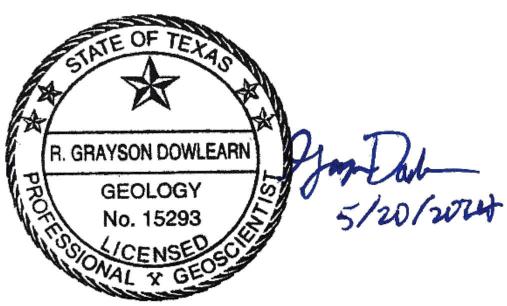
GAM RUN 24-006: HIGH PLAINS UNDERGROUND WATER CONSERVATION DISTRICT NO. 1 GROUNDWATER MANAGEMENT PLAN

Saheli Majumdar, Ph.D. and Grayson Dowlearn, P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-936-6079
May 20, 2024



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EXECUTIVE SUMMARY

Texas Water Code, Section 36.1071(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.

The TWDB provides data and information to the High Plains Underground Water Conservation District No. 1 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, which includes:

1. the annual amount of recharge from precipitation, if any, to the groundwater resources within the district;

2. the annual volume of water that discharges from the aquifer to springs and any surface-water bodies, including lakes, streams, and rivers for each aquifer within the district; 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 High Plains Underground Water Conservation District No. 1 should be adopted by the district on or before July 27, 2024 and submitted to the Executive Administrator of the TWDB on or before August 26,

2024. The current management plan for the High Plains Underground Water Conservation District No. 1 expires on October 25, 2024.

The management plan information for the aquifers within High Plains Underground Water Conservation District No. 1 was extracted from the groundwater availability model for the High Plains Aquifer System (Deeds and Jigmond, 2015).

This report replaces the results of GAM Run 19-002 (Shi, 2019). 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.

Tables 1 through 3 summarize the groundwater availability model data required by statute. 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 a generalized diagram of the groundwater flow components provided in Tables 1 through 3. If the High Plains Underground Water Conservation District No. 1 determines that the district boundaries used in the assessment do not reflect current conditions after reviewing the figures, please notify the TWDB Groundwater Modeling Department at your earliest convenience.

The flow components presented in this report do not represent the full groundwater budget. If additional inflow and outflow information would be helpful for planning purposes, the district may submit a request in writing to the TWDB Groundwater Modeling Department for the full groundwater budget.

METHODS

In accordance with the provisions of the Texas Water Code, Section 36.1071(h), the groundwater availability model of the High Plains Aquifer System was used to estimate information for the High Plains Underground Water Conservation District No. 1 management plan. Water budgets were extracted for the historical model period (1980 through 2012) 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

Groundwater availability model for the High Plains Aquifer System

- We used version 1.01 of the groundwater availability model for the High Plains Aquifer System to analyze the Ogallala, Edwards-Trinity (High Plains), and Dockum aquifers. See Deeds and Jigmond (2015) for assumptions and limitations of the model.
- The groundwater availability model for the High Plains Aquifer System contains the following four layers:
    - Layer 1 represents the Ogallala and Pecos Valley aquifers.
    - Layer 2 represents the Rita Blanca Aquifer and Edwards-Trinity (High Plains & Plateau) aquifers.
    - Layer 3 represents the upper Dockum Aquifer.
    - Layer 4 represents the lower Dockum Aquifer.
- The model was run with MODFLOW-NWT (Niswonger and others, 2011).
- Water budgets for the district were determined for the Ogallala Aquifer (Layer 1), the Edwards-Trinity (High Plains) Aquifer (Layer 2) and the Dockum Aquifer (Layers 3 and 4 combined).
- Additionally, flow between aquifers within High Plains Underground Water Conservations District No. 1 and equivalent units in New Mexico were determined and included within the annual flow between each aquifer in district portion of Tables 1, 2, and 3.
- Water budget terms were averaged for the period from 1980 through 2012.

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 model results for the aquifers located within the High Plains Underground Water Conservation District No. 1 and averaged over the historical calibration period, as shown in Tables 1 through 3.

- 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 the district—the lateral flow within the aquifer between the district and adjacent counties.
- Flow between aquifers—the net flow between the aquifer and adjacent hydrostratigraphic units. This amount of flow is controlled by the relative water levels in each hydrostratigraphic unit.

The information needed for the district’s management plan is summarized in Tables 1 through 3. Figures 1, 3, and 5 show the area of the model from which the values in Tables 1 through 3 were extracted. Figures 2, 4, and 6 provide a generalized diagram of the groundwater flow components provided 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 Ogallala Aquifer that is needed for the High Plains Underground Water Conservation District No. 1'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	269,799
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams and rivers	Ogallala Aquifer	11,791
Estimated annual volume of flow into the district within each aquifer in the district	Ogallala Aquifer	37,257
Estimated annual volume of flow out of the district within each aquifer in the district	Ogallala Aquifer	45,719
Estimated net annual volume of flow between each aquifer in the district	To Ogallala Aquifer from Edwards-Trinity (High Plains) Aquifer	308
	From Ogallala Aquifer to Dockum Aquifer	2,217
	To Ogallala Aquifer from Dockum equivalent units	12,608
	From Ogallala Aquifer to Ogallala equivalent units in New Mexico	2,839

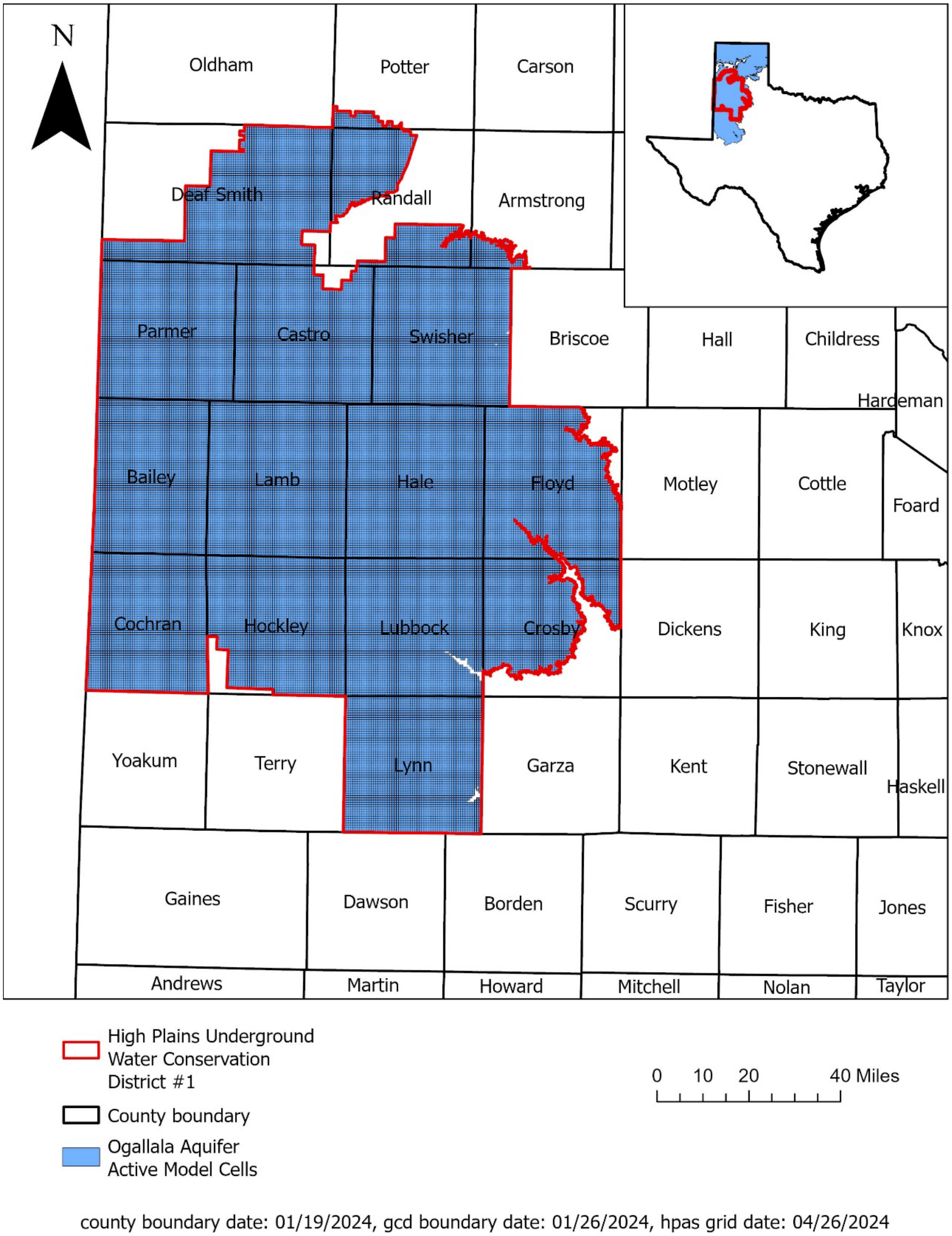
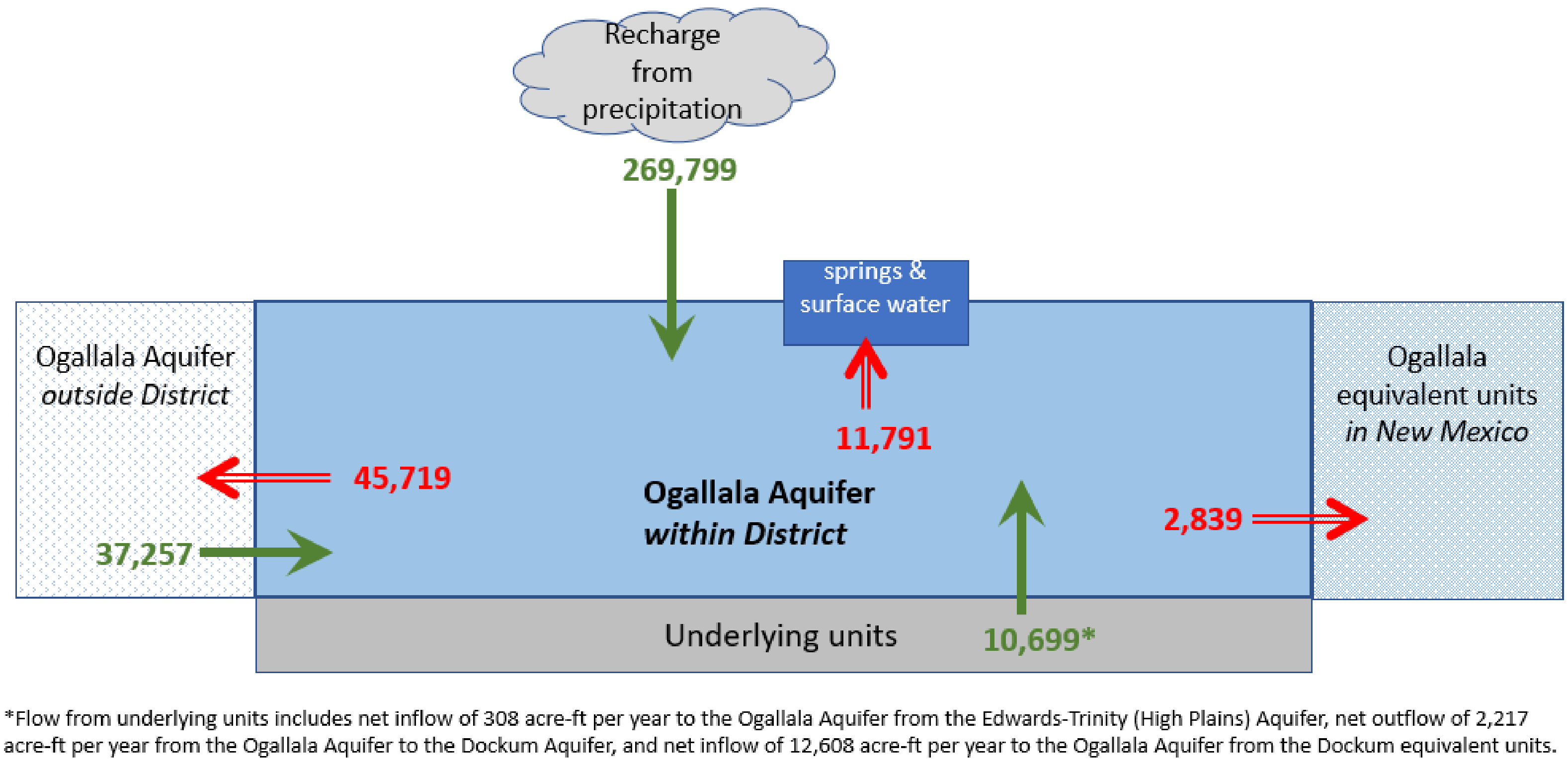


Figure 1: Area of the groundwater availability model for the High Plains Aquifer System from which the information in Table 1 was extracted (the Ogallala Aquifer extent within the district boundary).



Caveat: This diagram only includes the water budget items provided in Table 1. A complete water budget would include additional inflows and outflows. For a full groundwater budget, please submit a request in writing to the Groundwater Modeling Department.

Figure 2: Generalized diagram of the summarized budget information from Table 1, representing directions of flow for the Ogallala Aquifer within High Plains Underground Water Conservation District No.1. Flow values are expressed in acre-feet per year.

Table 2: Summarized information for the Edwards-Trinity (High Plains) Aquifer that is needed for the High Plains Underground Water Conservation District No. 1'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 (High Plains) Aquifer	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams and rivers	Edwards-Trinity (High Plains) Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (High Plains) Aquifer	4,469
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (High Plains) Aquifer	9,182
Estimated net annual volume of flow between each aquifer in the district	From Edwards-Trinity (High Plains) Aquifer to the Ogallala Aquifer	308
	From Edwards-Trinity (High Plains) Aquifer to Dockum Aquifer	331
	To Edwards-Trinity (High Plains) Aquifer from Edwards-Trinity equivalent units in New Mexico	3,718
	To Edwards-Trinity (High Plains) Aquifer from Dockum equivalent units	1,820

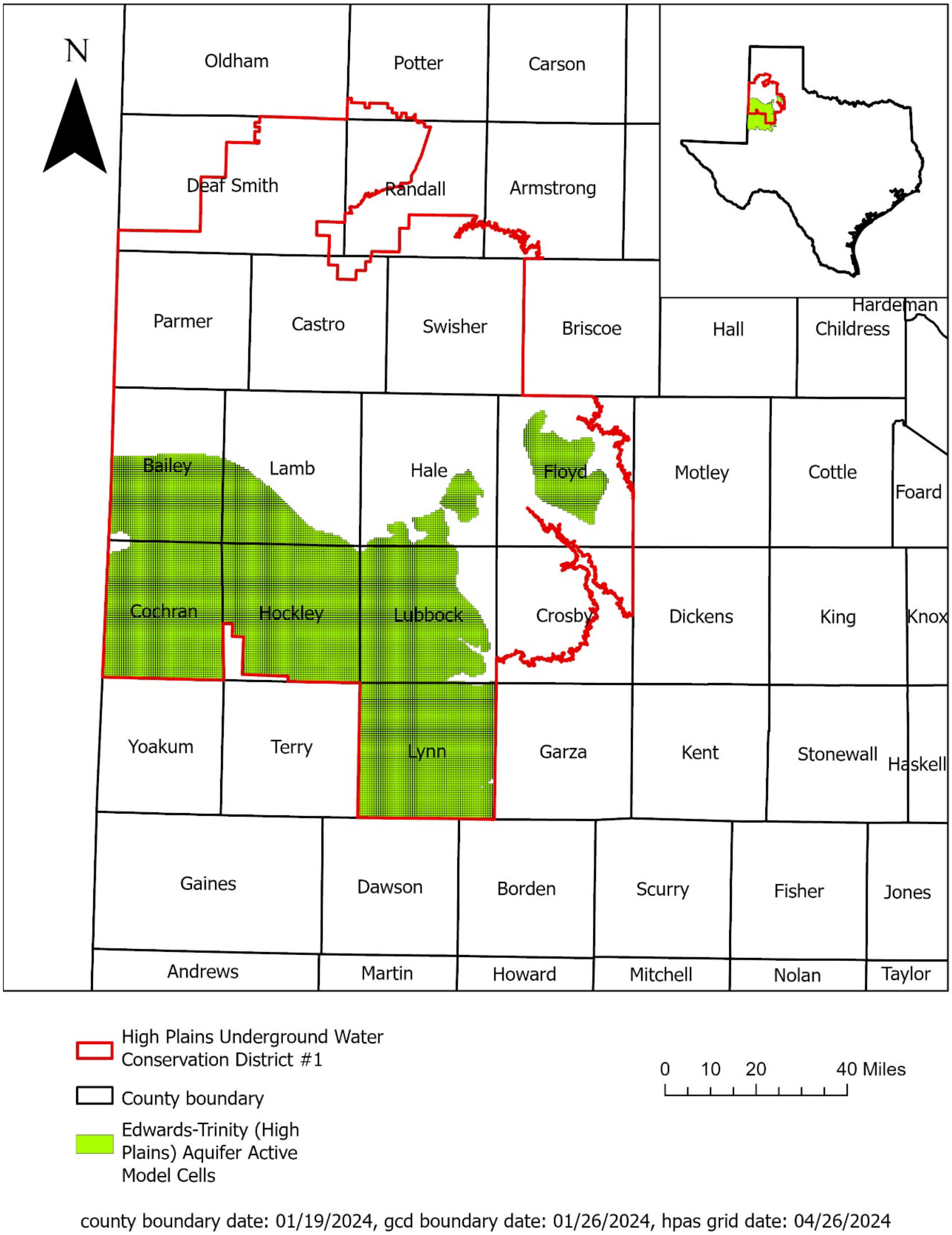
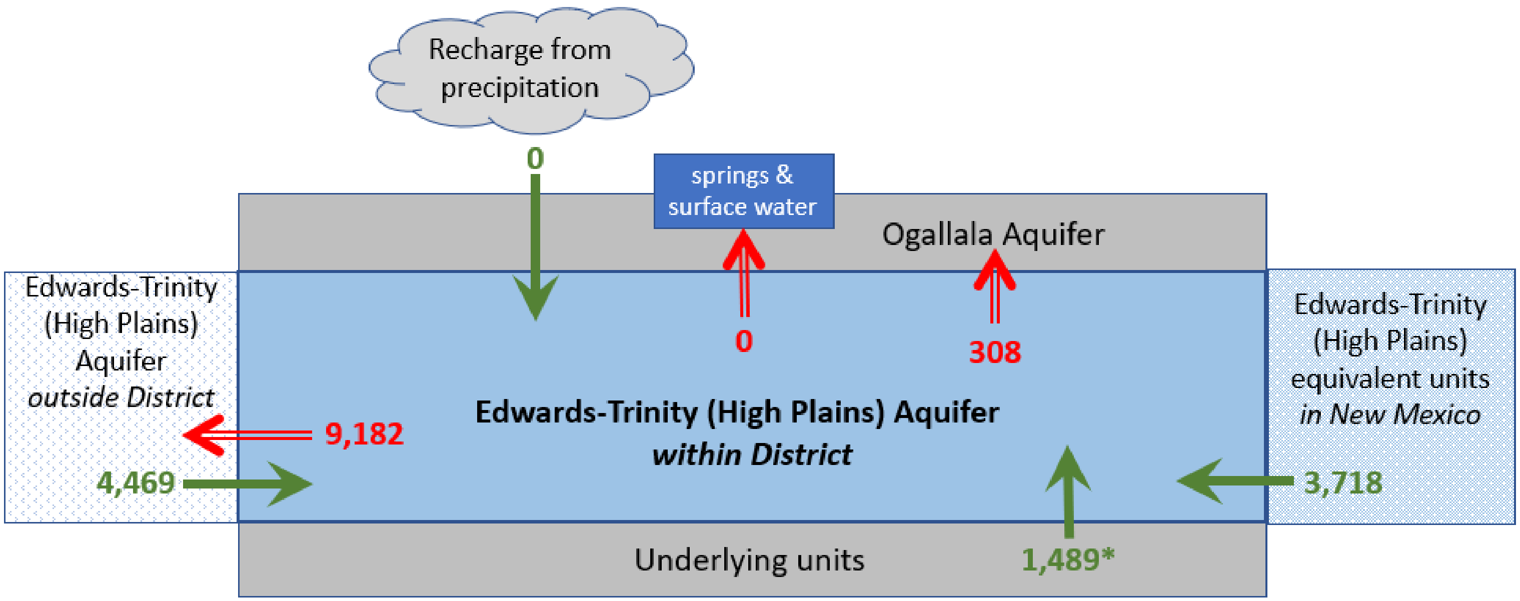


Figure 3: Area of the groundwater availability model for the High Plains Aquifer System from which the information in Table 2 was extracted (the Edwards-Trinity [High Plains] Aquifer extent within the district boundary).



*Flow from underlying units includes net outflow of 331 acre-ft per year from the Edwards-Trinity (High Plains) Aquifer to the Dockum Aquifer, and net inflow of 1,820 acre-ft per year to the Edwards-Trinity (High Plains) Aquifer from the Dockum equivalent units.

Caveat: This diagram only includes the water budget items provided in Table 2. A complete water budget would include additional inflows and outflows. For a full groundwater budget, please submit a request in writing to the Groundwater Modeling Department.

Figure 4: Generalized diagram of the summarized budget information from Table 2, representing directions of flow for the Edwards-Trinity (High Plains) Aquifer within High Plains Underground Water Conservation District No. 1. Flow values are expressed in acre-feet per year.

Table 3: Summarized information for the Dockum Aquifer that is needed for the High Plains Underground Water Conservation District No. 1'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	15
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams and rivers	Dockum Aquifer	124
Estimated annual volume of flow into the district within each aquifer in the district	Dockum Aquifer	4,218
Estimated annual volume of flow out of the district within each aquifer in the district	Dockum Aquifer	14,461
Estimated net annual volume of flow between each aquifer in the district	To Dockum Aquifer from Ogallala aquifer	2,217
	To Dockum Aquifer from Edwards Trinity (High Plains) aquifer	331
	To Dockum Aquifer from Dockum equivalent units in New Mexico	7
	To Dockum Aquifer from Dockum equivalent units in the District	826

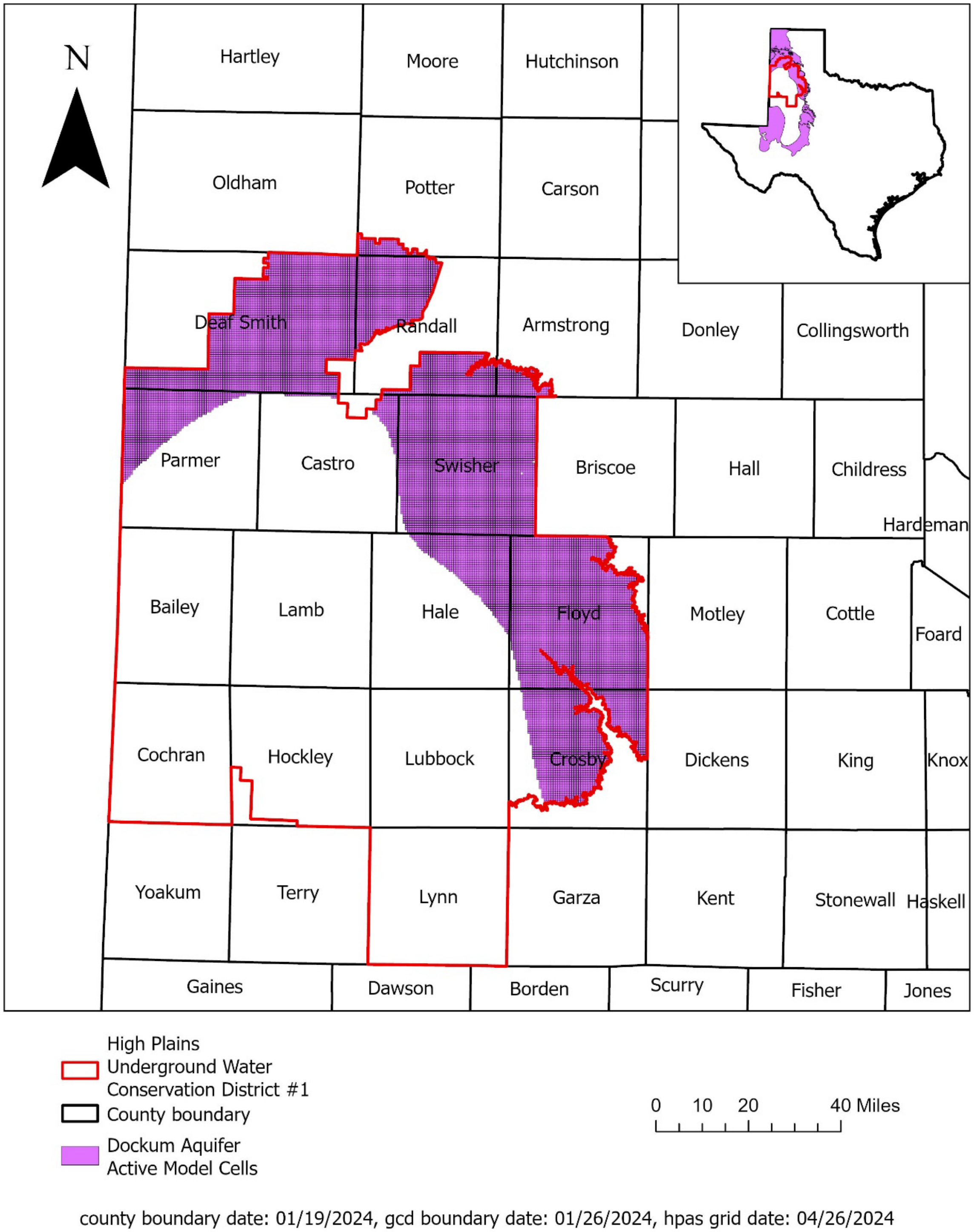
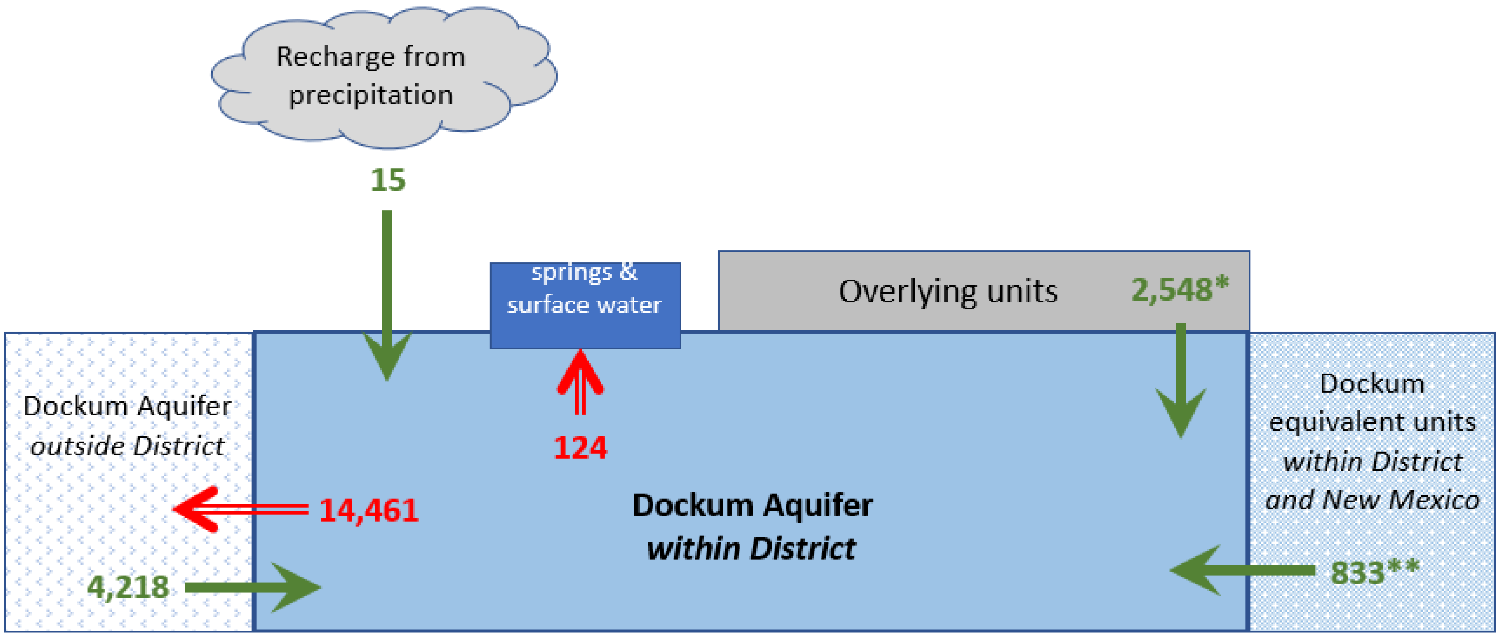


Figure 5: Area of the groundwater availability model for the High Plains Aquifer System from which the information in Table 3 was extracted (the Dockum Aquifer extent within the district boundary).



*Flow from overlying units includes net inflow of 2,217 acre-ft per year to the Dockum Aquifer from the Ogallala Aquifer, and net inflow of 331 acre-ft per year to the Dockum Aquifer from the Edwards-Trinity (High Plains) Aquifer.
**Flow from Dockum equivalent units includes net inflow of 826 acre-ft per year to the Dockum Aquifer from the Dockum equivalent units in the District and 7 acre-ft per year to the Dockum Aquifer from the Dockum equivalent units in New Mexico.

Caveat: This diagram only includes the water budget items provided in Table 3. A complete water budget would include additional inflows and outflows. For a full groundwater budget, please submit a request in writing to the Groundwater Modeling Department.

Figure 6: Generalized diagram of the summarized budget information from Table 3, representing directions of flow for the Dockum Aquifer within High Plains Underground Water Conservation District No. 1. Flow values are expressed in acre-feet per year.

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 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.

REFERENCES

Deeds, N. E. and Jigmond, M., 2015, Numerical Model Report for the High Plains Aquifer System Groundwater Availability Model, 640 p. http://www.twdb.texas.gov/groundwater/models/gam/hpas/HPAS_GAM_Numerical_Report.pdf

Harbaugh, A. W., 2009, Zonebudget Version 3.01, A computer program for computing subregional water budgets for MODFLOW ground-water flow models: U.S. Geological Survey Groundwater Software.

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Niswonger, R. G., Panday, S., and Ibaraki, M., 2011, MODFLOW-NWT, A Newtonian formulation for MODFLOW-2005: U.S. Geological Survey Survey Techniques and Methods 6-A37, 44 p.

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Texas Water Code § 36.1071