GAM Run 09-06

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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 additional information to High Plains Underground Water Conservation District No. 1 for its groundwater management plan. This modeling information, based on the newly approved groundwater availability model for the southern portion of the Ogallala Aquifer and the Edwards-Trinity (High Plains) Aquifer, is to be used in place of the results presented in Groundwater Availability Model Runs 08-63 (Oliver, 2008) and 09-03 (Oliver, 2009) in development of the district's groundwater management plan. The groundwater management plan for High Plains Underground Water Conservation District No. 1 is due for approval by the Executive Administrator of the Texas Water Development Board before June 16, 2009.

This report discusses the methods, assumptions, and results from model runs using the groundwater availability model for the southern portion of the Ogallala Aquifer and the Edwards-Trinity (High Plains) Aquifer. See Groundwater Availability Model Runs 08-63 (Oliver, 2008) and 09-03 (Oliver, 2009) for methods and assumptions relating to the results presented for the northern portion of the Ogallala Aquifer and the Dockum Aquifer, respectively. Table 1 summarizes the groundwater availability model data required by statute for the management plan for High Plains Underground Water Conservation District No. 1. Figure 1 shows the area of the model from which the values in Table 1 were extracted.

METHODS:

We ran the groundwater availability model for the southern portion of the Ogallala Aquifer and the Edwards-Trinity (High Plains) Aquifer and (1) extracted water budgets for each year of the 1980 through 2000 period 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:

- We used version 2.01 of the groundwater availability model for the southern portion of the Ogallala Aquifer and the Edwards-Trinity (High Plains) Aquifer. This model is an expansion on and update to the previously developed groundwater availability model for the southern portion of the Ogallala Aquifer described in Blandford and others (2003). See Blandford and others (2008) and Blandford and others (2003) for assumptions and limitations of the groundwater availability model.

- The model includes four layers representing the southern portion of the Ogallala and Edwards-Trinity (High Plains) aquifers. The units comprising the Edwards-Trinity (High Plains) Aquifer (primarily Edwards, Comanche Peak, and Antlers Sand formations) are separated from the overlying Ogallala Aquifer by a layer of Cretaceous shale, where present.

- The mean absolute error (a measure of the difference between simulated and measured water levels during model calibration) for the Ogallala Aquifer in 2000 is 33 feet. The mean absolute error for the Edwards-Trinity (High Plains) Aquifer in 1997 is 25 feet (Blandford and others, 2008). This represents 1.8 and 3.0 percent of the hydraulic head drop across the model area for each aquifer, respectively.

- Irrigation return flow was accounted for in the groundwater availability model by a direct reduction in agricultural pumping as described in Blandford and others (2003).

- We used Groundwater Vistas version 5.30 Build 10 (Environmental Simulations, Inc., 2007) as the interface to process model output.

- See Groundwater Availability Model Runs 08-63 (Oliver, 2008) and 09-03 (Oliver 2009) for methods and assumptions relating to the results presented for the northern portion of the Ogallala Aquifer and the Dockum Aquifer, respectively.

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 2000) 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 the groundwater management plan for High Plains Underground Water Conservation District No. 1. All values are reported in acre-feet per year. All numbers are rounded to the nearest 1 acre-foot. See Groundwater Availability Run 08-63 (Oliver, 2008) for assumptions for the northern portion of the Ogallala Aquifer and Groundwater Availability Run 09-03 (Oliver, 2009) for assumptions for the Dockum Aquifer.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Northern portion of the Ogallala Aquifer	51
	Southern portion of the Ogallala Aquifer	638,494[a]
	Edwards and Comanche Peak formations	0
	Antlers Sand Formation	0
	Upper portion of the Dockum Aquifer	0
	Lower portion of the Dockum Aquifer	1,029
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Northern portion of the Ogallala Aquifer	0[b]
	Southern portion of the Ogallala Aquifer	9,676
	Edwards and Comanche Peak formations	559
	Antlers Sand Formation	275
	Upper portion of the Dockum Aquifer	0
	Lower portion of the Dockum Aquifer	2,485
Estimated annual volume of flow into the district within each aquifer in the district	Northern portion of the Ogallala Aquifer	392
	Southern portion of the Ogallala Aquifer	18,947
	Edwards and Comanche Peak formations	619
	Antlers Sand Formation	716
	Upper portion of the Dockum Aquifer	519
	Lower portion of the Dockum Aquifer	8,265
Estimated annual volume of flow out of the district within each aquifer in the district	Northern portion of the Ogallala Aquifer	845
	Southern portion of the Ogallala Aquifer	26,713
	Edwards and Comanche Peak formations	819
	Antlers Sand Formation	818
	Upper portion of the Dockum Aquifer	283
	Lower portion of the Dockum Aquifer	12,166

[a] Irrigation return flow was accounted for in the model by a direct reduction in agricultural pumping as described in Blandford and others (2003).

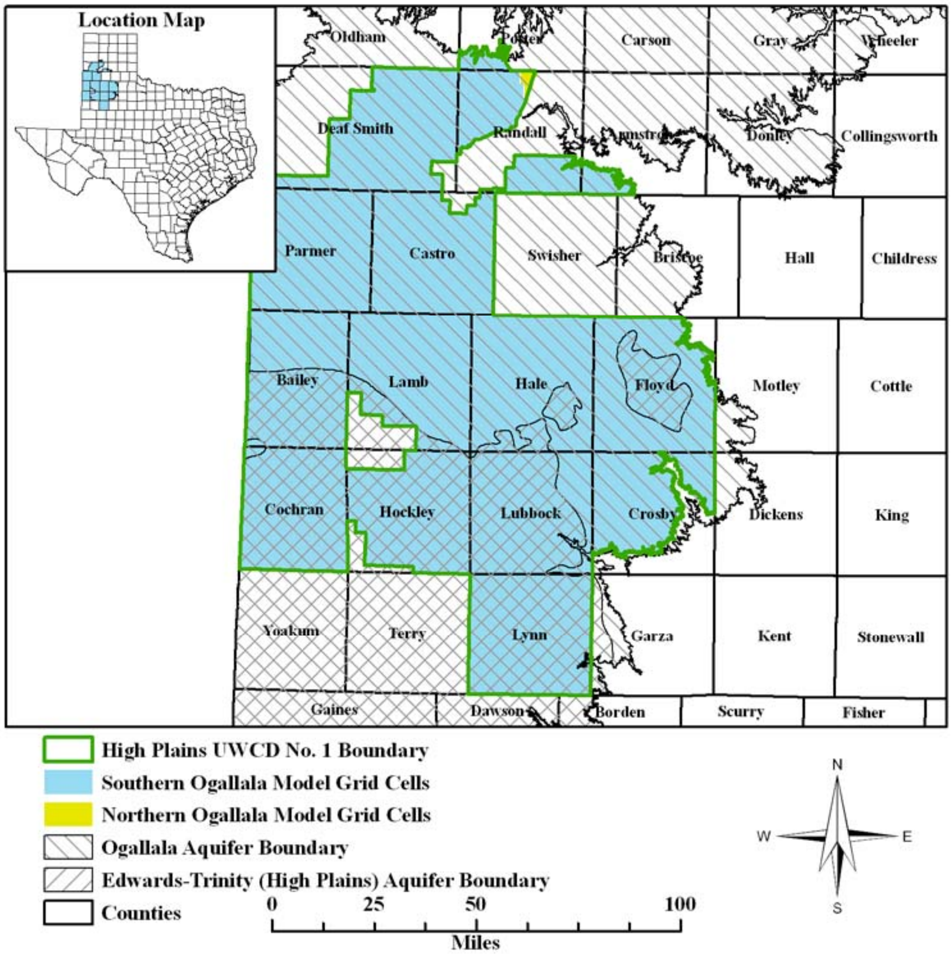
[b] The model for the northern portion of the Ogallala Aquifer does not include any major springs, lakes, streams, or rivers within the district.

Table 1 Continued:

Management Plan requirement	**Aquifer or confining unit**	**Results**
Estimated net annual volume of flow between each aquifer in the district	From the northern portion of the Ogallala Aquifer to underlying units	N.A.[c]
	From the southern portion of the Ogallala Aquifer to underlying units	6,548
	From overlying Ogallala Aquifer and Cretaceous shale into Edwards and Comanche Peak formations	6,102
	From overlying Edwards and Comanche Peak formations into Antlers Sand Formation	3,146
	From overlying units into Antlers Sand Formation	3,620
	From the upper portion of the Dockum Aquifer to the overlying units	3,194
	From the lower to the upper portion of the Dockum Aquifer	1,992
	From the overlying units (other than the upper portion of the Dockum Aquifer) to the lower portion of the Dockum Aquifer	7,537

[c] N.A.: Not applicable, the models do not consider flow into or out of the Ogallala Aquifer from other formations.

Figure 1: Area of the groundwater availability model for the southern portion of the Ogallala Aquifer and the Edwards-Trinity (High Plains) Aquifer 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.



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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 March 17, 2009.