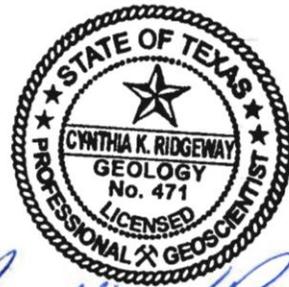


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# **GAM RUN 19-012: WES-TEX GROUNDWATER CONSERVATION DISTRICT GROUNDWATER MANAGEMENT PLAN**

Daryn R. Hardwick, Ph.D.  
Texas Water Development Board  
Groundwater Division  
Groundwater Availability Modeling Department  
512-475-0470  
June 3, 2019



A handwritten signature in blue ink that reads "Cynthia K. Ridgeway".

*Cynthia K. Ridgeway is the Manager of the Groundwater Availability Modeling Department and is responsible for oversight of work performed by Daryn R. Hardwick under her direct supervision. The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G. 471 on June 3, 2019.*

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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 Wes-Tex 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](mailto: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 Wes-Tex Groundwater Conservation District should be adopted by the district on or before November 12, 2019 and submitted to the Executive Administrator of the TWDB on or before December 12, 2019. The current management plan for the Wes-Tex Groundwater Conservation District expires on February 10, 2020.

We used three groundwater availability models to estimate the management plan information for the aquifers within the Wes-Tex Groundwater Conservation District. Information for the Edwards-Trinity (Plateau) Aquifer is from version 1.01 of the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers (Anaya and Jones, 2009). Information for the Dockum Aquifer is from version 1.01 of the groundwater availability model for the High Plains Aquifer System (Deeds and Jigmond, 2015). Information for the Blaine Aquifer is from version 1.01 of the groundwater availability model for the Seymour and Blaine aquifers (Ewing and others, 2004).

This report replaces the results of GAM Run 13-030 (Goswami, 2014), as the approach used for analyzing model results has been since refined and GAM Run 19-012 includes results from the groundwater availability model for the High Plains Aquifer System (Deeds and Jigmond, 2015), which was released after GAM Run 13-030. Tables 1, 2, and 3 summarize the groundwater availability model data required by statute and Figures 1, 2, and 3 show the area of the models from which the values in the tables were extracted. If, after review of the figures, the Wes-Tex 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 Wes-Tex Groundwater Conservation District groundwater management plan. Water budgets were extracted for the (post 1980) historical model periods for the Edwards-Trinity (Plateau) Aquifer (1980 through 2000), Dockum Aquifer (1980 through 2012), and Blaine Aquifer (1980 through 1999). We used ZONEBUDGET Version 3.01 (Harbaugh, 2009) to extract water budgets from the model results. 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:***

### ***Edwards-Trinity (Plateau) Aquifer***

- We used version 1.01 of the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers. See Anaya and Jones (2009) for assumptions and limitations of the model.
- The groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers contains 2 layers: Layer 1—represents the Edwards Group and equivalent limestone hydrostratigraphic units of the Edwards-Trinity (Plateau) Aquifer, and Layer 2—comprised of the undifferentiated Trinity Group hydrostratigraphic units or equivalent units of the Edwards-Trinity (Plateau) Aquifer. The two layers were lumped for calculating water budgets in the Edwards-Trinity (Plateau) Aquifer within the district.
- The model was run with MODFLOW-96 (Harbaugh and McDonald, 1996).

### ***High Plains Aquifer System***

- We used version 1.01 of the groundwater availability model for the High Plains Aquifer System for this analysis. See Deeds and Jigmond (2015) for assumptions and limitations of the model.
- The model has four layers which represent the Ogallala Aquifer (Layer 1), the Edwards-Trinity (High Plains) Aquifer (Layer 2), and the Dockum Units (Layers 3 and 4). We lumped layers 3 and 4 for calculating water budgets in the Dockum Aquifer within the district.
- Water budgets for the Dockum Aquifer within the district were averaged over the historical calibration period (1980 to 2012).
- The model was run with MODFLOW-NWT (Niswonger and others, 2011).

### ***Blaine Aquifer***

- Version 1.01 of the groundwater availability model for the Seymour and Blaine aquifers was used for this analysis. See Ewing and others (2004) for assumptions and limitations of the groundwater availability model.

- This groundwater availability model includes two layers which represent the Seymour Aquifer (Layer 1) and the Blaine Aquifer or its non-aquifer equivalent (Layer 2).
- The model was run with MODFLOW-2000 (Harbaugh and others, 2000).
- An overall water budget for the district was determined using Layer 2 for the Blaine Aquifer. The Seymour Aquifer (Layer 1) is not present in Wes-Tex Groundwater Conservation District.

### ***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 Edwards-Trinity (Plateau), Dockum, and Blaine aquifers located within Wes-Tex Groundwater Conservation District and averaged over the historical calibration periods, as shown in Tables 1 through 3.

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.

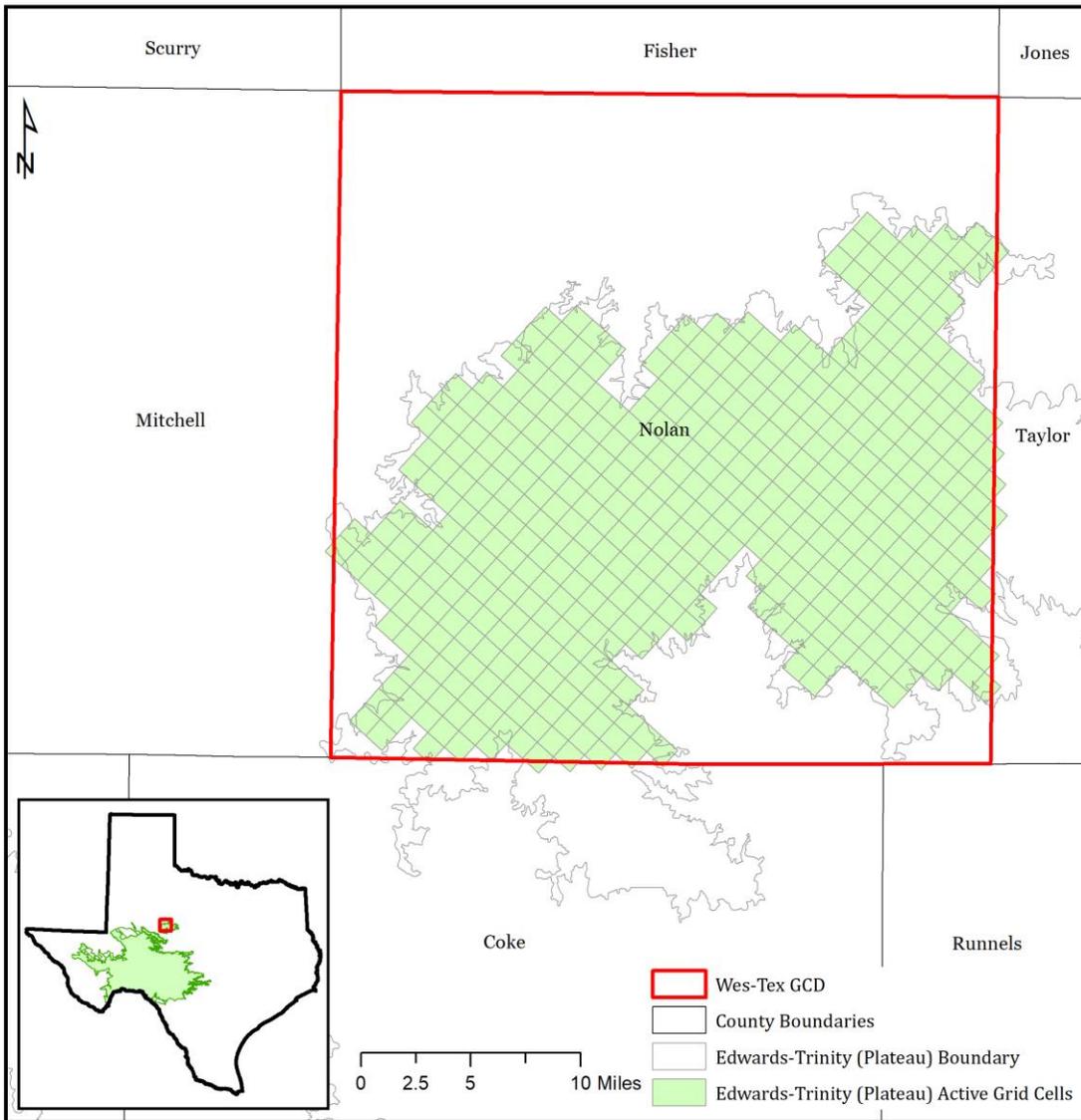
The information needed for the district's management plan is summarized in Tables 1 through 3. It is important to note that sub-regional water budgets are not exact. This is due to the size of the model cells and the approach used to extract data from the model. To avoid double accounting, a model cell 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 EDWARDS-TRINITY (PLATEAU) AQUIFER FOR WES-TEX 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	Edwards-Trinity (Plateau) Aquifer	11,385
Estimated annual volume of water that discharges from the aquifer to springs and any surface-water body including lakes, streams, and rivers	Edwards-Trinity (Plateau) Aquifer	10,813
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	215
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	1,197
Estimated net annual volume of flow between each aquifer in the district	Flow to other aquifers	NA <sup>1</sup>

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<sup>1</sup>Not applicable. Model assumes a no-flow boundary at the base.



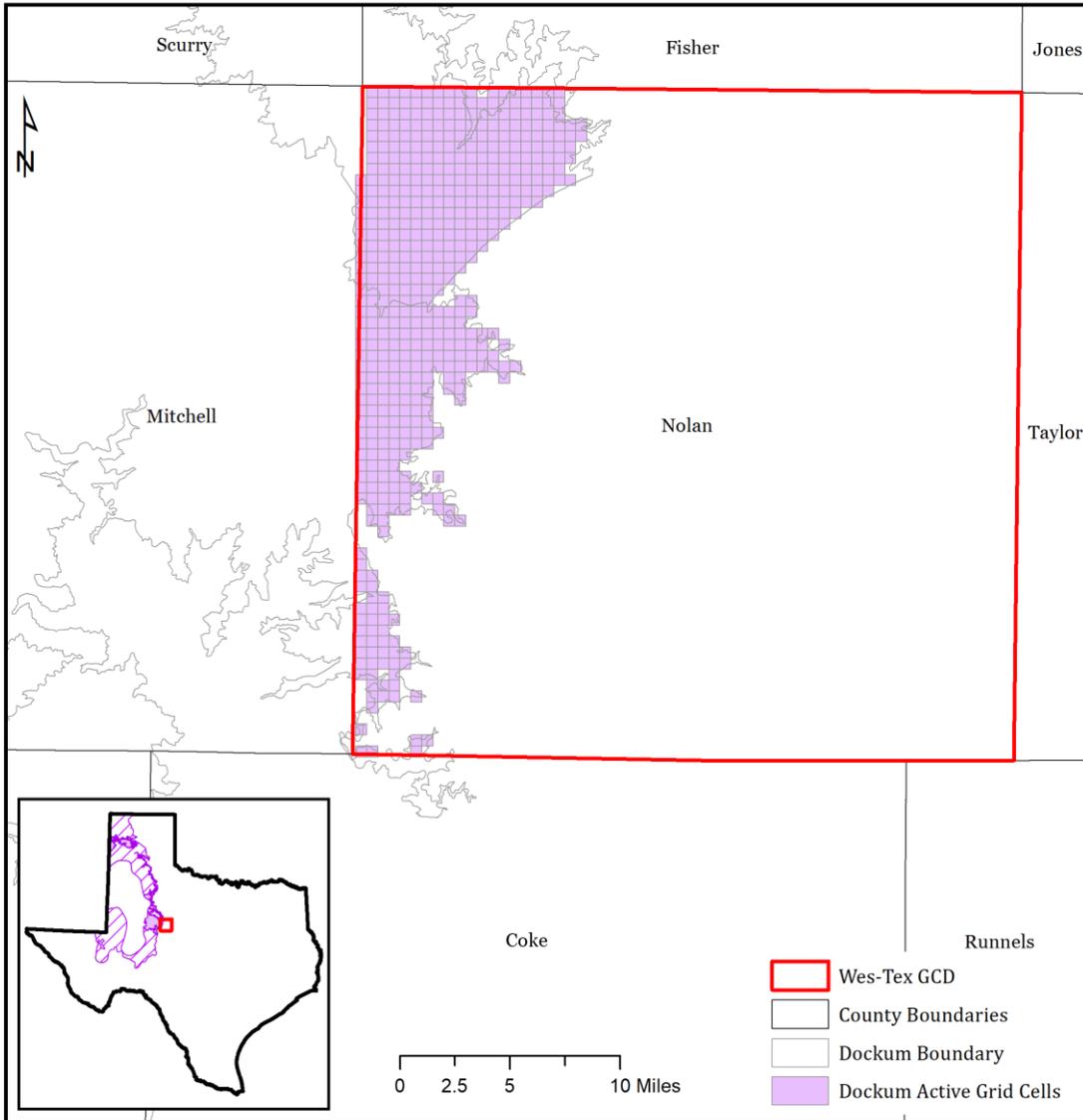
**FIGURE 1. AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE AQUIFER SYSTEM EXTENT WITHIN THE DISTRICT BOUNDARY).**

**TABLE 2. SUMMARIZED INFORMATION FOR THE DOCKUM AQUIFER FOR WES-TEX 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	Dockum Aquifer	1,759
Estimated annual volume of water that discharges from the aquifer to springs and any surface-water body including lakes, streams, and rivers	Dockum Aquifer	1,040
Estimated annual volume of flow into the district within each aquifer in the district	Dockum Aquifer	1,505
Estimated annual volume of flow out of the district within each aquifer in the district	Dockum Aquifer	878
Estimated net annual volume of flow between each aquifer in the district	Flow to other aquifers	NA <sup>2</sup>

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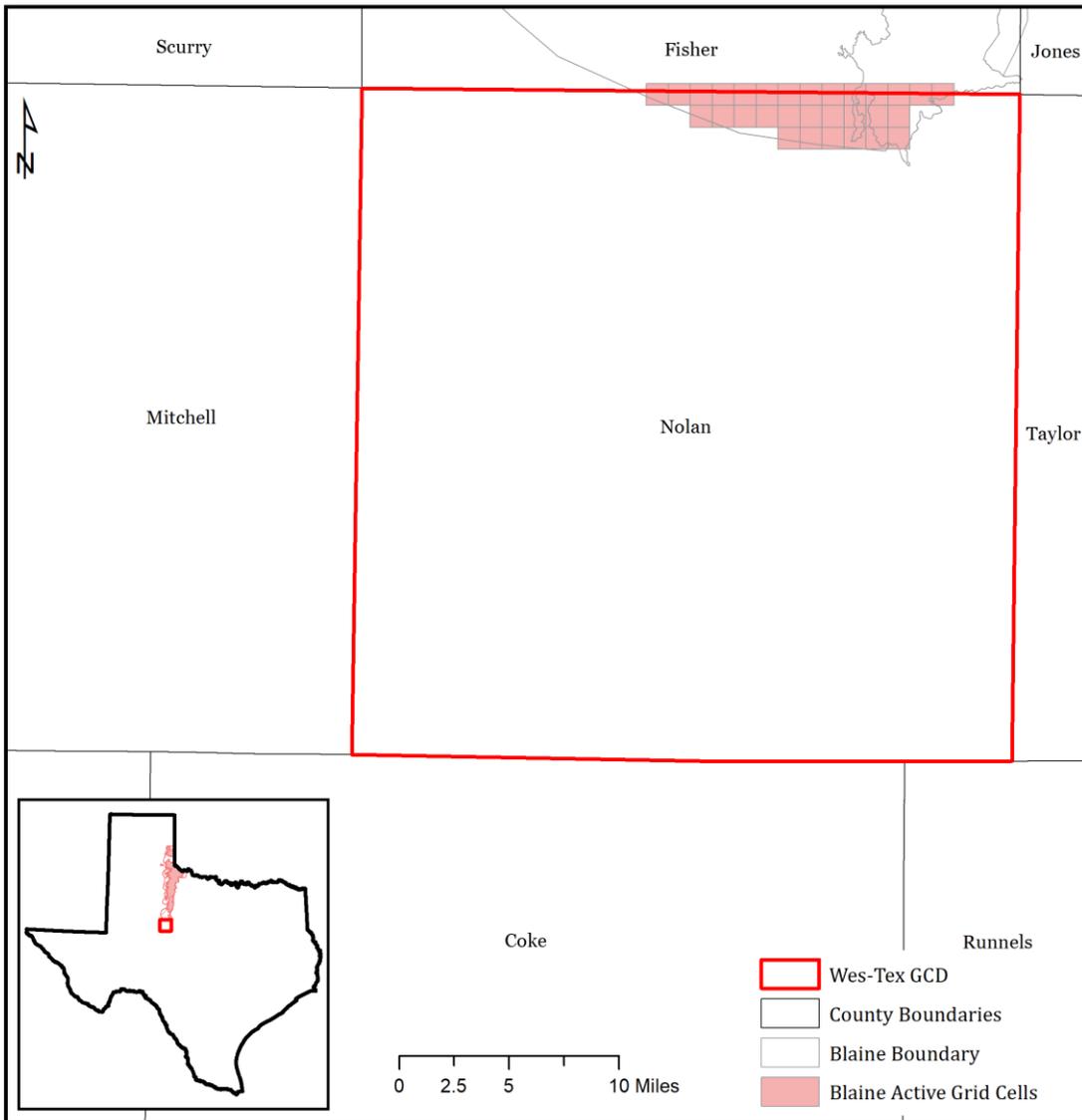
<sup>2</sup>Not applicable. Model assumes a no-flow boundary at the base.



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

**TABLE 3. SUMMARIZED INFORMATION FOR THE BLAINE AQUIFER FOR WES-TEX 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	Blaine Aquifer	459
Estimated annual volume of water that discharges from the aquifer to springs and any surface-water body including lakes, streams, and rivers	Blaine Aquifer	232
Estimated annual volume of flow into the district within each aquifer in the district	Blaine Aquifer	232
Estimated annual volume of flow out of the district within each aquifer in the district	Blaine Aquifer	593
Estimated net annual volume of flow between each aquifer in the district	From other Permian units to the Blaine Aquifer	1,737



**FIGURE 3. AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE BLAINE AQUIFER FROM WHICH THE INFORMATION IN TABLE 3 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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