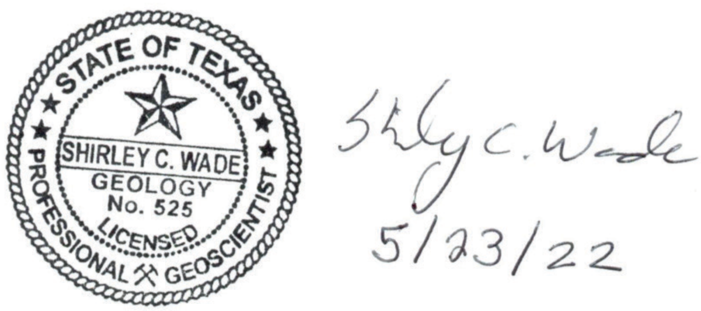
GAM RUN 22-005: PERMIAN BASIN UNDERGROUND WATER CONSERVATION DISTRICT MANAGEMENT PLAN

Shirley Wade, Ph.D., P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
(512) 936-0883
May 23, 2022



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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 Permian Basin Underground Water 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 Permian Basin Underground Water Conservation District should be adopted by the district on or before May 31, 2022 and submitted to the executive administrator of the TWDB on or before June 30, 2022. The current management plan for the Permian Basin Underground Water Conservation District expires on August 29, 2022.

We used the groundwater availability models for the High Plains Aquifer System (Deeds and others, 2015; Deeds and Jigmond, 2015) and the Edwards-Trinity (Plateau) Aquifer (Anaya and Jones, 2009) to estimate the management plan information for the Dockum, Edwards-Trinity (Plateau), and Ogallala aquifers within the Permian Basin Underground Water Conservation District. This report replaces the results of GAM Run 16-013 (Shi, 2016). Values may differ from the previous report as a result of routine updates to the spatial grid file used to define county, groundwater conservation district, and aquifer boundaries, which can impact the calculated water budget values. Additionally, the approach used for analyzing model results is reviewed during each update and may have been refined to better delineate groundwater flows. This report also includes a new figure not included in the previous report to help groundwater conservation districts better visualize water budget components. Tables 1 through 3 summarize the groundwater availability model data required by statute and Figures 1, 3, and 5 show the area of the models from which the values in Tables 1 through 3 were extracted. Figures 2, 4, and 6 provide generalized diagrams of the groundwater flow components provided in Tables 1 through 3. If, after review of the figures, the Permian Basin Underground Water 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 groundwater availability models mentioned above were used to estimate information for the Permian Basin Underground Water Conservation District management plan. Water budgets were extracted for the historical model periods for the Dockum and Ogallala aquifers (1980 through 2012) and the Edwards-Trinity (Plateau) Aquifer (1981 through 2000) 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, and the flow between aquifers within the district are summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Dockum and Ogallala aquifers

- We used version 1.01 of the groundwater availability model for the High Plains Aquifer System to analyze the Dockum and Ogallala aquifers. See Deeds and others (2015) and Deeds and Jigmond (2015) for assumptions and limitations of the model.

- The groundwater availability model for the High Plains Aquifer System contains four layers. In the model, Layer 1 represents the Ogallala Aquifer, Layer 2 represents the Rita Blanca, Edwards-Trinity (High Plains), and Edwards-Trinity (Plateau) aquifers where present, Layer 3 represents the upper portion of the Dockum Aquifer and equivalent units, and Layer 4 represents the lower portion of the Dockum Aquifer and equivalent units.

- Water budget values for the district were determined for the Ogallala Aquifer (Layer 1) and the Dockum Aquifer (Layers 3 and 4). The Rita Blanca and Edwards-Trinity (High Plains) do not occur within the Permian Basin Underground Water Conservation District and therefore no groundwater budget values are included for them in this report.

- Water budget terms were averaged for the period 1980 to 2012 (stress periods 52 through 84).

- The model was run with MODFLOW-NWT (Niswonger and others, 2011).

Edwards-Trinity (Plateau) Aquifer

- We used version 1.01 of the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers to analyze the Edwards-Trinity (Plateau) Aquifer. 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 two layers. Layer 1 represents the Edwards-Trinity (Plateau) Aquifer and the Pecos Valley Alluvium Aquifer and Layer 2 represents the Edwards-Trinity (Plateau) Aquifer.

- Water budget values for the district were determined for the Edwards-Trinity (Plateau) Aquifer (Layers 1 and 2, combined). The Pecos Valley Aquifer does not occur within the Permian Basin Underground Water District and therefore no groundwater budget values are included for it in this report.

- Water budget terms were averaged for the period 1981 to 2000 (stress periods 2 through 21).
- 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 groundwater availability models results for the Dockum, Edwards-Trinity (Plateau), and Ogallala aquifers located within the Permian Basin Underground Water Conservation District and averaged over the historical calibration period, 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 DOCKUM AQUIFER THAT IS NEEDED FOR THE PERMIAN BASIN UNDERGROUND WATER 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	4,678
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers.	Dockum Aquifer	1,696
Estimated annual volume of flow into the district within each aquifer in the district	Dockum Aquifer	40
Estimated annual volume of flow out of the district within each aquifer in the district	Dockum Aquifer	1,282
Estimated net annual volume of flow between each aquifer in the district	From the Dockum Aquifer to the Ogallala Aquifer	13
	To the Dockum Aquifer from the Edwards-Trinity (Plateau) Aquifer	44
	To the Dockum Aquifer from Dockum equivalents units	359
	Flow between the Dockum Aquifer and underlying units	Not Applicable[1]

[1] Not applicable because the model assumes a no flow barrier at the base of the Dockum Aquifer.

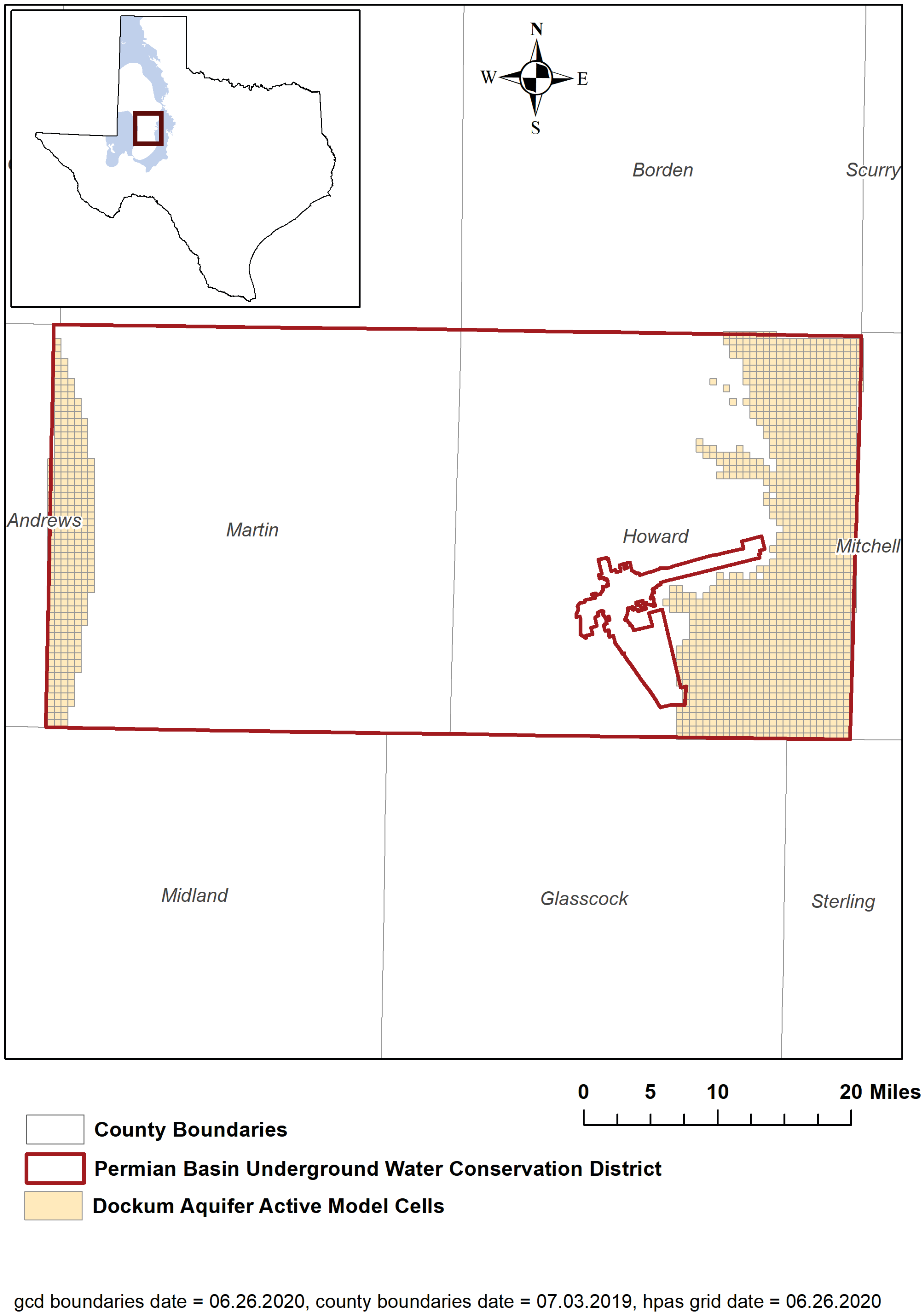
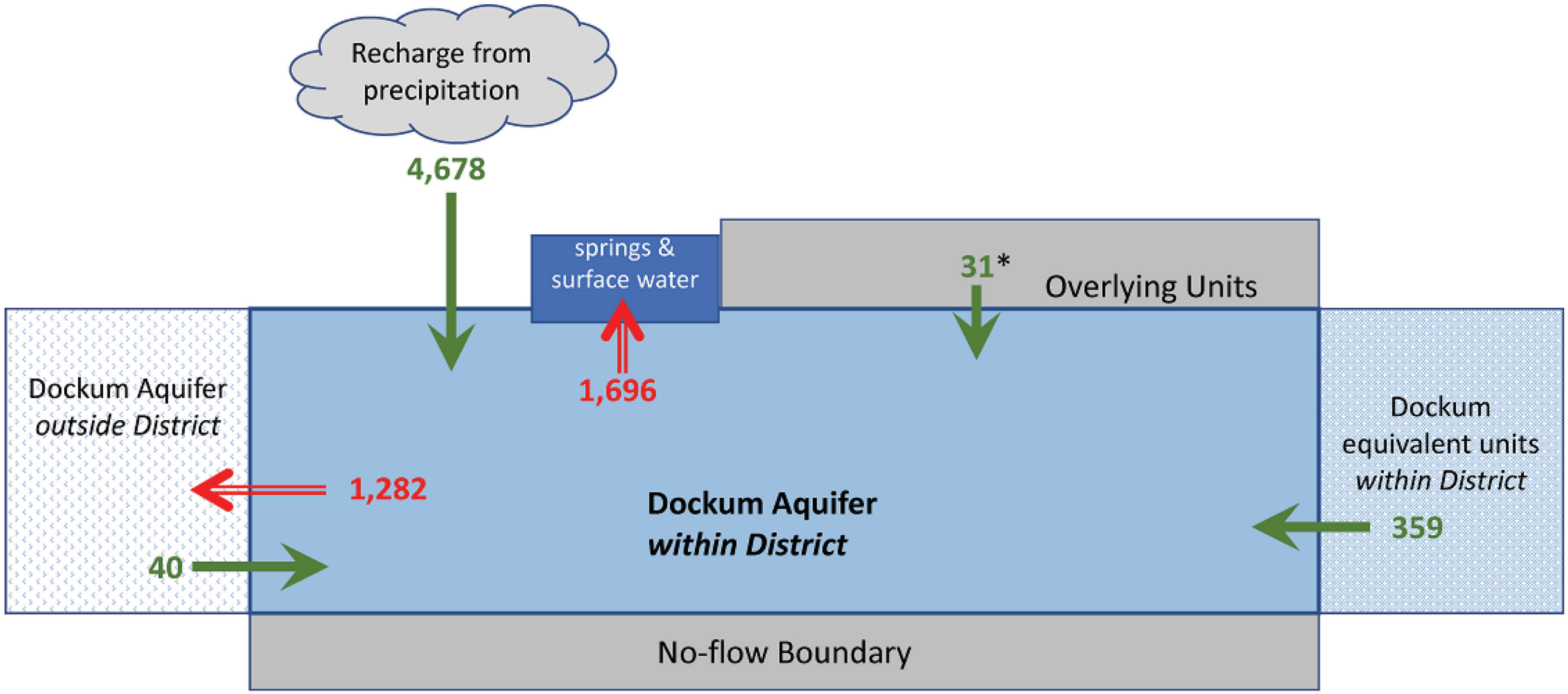


FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE HIGH PLAINS AQUIFER SYSTEM FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE DOCKUM AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).



* Flow from overlying units includes net outflow of 13 acre-feet per year to the Ogallala Aquifer, and net inflow of 44 acre-feet per year from the Edwards-Trinity (Plateau) Aquifer.

Caveat: This diagram only includes the water budget items provided in Table 1. A complete water budget would include additional inflows and outflows. If the District requires values for additional water budget items, please contact TWDB.

FIGURE 2: GENERALIZED DIAGRAM OF THE SUMMARIZED BUDGET INFORMATION FROM TABLE 1, REPRESENTING DIRECTIONS OF FLOW FOR THE DOCKUM AQUIFER WITHIN THE PERMIAN BASIN UNDERGROUND WATER CONSERVATION DISTRICT. FLOW VALUES EXPRESSED IN ACRE-FEET PER YEAR (AFY).

TABLE 2: SUMMARIZED INFORMATION FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER THAT IS NEEDED FOR THE PERMIAN BASIN UNDERGROUND WATER 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	3,929
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	124
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	2,610
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	6,204
Estimated net annual volume of flow between each aquifer in the district	To the Edwards-Trinity (Plateau) Aquifer from the Ogallala Aquifer[2]	915
	From the Edwards-Trinity (Plateau) Aquifer to the Dockum Aquifer[2]	44

[2] Value extracted from the groundwater availability model for the High Plains Aquifer System.

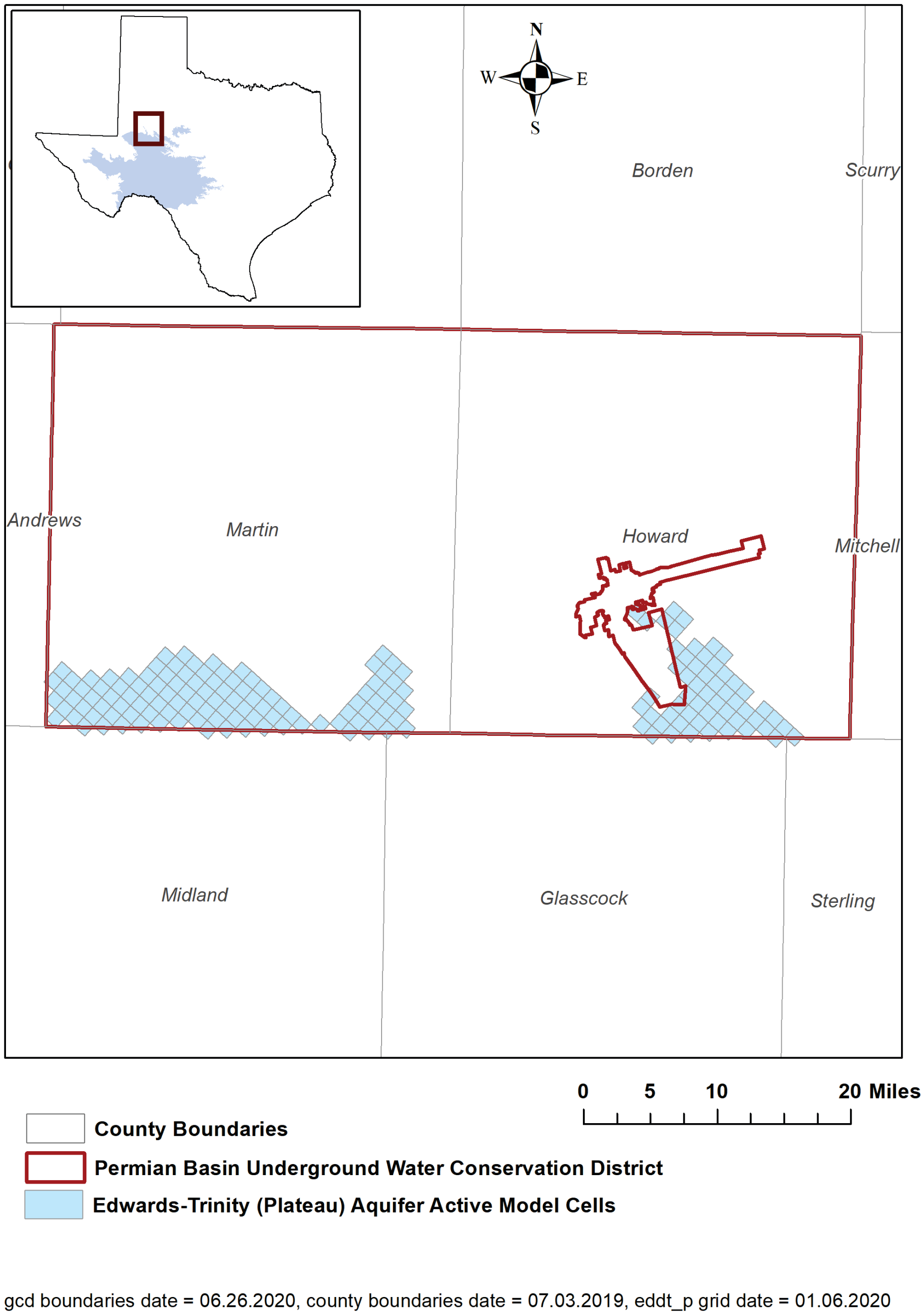
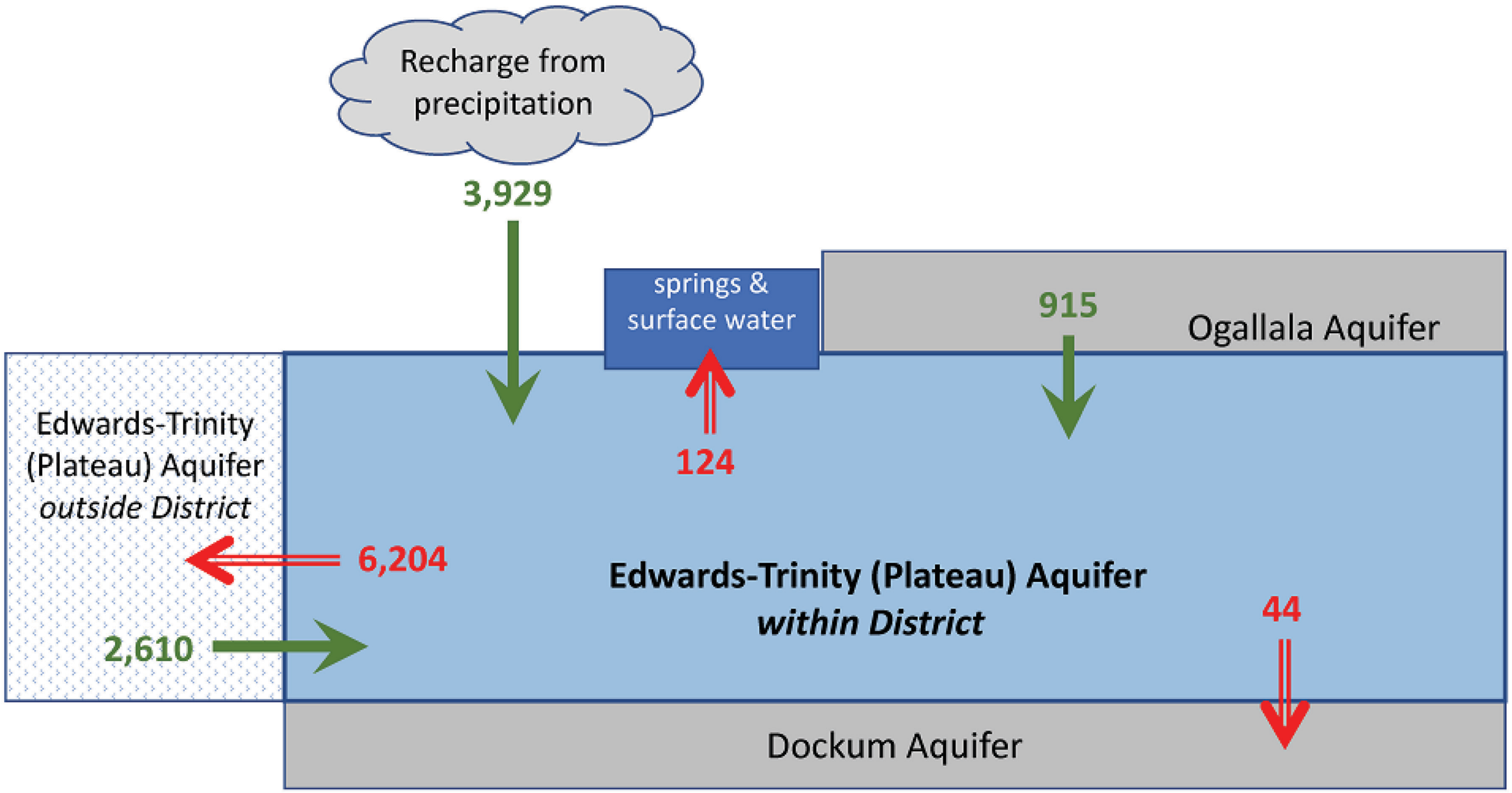


FIGURE 3: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE EDWARDS-TRINITY [PLATEAU] AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).



Caveat: This diagram only includes the water budget items provided in Table 2. A complete water budget would include additional inflows and outflows. If the District requires values for additional water budget items, please contact TWDB.

FIGURE 4: GENERALIZED DIAGRAM OF THE SUMMARIZED BUDGET INFORMATION FROM TABLE 2, REPRESENTING DIRECTIONS OF FLOW FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER WITHIN THE PERMIAN BASIN UNDERGROUND WATER CONSERVATION DISTRICT. FLOW VALUES EXPRESSED IN ACRE-FEET PER YEAR (AFY).

TABLE 3: SUMMARIZED INFORMATION FOR THE OGALLALA AQUIFER THAT IS NEEDED FOR THE PERMIAN BASIN UNDERGROUND WATER 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	Ogallala Aquifer	50,317
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers.	Ogallala Aquifer	11,848
Estimated annual volume of flow into the district within each aquifer in the district	Ogallala Aquifer	5,225
Estimated annual volume of flow out of the district within each aquifer in the district	Ogallala Aquifer	3,532
Estimated net annual volume of flow between each aquifer in the district	To the Ogallala Aquifer from the Dockum Aquifer	13
	From the Ogallala Aquifer to the Edwards-Trinity (Plateau) Aquifer	915
	To the Ogallala Aquifer from Dockum equivalent units	593

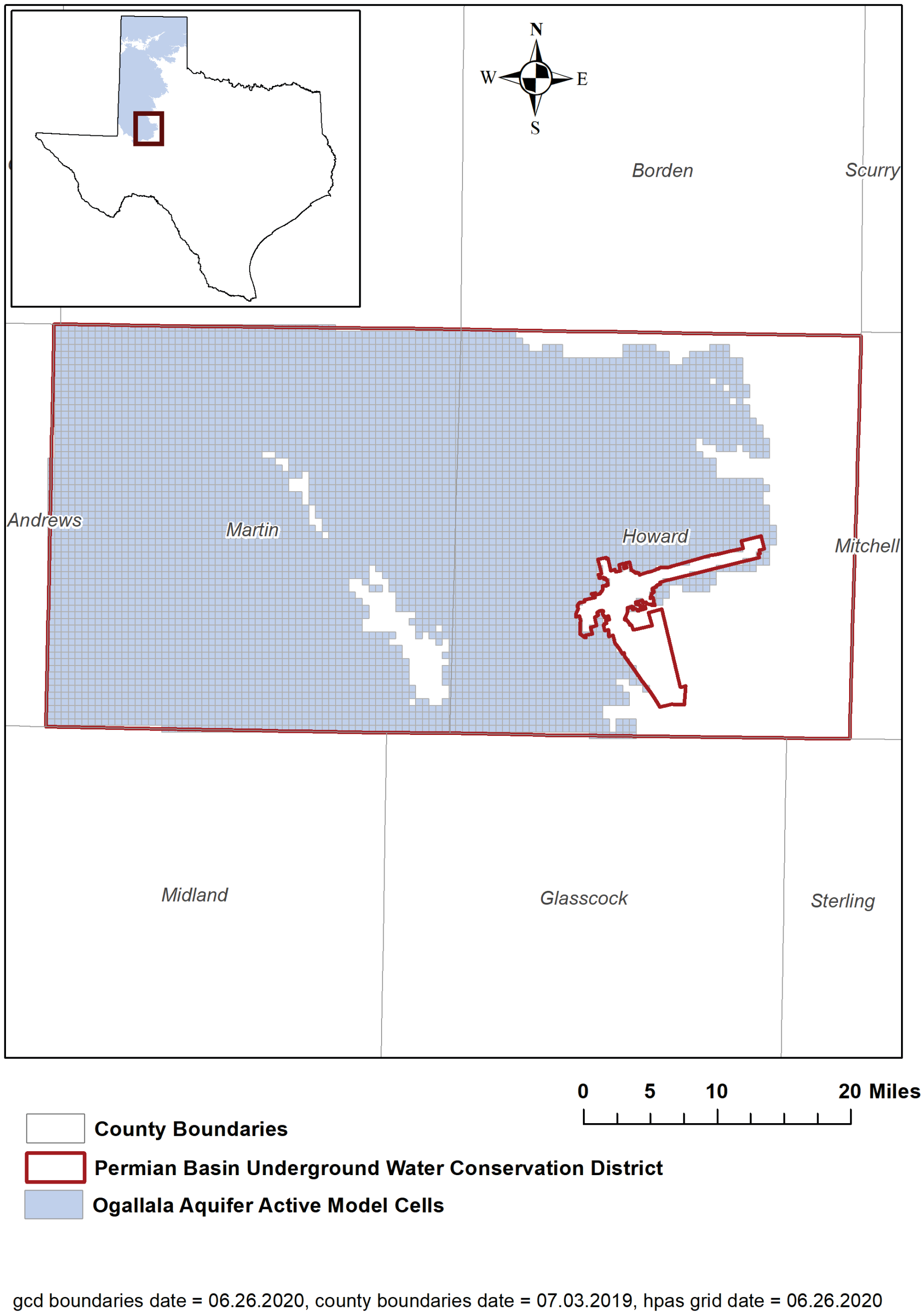
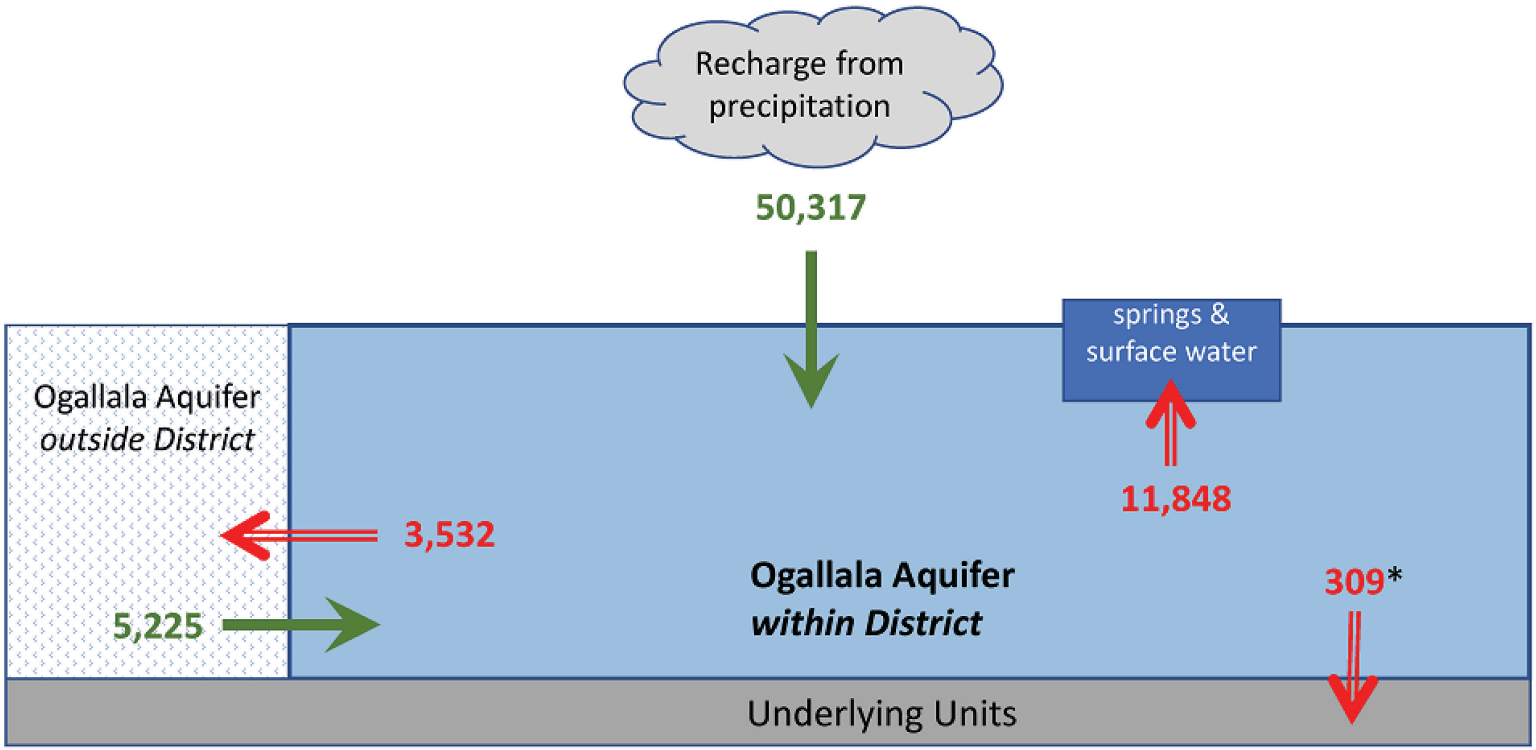


FIGURE 5: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE HIGH PLAINS AQUIFER SYSTEM FROM WHICH THE INFORMATION IN TABLE 3 WAS EXTRACTED (OGALLALA AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).



* Flow to underlying units includes net outflow of 915 acre-feet per year to Edwards-Trinity (Plateau) Aquifer, and net inflow of 593 acre-feet per year from Dockum equivalent units and 13 acre-feet per year from the Dockum Aquifer.

Caveat: This diagram only includes the water budget items provided in Table 3. A complete water budget would include additional inflows and outflows. If the District requires values for additional water budget items, please contact TWDB.

FIGURE 6: GENERALIZED DIAGRAM OF THE SUMMARIZED BUDGET INFORMATION FROM TABLE 3, REPRESENTING DIRECTIONS OF FLOW FOR THE OGALLALA AQUIFER WITHIN THE PERMIAN BASIN UNDERGROUND WATER CONSERVATION DISTRICT. FLOW VALUES EXPRESSED IN ACRE-FEET PER YEAR (AFY).

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 historic groundwater flow conditions includes the assumptions about the location in the aquifer where historic 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 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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