GAM Run 10-024

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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 Wintergarden Groundwater Conservation District for its groundwater management plan. The groundwater management plan for the Wintergarden Groundwater Conservation District was due for approval by the Executive Administrator of the Texas Water Development Board before January 25, 2011. This report supersedes GAM Run 05-28 (Wade, 2005) because the groundwater availability model for the Yegua-Jackson Aquifer has since been released and is required to be included. In addition, the methodology for extracting model information has changed since GAM Run 05-28 was released.

This report discusses the method, assumptions, and results from model runs using the groundwater availability models for the southern part of the Carrizo-Wilcox, Queen City, and Sparta aquifers, and the Yegua-Jackson Aquifer. Tables 1 through 4 summarizes the groundwater availability model data required by the statute, and figures 1 through 4 shows the area of each model from which the values in tables were extracted.

METHODS:

We ran the groundwater availability models for the southern part of the Carrizo-Wilcox, Queen City, and Sparta aquifers (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). It should be noted that GAM Run 05-28 (Wade, 2005) used the model boundaries within the district; we are now using the official aquifer boundaries to extract information from the models. In addition, we are using average water budget information from the transient calibration instead of the steady-state model to include the affects of pumping on the aquifer system. Therefore the results from this report may differ slightly from GAM Run 05-28.

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, Sparta and Queen City aquifers

- We used Version 2.01 of the groundwater availability model for the southern 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 southern 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 (Layer 6),
  7. the Middle Wilcox Aquifer (Layer 7), and
  8. the Lower Wilcox Aquifer (Layer 8).

  Information extracted and summarized for layer 5 to 8 represents the Carrizo-Wilcox Aquifer, layer 3 represents Queen City Aquifer, and layer 1 represent Sparta Aquifer.
- The root mean squared error (a measure of the difference between simulated and actual water levels during model calibration) in the groundwater availability model is 23 feet for the Sparta Aquifer, 18 feet for the Queen City Aquifer, and 33 feet for the Carrizo Aquifer for the calibration period (1980 to 1989) and 19, 22, and 48 feet for the same aquifers, respectively, in the verification period (1990 to 1999) (Kelley others, 2004). These root mean squared errors are between seven and ten percent of the range of measured water levels (Kelley 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.

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 southern part of the Carrizo-Wilcox, Queen City, and Sparta aquifers, and 1980 through 1997 for the Yegua-Jackson Aquifer) in the district, as shown in tables 1 through 4. 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 4. 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 4).

As depicted by Kalaswad and Arroyo (2006), groundwater in the southern 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) and brackish (1,000 to 10,000 milligrams per liter total dissolved solids) groundwater.

Table 1: Carrizo-Wilcox Aquifer's summarized information required for the Wintergarden 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	15,229
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	326
Estimated annual volume of flow into the district within each aquifer in the district	Carrizo-Wilcox Aquifer	25,485
Estimated annual volume of flow out of the district within each aquifer in the district	Carrizo-Wilcox Aquifer	22,227
Estimated net annual volume of flow between each aquifer in the district	Reklaw Confining Unit and other overlying unit into Carrizo-Wilcox Aquifer	28,227

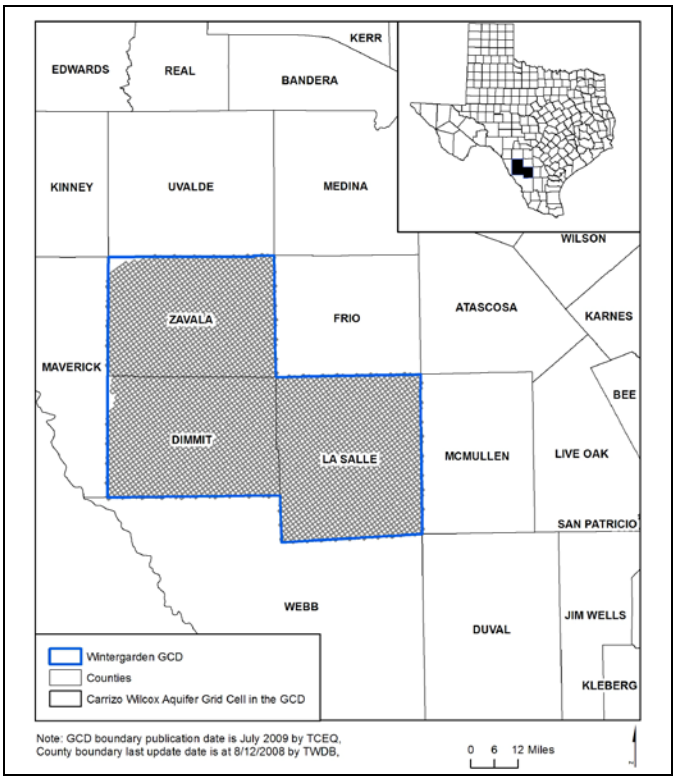

Figure 1: Area of the groundwater availability model for the Carrizo-Wilcox Aquifer from which the information in Table 1 was extracted (the aquifer extent within the Wintergarden Groundwater Conservation District boundary).

Table 2: Sparta Aquifer's summarized information required for the Wintergarden 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	Sparta Aquifer	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Sparta Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Sparta Aquifer	778
Estimated annual volume of flow out of the district within each aquifer in the district	Sparta Aquifer	592
Estimated net annual volume of flow between each aquifer in the district	Weches Confining Unit into Sparta Aquifer	24
	Upper lying younger unit to Sparta	69

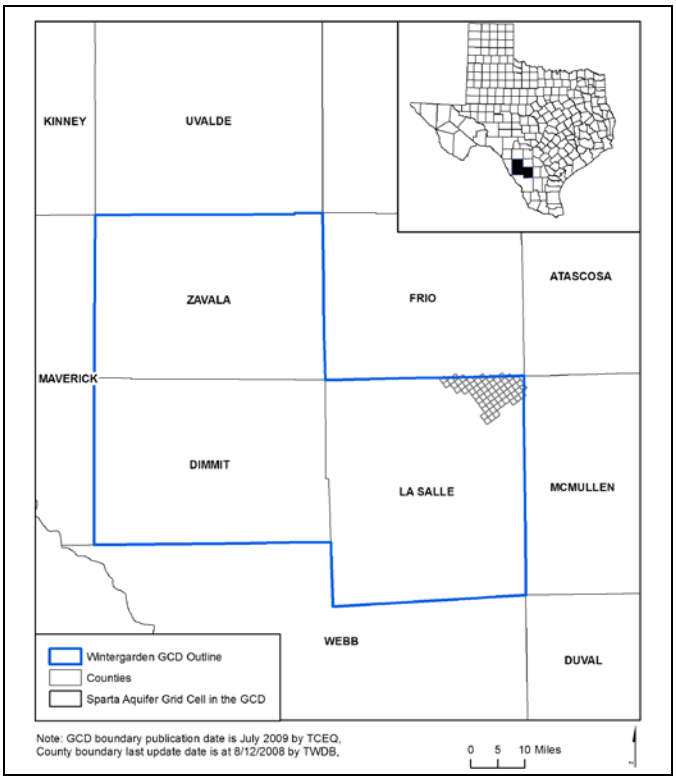

Figure 2: Area of the groundwater availability model for the Sparta Aquifer from which the information in Table 2 was extracted (the aquifer extent within the Wintergarden Groundwater Conservation District boundary).

Table 3: Queen City Aquifer's summarized information required for the Wintergarden 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	Queen City Aquifer	0
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	0
Estimated annual volume of flow into the district within each aquifer in the district	Queen City Aquifer	981
Estimated annual volume of flow out of the district within each aquifer in the district	Queen City Aquifer	309
Estimated net annual volume of flow between each aquifer in the district	Queen City Aquifer To Weches Confining Unit	386
	Queen City Aquifer into the Reklaw Confining Unit	438

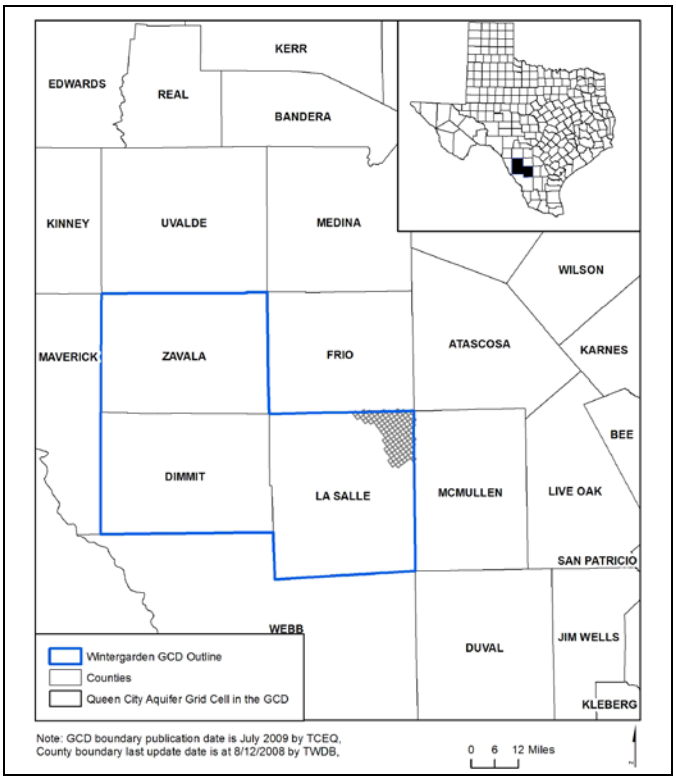

Figure 3: Area of the groundwater availability model for the Queen City Aquifer from which the information in Table 3 was extracted (the aquifer extent within the Wintergarden Groundwater Conservation District boundary).

Table 4: Yegua-Jackson Aquifer's summarized information required for the Wintergarden 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	7,618
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	8,190
Estimated annual volume of flow into the district within each aquifer in the district	Yegua-Jackson Aquifer	2,717
Estimated annual volume of flow out of the district within each aquifer in the district	Yegua-Jackson Aquifer	2,671
Estimated net annual volume of flow between each aquifer in the district	Not applicable	Not applicable

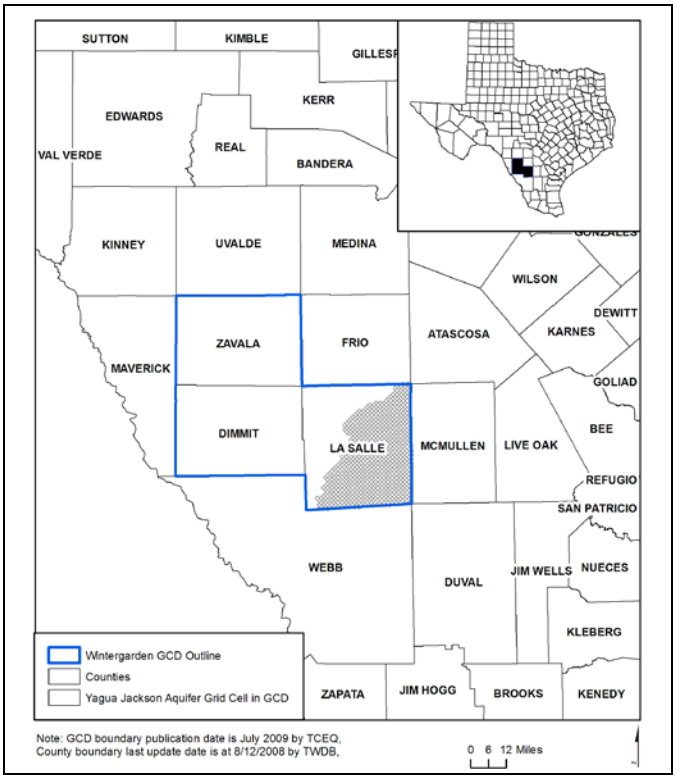

Figure 4: Area of the groundwater availability model for the Yegua-Jackson Aquifer from which the information in Table 4 was extracted (the aquifer extent within the Wintergarden Groundwater Conservation District boundary).

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