GAM Run 10-029

by Eric Aschenbach
Texas Water Development Board
Groundwater Availability Modeling Section
(512) 463-1708
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Cynthia K. Ridgeway is the Manager of the Groundwater Availability Modeling Section and is responsible for oversight of work performed by Eric Aschenbach under her direct supervision. The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G. 471 on January 4, 2011.

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 report is to provide information to Post Oak Savannah Groundwater Conservation District for its groundwater management plan. The groundwater management plan for Post Oak Savannah Groundwater Conservation District is due for approval by the Executive Administrator of the Texas Water Development Board before July 24, 2011.

This report discusses the method, assumptions, and results from model runs using the groundwater availability models for the northern part of the Trinity Aquifer; the central part of the Carrizo-Wilcox, Queen City, and Sparta aquifers; and the Yegua Jackson Aquifer. Tables 1 through 8 summarize the groundwater availability model data required by the statute, and figures 1 through 8 show the area of each model from which the values in the respective tables were extracted. If after review of the figures, Post Oak Savannah Groundwater Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the Texas Water Development Board immediately.

The Brazos River Alluvium Aquifer also underlies the Post Oak Savannah 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 Brazos River Alluvium Aquifer, they may request it from the Groundwater Technical Assistance Section of the Texas Water Development Board.

METHODS:

The groundwater availability model for the northern part of the Trinity Aquifer (1980 through 1999); the central part of the Carrizo-Wilcox, Queen City, and Sparta aquifers (1980 through 1999); and the Yegua-Jackson Aquifer (1980 through 1997) were run for this analysis. Water budgets for each year of the transient model period were extracted and the average 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 aquifers located within the district are summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Trinity Aquifer

- Version 1.01 of the groundwater availability model for the northern section of the Trinity Aquifer was used for this analysis. See Bené and others (2004) for assumptions and limitations of the model.

- The northern part of the Trinity Aquifer model includes seven layers, which generally correspond to:

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

    Layer 1 is not present in the district. Out of the remaining layers listed above, an overall water budget for the district was determined for the Trinity Aquifer (Layer 2 through Layer 7, collectively).

- 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).

- As depicted by Bené and others (2004) and LBG-Guyton Associates (2003), groundwater in the Trinity Aquifer within the Post Oak Savannah Groundwater Conservation District is predominantly brackish (1,000 to 10,000 milligrams per liter total dissolved solids).

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

Carrizo-Wilcox, Queen City, and Sparta aquifers

- Version 2.01 of the groundwater availability model for the central part of the Carrizo-Wilcox, Queen City, and Sparta aquifers was used for this analysis. 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, which generally correspond to (from top to bottom):

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

Out of the eight layers listed above, individual water budgets for the district were determined for the Sparta Aquifer (Layer 1), the Queen City Aquifer (Layer 3), and each layer of the Carrizo-Wilcox Aquifer (Layer 5 through 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 to 1990) and 24, 33, 32, and 43 feet for the same aquifers, respectively, in the verification period (1991 to 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.

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

Yegua-Jackson Aquifer

- Version 1.01 of the groundwater availability model for the Yegua-Jackson Aquifer was used for this analysis. See Deeds and others (2010) for assumptions and limitations of the groundwater availability model.

- This groundwater availability model includes five layers, which generally correspond to (from top to bottom):

  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.

  An overall water budget for the district was determined for the Yegua-Jackson Aquifer (Layer 1 through Layer 5, collectively for the portions that represent the Yegua-Jackson Aquifer).

- As reported in Deeds and others (2010), the mean absolute errors (a measure of the difference between simulated and measured water levels during model calibration) for the Jackson Group (combined upper and lower Jackson units), Upper Yegua, and Lower Yegua portions of the Yegua-Jackson Aquifer for the historical-calibration period of the model are 31.1, 23.9, and 24.5 feet, respectively. These represent 10.3, 5.7 and 6.3 percent of the hydraulic head drop across each model area, respectively.

- Groundwater Vistas Version 5 (Environmental Simulations, Inc. 2007) was used 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 runs in the district, as shown in tables 1 through 8. The components of the modified budget shown in tables 1 through 8 include:

- Precipitation recharge—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—The total water discharging from the aquifer (outflow) to surface water features such as streams, reservoirs, and drains (springs).

- Flow into and out of district—The lateral flow within the aquifer between the district and adjacent counties.

- Flow between aquifers—The vertical flow 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 8. 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 through 8).

Table 1: Summarized information for the Trinity Aquifer that is needed for Post Oak Savannah Groundwater Conservation District's groundwater management plan. All values are reported in acre-feet per year and rounded to the nearest 1 acre-foot. These flows include brackish waters.

Management Plan requirement	Aquifer or confining unit	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	423
Estimated annual volume of flow out of the district within each aquifer in the district	Trinity Aquifer	678
Estimated net annual volume of flow between each aquifer in the district	Not applicable	Not applicable

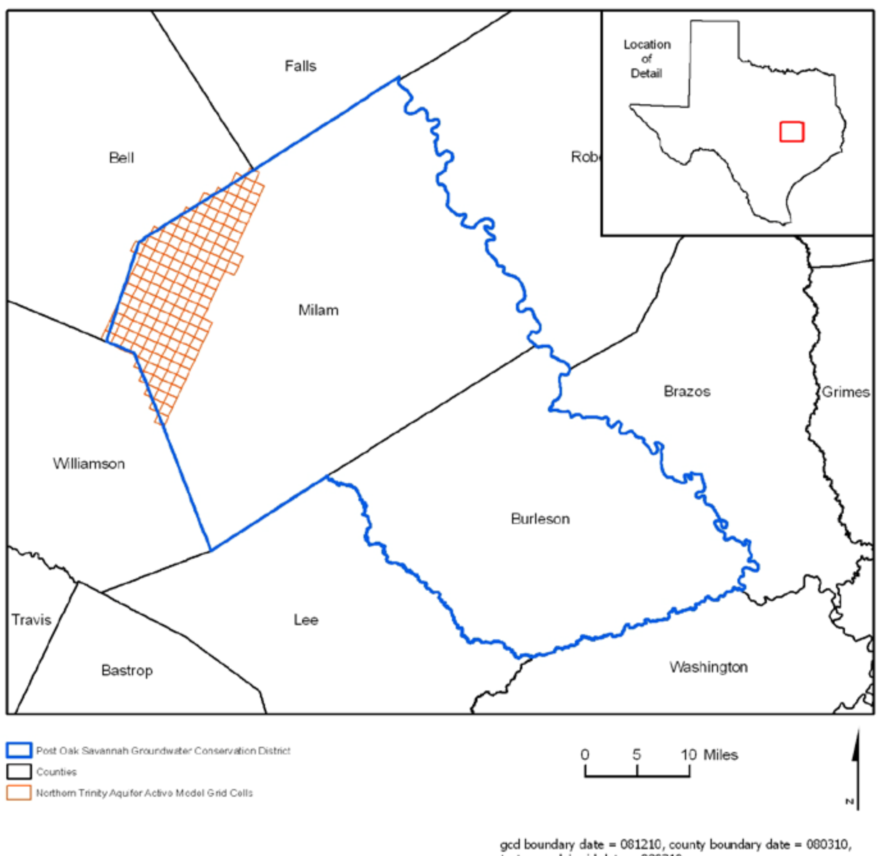

Figure 1: Area of the groundwater availability model for the northern portion of the Trinity Aquifer from which the information in Table 1 was extracted (the aquifer extent within the district boundary).

Table 2: Summarized information for the Sparta Aquifer that is needed for Post Oak Savannah Groundwater Conservation District's groundwater management plan. All values are reported in acre-feet per year and rounded to the nearest 1 acre-foot. These flows may include fresh and brackish waters.

Management Plan requirement	Aquifer	Results
Estimated annual amount of recharge from precipitation to the district	Sparta Aquifer	7,424
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Sparta Aquifer	4,807
Estimated annual volume of flow into the district within each aquifer in the district	Sparta Aquifer	739
Estimated annual volume of flow out of the district within each aquifer in the district	Sparta Aquifer	1,226
Estimated net annual volume of flow between each aquifer in the district	Weches Confining Unit and adjacent underlying areas into the Sparta Aquifer	1,569

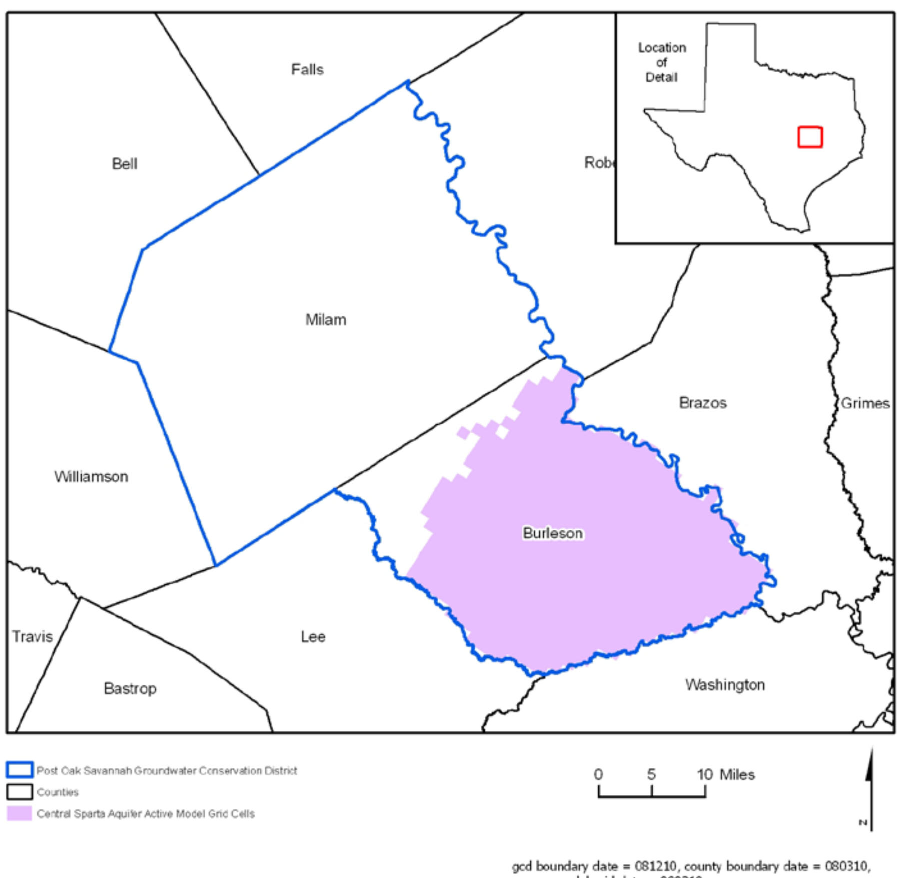

Figure 2: Area of the groundwater availability model for the Sparta Aquifer from which the information in Table 2 was extracted (the aquifer extent within the district boundary).

Table 3: Summarized information for the Queen City Aquifer that is needed for Post Oak Savannah Groundwater Conservation District's groundwater management plan. All values are reported in acre-feet per year and rounded to the nearest 1 acre-foot. These flows may include fresh and brackish waters.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Queen City Aquifer	8,812
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	12,028
Estimated annual volume of flow into the district within each aquifer in the district	Queen City Aquifer	1,316
Estimated annual volume of flow out of the district within each aquifer in the district	Queen City Aquifer	947
Estimated net annual volume of flow between each aquifer in the district	Queen City Aquifer into the overlying Weches Confining Unit	1,435
	Reklaw Confining Unit and adjacent underlying areas into the Queen City Aquifer	861

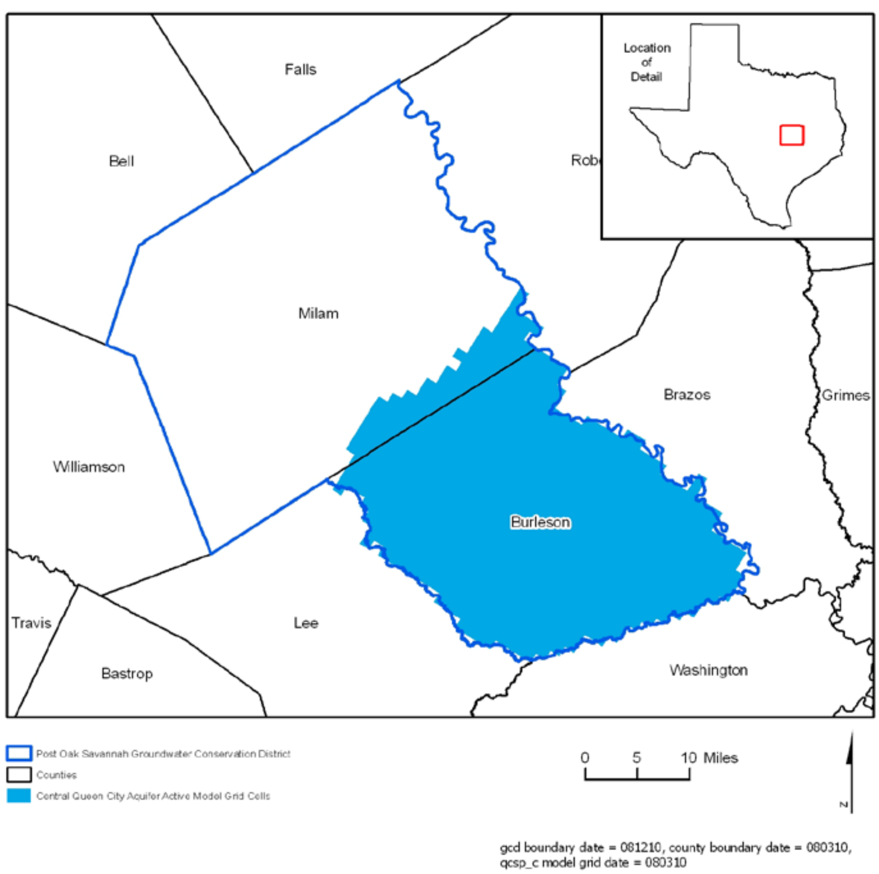

Figure 3: Area of the groundwater availability model for the southern portion of the Queen City Aquifer from which the information in Table 3 was extracted (the aquifer extent within the district boundary).

Table 4: Summarized information for the Carrizo Aquifer that is needed for Post Oak Savannah Groundwater Conservation District's groundwater management plan. All values are reported in acre-feet per year and rounded to the nearest 1 acre-foot. These flows may include fresh and brackish waters.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Carrizo Aquifer	4,018
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Carrizo Aquifer	1,964
Estimated annual volume of flow into the district within each aquifer in the district	Carrizo Aquifer	3,810
Estimated annual volume of flow out of the district within each aquifer in the district	Carrizo Aquifer	2,424
Estimated net annual volume of flow between each aquifer in the district	Carrizo Aquifer into the overlying Reklaw Confining Unit	233
	Carrizo Aquifer into the underlying Upper Wilcox Aquifer (Calvert Bluff Formation)	317

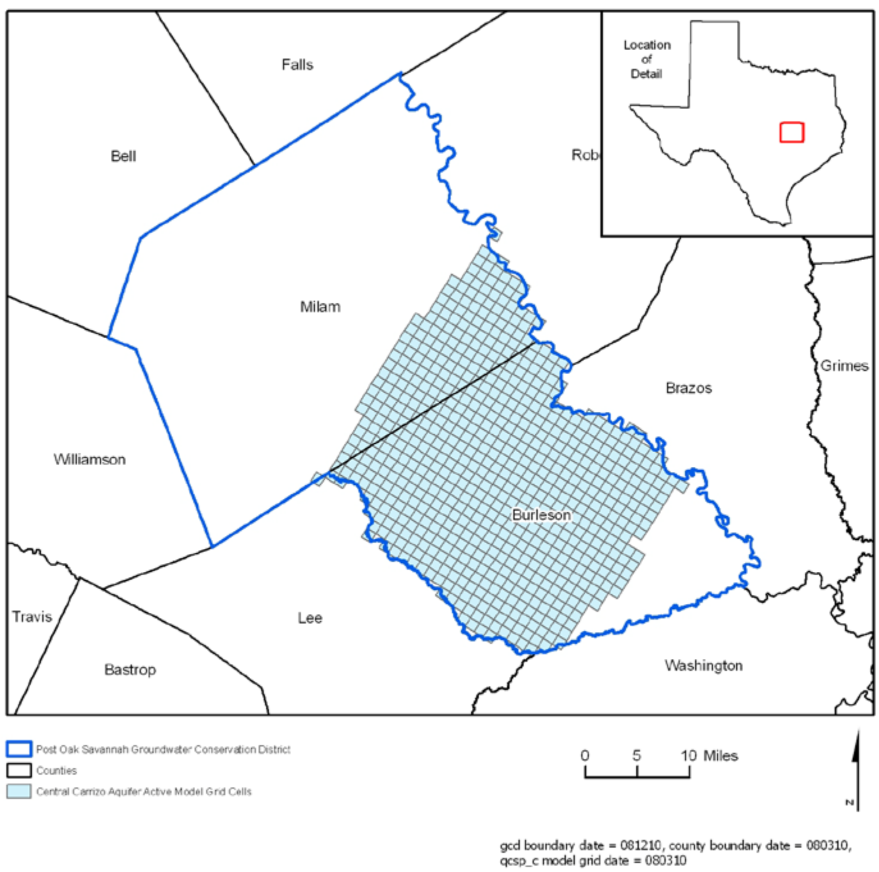

Figure 4: Area of the groundwater availability model for the Carrizo Aquifer from which the information in Table 4 was extracted (the aquifer extent within the district boundary).

Table 5: Summarized information for the Upper Wilcox Aquifer (Calvert Bluff Formation) that is needed for Post Oak Savannah Groundwater Conservation District's groundwater management plan. All values are reported in acre-feet per year and rounded to the nearest 1 acre-foot. These flows may include fresh and brackish waters.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Upper Wilcox Aquifer (Calvert Bluff Formation)	7,330
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Upper Wilcox Aquifer (Calvert Bluff Formation)	7,995
Estimated annual volume of flow into the district within each aquifer in the district	Upper Wilcox Aquifer (Calvert Bluff Formation)	2,416
Estimated annual volume of flow out of the district within each aquifer in the district	Upper Wilcox Aquifer (Calvert Bluff Formation)	2,000
Estimated net annual volume of flow between each aquifer in the district	Carrizo Aquifer into the underlying Upper Wilcox Aquifer (Calvert Bluff Formation)	317
	Upper Wilcox Aquifer (Calvert Bluff Formation) into the underlying Middle Wilcox Aquifer (Simsboro Formation)	3,451

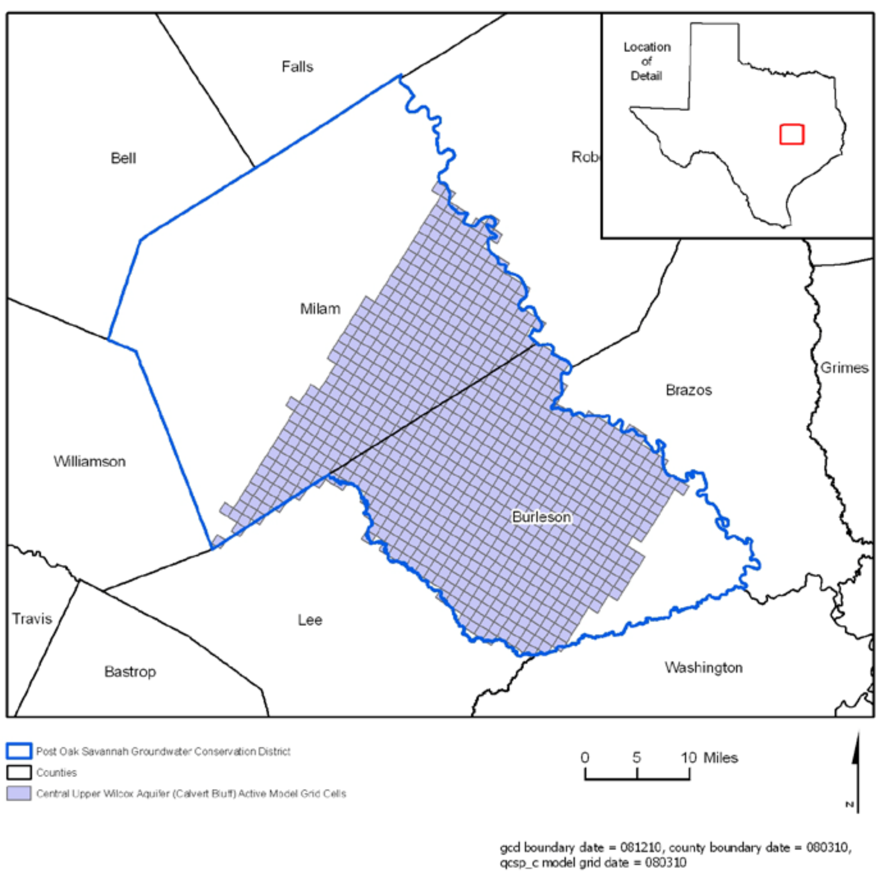

Figure 5: Area of the groundwater availability model for the Upper Wilcox Aquifer (Calvert Bluff Formation) from which the information in Table 5 was extracted (the aquifer extent within the district boundary).

Table 6: Summarized information for the Middle Wilcox Aquifer (Simsboro Formation) that is needed for Post Oak Savannah Groundwater Conservation District's groundwater management plan. All values are reported in acre-feet per year and rounded to the nearest 1 acre-foot. These flows may include fresh and brackish waters.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Middle Wilcox Aquifer (Simsboro Formation)	12,540
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Middle Wilcox Aquifer (Simsboro Formation)	18,827
Estimated annual volume of flow into the district within each aquifer in the district	Middle Wilcox Aquifer (Simsboro Formation)	10,804
Estimated annual volume of flow out of the district within each aquifer in the district	Middle Wilcox Aquifer (Simsboro Formation)	18,025
Estimated net annual volume of flow between each aquifer in the district	Upper Wilcox Aquifer (Calvert Bluff Formation) into the underlying Middle Wilcox Aquifer (Simsboro Formation)	3,451
	Lower Wilcox Aquifer (Hooper Formation) into the overlying Middle Wilcox Aquifer (Simsboro Formation)	1,537

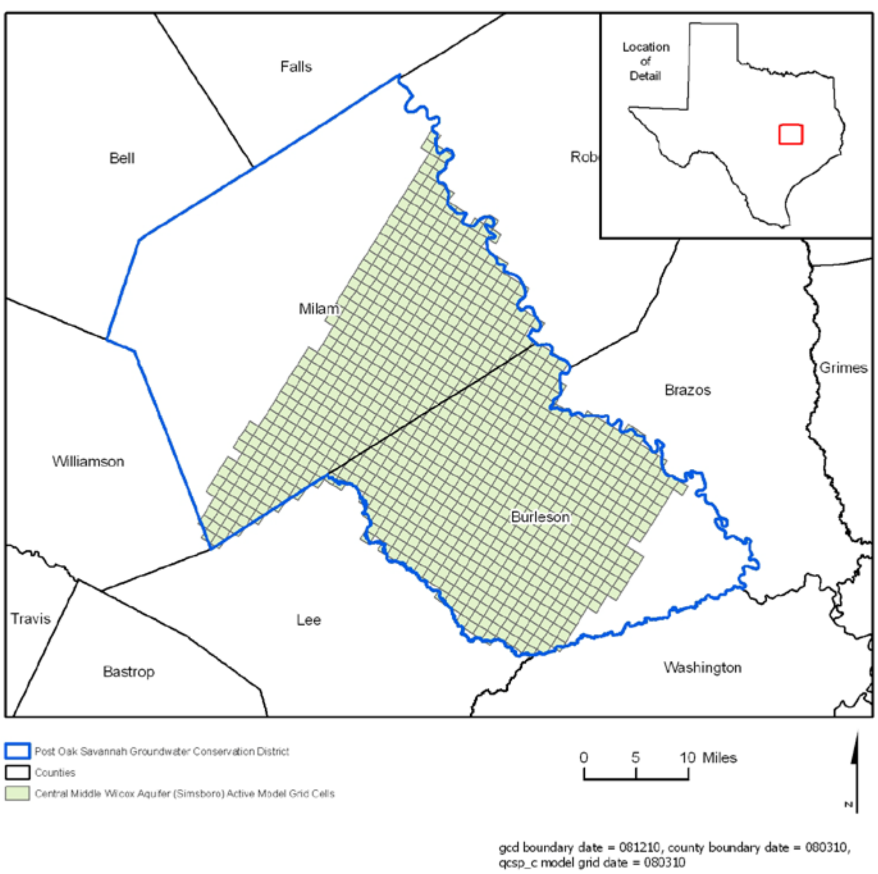

Figure 6: Area of the groundwater availability model for the Middle Wilcox Aquifer (Simsboro Formation) from which the information in Table 6 was extracted (the aquifer extent within the district boundary).

Table 7: Summarized information for the Lower Wilcox Aquifer (Hooper Formation) that is needed for Post Oak Savannah Groundwater Conservation District's groundwater management plan. All values are reported in acre-feet per year and rounded to the nearest 1 acre-foot. These flows may include fresh and brackish waters.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Lower Wilcox Aquifer (Hooper Formation)	2,391
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Lower Wilcox Aquifer (Hooper Formation)	1,748
Estimated annual volume of flow into the district within each aquifer in the district	Lower Wilcox Aquifer (Hooper Formation)	3,572
Estimated annual volume of flow out of the district within each aquifer in the district	Lower Wilcox Aquifer (Hooper Formation)	3,232
Estimated net annual volume of flow between each aquifer in the district	Lower Wilcox Aquifer (Hooper Formation) into the overlying Middle Wilcox Aquifer (Simsboro Formation)	1,537

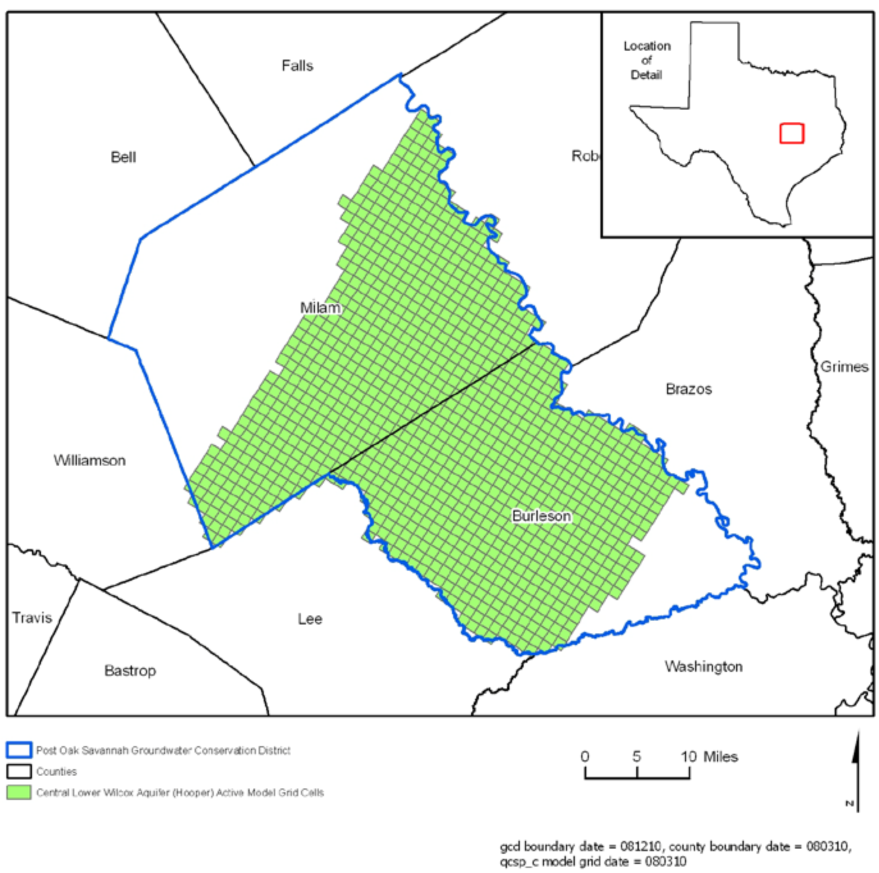

Figure 7: Area of the groundwater availability model for the Lower Wilcox Aquifer (Hooper Formation) from which the information in Table 7 was extracted (the aquifer extent within the district boundary).

Table 8: Summarized information for the Yegua-Jackson Aquifer that is needed for Post Oak Savannah Groundwater Conservation District's groundwater management plan. All values are reported in acre-feet per year and rounded to the nearest 1 acre-foot.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Yegua-Jackson Aquifer	22,459
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	13,923
Estimated annual volume of flow into the district within each aquifer in the district	Yegua-Jackson Aquifer	4,436
Estimated annual volume of flow out of the district within each aquifer in the district	Yegua-Jackson Aquifer	8,017
Estimated net annual volume of flow between each aquifer in the district	Not applicable	Not applicable

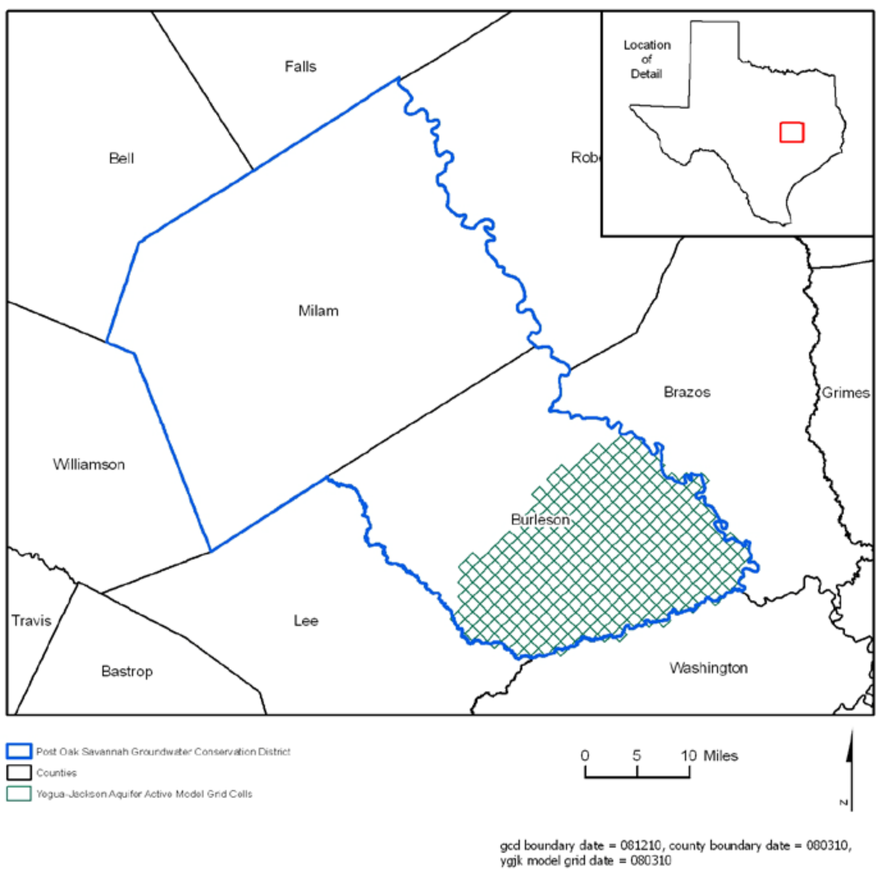

Figure 8: Area of the groundwater availability model for the Yegua-Jackson Aquifer from which the information in Table 8 was extracted (the aquifer extent within the district boundary).

REFERENCES:

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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.