GAM Run 08-89

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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 Lost Pines Groundwater Conservation District for its groundwater management plan. The groundwater management plan for Lost Pines Groundwater Conservation District is due for approval by the Executive Administrator of the Texas Water Development Board before February 15, 2010.

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 Trinity 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 also underlies the Lost Pines Groundwater Conservation District. However, a groundwater availability model for this minor aquifer has not been completed at this time. If the district would like information for the Yegua Jackson 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 Trinity 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 1989) and 24, 33, 32, and 43 feet for the same aquifers, respectively, in the verification period (1990 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 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).

- 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.

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 calibration and verification 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).

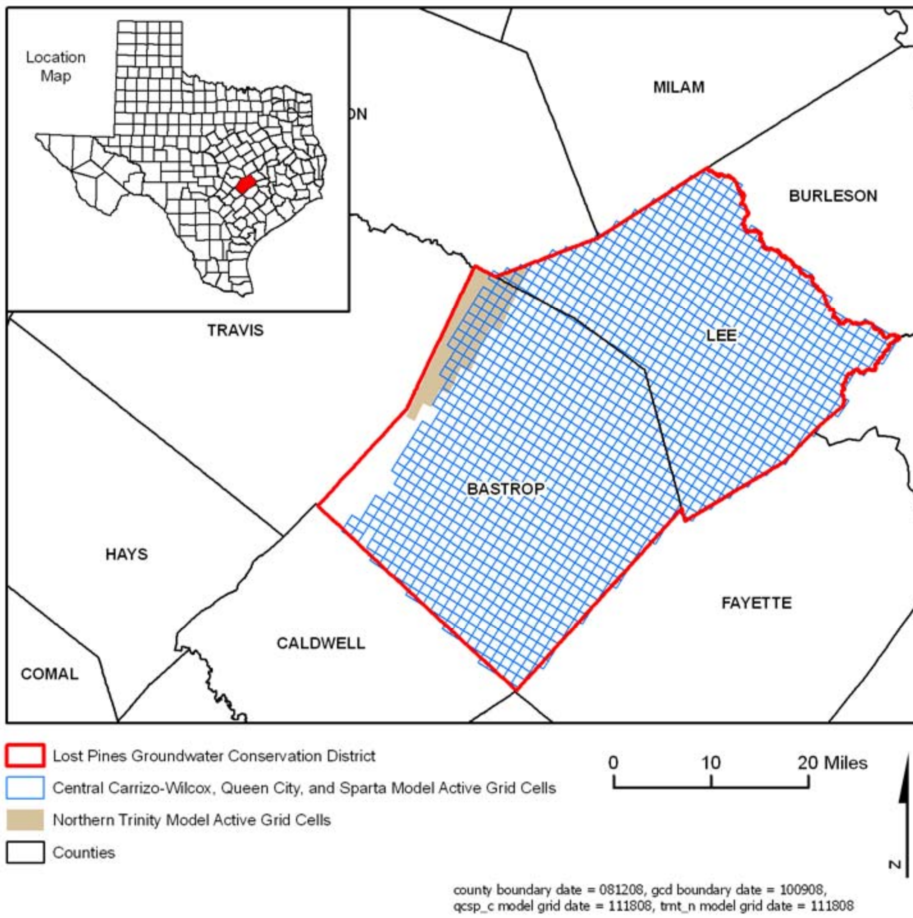
As depicted by Bené and others (2004) and Kelley and others (2004), groundwater in the Trinity Aquifer and the Carrizo-Wilcox, Queen City, and Sparta aquifers ranges from fresh to saline. The reported values in this report for flow terms include fresh (less than 1,000 milligrams per liter total dissolved 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 Lost Pines 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	Woodbine Aquifer	0
	Washita and Fredericksburg series	0
	Paluxy Aquifer	0
	Glen Rose Formation	0
	Hensell Aquifer	0
	Pearsall/Cow Creek/Hammett/Sligo formations	0
	Hosston Aquifer	0
	Sparta Aquifer	10,142
	Weches Confining Unit	1,306
	Queen City Aquifer	7,256
	Reklaw Confining Unit	2,010
	Carrizo Aquifer	12,166
	Wilcox (upper) Aquifer	9,033
	Wilcox (middle) Aquifer	5,172
	Wilcox (lower) Aquifer	3,234
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Woodbine Aquifer	0
	Washita and Fredericksburg series	0
	Paluxy Aquifer	0
	Glen Rose Formation	0
	Hensell Aquifer	0
	Pearsall/Cow Creek/Hammett/Sligo formations	0
	Hosston Aquifer	0
	Sparta Aquifer	4,564
	Weches Confining Unit	244
	Queen City Aquifer	5,488
	Reklaw Confining Unit	581
	Carrizo Aquifer	17,012
	Wilcox (upper) Aquifer	5,603
	Wilcox (middle) Aquifer	4,834
	Wilcox (lower) Aquifer	5,331
Estimated annual volume of flow into the district within each aquifer in the district	Woodbine Aquifer	0
	Washita and Fredericksburg series	133
	Paluxy Aquifer	4
	Glen Rose Formation	224
	Hensell Aquifer	2
	Pearsall/Cow Creek/Hammett/Sligo formations	1
	Hosston Aquifer	154
	Sparta Aquifer	1,299
	Weches Confining Unit	57
	Queen City Aquifer	670
	Reklaw Confining Unit	115
	Carrizo Aquifer	2,702
	Wilcox (upper) Aquifer	940

Management Plan requirement	Aquifer or confining unit	Results
	Wilcox (middle) Aquifer	6,356
	Wilcox (lower) Aquifer	4,026
Estimated annual volume of flow out of the district within each aquifer in the district	Woodbine Aquifer	0
	Washita and Fredericksburg series	170
	Paluxy Aquifer	4
	Glen Rose Formation	277
	Hensell Aquifer	2
	Pearsall/Cow Creek/Hammett/Sligo formations	1
	Hosston Aquifer	206
	Sparta Aquifer	733
	Weches Confining Unit	72
	Queen City Aquifer	3,354
	Reklaw Confining Unit	267
	Carrizo Aquifer	5,500
	Wilcox (upper) Aquifer	2,515
	Wilcox (middle) Aquifer	7,417
	Wilcox (lower) Aquifer	4,280
Estimated net annual volume of flow between each aquifer in the district	Woodbine Aquifer into the Washita and Fredericksburg series	9
	Paluxy Aquifer into the Washita and Fredericksburg series	5
	Paluxy Aquifer into the Glen Rose Formation	19
	Hensell Aquifer into the Glen Rose Formation	7
	Hensell Aquifer into the Pearsall/Cow Creek/Hammett/Sligo formations	17
	Pearsall/Cow Creek/Hammett/Sligo formations into the Hosston Aquifer	34
	Weches Confining Unit into the Sparta Aquifer	970
	Queen City Aquifer into the Weches Confining Unit	946
	Queen City Aquifer into the Reklaw Confining Unit	179
	Reklaw Confining Unit into the Carrizo Aquifer	1,309
	Carrizo Aquifer into the Wilcox (upper) Aquifer	44
	Wilcox (upper) Aquifer into the Wilcox (middle) Aquifer	1,567
	Wilcox (lower) Aquifer into the Wilcox (middle) Aquifer	1,203

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 Trinity Aquifer from which the information in Table 1 was extracted (the aquifer extent within the Lost Pines Groundwater Conservation District boundary).



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.

Dutton, A.R., Harden, B., Nicot, J.P., and O'Rourke, D., 2003, Groundwater availability model for the central part of the Carrizo-Wilcox Aquifer in Texas: Contract report to the Texas Water Development Board, 295 p., http://www.twdb.state.tx.us/gam/czwx_c/czwx_c.htm.

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

Kelley, V.A., Deeds, N.E., Fryar, D.G., and Nicot, J.P., 2004, Groundwater availability models for the Queen City and Sparta aquifers: Contract report to the Texas Water Development Board, 867 p., http://www.twdb.state.tx.us/gam/qc_sp/qc_sp.htm.

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 20, 2009.