GAM Run 10-009

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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 the Clearwater Underground Water Conservation District for its groundwater management plan based on the district boundaries. The groundwater management plan for Clearwater Underground Water Conservation District is due for approval by the Executive Administrator of the Texas Water Development Board before March 6, 2011. The Clearwater Underground Water Conservation District falls within two existing aquifer systems- the northern section of the Trinity Aquifer and the northern section of the Edwards (Balcones Fault Zone) Aquifer.

This report discusses the method, assumptions, and results from model runs using the groundwater availability models for the northern section of the Trinity Aquifer and the northern section of the Edwards (Balcones Fault Zone) Aquifer. Tables 1 and 2 summarize the groundwater availability model data required by statute for Clearwater Underground Water Conservation District's groundwater management plan. Figure 1 and 2 show the areas of the model from which the values in Table 1 and Table 2 were extracted respectively.

METHODS:

The original run of the groundwater availability model for the northern section of the Trinity Aquifer was done by Mr. Eric Aschenbach. The results of the run were processed (1) to extract water budgets for each year of the 1980 through 1999 period and (2) to average 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 northern section of the Trinity Aquifer located within the district. The results are shown in Table 1.

The groundwater availability model for the northern segment of the Edwards (Balcones Fault Zone) Aquifer was run by Mr. Mohammad Hassan and (1) water budgets for each year of the 1980 through 2000 period were extracted and (2) the annual water budget values for recharge, surface water outflow, inflow to the district, outflow from the district for the portions of the northern section of the Edwards (Balcones Fault Zone) Aquifer located within the district were averaged. Since the aquifer system is one layer model, there were no inter-aquifer flow (upper), and net inter-aquifer flow (lower). The results are shown in Table 2.

PARAMETERS AND ASSUMPTIONS:

Trinity Aquifer

- We used version 1.01 of the groundwater availability model for the northern section of the Trinity Aquifer. See Bené and others (2004) for assumptions and limitations of the model.

- The northern section of the Trinity Aquifer model includes seven layers representing:

  1. the Woodbine Aquifer (Layer 1),
  2. the Washita and Fredericksburg Confining Unit (Layer 2),
  3. the Paluxy Aquifer (Layer 3),
  4. the Glen Rose Confining Unit (Layer 4),
  5. the Hensell Aquifer (Layer 5),
  6. the Pearsall/Cow Creek/Hammett/Sligo Confining Unit (Layer 6), and
  7. the Hosston Aquifer (Layer 7).

  It should be noted that Layer 1 is not present in the district and layers 3 to 7 represent the Trinity Aquifer system.

- The mean absolute error (a measure of the difference between simulated and actual water levels during model calibration) for the four main aquifers in the model (Woodbine, Paluxy, Hensell, and Hosston) for the calibration and verification time periods (1980 through 1999) ranged from approximately 37 to 75 feet. The root mean squared error was less than ten percent of the maximum change in water levels across the model (Bené and others, 2004).

- The evapotranspiration package of the groundwater availability model was used to represent evaporation, transpiration, springs, seeps, and discharge to streams not modeled by the streamflow-routing package as described in Bené and others (2004).

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

Edwards (Balcones Fault Zone) Aquifer

- We used version 1.01 of the groundwater availability model for the northern section of the Edwards (Balcones Fault Zone) Aquifer.

- See Jones (2003) for a more detailed discussion of assumptions and limitations of the groundwater availability model for the northern segment of the Edwards (Balcones Fault Zone) Aquifer.

- The model consists of one layer representing the northern segment of the Edwards (Balcones Fault Zone) Aquifer and assumes no hydraulic communication with the underlying Trinity Aquifer.

- The model utilizes the MODFLOW Drain package to simulate discharge from springs and perennial streams with the assumption that the perennial streams are always gaining water from the aquifer.

- 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 models. 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 each model run (1980 through 1999) for the Trinity Aquifer and (1980 through 2000) for the Edward (Balcones Fault Zone) Aquifer in the district. The components of the modified budget shown in Tables include:

- Precipitation recharge—This is the 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 and Table 2. 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 and Figure 2).

Table 1: The Trinity Aquifer's summarized information needed for the Clearwater Underground Water 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. Reported flow estimates include both fresh and brackish waters present in the aquifers.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Trinity Aquifer	4,533
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers[1]	Trinity Aquifer	4,164
Estimated annual volume of flow into the district within each aquifer in the district	Trinity Aquifer	5,214
Estimated annual volume of flow out of the district within each aquifer in the district	Trinity Aquifer	4,154
Estimated net annual volume of flow between each aquifer in the district	Washita Fredericksburg Confining Unit into Trinity Aquifer	51

Note: 1) The evapotranspiration package of the groundwater availability model includes evaporation, transpiration, springs, seeps, and discharge to streams not modeled by the streamflow-routing package as described in Bené and others (2004). The surface water outflow estimate in Table 1 includes the results from the evapotranspiration package for model grid cells containing springs and streams not modeled by the streamflow-routing package.

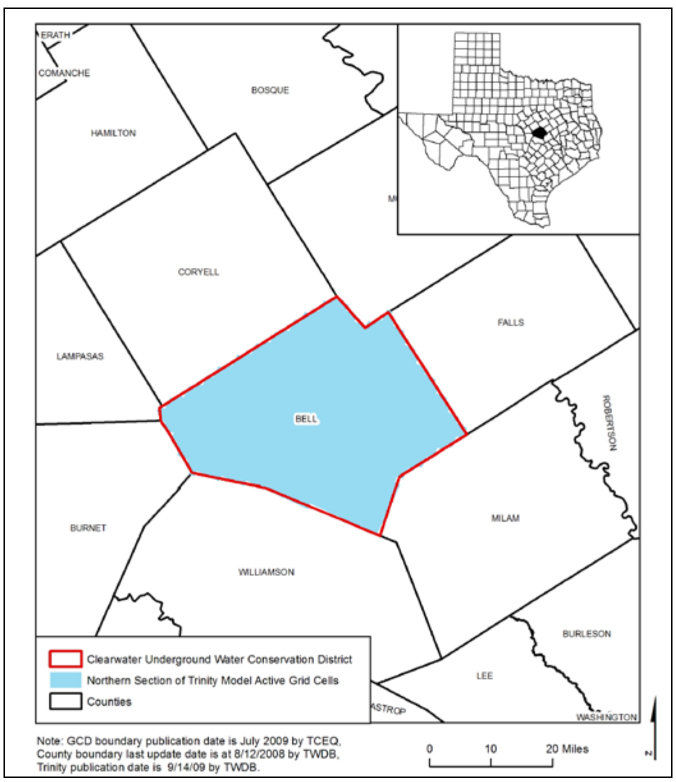

Figure 1: Area of the groundwater availability model for the northern portion of the Trinity Aquifer from which the information in Table 1 was extracted (the aquifer extent within the Clearwater Underground Water Conservation District boundary).

Table 2: The Edwards (Balcones Fault Zone) Aquifer's summarized information needed for the Clearwater Underground Water 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. Reported flow estimates include both fresh and brackish waters present in the aquifers.

Management Plan requirement	Aquifer	Results
Estimated annual amount of recharge from precipitation to the district	Edwards (Balcones Fault Zone) Aquifer	27,549
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Edwards (Balcones Fault Zone) Aquifer	27,485
Estimated annual volume of flow into the district within each aquifer in the district	Edwards (Balcones Fault Zone) Aquifer	6,478
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards (Balcones Fault Zone) Aquifer	5,721
Estimated net annual volume of flow between each aquifer in the district[1]	Edwards (Balcones Fault Zone) Aquifer into overlying units	121

Note 1) There was no vertical flow component since this is a one-layer model, but net flow from the adjacent overlying units was simulated in the model using the MODFLOW General Head Package as mentioned in Jones (2003).

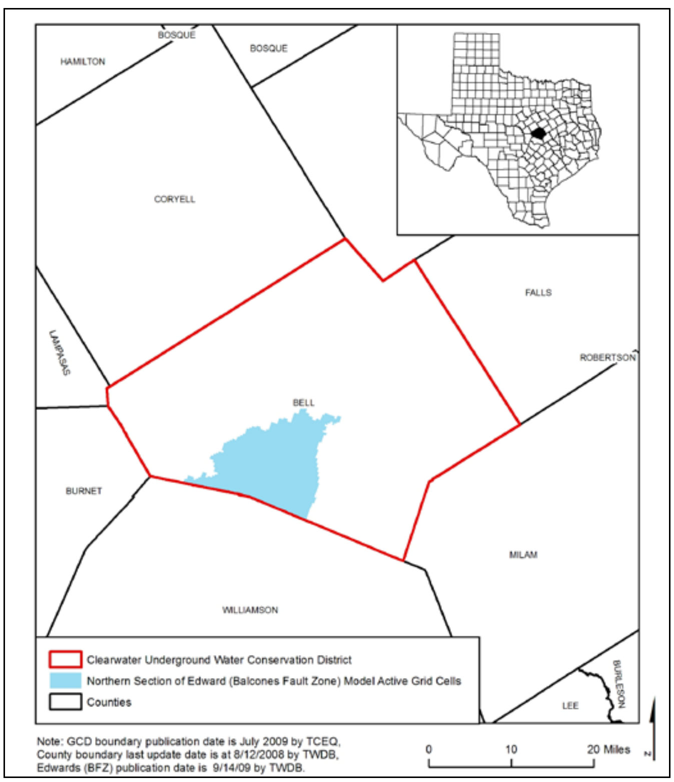

Figure 2: Area of the groundwater availability model for the northern section of the Edwards (Balcones Fault Zone) aquifer from which the information in Table 2 was extracted.

REFERENCES:

Bené, J., Harden, B., O'Rourke, D., Donnelly, A., and Yelderman, J., 2004, Northern Trinity/Woodbine Groundwater Availability Model: contract report to the Texas Water Development Board by R.W. Harden and Associates, 391 p., http://www.twdb.state.tx.us/gam/trnt_n/trnt_n.htm.

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

LBG-Guyton Associates, 2003, Brackish Groundwater Manual for Texas Regional Water Planning Groups: contract report to the Texas Water Development Board, 188 p., http://www.twdb.state.tx.us/RWPG/rpgm_rpts/2001483395.pdf.

Ian C. Jones, 2003, Groundwater Availability Modeling: Northern Segment of Edwards Aquifer, Texas, Report 358, Texas Water Development Board, 75p., http://www.twdb.state.tx.us/gam/ebfz_n/Report358.pdf