GAM RUN 15-002: MEDINA COUNTY GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN

by William Kohlrenken, GISP
Texas Water Development Board
Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 463-8279
June 30, 2015

Cynthia K. Ridgeway is the Manager of the Groundwater Availability Modeling Section and is responsible for oversight of work performed by William Kohlrenken under her direct supervision. The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G. 471 on June 30, 2015.

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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. 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 the Medina County Groundwater Conservation District—fulfills the requirements noted above. Part 1 of the two-part package is the Estimated 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 Medina County Groundwater Conservation District should be adopted by the district on or before January 14, 2016 and submitted to the executive administrator of the TWDB on or before February 13, 2016. The current management plan for the Medina County Groundwater Conservation District expires on April 13, 2016.

This report discusses the methods, assumptions, and results from model runs using the groundwater availability models for the Hill Country portion of the Trinity Aquifer (Jones and others, 2009) and the southern portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers (Kelley and others, 2004). Please note that the Edwards (Balcones Fault Zone) Aquifer occurs within the boundaries of the Medina County Groundwater Conservation District but is excluded from this report because the district does not have jurisdiction over that aquifer. This model run replaces the results of GAM Run 09-31 (Aschenbach, 2009). GAM Run 15-002 meets current standards set after the release of GAM Run 09-31. Tables 1 and 2 summarize the groundwater availability model data required by statute, and figures 1 and 2 show the area of the models from which the values in the table were extracted. If after review of the figures, the Medina County 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.

The Trinity Aquifer underlies the Edwards (Balcones Fault Zone) Aquifer within the district boundaries. However, the underlying portion of the Trinity Aquifer in not included in the groundwater availability model for the Hill Country portion of the Trinity Aquifer. Information for the Trinity Aquifer underlying the Edwards (Balcones Fault Zone) Aquifer is being provided separately from the Groundwater Technical Assistance Section of the TWDB.

METHODS:

In accordance with the provisions of the Texas State Water Code, Section 36.1071, Subsection (h), the groundwater availability model for the Hill Country portion of the Trinity Aquifer (Jones and others, 2009) and the southern portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers (Kelley and others, 2004) were run for this analysis. Medina County Groundwater Conservation District water budgets were extracted for the historical model period (1981 through 1997 for the Hill Country portion of the Trinity Aquifer and 1980 through 1999 for the southern portion of the Carrizo-Wilcox Aquifer) 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 portion of the aquifer located within the district is summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Hill Country portion of the Trinity Aquifer System

- Version 2.01 of the groundwater availability model for the Hill Country portion of the Trinity Aquifer System was used for this analysis. See Jones and others (2009) for assumptions and limitations of the groundwater availability model.

- This groundwater availability model includes four layers, which represent the Edwards Group of the Edwards-Trinity (Plateau) Aquifer (Layer 1), the Upper Trinity Aquifer (Layer 2), the Middle Trinity Aquifer (Layer 3), and the Lower Trinity Aquifer (Layer 4).

- An overall water budget for the Medina County Groundwater Conservation District was determined for the Hill Country portion of the Trinity Aquifer System (Layers 2 through 4 collectively for the portions of the model that represent the Trinity Aquifer System).

- The General-Head Boundary (GHB) package of MODFLOW was used to represent flow out of the study area and across the Balcones Fault Zone (BFZ) into the Edwards (BFZ) Aquifer or the deeper Trinity Aquifer units located beneath the Edwards (BFZ). For simplicity, the GHB that corresponds to the uppermost layer of the Trinity Aquifer (Layer 2) was used to represent the flow from the Trinity Aquifer, across the Balcones Fault Zone and into the portion of the Edwards (BFZ) Aquifer within the Edwards Aquifer Authority (EAA) District. This flow is included in the management plan requirement for "estimated annual volume of flow out of the district within each aquifer in the district." The GHB in Layer 3 was assumed to represent the flow from the Trinity Aquifer, across the Balcones Fault Zone into the deeper Trinity Aquifer units. This flow is not specifically listed in the management plan requirement tables.

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

Carrizo-Wilcox, Queen City, and Sparta Aquifers

- Version 2.01 of the groundwater availability model for the southern part of the Carrizo-Wilcox, Queen City, and Sparta aquifers was used for this analysis. See Deeds and others (2003) and Kelley 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, which represent 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).

- An overall water budget for the Medina County Groundwater Conservation District was determined for the Carrizo-Wilcox Aquifer (Layers 5 through 8 collectively. The Sparta and Queen City aquifers are not present in Medina County Groundwater Conservation District

- The model was run with MODFLOW-96.

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 run in the district, as shown in tables 1 and 2.

- 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 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 the aquifer and adjacent 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.

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 THAT IS NEEDED FOR THE MEDINA COUNTY 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	6,918
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Trinity Aquifer	6,412
Estimated annual volume of flow into the district within each aquifer in the district	Trinity Aquifer	24,023
Estimated annual volume of flow out of the district within each aquifer in the district	Trinity Aquifer	23,176
Estimated net annual volume of flow between each aquifer in the district	Not Applicable*	Not Applicable*

*Not applicable because flow leaving the Trinity Aquifer and entering the Edwards (Balcones Fault Zone) Aquifer is considered flow leaving the district (from Medina County Groundwater Conservation District to the Edwards Aquifer Authority). The model also assumes a no flow barrier at the base of the Lower Trinity unit of the Trinity Aquifer.

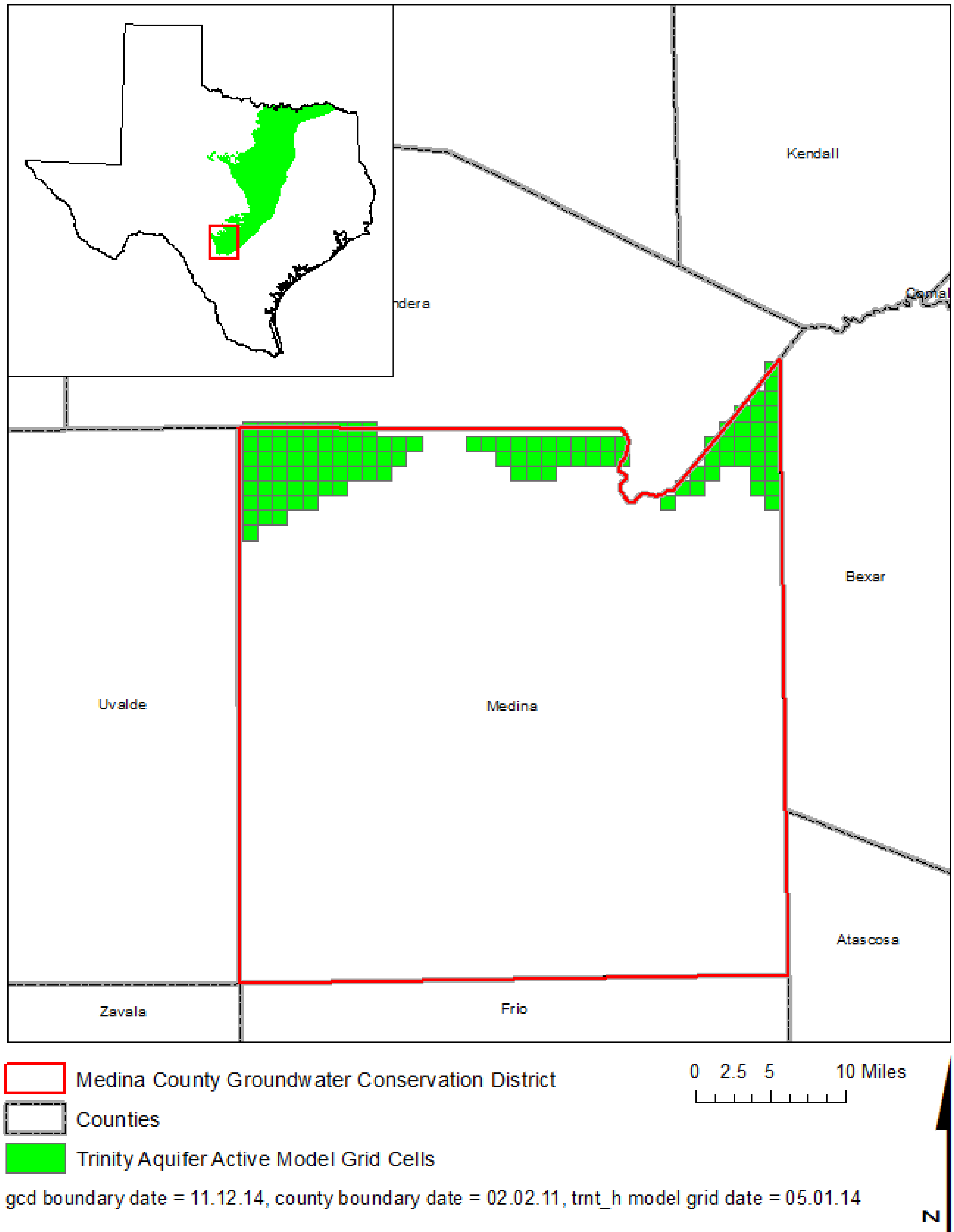

FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE HILL COUNTRY PORTION OF THE TRINITY AQUIFERS FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE TRINITY AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 2: SUMMARIZED INFORMATION FOR THE CARRIZO-WILCOX AQUIFER THAT IS NEEDED FOR THE MEDINA COUNTY 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	14,197
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	588
Estimated annual volume of flow into the district within each aquifer in the district	Carrizo-Wilcox Aquifer	1,294*
Estimated annual volume of flow out of the district within each aquifer in the district	Carrizo-Wilcox Aquifer	30,046*
Estimated net annual volume of flow between each aquifer in the district*	From the Carrizo-Wilcox Aquifer to the Reklaw Formation	14

*The model assumes a no flow barrier at the base of the Carrizo-Wilcox Aquifer.

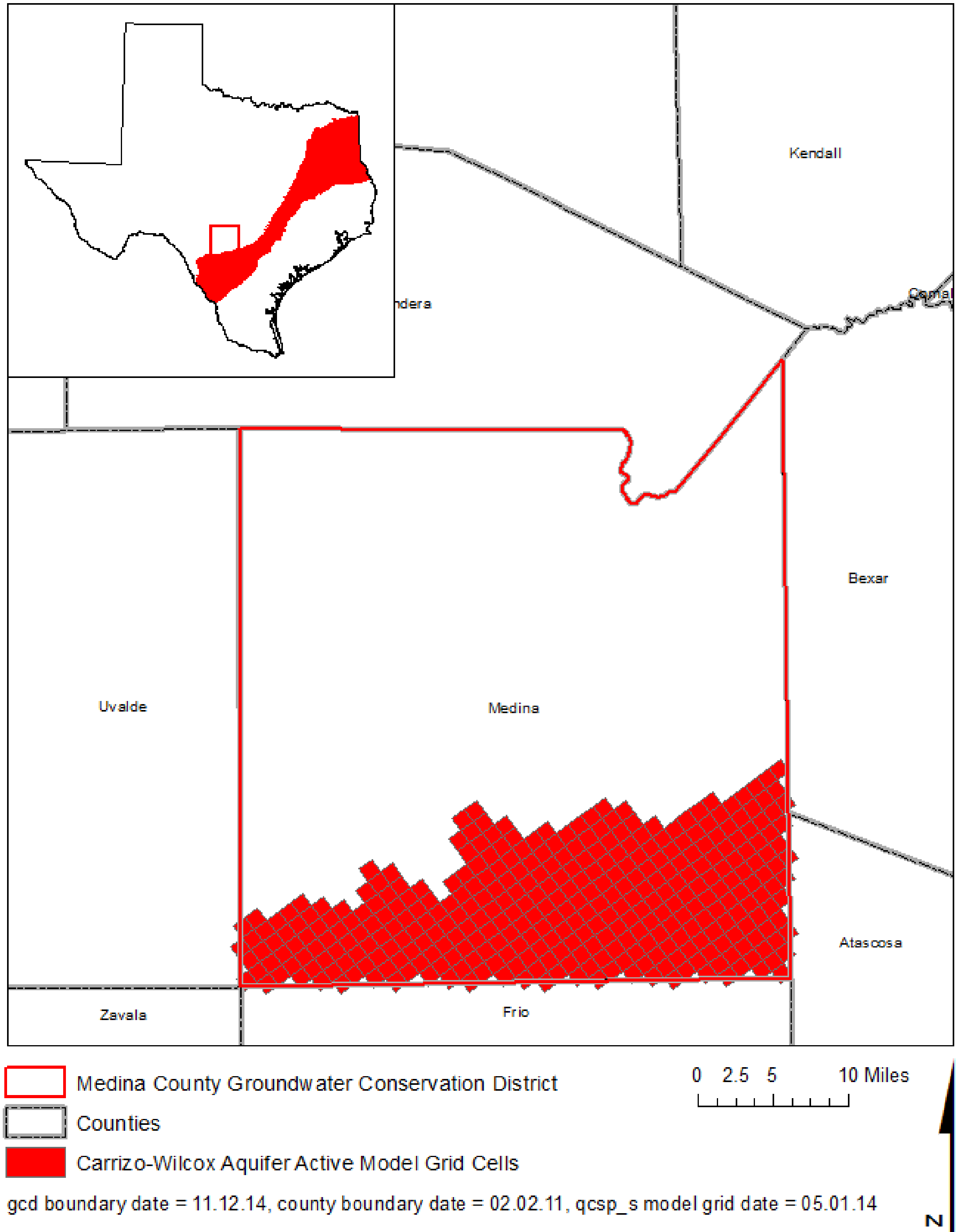

FIGURE 2: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE SOUTHERN PART OF THE CARRIZO-WILCOX AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE CARRIZO-WILCOX AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

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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