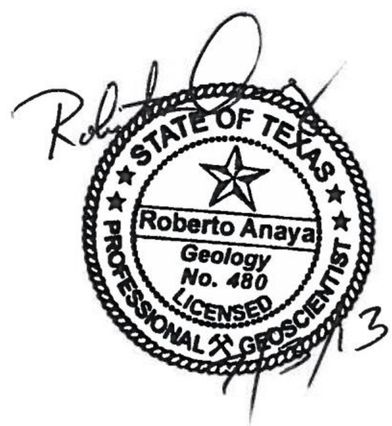
GAM Run 13-013: Neches & Trinity Valleys Groundwater Conservation District Management Plan

by Roberto Anaya, P.G.
Texas Water Development Board
Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 463-6115
July 3, 2013



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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 (TWDB) 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:

- the annual amount of recharge from precipitation to the groundwater resources within the district, if any;
- 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
- the annual volume of flow into and out of the district within each aquifer and between aquifers in the district.

This report (Part 2 of a two-part package of information from the TWDB to Neches & Trinity Valleys Groundwater Conservation District) fulfills the requirements noted above. Part 1 of the 2-part package is the Historical Water Use/State Water Plan data report. The District will receive this data report from the TWDB Groundwater Technical Assistance Section. Questions about the data report can be directed to Mr. Stephen Allen, Stephen.Allen@twdb.texas.gov, (512) 463-7317.

The groundwater management plan for the Neches & Trinity Valleys Groundwater Conservation District should be adopted by the district on or before July 16, 2014 and submitted to the executive administrator of the TWDB on or before August 15, 2014. The current management plan for Neches & Trinity Valleys Groundwater Conservation District expires on October 14, 2014. This report discusses the methods, assumptions, and results from model runs using the groundwater availability models for the Trinity, Nacatoch, Carrizo-Wilcox, Queen City, and Sparta aquifers. Tables 1 through 5 summarize the groundwater availability model data required by the statute, and Figures 1 through 5 show the area of the model from which the values in the table was extracted. This model run replaces the results of GAM Run 09-021. GAM Run 13-013 meets current standards set after the release of GAM Run 09-021 including a refinement of using the extent of the official aquifers boundaries within the district. The water budget values listed in the two model runs may differ because of this change in methodology. If after review of the figures, Neches & Trinity Valleys 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. Per statute TWDB is required to provide the districts with data from the official groundwater availability models.

METHODS:

In accordance with the provisions of the Texas State Water Code, Section 36.1071, Subsection (h), the groundwater availability models for the Trinity, Nacatoch, Carrizo -Wilcox, Queen City, and Sparta aquifers were run for this analysis. Neches & Trinity Valleys Groundwater Conservation District Water groundwater budgets for the historical 1980 to 1999 model period were extracted using ZONEBUDGET Version 3.01 (Harbaugh, 2009) 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

- We used version 1.01 of the groundwater availability model for the northern portion of the Trinity and Woodbine aquifers. See Bené and others (2004) for assumptions and limitations of the groundwater availability model for the northern portion of the Trinity and Woodbine aquifers.

- The groundwater availability model includes seven layers, that roughly correspond to:

    - the Woodbine Aquifer (Layer 1),
    - the Fredericksburg and Washita Confining Unit (Layer 2),
    - the Paluxy Aquifer Unit of the Trinity Aquifer (Layer 3),
    - the Glen Rose Confining Unit of the Trinity Aquifer (Layer 4),
    - the Hensell Sand Aquifer Unit of the Trinity Aquifer (Layer 5),
    - the Twin Mountains Confining Units of the Trinity Aquifer (Layer 6), and
    - the Hosston Aquifer Unit of the Trinity Aquifer (Layer 7).

- The Woodbine Aquifer and Fredericksburg and Washita confining units (Layers 1 and 2) are not substantively or not at all present in the district. The reported water budget values for these layers, therefore, are very small or zero. Accordingly, these values are not presented in in this report. The Trinity Aquifer units (Layers 3 through 7) were combined collectively to calculate water budget values for the Trinity Aquifer.

- Groundwater in the Trinity Aquifer is generally fresh except in the deeper down-dip portions of the aquifer, as is present within the Neches & Trinity Valleys Groundwater Conservation District, where total dissolved solids can range between 1,000 and 5,000 milligrams per liter (George and others, 2011). Groundwater with total dissolved solids of less than 1,000 milligrams per liter are considered fresh and total dissolved solids between 1,000 to 10,000 milligrams per liter are considered brackish, while total dissolved solids between 10,000 and 35,000 milligrams per liter are considered saline (Ashworth and Hopkins, 1995).

- The model was run with MODFLOW-96 (Harbaugh and McDonald, 1996).

Nacatoch Aquifer

- We used version 1.01 of the groundwater availability model for the Nacatoch Aquifer. See Beach and others (2009) for assumptions and limitations of the groundwater availability model for the Nacatoch Aquifer.

- The groundwater availability model includes two layers, that roughly correspond to:

    - the Younger overlying confining and productive units (Layer 1) and

    - the Nacatoch Aquifer (Layer 2).

- Groundwater in the Nacatoch Aquifer is generally fresh within the Neches & Trinity Valleys Groundwater Conservation District, where total dissolved solids are less than 1,000 milligrams per liter (Beach and others, 2009). Groundwater with total dissolved solids of less than 1,000 milligrams per liter are considered fresh and total dissolved solids between 1,000 to 10,000 milligrams per liter are considered brackish, while total dissolved solids between 10,000 and 35,000 milligrams per liter are considered saline (Ashworth and Hopkins, 1995).

- The model was run with MODFLOW-96 (Harbaugh and McDonald, 1996).

Carrizo-Wilcox, Queen City, and Sparta Aquifers

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

- The groundwater availability model includes eight layers, that roughly correspond to:

    - the Sparta Aquifer (Layer 1),

    - the Weches Confining Unit (Layer 2),

    - the Queen City Aquifer (Layer 3),

    - the Reklaw Confining Unit (Layer 4),

  - the Carrizo Aquifer (Layer 5),
  - the Upper Wilcox Aquifer (Layer 6),
  - the Middle Wilcox Aquifer (Layer 7), and
  - the Lower Wilcox Aquifer (Layer 8).

- The Carrizo and Wilcox aquifer units (Layers 5 through 8) were combined collectively to calculate water budgets for the Carrizo-Wilcox Aquifer.
- The Queen City Aquifer (Layer 3) was used to calculate water budgets for the Queen City Aquifer.
- The Sparta Aquifer (Layer 1) was used to calculate water budgets for the Sparta Aquifer.
- Groundwater in the Carrizo-Wilcox Aquifer is generally fresh within the Neches & Trinity Valleys Groundwater Conservation District, except for isolated areas where high total dissolved solids above 1,000 milligrams per liter possibly due to oil industry associated pollution (Fryar and others, 2003 and Preston and Moore, 1991). Groundwater with total dissolved solids of less than 1,000 milligrams per liter are considered fresh and total dissolved solids between 1,000 to 10,000 milligrams per liter are considered brackish, while total dissolved solids between 10,000 and 35,000 milligrams per liter are considered saline (Ashworth and Hopkins, 1995).
- The model was run with MODFLOW-96 (Harbaugh and McDonald, 1996).

RESULTS:

A groundwater budget summarizes the amount of water entering and leaving the aquifer according to the groundwater availability model. Selected groundwater budget components listed below were extracted from the model results 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 Table 1.

- 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 net 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. In some cases this flow term includes lateral flow between the official aquifer and adjacent portions of the same hydrogeologic units which are not part of the official aquifer and may contain brackish water.

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 a district or county boundary, 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 (Figure 1).

TABLE 1: SUMMARIZED INFORMATION FOR THE TRINITY AQUIFER THAT IS NEEDED FOR THE NECHES & TRINITY 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	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	209
Estimated annual volume of flow out of the district within each aquifer in the district	Trinity Aquifer	216
Estimated net annual volume of flow between each aquifer in the district	Between the Trinity Aquifer and the younger overlying units	0
	Between the Trinity Aquifer and the older underlying units	0

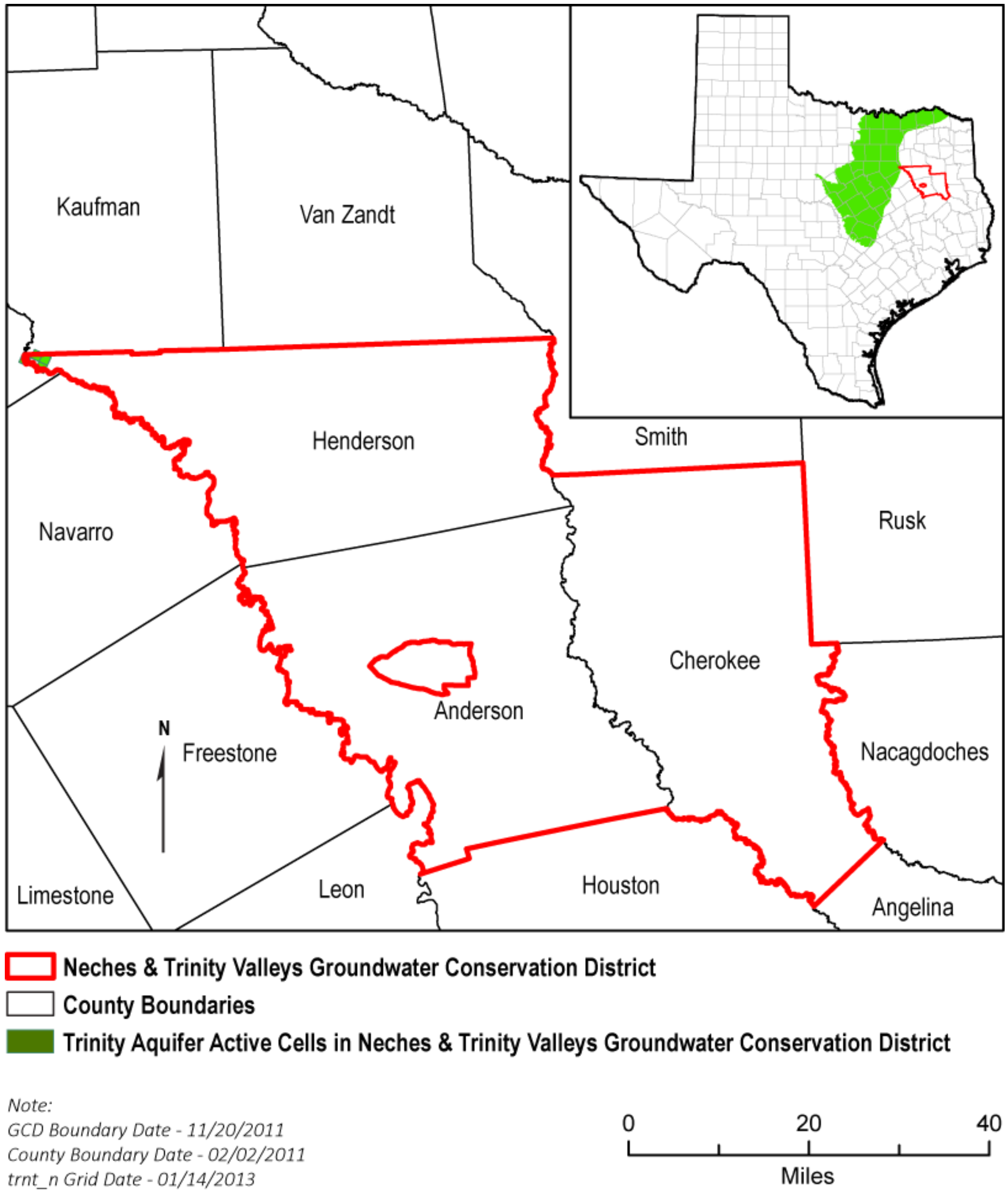

FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE NORTHERN PORTION OF THE TRINITY AQUIFER FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE TRINITY AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 2: SUMMARIZED INFORMATION FOR THE NACATOCH AQUIFER THAT IS NEEDED FOR THE NECHES & TRINITY 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	Nacatoch Aquifer	56
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Nacatoch Aquifer	357
Estimated annual volume of flow into the district within each aquifer in the district	Nacatoch Aquifer	1,092
Estimated annual volume of flow out of the district within each aquifer in the district	Nacatoch Aquifer	260
Estimated net annual volume of flow between each aquifer in the district	From the Nacatoch Aquifer into younger overlying units	223
	Between the Nacatoch Aquifer the underlying confining unit	0

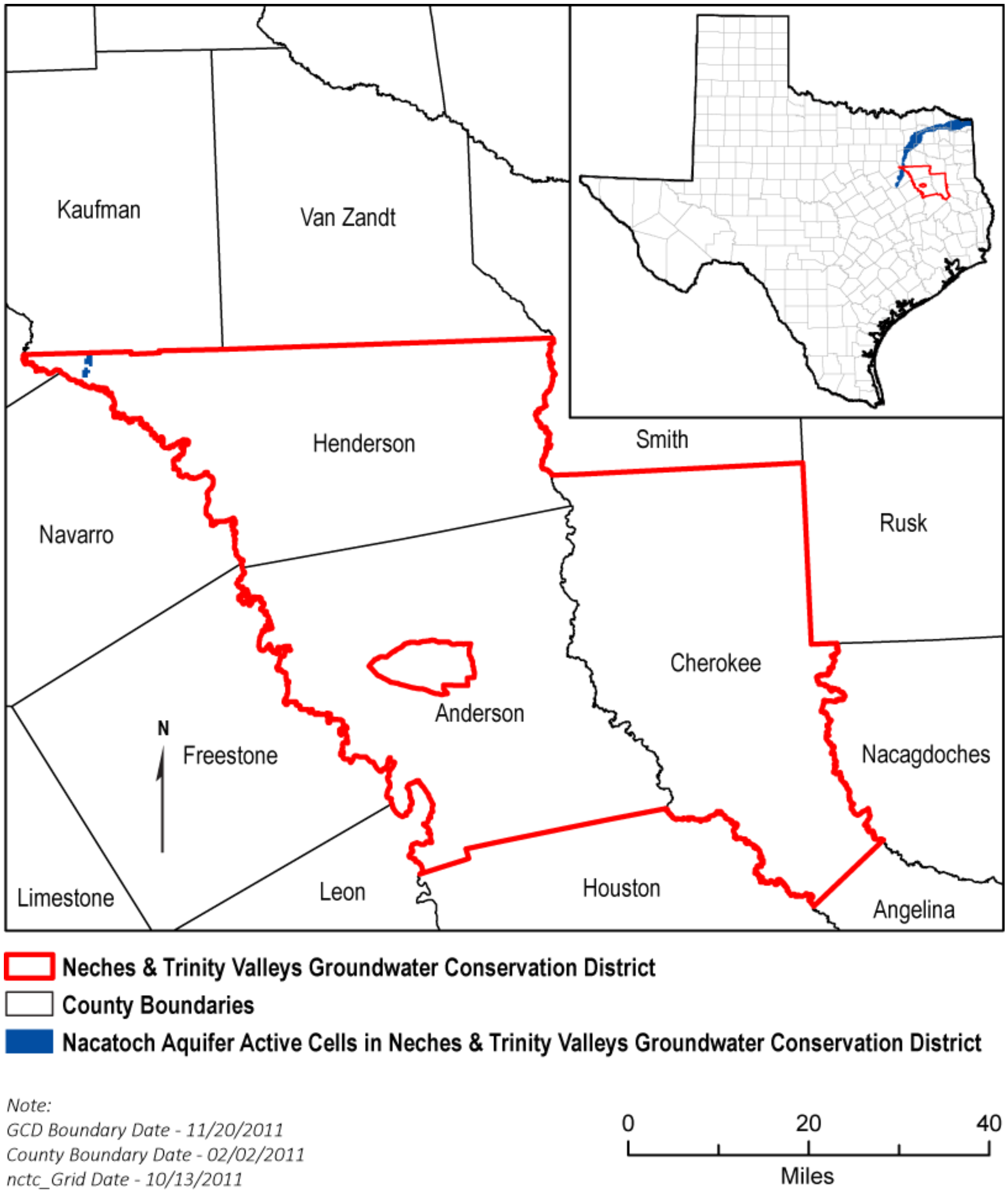

FIGURE 2: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE NACATOCH AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE NACATOCH AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 3: SUMMARIZED INFORMATION FOR THE CARRIZO-WILCOX AQUIFER THAT IS NEEDED FOR THE NECHES & TRINITY 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	Carrizo-Wilcox Aquifer	18,770
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	10,374
Estimated annual volume of flow into the district within each aquifer in the district	Carrizo-Wilcox Aquifer	23,381
Estimated annual volume of flow out of the district within each aquifer in the district	Carrizo-Wilcox Aquifer	17,297
Estimated net annual volume of flow between each aquifer in the district	From the overlying Reklaw confining unit into Carrizo-Wilcox Aquifer	8,787
	Between the Carrizo-Wilcox Aquifer and the underlying confining unit	0

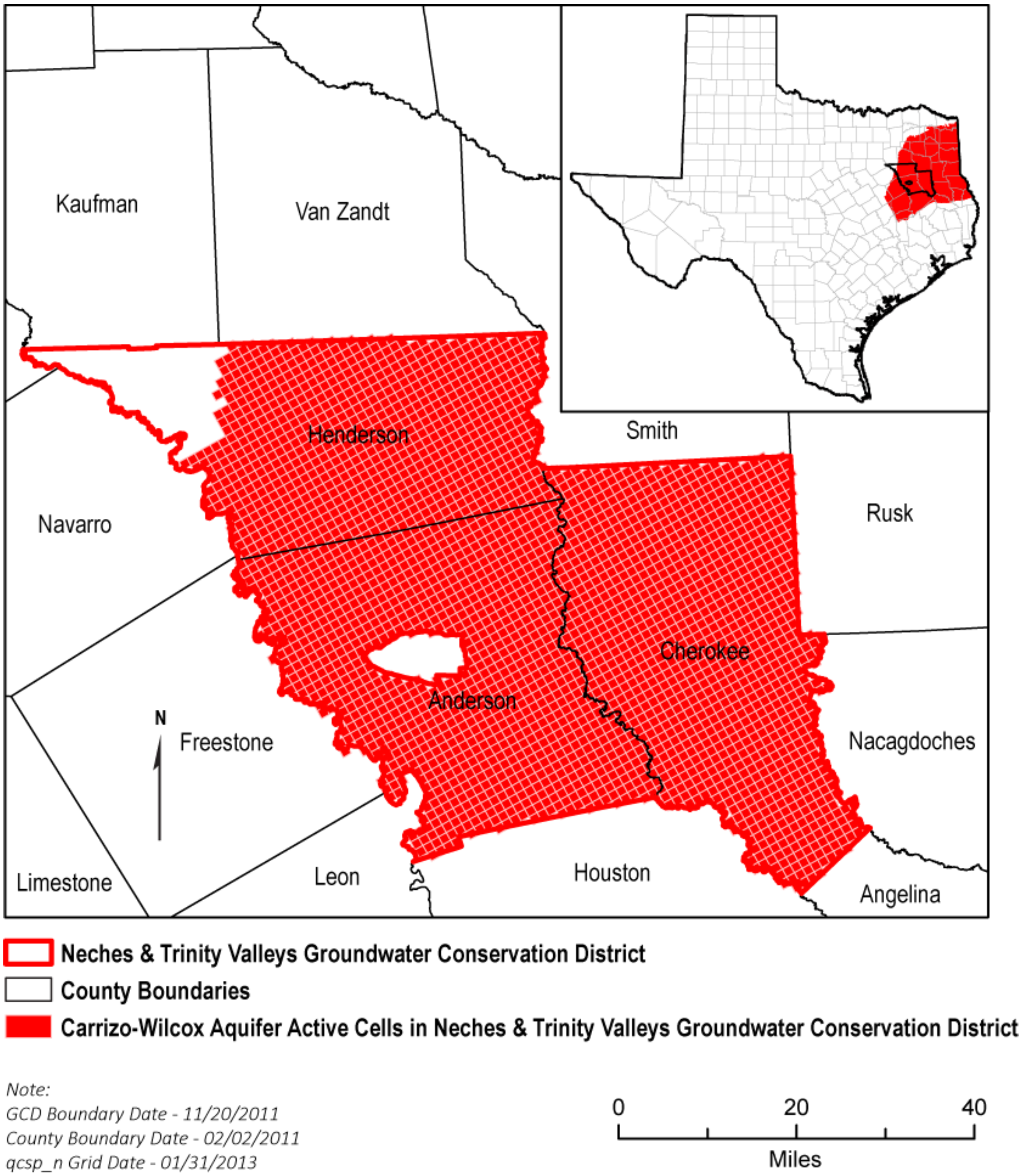

FIGURE 3: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE NORTHERN PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS FROM WHICH THE INFORMATION IN TABLE 3 WAS EXTRACTED FOR THE CARRIZO-WILCOX AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY.

TABLE 4: SUMMARIZED INFORMATION FOR THE QUEEN CITY AQUIFER THAT IS NEEDED FOR THE NECHES & TRINITY 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	Queen City Aquifer	73,209
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	42,283
Estimated annual volume of flow into the district within each aquifer in the district	Queen City Aquifer	5,412
Estimated annual volume of flow out of the district within each aquifer in the district	Queen City Aquifer	5,035
Estimated net annual volume of flow between each aquifer in the district	From the overlying Weches confining unit into the Queen City Aquifer	7,917
	From the Queen City Aquifer into the underlying Reklaw confining unit	6,975

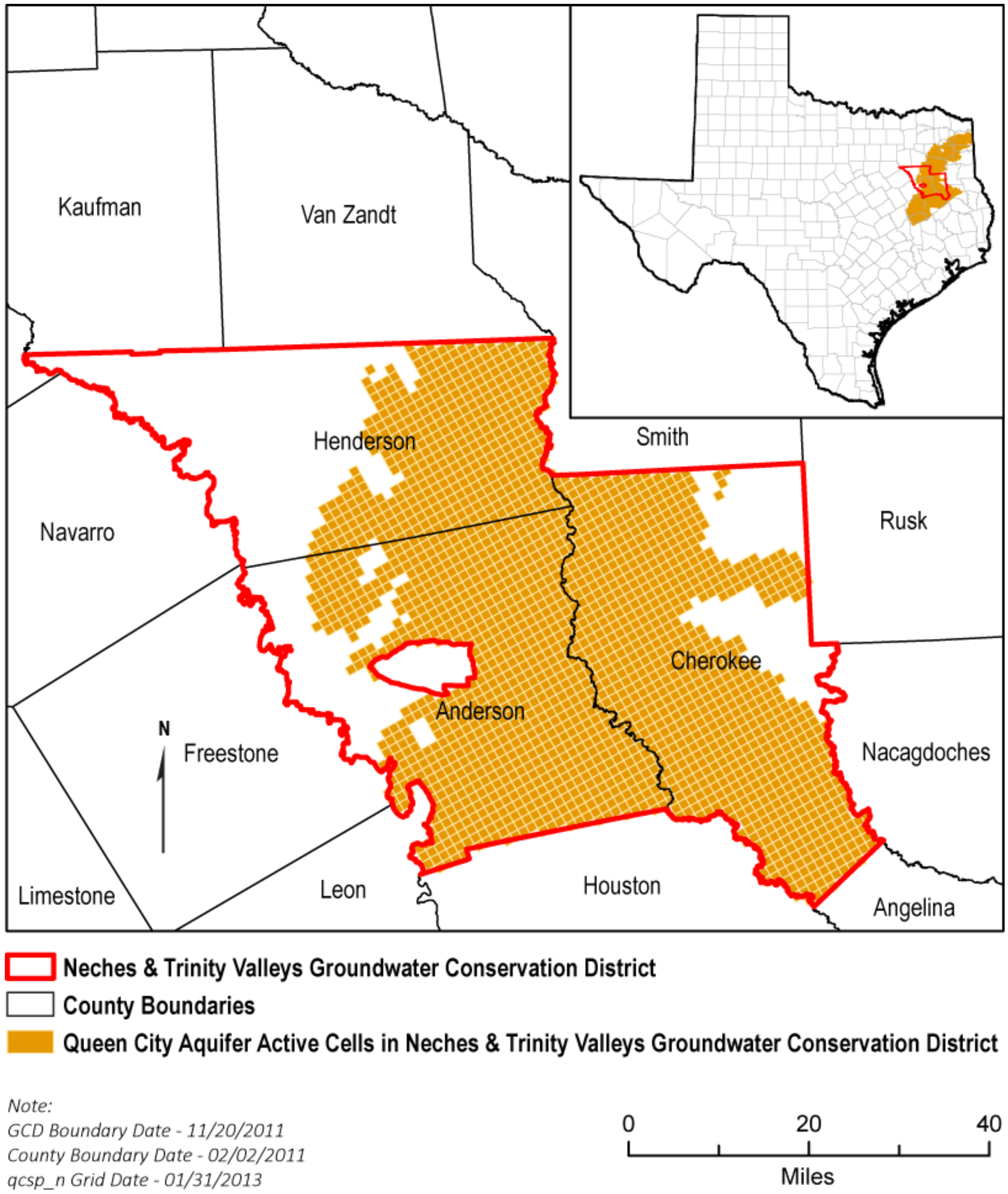

FIGURE 4: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE NORTHERN PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS FROM WHICH THE INFORMATION IN TABLE 4 WAS EXTRACTED FOR THE QUEEN CITY AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY.

TABLE 5: SUMMARIZED INFORMATION FOR THE SPARTA AQUIFER THAT IS NEEDED FOR THE NECHES & TRINITY 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	Sparta Aquifer	17,031
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Sparta Aquifer	5,975
Estimated annual volume of flow into the district within each aquifer in the district	Sparta Aquifer	828
Estimated annual volume of flow out of the district within each aquifer in the district	Sparta Aquifer	2,094
Estimated net annual volume of flow between each aquifer in the district	From the Sparta Aquifer into the younger overlying units	195
	From the Sparta Aquifer into the underlying Weches confining unit	3,129

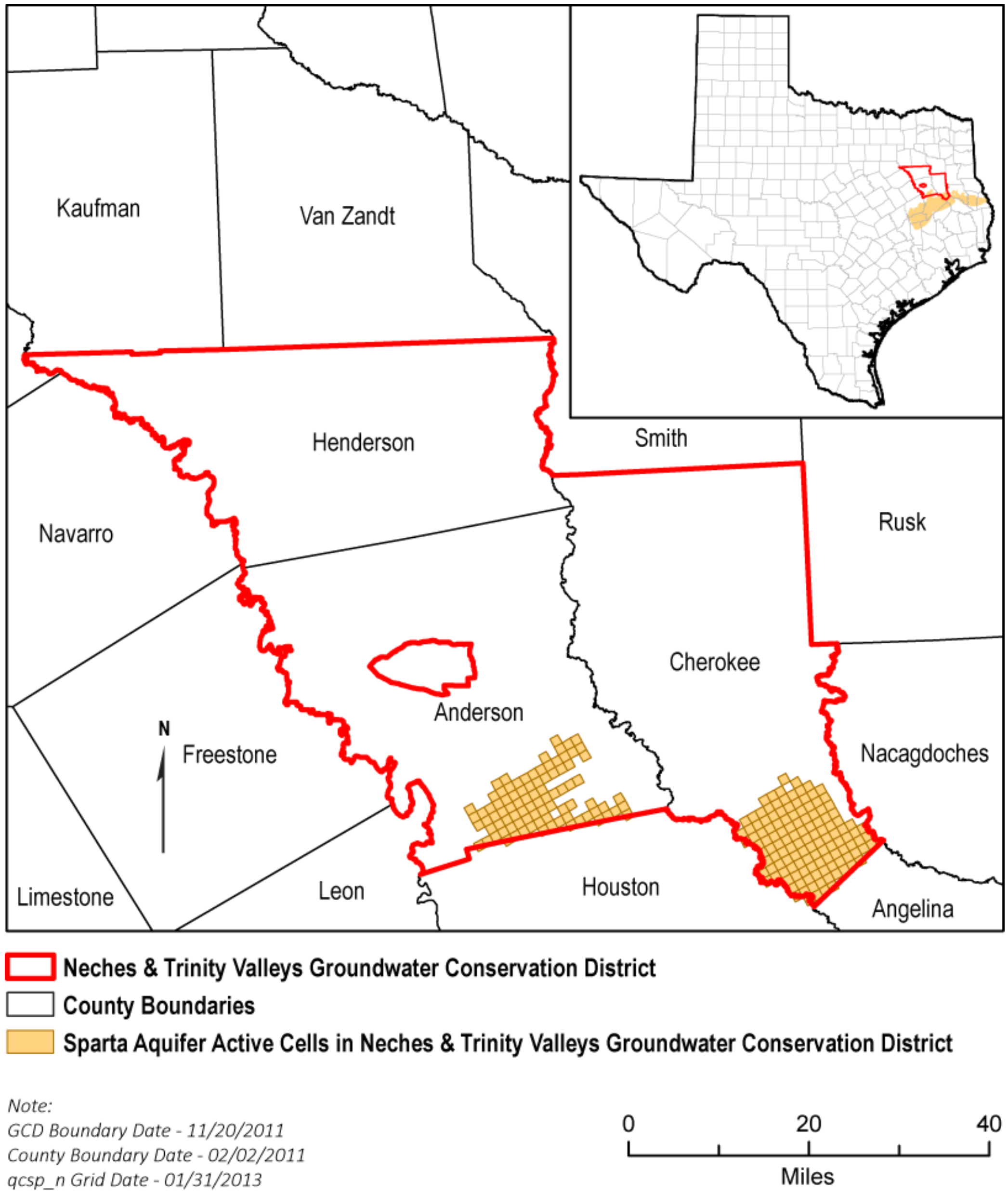

FIGURE 5: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE NORTHERN PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS FROM WHICH THE INFORMATION IN TABLE 5 WAS EXTRACTED FOR THE SPARTA AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY.

LIMITATIONS

The groundwater model(s) used in completing this analysis is the best available scientific tool that can be used to meet the stated objective(s). To the extent that this analysis will be used for planning purposes and/or regulatory purposes related to pumping in the past and into the future, it is important to recognize the assumptions and limitations associated with the use of the results. In reviewing the use of models in environmental regulatory decision making, the National Research Council (2007) noted:

> *"Models will always be constrained by computational limitations, assumptions, and knowledge gaps. They can best be viewed as tools to help inform decisions rather than as machines to generate truth or make decisions. Scientific advances will never make it possible to build a perfect model that accounts for every aspect of reality or to prove that a given model is correct in all respects for a particular regulatory application. These characteristics make evaluation of a regulatory model more complex than solely a comparison of measurement data with model results."*

A key aspect of using the groundwater model to evaluate historic groundwater flow conditions includes the assumptions about the location in the aquifer where historic pumping was placed. Understanding the amount and location of historic pumping is as important as evaluating the volume of groundwater flow into and out of the district, between aquifers within the district (as applicable), interactions with surface water (as applicable), recharge to the aquifer system (as applicable), and other metrics that describe the impacts of that pumping. In addition, assumptions regarding precipitation, recharge, and interaction with streams are specific to particular historic time periods.

Because the application of the groundwater models was designed to address regional scale questions, the results are most effective on a regional scale. The TWDB makes no warranties or representations related to the actual conditions of any aquifer at a particular location or at a particular time.

It is important for groundwater conservation districts to monitor groundwater pumping and overall conditions of the aquifer. Because of the limitations of the groundwater model and the assumptions in this analysis, it is important that the groundwater conservation districts work with the TWDB to refine this analysis in the future given the reality of how the aquifer responds to the actual amount and location of pumping now and in the future. Historic precipitation patterns also need to be placed in context as future climatic conditions, such as dry and wet year precipitation patterns, may differ and affect groundwater flow conditions.

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