GAM Run 10-014

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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 Lost Pines Groundwater Conservation District for its groundwater management plan. The groundwater management plan for the Lost Pines Groundwater Conservation District was 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, the northern part of the Trinity Aquifer, and the Yegua-Jackson Aquifer. This report replaces GAM Run 08-89 (Aschenbach, 2009) due to the release of the groundwater availability model for the Yegua-Jackson Aquifer in May of 2010. Tables 1 through 5 summarizes the groundwater availability model data required by the statute, and figures 1 through 5 shows the area of each model from which the values in Tables were extracted.

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).

We ran the groundwater availability model for Yegua-Jackson Aquifer and (1) extracted water budgets for each year of the 1980 through 1997 period and (2) averaged the annual water budget values for recharge, surface water outflow, inflow to the district, outflow from the district for the portions of the Yegua-Jackson Aquifer located within the district.

PARAMETERS AND ASSUMPTIONS:

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 Bené 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).

- Information extracted and summarized for layer 1 represents the Sparta Aquifer, layer 3 represents the Queen City Aquifer, and layers 5 to 8 were summarized and reported for the Carrizo-Wilcox Aquifer.

- 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).

- Groundwater in the Carrizo-Wilcox, Queen City, and Sparta aquifers ranges from fresh to brackish in composition (Kelley and others, 2004). Groundwater with total dissolved solids of less than 1,000 milligrams per liter are considered fresh and total dissolved solids of 1,000 to 10,000 milligrams per liter are considered brackish.

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

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).

- Information extracted and summarized for layers 2 to 7 were assumed to represent the Trinity Aquifer.

- 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.

Yegua-Jackson Aquifer

- We used version 1.01 of the groundwater availability model for the western section of the Yegua-Jackson Aquifer. See Kelley and others (2010) for assumptions and limitations of the model.

- The Yegua-Jackson Aquifer model includes five layers representing:
  1. outcrop section for the Yegua-Jackson Aquifer and younger overlying units,
  2. the upper portion of the Jackson Group,
  3. the lower portion of the Jackson Group,
  4. the upper portion of the Yegua Group, and
  5. the lower portion of the Yegua Group.

- Information was extracted and summarized for portions of layer 1 that represent the Yegua-Jackson as well as layers 2 to 5.

- 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 (Jackson Group, Upper Yagua and Lower Yagua) for the transient calibration period (1980 through 1997) ranged from approximately 31 to23 feet. The root mean squared error was about ten percent (or less) of the maximum change in water levels across the model (Deeds and others, 2010).

- The recharge used for the model run represents average recharge as described in Deeds and others (2010).

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

- The model results presented in this report were extracted from all areas of the model representing the units comprising the Yegua-Jackson Aquifer. For this reason, the reported values may reflect water of quality ranging from fresh to brackish and saline. This is especially true for the subcrop portions of the aquifer in the northeastern part of the District.

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 for the central part of the Carrizo-Wilcox, Queen City, and Sparta aquifers, and the northern part of the Trinity Aquifer and 1980 through 1997 for the Yegua-Jackson Aquifer) in the district, as shown in Table 1 through Table 5. The components of the modified budgets shown in Tables include:

- Precipitation recharge—This is the aerially 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 tables 1 through 5. 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 figures 1 to 5).

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: Sparta Aquifer's summarized information required for the 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	Sparta Aquifer	10,142
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Sparta Aquifer	4,564
Estimated annual volume of flow into the district within each aquifer in the district	Sparta Aquifer	1,299
Estimated annual volume of flow out of the district within each aquifer in the district	Sparta Aquifer	733
Estimated net annual volume of flow between each aquifer in the district	Weches Confining Unit into the Sparta Aquifer	970

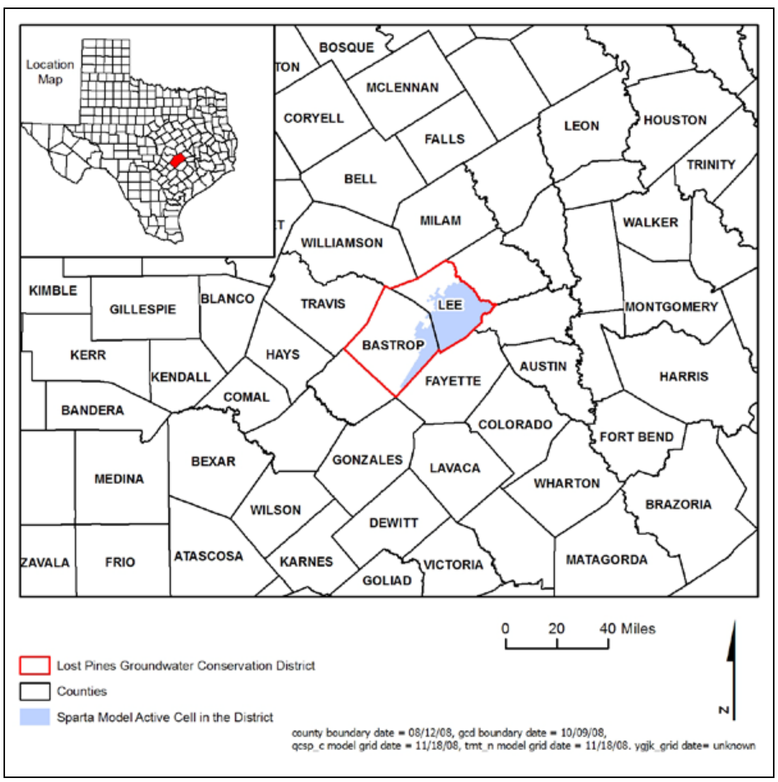

Figure 1: Area of the groundwater availability model for the Sparta Aquifer from which the information in Table 1 was extracted (the aquifer extent within the Lost Pines Groundwater Conservation District boundary).

Table 2: Queen City Aquifer’s summarized information required for the 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	Queen City Aquifer	7,256
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Queen City Aquifer	5,488
Estimated annual volume of flow into the district within each aquifer in the district	Queen City Aquifer	670
Estimated annual volume of flow out of the district within each aquifer in the district	Queen City Aquifer	3,354
Estimated net annual volume of flow between each aquifer in the district	Queen City Aquifer into the Weches Confining Unit	946
	Queen City Aquifer into the Reklaw Confining Unit	179

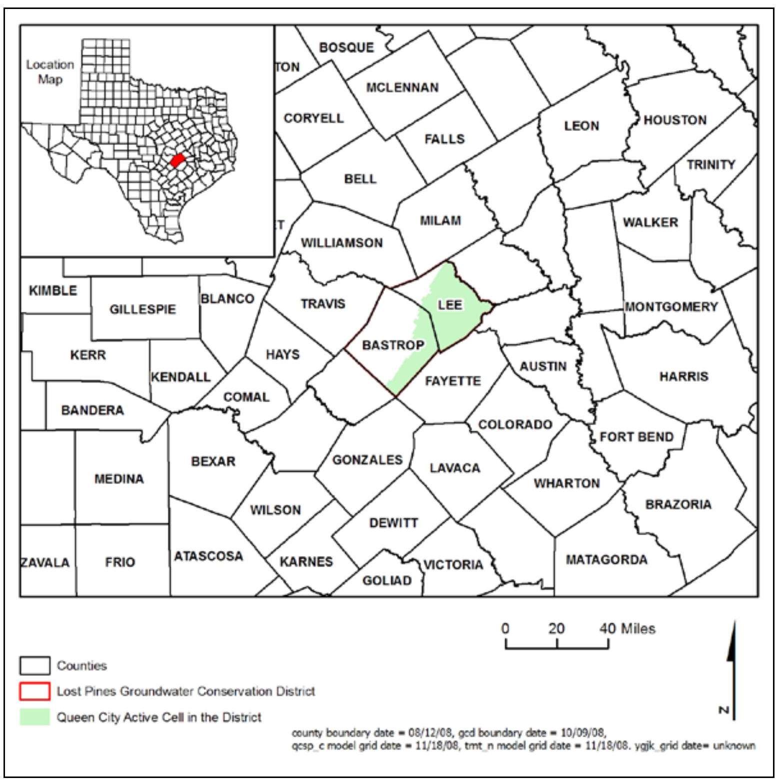

Figure 2: Area of the groundwater availability model for the Queen City Aquifer from which the information in Table 2 was extracted (the aquifer extent within the Lost Pines Groundwater Conservation District boundary).

Table 3: Carrizo-Wilcox Aquifer's summarized information required for the 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	Carrizo-Wilcox Aquifer	29,604
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Carrizo-Wilcox Aquifer	32,780
Estimated annual volume of flow into the district within each aquifer in the district	Carrizo-Wilcox Aquifer	14,023
Estimated annual volume of flow out of the district within each aquifer in the district	Carrizo-Wilcox Aquifer	19,713
Estimated net annual volume of flow between each aquifer in the district	Reklaw Confining Unit into the Carrizo-Wilcox Aquifer	1,309

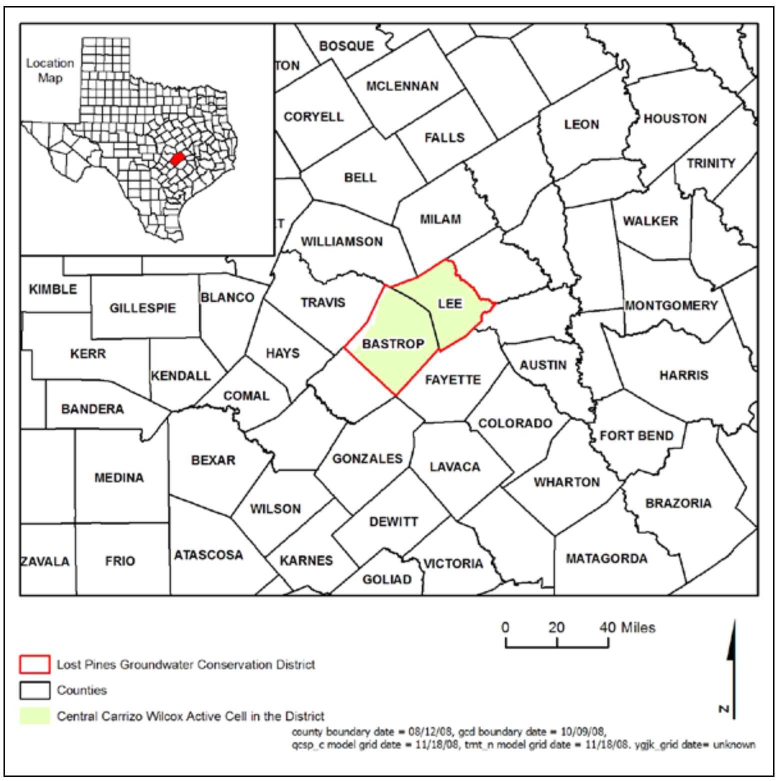

Figure 3: Area of the groundwater availability model for the Carrizo-Wilcox Aquifer from which the information in Table 3 was extracted (the aquifer extent within the Lost Pines Groundwater Conservation District boundary).

Table 4: Trinity Aquifer's summarized information required for the 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	Results
Estimated annual amount of recharge from precipitation to the district	Trinity Aquifer	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Trinity Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Trinity Aquifer	517
Estimated annual volume of flow out of the district within each aquifer in the district	Trinity Aquifer	661
Estimated net annual volume of flow between each aquifer in the district	Not applicable	Not Applicable

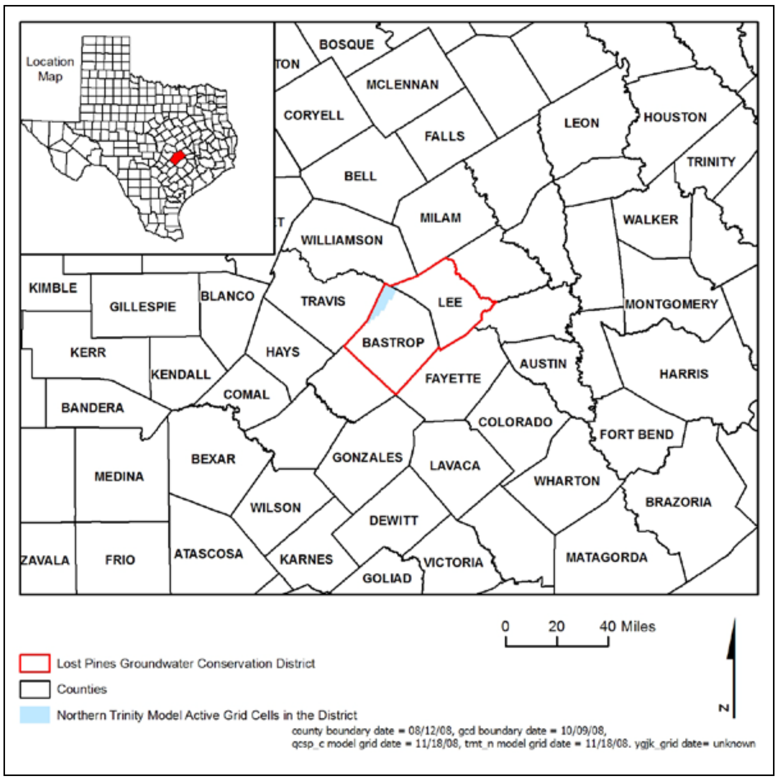

Figure 4: Area of the groundwater availability model for the Trinity Aquifer from which the information in Table 4 was extracted (the aquifer extent within the Lost Pines Groundwater Conservation District boundary).

Table 5: Yegua-Jackson Aquifer‘s summarized information required for the 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	Results
Estimated annual amount of recharge from precipitation to the district	Yegua-Jackson Aquifer	38,859
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Yegua-Jackson Aquifer	35,780
Estimated annual volume of flow into the district within each aquifer in the district	Yegua-Jackson Aquifer	5,883
Estimated annual volume of flow out of the district within each aquifer in the district	Yegua-Jackson Aquifer	10,155
Estimated net annual volume of flow between each aquifer in the district	Not applicable	Not applicable

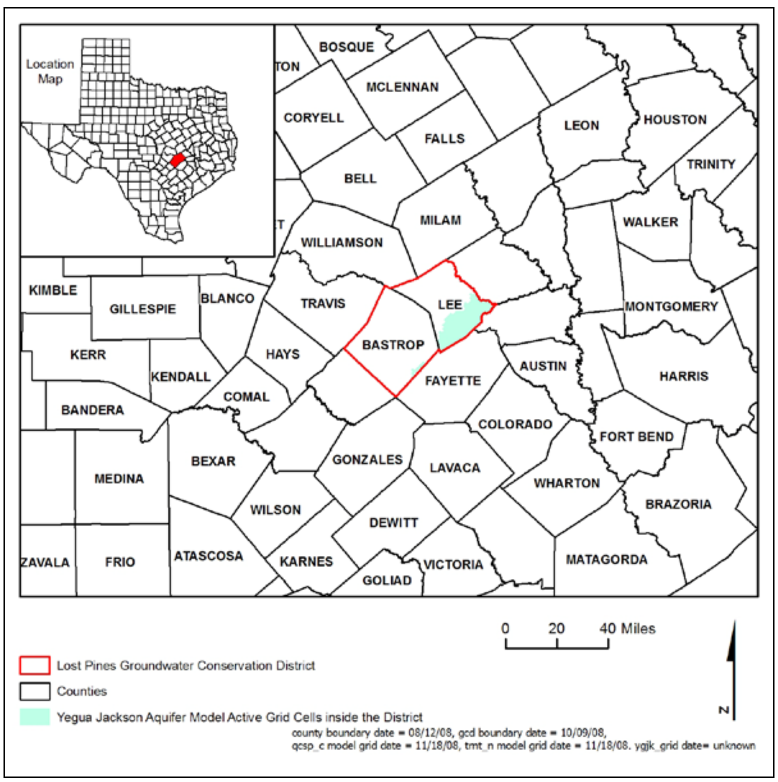

Figure 5: Area of the groundwater availability model for the Yegua-Jackson Aquifer from which the information in Table 5 was extracted (the aquifer extent within the Lost Pines Groundwater Conservation District boundary).

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