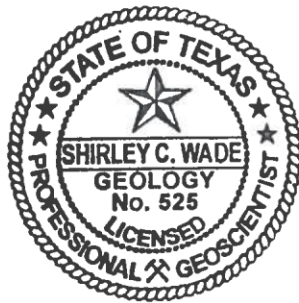

GAM RUN 18-017: NECHES AND TRINITY VALLEYS GROUNDWATER CONSERVATION DISTRICT GROUNDWATER MANAGEMENT PLAN

Shirley C. Wade, Ph.D., P.G.
Texas Water Development Board
Groundwater Division
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512-936-0883
March 6, 2019



Shirley C. Wade
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EXECUTIVE SUMMARY:

Texas State Water Code, Section 36.1071, Subsection (h) (Texas Water Code, 2011), 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.

The TWDB provides data and information to the Neches and Trinity Valleys Groundwater Conservation District in two parts. Part 1 is the Estimated Historical Water Use/State Water Plan dataset report, which will be provided to you separately by the TWDB Groundwater Technical Assistance Department. Please direct questions about the water data report to Mr. Stephen Allen at 512-463-7317 or stephen.allen@twdb.texas.gov. Part 2 is the required groundwater availability modeling information and this information includes:

1. the annual amount of recharge from precipitation, if any, to the groundwater resources within the district;
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 groundwater management plan for the Neches and Trinity Valleys Groundwater Conservation District should be adopted by the district on or before May 8, 2019 and submitted to the Executive Administrator of the TWDB on or before June 7, 2019. The current management plan for the Neches and Trinity Valleys Groundwater Conservation District expires on August 6, 2019.

We used three groundwater availability models to estimate the management plan information for the aquifers within the Neches and Trinity Valleys Groundwater Conservation District. Information for the Trinity Aquifer is from version 2.01 of the groundwater availability model for the northern portion of the Trinity and Woodbine Aquifers (Kelley and others, 2014). Information for the Nacatoch Aquifer is from version 1.01 of the groundwater availability model for the Nacatoch Aquifer (Beach and others, 2009). Information for the Carrizo-Wilcox, Queen City, and Sparta aquifers is from version 2.01 of the groundwater availability model for the northern part of the Carrizo-Wilcox, Queen City, and Sparta aquifers (Kelley and others, 2004).

This report replaces the results of GAM Run 13-013 (Anaya, 2013). GAM Run 18-017 is based on the updated boundary of Neches and Trinity Valleys Groundwater Conservation District and includes results from the more recent groundwater availability model for the northern portion of the Trinity and Woodbine Aquifers (version 2.01; Kelley and others, 2014). Tables 1 through 5 summarize the groundwater availability model data required by statute and Figures 1 through 5 show the area of the models from which the values in the tables were extracted. If, after review of the figures, the Neches and Trinity Valleys Groundwater Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the TWDB at your earliest convenience.

METHODS:

In accordance with the provisions of the Texas State Water Code, Section 36.1071, Subsection (h), the three groundwater availability models mentioned above were used to estimate information for the Neches and Trinity Valleys Groundwater Conservation District management plan. Water budgets were extracted for the historical model periods for the Trinity Aquifer (1980 through 2012), Nacatoch Aquifer (1980 through 1997), and Carrizo-Wilcox, Queen City, and Sparta aquifers (1980 through 1999) using ZONEBUDGET Version 3.01 (Harbaugh, 2009). The average annual water budget values for recharge, surface-water outflow, inflow to the district, and outflow from the district for the aquifers within the district are summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Trinity Aquifer and Woodbine Aquifer

- We used version 2.01 of the updated groundwater availability model for the northern portion of the Trinity and Woodbine aquifers. See Kelley and others (2014) for assumptions and limitations of the model.
- The groundwater availability model for the northern portion of the Trinity and Woodbine aquifers contains eight layers: Layer 1 (the surficial outcrop area of the units in layers 2 through 8 and units younger than Woodbine Aquifer), Layer 2 (Woodbine Aquifer and pass-through cells), Layer 3 (Washita and Fredericksburg, Edwards (Balcones Fault Zone), and pass-through cells), and Layers 4 through 8 (Trinity Aquifer).
- The model was run with MODFLOW-NWT (Niswonger and others, 2011).
- Perennial rivers and reservoirs were simulated using the MODFLOW-NWT river package. Ephemeral streams, flowing wells, springs, and evapotranspiration in riparian zones along perennial rivers were simulated using the MODFLOW-NWT drain package; however, groundwater discharge to surface water from the Trinity Aquifer does not occur in Neches and Trinity Valleys Groundwater Conservation District.

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.
- This groundwater availability model includes eight layers, which generally represent the Sparta Aquifer (Layer 1), the Weches Formation confining unit (Layer 2), the Queen City Aquifer (Layer 3), the Reklaw Formation confining unit (Layer 4), the Carrizo Formation (Layer 5), the Upper Wilcox (Layer 6), the Middle Wilcox (Layer 7), and the Lower Wilcox (Layer 8).
- Individual water budgets for the district were determined for the Sparta Aquifer (Layer 1), the Queen City Aquifer (Layer 3), and the Carrizo-Wilcox Aquifer (Layers 5 through 8, collectively).

- 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.
- This groundwater availability model includes two layers that generally represent younger overlying confining units as well as major alluvium and terrace deposits (Layer 1) and Nacatoch Aquifer deposits with some minor alluvial and terrace deposits (Layer 2).
- An overall water budget for the district was determined for the Nacatoch Aquifer (Layer 2 for the portion that represents the Nacatoch Aquifer).
- The model was run with MODFLOW-2000 (Harbaugh and others, 2000).

RESULTS:

A groundwater budget summarizes the amount of water entering and leaving the aquifers according to the groundwater availability model. Selected groundwater budget components listed below were extracted from the groundwater availability model results for the Trinity, Nacatoch, Carrizo-Wilcox, Queen City, and Sparta aquifers located within Neches and Trinity Valleys Groundwater Conservation District and averaged over the historical calibration periods, as shown in Tables 1 through 5.

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.
2. Surface-water outflow—the total water discharging from the aquifer (outflow) to surface-water features such as streams, reservoirs, and springs.
3. Flow into and out of district—the lateral flow within the aquifer between the district and adjacent counties.
4. Flow between aquifers—the net vertical flow between the aquifer and adjacent aquifers or confining units. This flow is controlled by the relative water levels in each aquifer and aquifer properties of each aquifer or confining unit that define the amount of leakage that occurs.

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 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.

TABLE 1. SUMMARIZED INFORMATION FOR THE TRINITY AQUIFER FOR NECHES AND TRINITY VALLEYS 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	99
Estimated annual volume of flow out of the district within each aquifer in the district	Trinity Aquifer	167
Estimated net annual volume of flow between each aquifer in the district	Between the Trinity Aquifer and overlying units	0
	From downdip Trinity units into the Trinity Aquifer	67
	Between the Trinity Aquifer and underlying units ¹	0

¹ The model assumes a no-flow boundary at the base of the Trinity Aquifer.

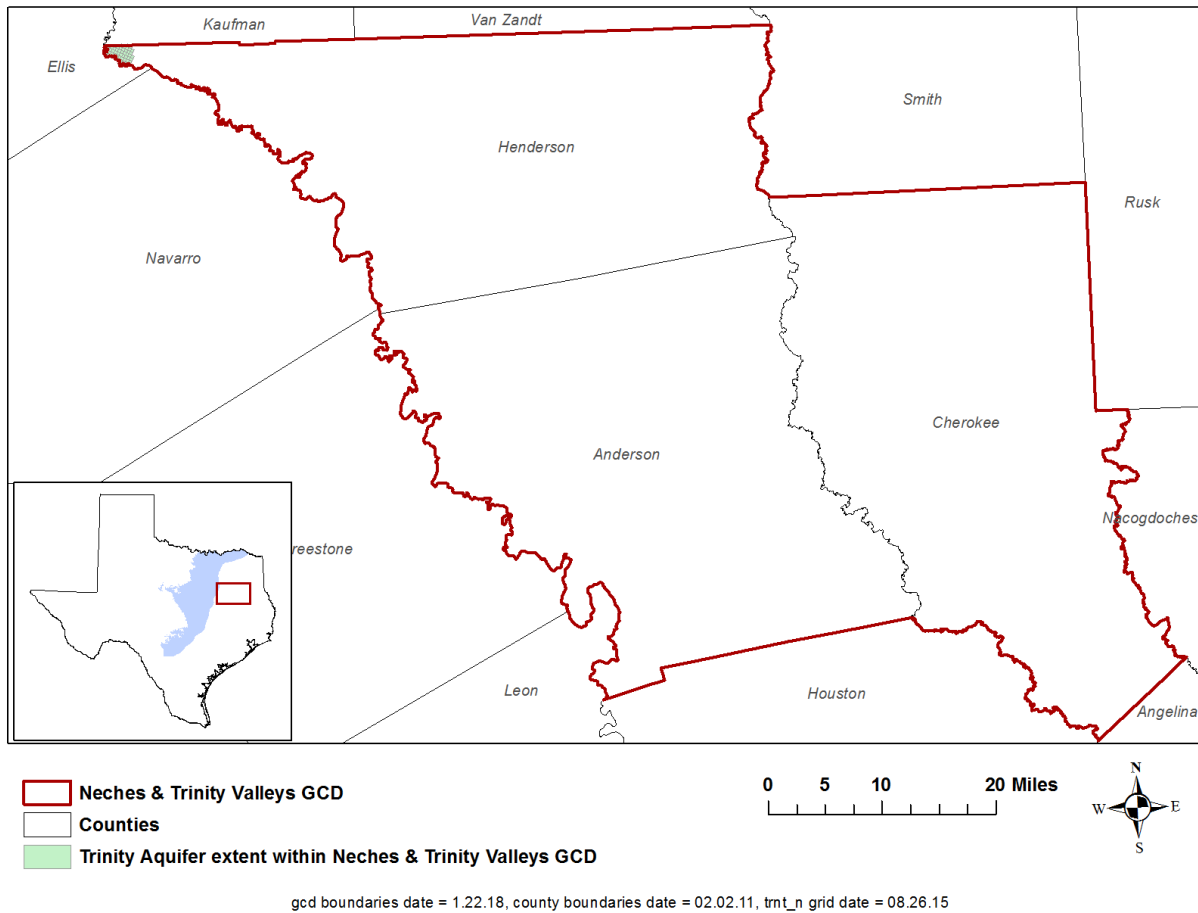


FIGURE 1. AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE TRINITY AQUIFER FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE AQUIFER SYSTEM EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 2. SUMMARIZED INFORMATION FOR THE NACATOCH AQUIFER FOR NECHES AND TRINITY VALLEYS 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	428
Estimated annual volume of flow out of the district within each aquifer in the district	Nacatoch Aquifer	101
Estimated net annual volume of flow between each aquifer in the district	Flow into the Nacatoch Aquifer from overlying units	223
	Flow into the Nacatoch Aquifer from downdip units	518
	Flow between the Nacatoch Aquifer and underlying units ²	0

² Model assumes a no-flow boundary at the base of the Nacatoch Aquifer

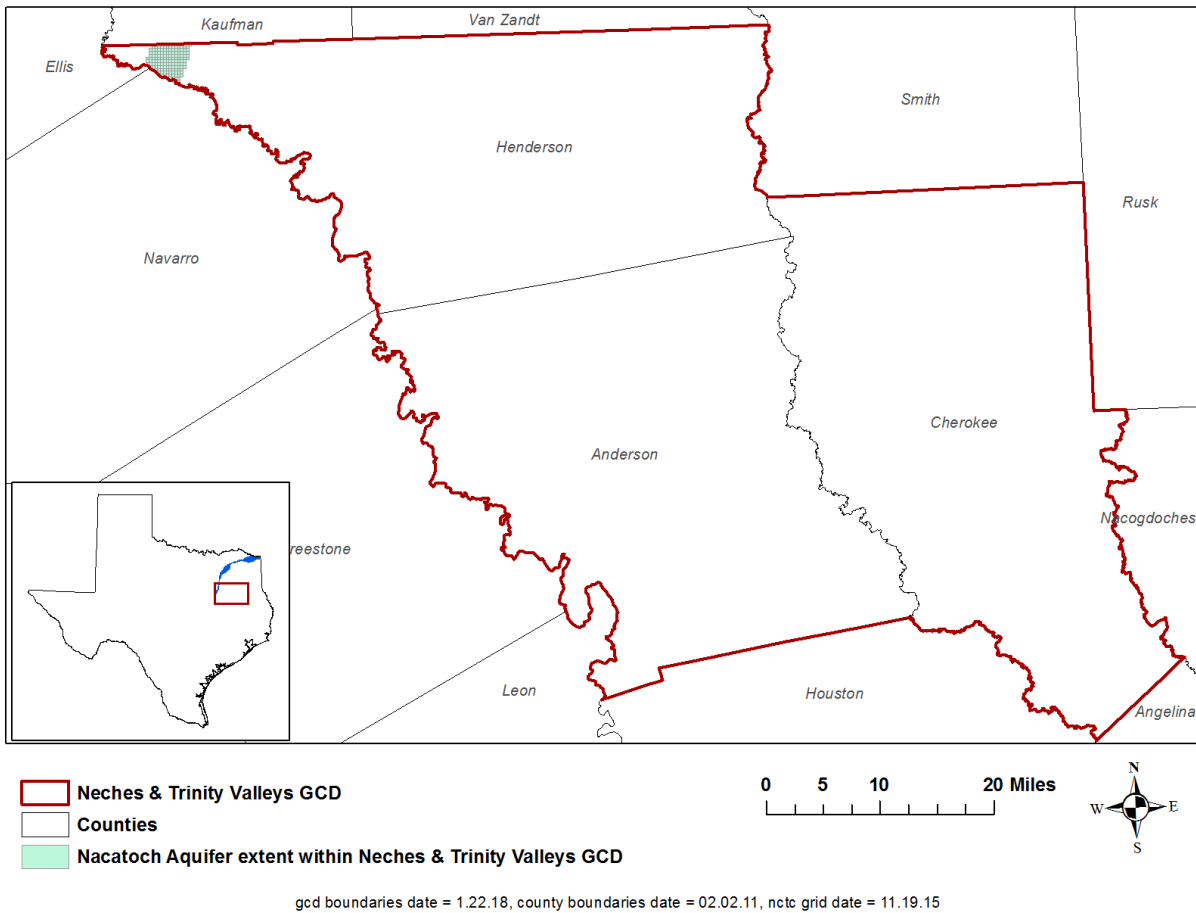


FIGURE 2. AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE NACATOCH AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE AQUIFER SYSTEM EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 3. SUMMARIZED INFORMATION FOR THE CARRIZO-WILCOX AQUIFER FOR NECHES AND TRINITY VALLEYS 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	21,789
Estimated annual volume of flow out of the district within each aquifer in the district	Carrizo-Wilcox Aquifer	15,550
Estimated net annual volume of flow between each aquifer in the district	Flow into the Carrizo-Wilcox Aquifer from the overlying Reklaw confining unit	8,913
	Flow between the Carrizo-Wilcox Aquifer and underlying units ³	0

³ Model assumes a no-flow boundary at the base of the Carrizo-Wilcox Aquifer

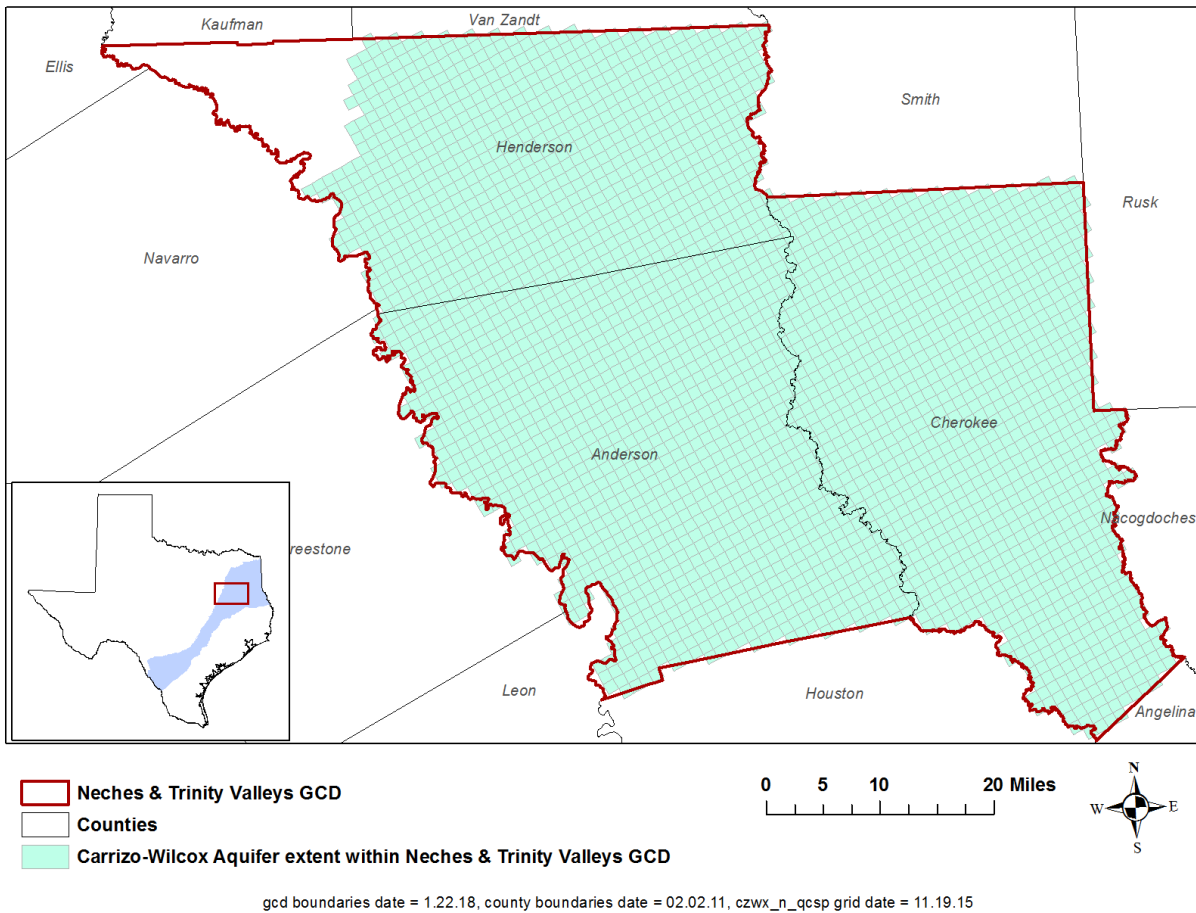


FIGURE 3. AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE CARRIZO-WILCOX AQUIFER FROM WHICH THE INFORMATION IN TABLE 3 WAS EXTRACTED (THE AQUIFER SYSTEM EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 4. SUMMARIZED INFORMATION FOR THE QUEEN CITY AQUIFER FOR NECHES AND TRINITY VALLEYS 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	75,061
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	42,583
Estimated annual volume of flow into the district within each aquifer in the district	Queen City Aquifer	4,559
Estimated annual volume of flow out of the district within each aquifer in the district	Queen City Aquifer	3,240
Estimated net annual volume of flow between each aquifer in the district	Flow into the Queen City Aquifer from the Weches confining unit	7,917
	Flow into the Reklaw confining unit from the Queen City Aquifer	7,065

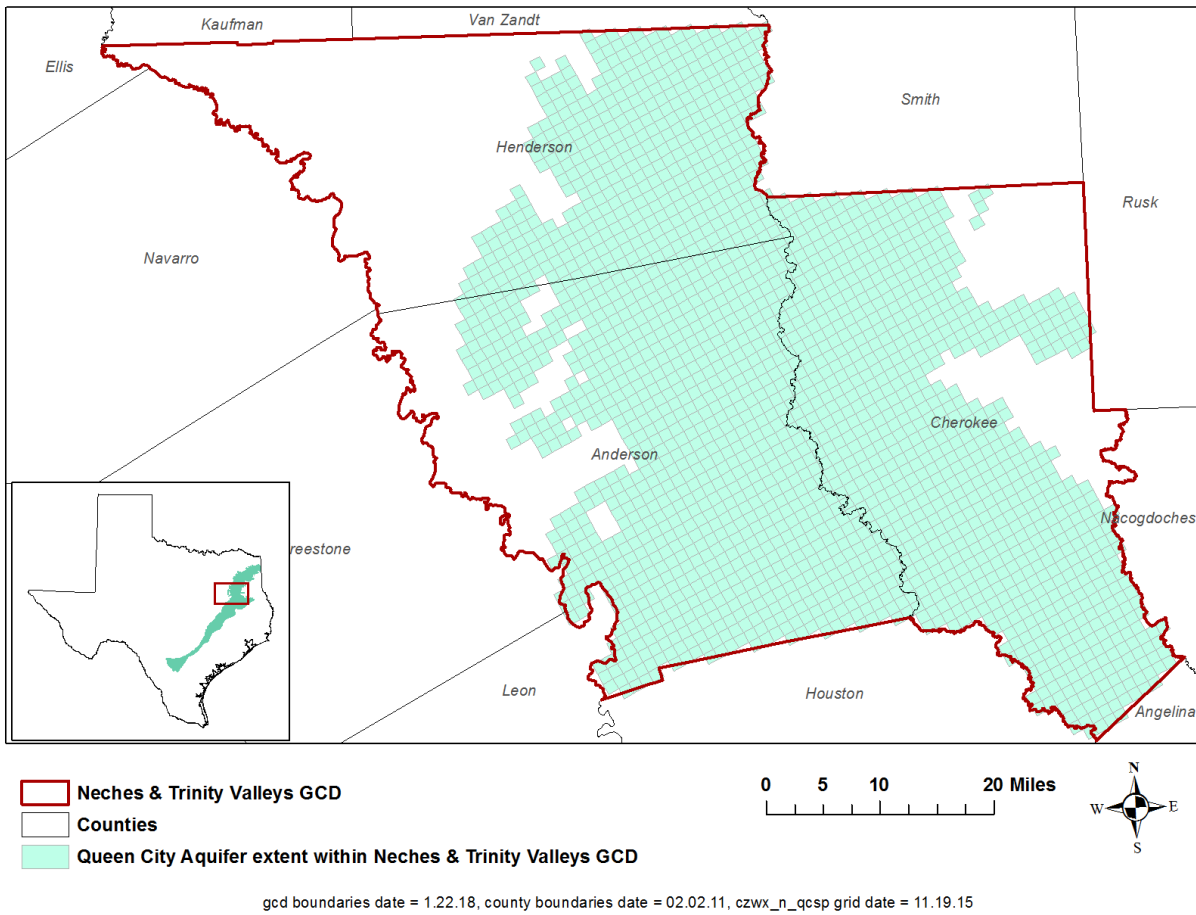


FIGURE 4. AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE QUEEN CITY AQUIFER FROM WHICH THE INFORMATION IN TABLE 4 WAS EXTRACTED (THE AQUIFER SYSTEM EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 5. SUMMARIZED INFORMATION FOR THE SPARTA AQUIFER SYSTEM FOR NECHES AND TRINITY VALLEYS 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	389
Estimated annual volume of flow out of the district within each aquifer in the district	Sparta Aquifer	1,913
Estimated net annual volume of flow between each aquifer in the district	Flow from the Sparta aquifer into overlying younger units	195
	Flow from the Sparta Aquifer System into the Weches confining unit	3,129

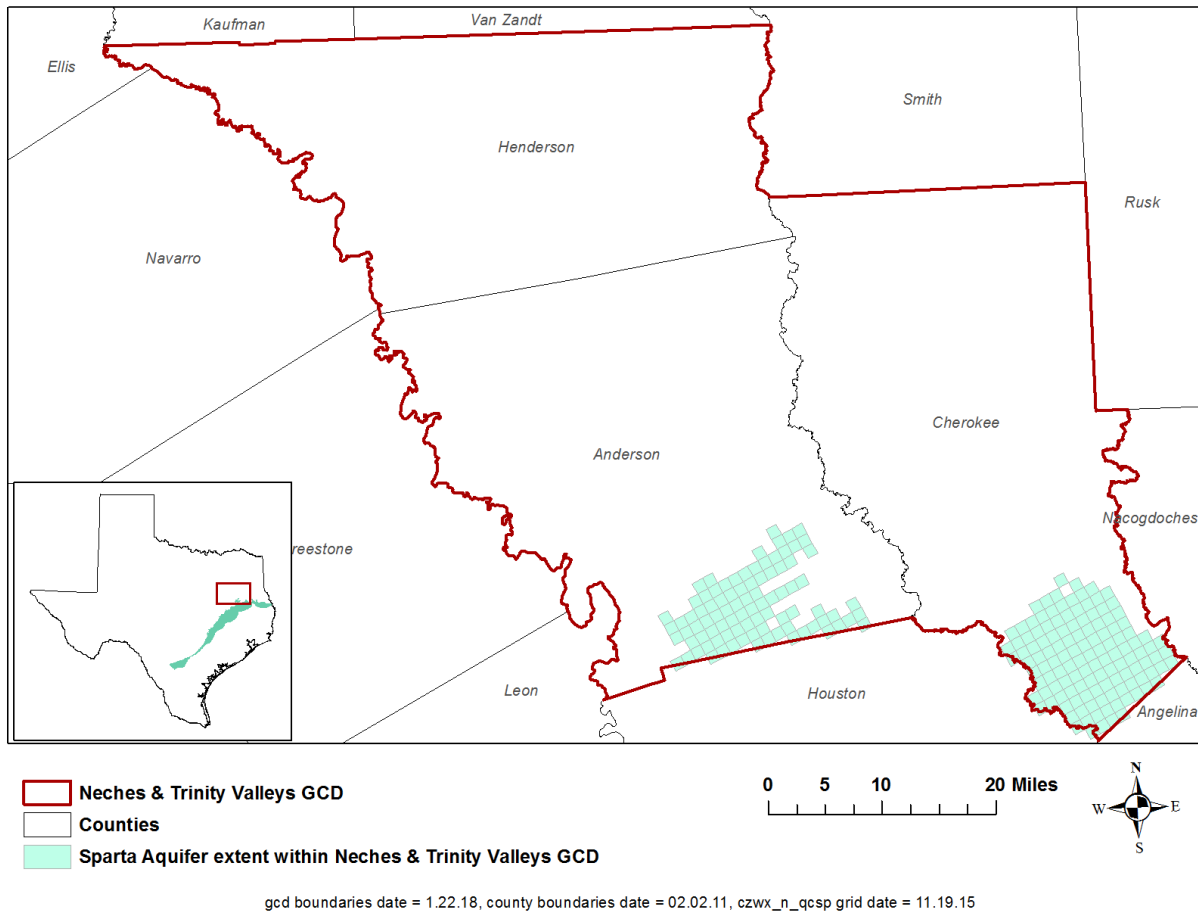


FIGURE 5. AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE SPARTA AQUIFER FROM WHICH THE INFORMATION IN TABLE 5 WAS EXTRACTED (THE AQUIFER SYSTEM EXTENT WITHIN THE DISTRICT BOUNDARY).

LIMITATIONS:

The groundwater models used in completing this analysis are the best available scientific tools that can be used to meet the stated objectives. 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 historical groundwater flow conditions includes the assumptions about the location in the aquifer where historical pumping was placed. Understanding the amount and location of historical 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 historical 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. Historical 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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