GAM Run 08-87

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EXECUTIVE SUMMARY:

Texas State 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 Bluebonnet Groundwater Conservation District for its groundwater management plan. The groundwater management plan for Bluebonnet Groundwater Conservation District is due for approval by the Executive Administrator of the Texas Water Development Board before November 18, 2009.

This report discusses the method, assumptions, and results from model runs using the groundwater availability models for the central part of the Carrizo-Wilcox, Queen City, and Sparta aquifers, and the northern part of the Gulf Coast 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 Yegua Jackson Aquifer and Brazos River Alluvium Aquifer also underlie the Bluebonnet 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 Yegua Jackson Aquifer or Brazos River Alluvium 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 central part of the Carrizo-Wilcox, Queen City, and Sparta aquifers, and the northern part of the Gulf Coast Aquifer and (1) extracted water budgets for each year of the 1980 through 1999 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).

PARAMETERS AND ASSUMPTIONS:

Groundwater availability model for the central parts of the Carrizo-Wilcox, Queen City, and Sparta aquifers

- We used Version 2.01 of the groundwater availability model for the central part of the Carrizo-Wilcox, Queen City, and Sparta aquifers. See Dutton and others (2003) and Kelley and others (2004) for assumptions and limitations of the groundwater availability model for the central part of the Carrizo-Wilcox, Queen City, and Sparta aquifers.

- This groundwater availability model includes eight layers, representing (from top to bottom):

    1. the Sparta Aquifer (Layer 1),
    2. the Weches Confining Unit (Layer 2),
    3. the Queen City Aquifer (Layer 3),
    4. the Reklaw Confining Unit (Layer 4),
    5. the Carrizo Aquifer (Layer 5),
    6. the Upper Wilcox Aquifer (Calvert Bluff Formation—Layer 6),
    7. the Middle Wilcox Aquifer (Simsboro Formation—Layer 7), and
    8. the Lower Wilcox Aquifer (Hooper Formation—Layer 8).

- The root mean square error (a measure of the difference between simulated and actual water levels during model calibration) in the groundwater availability model is 22 feet for the Sparta Aquifer, 27 feet for the Queen City Aquifer, 36 feet for the Carrizo Aquifer, and 31 feet for the Simsboro Aquifer for the calibration period (1980 through 1990) and 24, 33, 32, and 43 feet for the same aquifers, respectively, in the verification period (1991 through 1999) (Kelley and others, 2004). These root mean square errors are between four and eleven percent of the range of measured water levels (Kelley and others, 2004)

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

Groundwater availability model for the northern part of the Gulf Coast Aquifer

- We used Version 2.01 of the groundwater availability model for the northern part of the Gulf Coast Aquifer. See Kasmarek and Robinson (2004) for assumptions

- The model simulates groundwater flow through four hydrostratigraphic layers. These layers are (from top to bottom):

  1. the Chicot Aquifer,
  2. the Evangeline Aquifer,
  3. the Burkeville Confining Unit, and
  4. the Jasper Aquifer.

- The root mean square (RMS) error (a measure of the difference between simulated and actual water levels during model calibration) in the groundwater availability model for 2000 is about 31 feet for the Chicot aquifer, about 40 feet for the Evangeline aquifer, and about 34 feet for the Jasper aquifer. The RMS errors are about 7, 8, and 17 percent, respectively, of the total range in measured heads for the respective aquifers (Kasmarek and Robinson, 2004).

- The transient portion of the model has a total of 53 stress periods for the 1980 through 1999 period. Of these, monthly stress periods were assigned for 1980, 1982 and 1988. Monthly stress periods were assigned for those years due to substantially lower-than-average precipitation recorded in the modeling study area. The remainder of the stress periods are annual.

- We assumed that in the outcrop where surface water courses intersect the general head boundary, the general head boundary simulates groundwater-surface water interaction. In the rest of the outcrop, groundwater recharge occurs into the aquifer depending on the water level elevation head and hydraulic conductance values assigned in the general head boundary model cells.

- 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 calibrated portion of the model run (1980 through 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. "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).

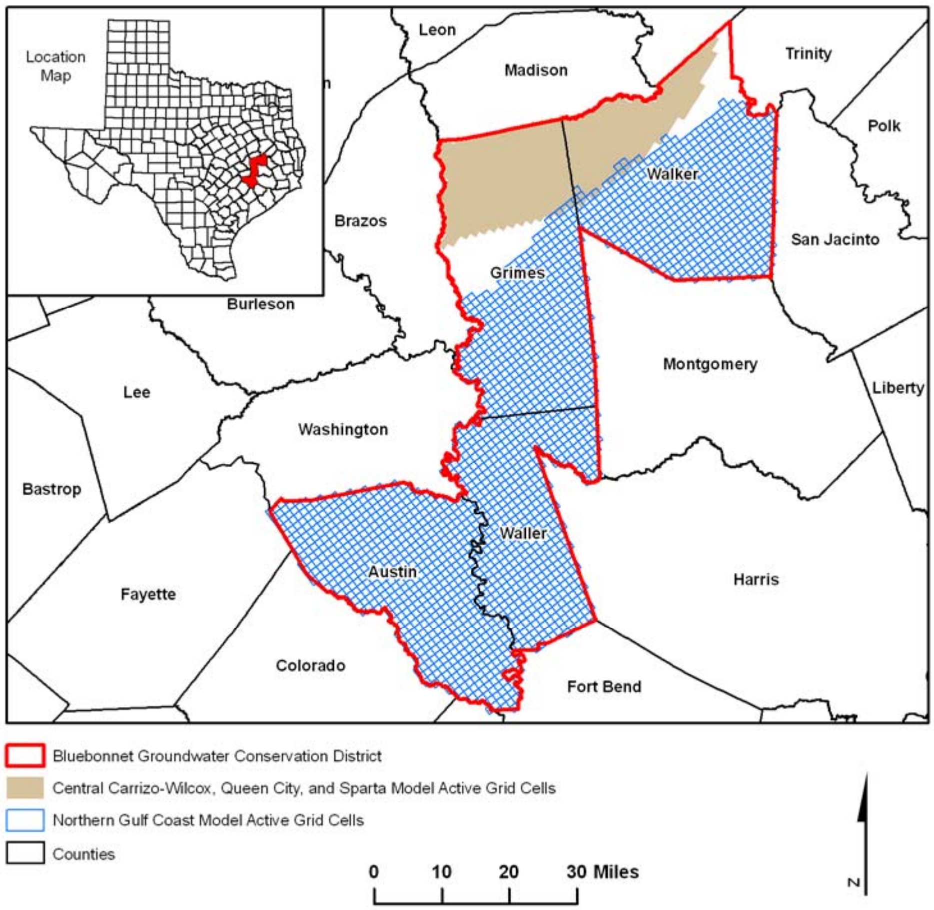
As depicted by Kalaswad and Arroyo (2006) and Kelley and others (2004), groundwater in the Gulf Coast Aquifer and the Carrizo-Wilcox, Queen City, and Sparta aquifers ranges from fresh to saline. The reported values in this report for flow terms include fresh (less than 1,000 milligrams per liter total dissolved solids), brackish (1,000 to 10,000 milligrams per liter total dissolved solids), and saline (greater than 10,000 milligrams per liter total dissolved solids) groundwater.

Table 1: Summarized information needed for Bluebonnet 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. 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 *(*Recharge in the groundwater availability model for the northern parts of the Texas Gulf Coast Aquifer was estimated using a General Head Boundary Package.)*	Chicot Aquifer*	37,530
	Evangeline Aquifer*	10,763
	Burkeville Confining Unit*	4
	Jasper Aquifer*	5,919
	Sparta Aquifer	0
	Weches Confining Unit	0
	Queen City Aquifer	0
	Reklaw Confining Unit	0
	Carrizo Aquifer	0
	Wilcox (upper) Aquifer	0
	Wilcox (middle) Aquifer	0
	Wilcox (lower) Aquifer	0

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Chicot Aquifer	1,650
	Evangeline Aquifer	11,004
	Burkeville Confining Unit	0
	Jasper Aquifer	3,903
	Sparta Aquifer	0
	Weches Confining Unit	0
	Queen City Aquifer	0
	Reklaw Confining Unit	0
	Carrizo Aquifer	0
	Wilcox (upper) Aquifer	0
	Wilcox (middle) Aquifer	0
	Wilcox (lower) Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Chicot Aquifer	9,897
	Evangeline Aquifer	18,562
	Burkeville Confining Unit	33
	Jasper Aquifer	14,448
	Sparta Aquifer	417
	Weches Confining Unit	60
	Queen City Aquifer	206
	Reklaw Confining Unit	72
	Carrizo Aquifer	1,044
	Wilcox (upper) Aquifer	403
	Wilcox (middle) Aquifer	1,283
	Wilcox (lower) Aquifer	356
Estimated annual volume of flow out of the district within each aquifer in the district	Chicot Aquifer	20,145
	Evangeline Aquifer	24,542
	Burkeville Confining Unit	48
	Jasper Aquifer	21,450
	Sparta Aquifer	633
	Weches Confining Unit	75
	Queen City Aquifer	126
	Reklaw Confining Unit	64
	Carrizo Aquifer	1,026
	Wilcox (upper) Aquifer	392
	Wilcox (middle) Aquifer	1,391
	Wilcox (lower) Aquifer	278
Estimated net annual volume of flow between each aquifer in the district	Chicot Aquifer into the Evangeline Aquifer	44,149
	Evangeline Aquifer into the Burkeville Confining Unit	1,158
	Burkeville Confining Unit into the Jasper Aquifer	1,113
	Weches Confining Unit into the Sparta Aquifer	201
	Queen City Aquifer into the Weches Confining Unit	212
	Reklaw Confining Unit into the Queen City Aquifer	54
	Carrizo Aquifer into the Reklaw Confining Unit	17
	Carrizo Aquifer into the Wilcox (upper) Aquifer	10
	Wilcox (upper) Aquifer into the Wilcox (middle) Aquifer	24
	Wilcox (lower) Aquifer into the Wilcox (middle) Aquifer	80

Figure 1: Area of the groundwater availability model for the central part of the Carrizo-Wilcox, Queen City, and Sparta aquifers, and the northern part of the Gulf Coast Aquifer from which the information in Table 1 was extracted (the aquifer extent within the Bluebonnet Groundwater Conservation District boundary).



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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 May 8, 2009.