GAM Run 09-017

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EXECUTIVE SUMMARY:

Texas 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 Clear Fork Groundwater Conservation District for its groundwater management plan. The groundwater management plan for Clear Fork Groundwater Conservation District is due for approval by the Executive Administrator of the Texas Water Development Board before July 6, 2010.

This report discusses the methods, assumptions, and results from model runs using the groundwater availability models for the Seymour and Dockum aquifers. Table 1 summarizes the groundwater availability model data required by statute for Clear Fork 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 Blaine Aquifer also underlies Clear Fork Groundwater Conservation District; however, a groundwater availability model for the portion of this aquifer within the district has not been completed at this time. 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 Seymour and Dockum aquifers and (1) extracted water budgets for each year from 1980 through 1997 (Dockum Aquifer) or 1999 (Seymour Aquifer) 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) for the portions of the aquifers located within the district.

PARAMETERS AND ASSUMPTIONS:

Groundwater Availability Model for the Seymour Aquifer

- We used Version 1.01 of the groundwater availability model for the Seymour and Blaine aquifers. See Ewing and others (2004) for assumptions and limitations of the groundwater availability model for the Seymour and Blaine aquifers.

- The groundwater availability model includes two layers, representing the Seymour Aquifer (Layer 1) and the Blaine Aquifer and other Permian sediments (Layer 2). Due to a change in the boundary of the Blaine Aquifer subsequent to model development, a groundwater availability model for the portion of the Blaine Aquifer within the district is not available at this time.

- The root mean square error (a measure of the difference between simulated and actual water levels during model calibration) of the entire model for the period of 1990 to 1999 ranges from 19.6 feet (Seymour Aquifer) to 26.4 feet (Blaine Aquifer and other Permian sediments), representing one percent and three percent of the range of measured water levels respectively (Ewing and others, 2004).

- All stress periods of the groundwater availability model for the Seymour and Blaine aquifers are monthly. The current model run for 1980 through 1999, therefore, consists of 240 individual stress periods.

- 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 aquifers represented in Layer 1 and the upper portion of the Dockum Aquifer, represented by Layer 2, are not present within the district. Because of this, no results are presented for these units 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 5.30 Build 10 (Environmental Simulations, Inc., 2007) as the interface to process model output for the groundwater availability model for the Dockum Aquifer.

RESULTS:

A groundwater budget summarizes the water entering and leaving the aquifer according to the groundwater availability model. The model is based on the U.S. Geological Survey's MODFLOW 2000 groundwater modeling code (Harbaugh and others, 2000). 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 1997 or 1980 to 1999) 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.

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 model cell's centroid. 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 Clear Fork Groundwater Conservation District's groundwater management plan[a]. 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[a]
Estimated annual amount of recharge from precipitation to the district	Seymour	12,402
	Lower portion of the Dockum Aquifer	2,010
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Seymour	3,173
	Lower portion of the Dockum Aquifer	266
Estimated annual volume of flow into the district within each aquifer in the district	Seymour	0
	Lower portion of the Dockum Aquifer	63
Estimated annual volume of flow out of the district within each aquifer in the district	Seymour	460
	Lower portion of the Dockum Aquifer	117
Estimated net annual volume of flow between each aquifer in the district	From the Seymour to the Blaine and other Permian Units	230
	Between overlying units and the lower portion of the Dockum Aquifer	NA[b]

[a] A mass balance error of one percent or less is normally considered acceptable for water budgets extracted from numerical flow models (Anderson and Woessner, 1992); however, the water budgets for some stress periods of the groundwater availability model for the Seymour and Blaine aquifers exceeded one percent. After investigating the cause and several alternative approaches to defining the water budget it was determined that, after averaging all 240 stress periods together, the results are reasonable and appropriate for the purposes of the district's management plan.

[b] NA—Not Applicable: The groundwater availability model for the Dockum Aquifer does not consider any units overlying or underlying the lower portion of the Dockum Aquifer within the district.

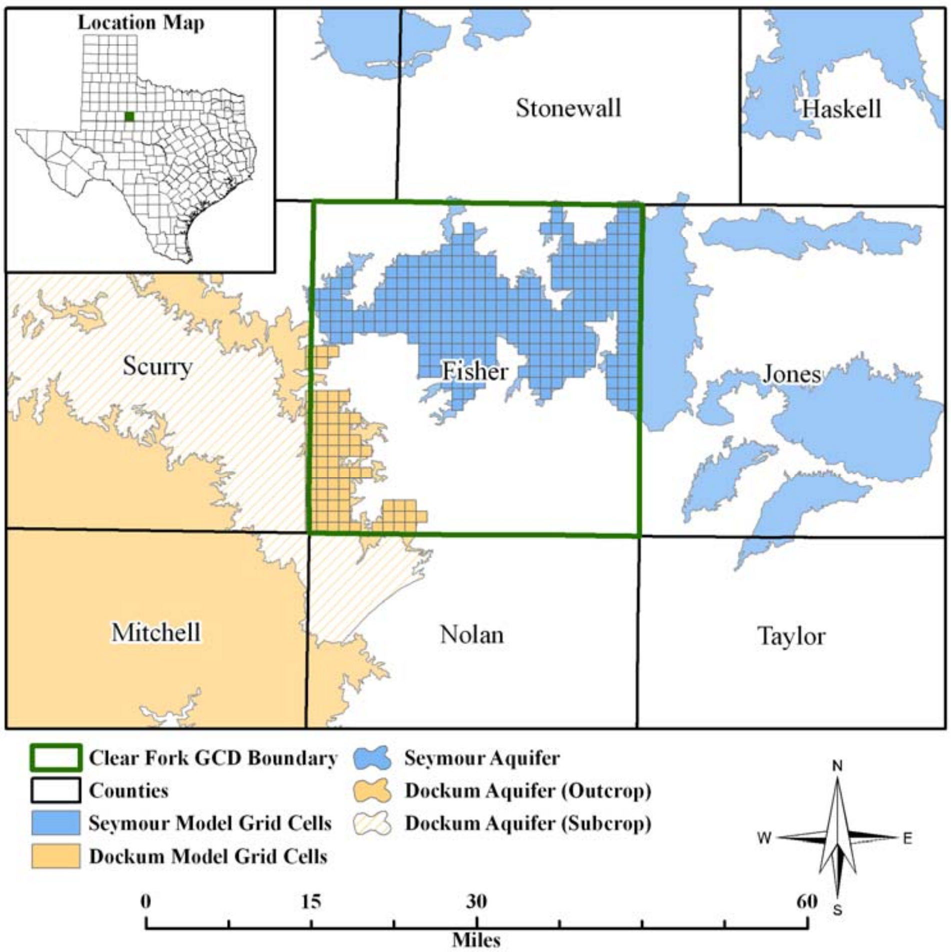

Figure 1: Area of the groundwater availability models from which the information in Table 1 was extracted. Note that model grid cells that straddle a political boundary were assigned to one side of the boundary based on the centroid of the model cell as described above.

REFERENCES:

Anderson, M.P., and Woessner, W.W., 1992, Applied Groundwater Modeling, Simulation of Flow and Advective Transport, Academic Press, Inc., New York, 381 p.

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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 July 24, 2009.