consist of the collective water budget results for all layers of the model within the area representing each aquifer, shown in Figure 1.

- Modeled areas within the district but outside of the official aquifer boundaries were not included in the analysis.

- The root mean square error (a measure of the difference between simulated and actual water levels during model calibration) of the groundwater availability model for the period of 1990 to 2000 is 143 feet, or six percent of the range of measured water levels (Anaya and Jones, 2004).

- We used Processing Modflow for Windows (PMWIN) version 5.3 (Chiang and Kinzelbach, 2001) as the interface to process model output.

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. Because of this, no results are presented for the upper portion of the Dockum Aquifer in Table 1.

- 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 65.0 feet and 69.6 feet for the upper and lower portions of the Dockum Aquifer, respectively (Ewing and others, 2008). This represents 2.7 and 3.0 percent of the hydraulic head drop across the model area for these same aquifers, respectively.

- The MODFLOW Drain package was used to simulate both evapotranspiration and springs. However, only the results from model grid cells representing springs were incorporated into the surface water outflow values shown in Table 1.

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

RESULTS:

A groundwater budget summarizes the 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 calibrated portion of the model run (1980 to 1999 or 1980 to 1997) 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 an aquifer between the district and adjacent areas.

- Flow between aquifers—This describes the flow 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 flow that occurs. "Inflow" to an aquifer from a neighboring aquifer will always equal the "Outflow" from the other aquifer.

As mentioned in Parameters and Assumptions above, the groundwater availability model for the Edwards-Trinity (Plateau) Aquifer consists of two layers which together represent both the Edwards-Trinity (Plateau) and Pecos Valley aquifers. The areas of this model from which the water budgets in Table 1 were extracted were delineated and assigned to either the Edwards-Trinity (Plateau) Aquifer or the Pecos Valley Aquifer based on the relative saturated thickness of each. For example, if greater than 50 percent of the total saturated thickness of a model grid cell consisted of the Edwards-Trinity (Plateau) Aquifer, the cell was assigned as representing the Edwards-Trinity (Plateau) Aquifer. The model grid cells used to represent each of the aquifers within the district are shown in Figure 1.

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 a district or county boundary, 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.

Table 1: Summarized information needed for Middle Pecos 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	Edwards-Trinity (Plateau) Aquifer	140,509
	Pecos Valley Aquifer	14,115
	Dockum Aquifer	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Edwards-Trinity (Plateau) Aquifer	31,222
	Pecos Valley Aquifer	9,804
	Dockum Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	32,993
	Pecos Valley Aquifer	3,441
	Dockum Aquifer	554
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	74,562
	Pecos Valley Aquifer	4,538
	Dockum Aquifer	302
Estimated net annual volume of flow between each aquifer in the district	From the Edwards-Trinity (Plateau) Aquifer to the Pecos Valley Aquifer	8,891
	From the overlying units to the Dockum Aquifer	582
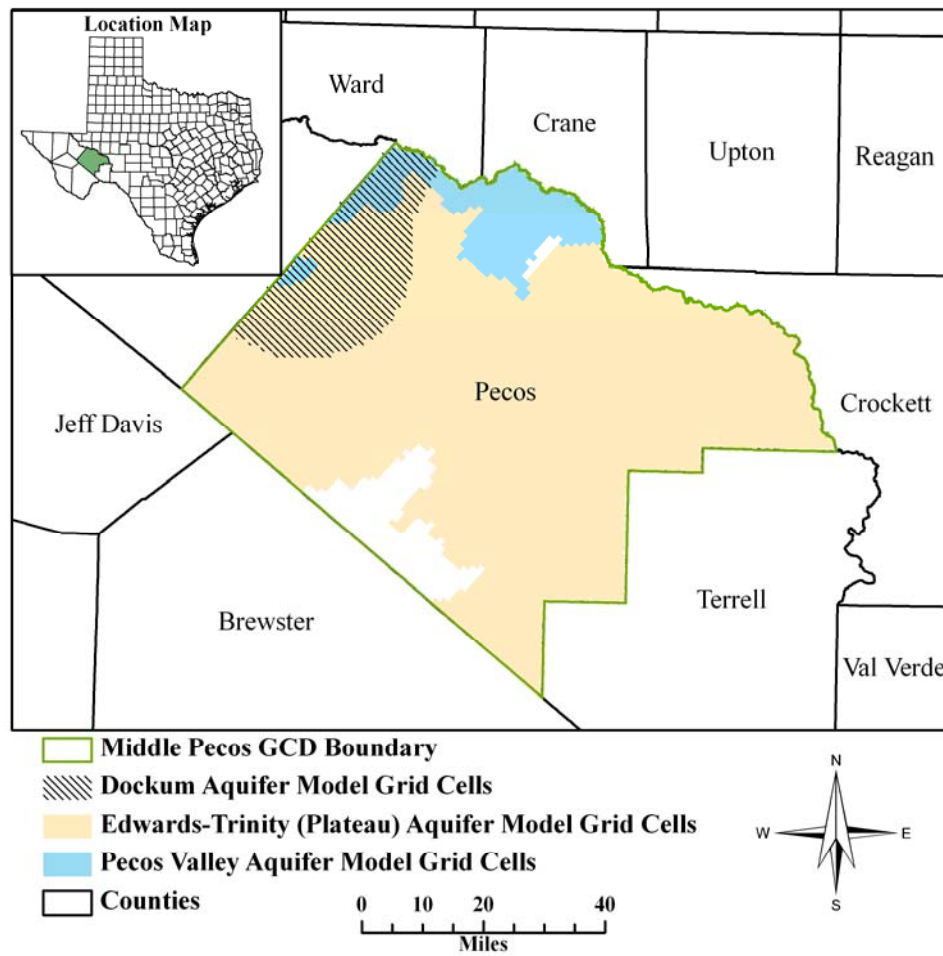
Figure 1:   Areas of the groundwater availability models from which the information in Table 1 was extracted. Note that model grid cells that straddle a political boundary were assigned to one side of the boundary based on the centroid of the model cell as described above.

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.

Chiang, W., and Kinzelbach, W., 2001, Groundwater Modeling with PMWIN, 346 p.

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.

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 January 23, 2009.