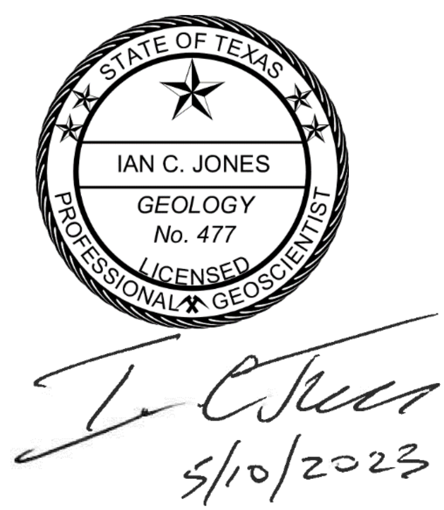
GAM Run 23-001: Reeves County Groundwater Conservation District Management Plan

Dwight Zedric Q. Capus, G.I.T. and Ian Jones, Ph.D., P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-936-2404

May 10, 2023



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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 Reeves County 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, which 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 Reeves County Groundwater Conservation District should be adopted by the district on or before May 107, 2023 and submitted to the executive administrator of the TWDB on or before June 16, 2023. The current management plan for the Reeves County Groundwater Conservation District expires on August 15, 2023.

We used four groundwater availability models for the Reeves County Groundwater Conservation District. Information for Capitan Reef Complex Aquifer is from version 1.01 of the groundwater availability model for the Capitan Reef Complex Aquifer (Jones, 2016). Information for the Rustler Aquifer is from version 1.01 of the groundwater availability model for the Rustler Aquifer (Ewing and others, 2012). 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 Pecos Valley and Edwards-Trinity (Plateau) aquifers is from version 1.01 of the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers (Anaya and Jones, 2009). While a small portion of the Igneous Aquifer underlies the district at the southern tip of Reeves County, the model for Igneous Aquifer does not extend into Reeves County. For more information concerning this aquifer, please contact Mr. Stephen Allen at 512-463-7317 or stephen.allen@twdb.texas.gov.

This report replaces the results of GAM Run 18-001 (Jones, 2018). 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 5 summarize the groundwater availability model data required by statute. Figures 1, 3, 5, 7, and 9 show the areas of the respective models from which the values in Tables 1 through 5 were extracted. Figures 2, 4, 6, 8, and 10 provide a generalized diagram of the groundwater flow components provided in Tables 1 through 5. If, after review of the figures, the Reeves 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 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 State Water Code, Section 36.1071, Subsection (h), the groundwater availability model mentioned above was used to estimate information for the Reeves County Groundwater Conservation District management plan. Water budgets were extracted for the historical model period for the Capitan Reef Complex Aquifer (1980 through 2005), Rustler Aquifer (1980 through 2008), Dockum Aquifer (1980 through 2012), and the Edwards-Trinity (Plateau) and Pecos Valley aquifers (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:

Capitan Reef Complex Aquifer

- We used version 1.01 of the groundwater availability model for the Capitan Reef Complex Aquifer (Jones, 2016) to analyze the Capitan Reef Complex Aquifer. See Jones (2016) for assumptions and limitations of the groundwater availability model.
- The model has five active layers representing the Edwards-Trinity (Plateau) and Pecos Valley aquifers (Layer 1); Dockum Aquifer and Dewey Lake Formation (Layer 2); Rustler Aquifer (Layer 3); Artesia Group, Salado Formation, and Castile Formation (Layer 4), and Capitan Reef Complex Aquifer, Delaware Basin, and San Andres Formation (Layer 5).
- While the model for the Capitan Reef Complex Aquifer includes the Pecos Valley Alluvium, Edwards-Trinity (Plateau), Dockum, and Rustler aquifers, the focus of the model run was to extract information for the Capitan Reef Complex Aquifer. Thus, model layer 5 was used for the management plan analysis.
- It should be noted that the model for the Capitan Reef Complex Aquifer only includes the eastern “arm” of the aquifer and does not include the small aquifer extent at the end of the western “arm” located within the district boundary.
- Water budget terms were averaged for the period 1980 through 2005 (stress periods 50 through 75)
- The model was run with MODFLOW-2005 (Harbaugh, 2005).

Rustler Aquifer

- We used version 1.01 of the groundwater availability model for the Rustler Aquifer Groundwater Availability Model (Ewing and Others, 2012) to analyze the Rustler Aquifer. See Ewing and others (2012) for assumptions and limitations of the groundwater availability model.

- The model has two active layers representing the Dewey Lake Formation and Dockum Aquifer (Layer 1) and the Rustler Aquifer (Layer 2). While the model for the Rustler Aquifer includes the Dockum Aquifer, the focus of the model run was to extract information for the Rustler Aquifer. Thus, model layer 2 was used for the management plan analysis.
- Water budget terms were averaged for the period 1980 through 2008 (stress periods 63 through 91).
- The model was run with MODFLOW-2000 (Harbaugh and Others, 2000).

Dockum Aquifer

- We used version 1.01 of the groundwater availability model for the High Plains Aquifer System to analyze the Dockum Aquifer. 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 the following four layers:
    - Layer 1 represents the Ogallala and Pecos Valley aquifers where present.
    - 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.
    - Layer 4 represents the lower portion of the Dockum Aquifer and equivalent units.
- While the model for the High Plains Aquifer System includes the Pecos Valley and Edwards-Trinity (Plateau) aquifers, the focus of the model run was to extract information for the Dockum Aquifer. Thus, model layers 3 and 4 were used for the management plan analysis.
- Water budget terms were averaged for the period 1980 through 2012 (stress periods 52 through 84).
- The model was run with MODFLOW-NWT (Niswonger and others, 2011).

Edwards-Trinity (Plateau) and Pecos Valley aquifers

- 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) 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 model contains the following two layers:
    - Layer 1 represents the Pecos Valley Aquifer, Edwards Group and equivalent limestone hydrostratigraphic units of the Edwards-Trinity (Plateau) Aquifer, and undifferentiated Trinity Group hydrostratigraphic units or equivalent units of the Edwards-Trinity (Plateau) Aquifer, and
    - Layer 2 represents the Edwards Group and equivalent limestone hydrostratigraphic units of the Edwards-Trinity (Plateau) Aquifer and the undifferentiated Trinity Group hydrostratigraphic units or equivalent units of the Edwards-Trinity (Plateau) Aquifer.
- Water budget terms were averaged for the period 1981 through 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 model results for the Capitan Reef Complex, Rustler, Dockum, Pecos Valley, and Edwards-Trinity (Plateau) aquifers located within the Reeves County Groundwater Conservation District and averaged over the historical calibration period, 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. Figures 2, 4, 6, 8, and 10 provide a generalized diagram of the groundwater flow components provided 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 CAPITAN REEF COMPLEX AQUIFER THAT IS NEEDED FOR THE REEVES 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	Capitan Reef Complex Aquifer	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Capitan Reef Complex Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Capitan Reef Complex Aquifer	878
Estimated annual volume of flow out of the district within each aquifer in the district	Capitan Reef Complex Aquifer	774
Estimated net annual volume of flow between each aquifer in the district	From the Capitan Reef Complex Aquifer to the overlying stratigraphic units	115
	To the Capitan Reef Complex Aquifer from the Delaware basin	2

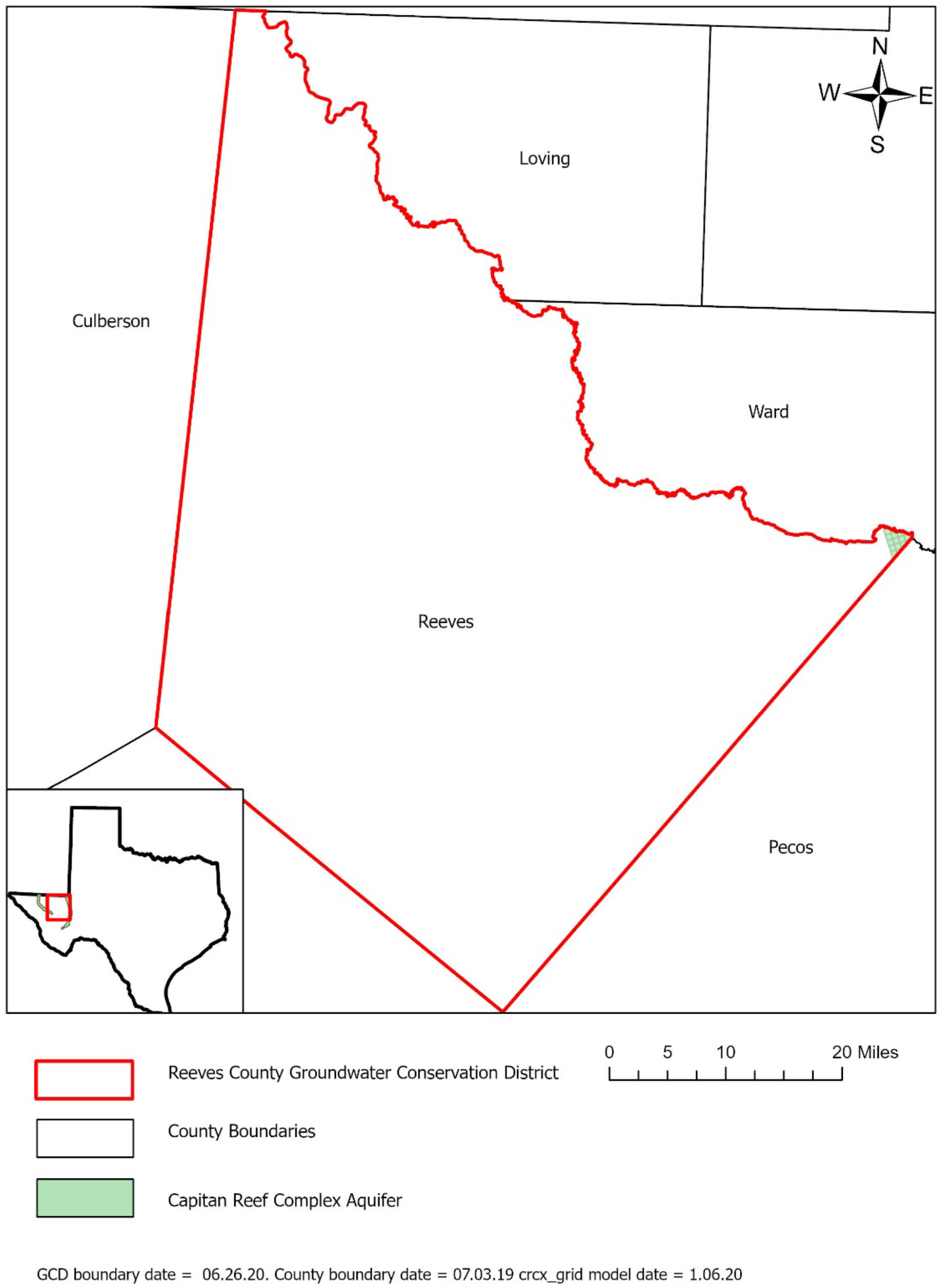
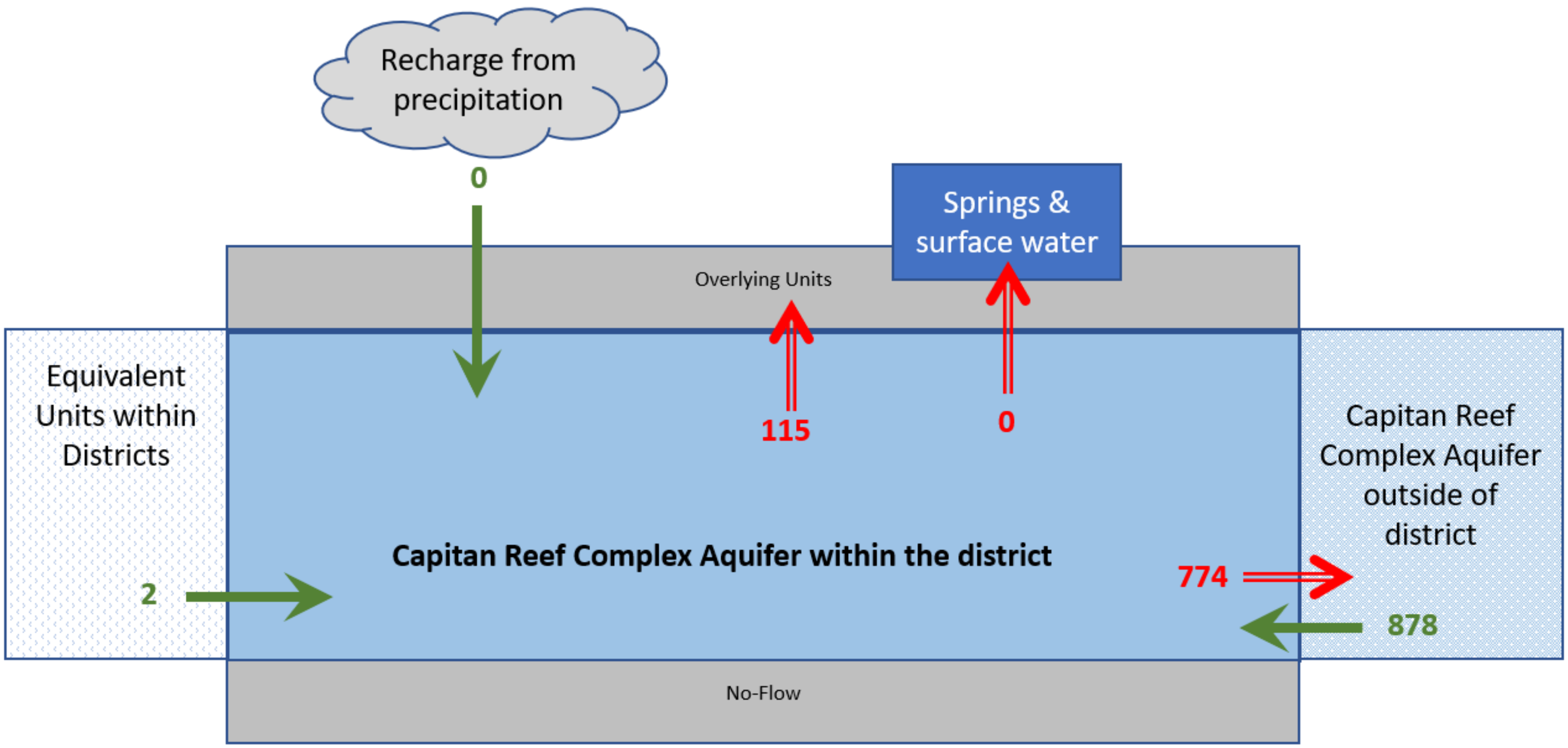


FIGURE 1: AREA OF GROUNDWATER AVAILABILITY MODEL FOR THE CAPITAN REEF COMPLEX AQUIFER SYSTEM FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE CAPITAN REEF COMPLEX AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).



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 CAPITAN REEF COMPLEX AQUIFER WITHIN REEVES COUNTY GROUNDWATER CONSERVATION DISTRICT. FLOW VALUES EXPRESSED IN ACRE-FEET PER YEAR.

TABLE 2: SUMMARIZED INFORMATION FOR THE RUSTLER AQUIFER THAT IS NEEDED FOR THE REEVES 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	Rustler Aquifer	147
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Rustler Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Rustler Aquifer	1,478
Estimated annual volume of flow out of the district within each aquifer in the district	Rustler Aquifer	322
Estimated net annual volume of flow between each aquifer in the district	From the Rustler Aquifer to the Dewey Lake/Dockum Equivalent Aquifer	1,332
	From the Rustler Aquifer to the Dockum Aquifer	1,452
	To the Rustler Aquifer from the Rustler equivalent units	27

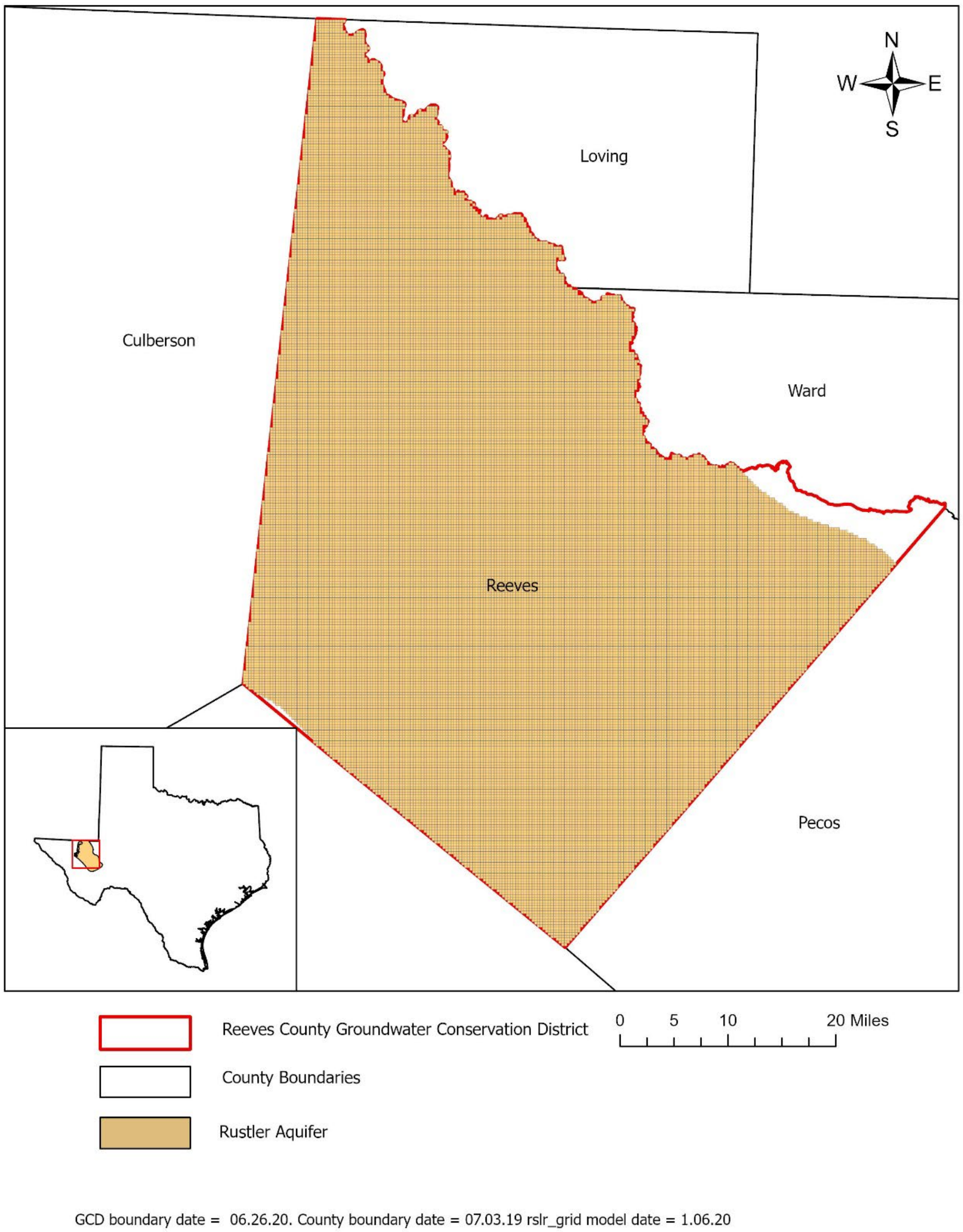
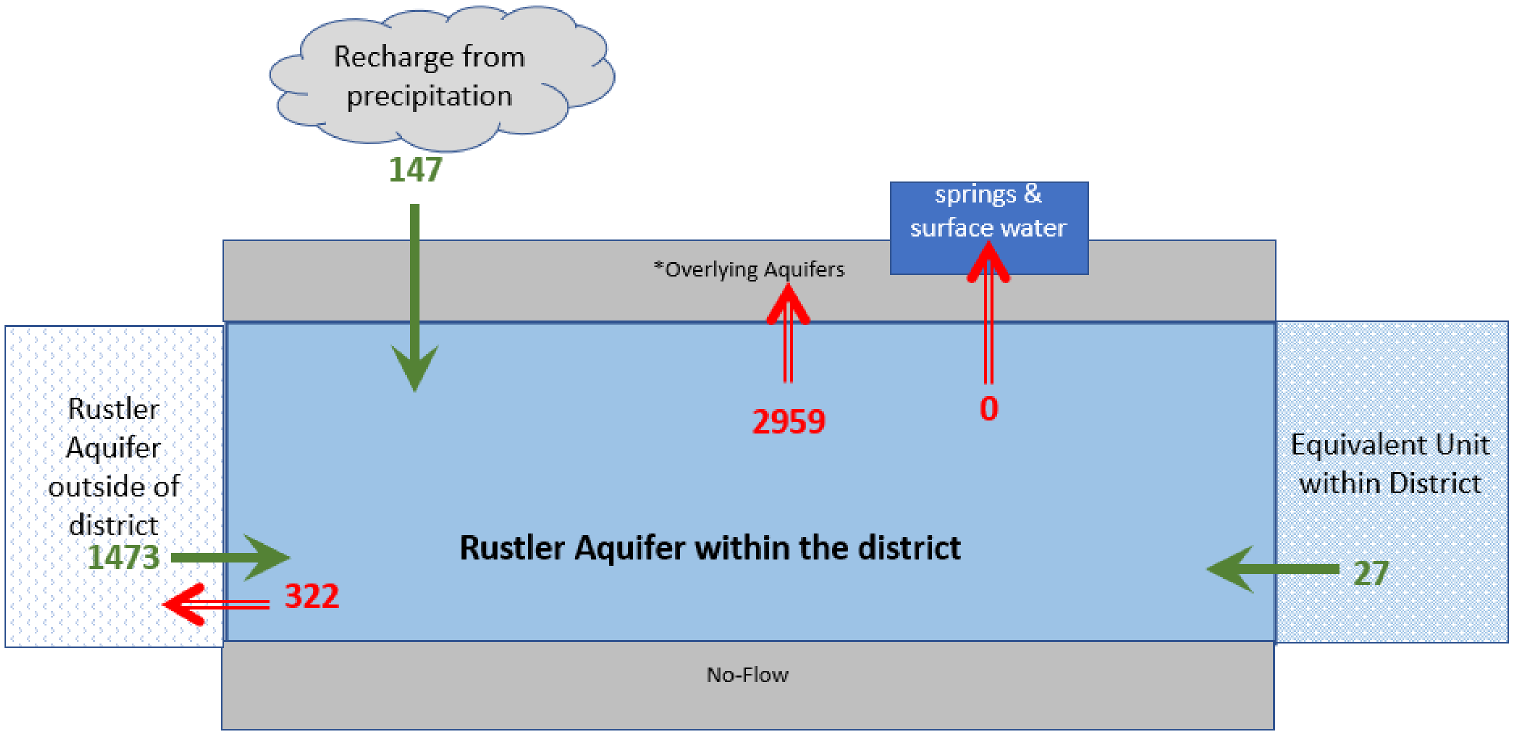


FIGURE 3: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR RUSTLER AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE RUSTLER AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).



*Flow from Overlying units includes net flow of 1,332 acre-feet per year from Rustler Aquifer to Dockum/Dewey Lake Equivalent Aquifer and 1,452 acre-feet from Rustler Aquifer to Dockum Aquifer

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 RUSTLER AQUIFER WITHIN REEVES COUNTY GROUNDWATER CONSERVATION DISTRICT. FLOW VALUES EXPRESSED IN ACRE-FEET PER YEAR.

TABLE 3: SUMMARIZED INFORMATION FOR THE DOCKUM AQUIFER THAT IS NEEDED FOR THE REEVES 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.

<table>
<tr><th>Management Plan requirement</th><th>Aquifer or confining unit</th><th>Results</th></tr>
<tr><td>Estimated annual amount of recharge from precipitation to the district</td><td>Dockum Aquifer</td><td>0</td></tr>
<tr><td>Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers</td><td>Dockum Aquifer</td><td>0</td></tr>
<tr><td>Estimated annual volume of flow into the district within each aquifer in the district</td><td>Dockum Aquifer</td><td>411</td></tr>
<tr><td>Estimated annual volume of flow out of the district within each aquifer in the district</td><td>Dockum Aquifer</td><td>351</td></tr>
<tr><td rowspan="2">Estimated net annual volume of flow between each aquifer in the district</td><td>From the Dockum Aquifer to the Pecos Valley Aquifer</td><td>211</td></tr>
<tr><td>To the Dockum Aquifer from the Edwards-Trinity (Plateau) Aquifer</td><td>285</td></tr>
</table>

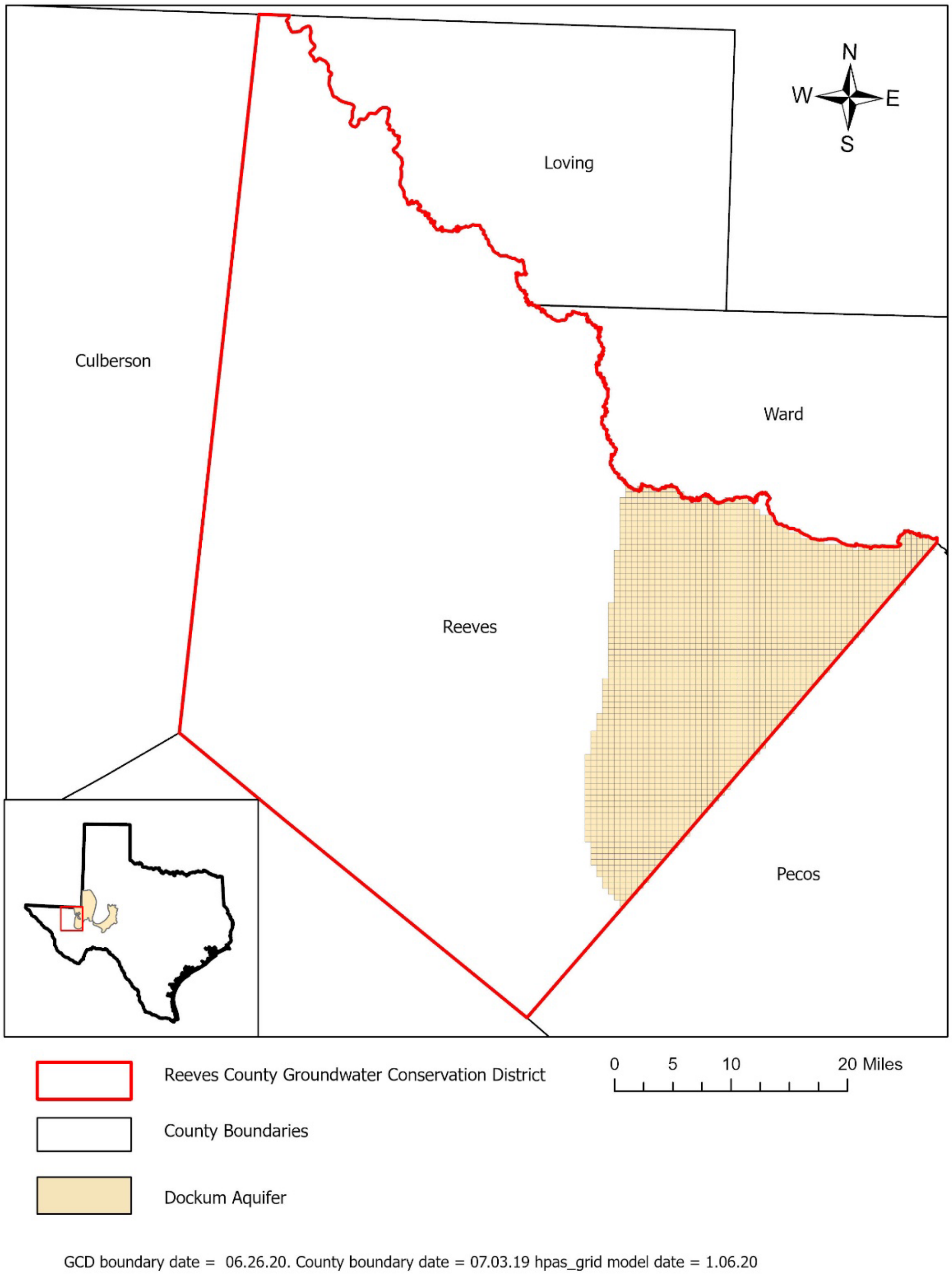
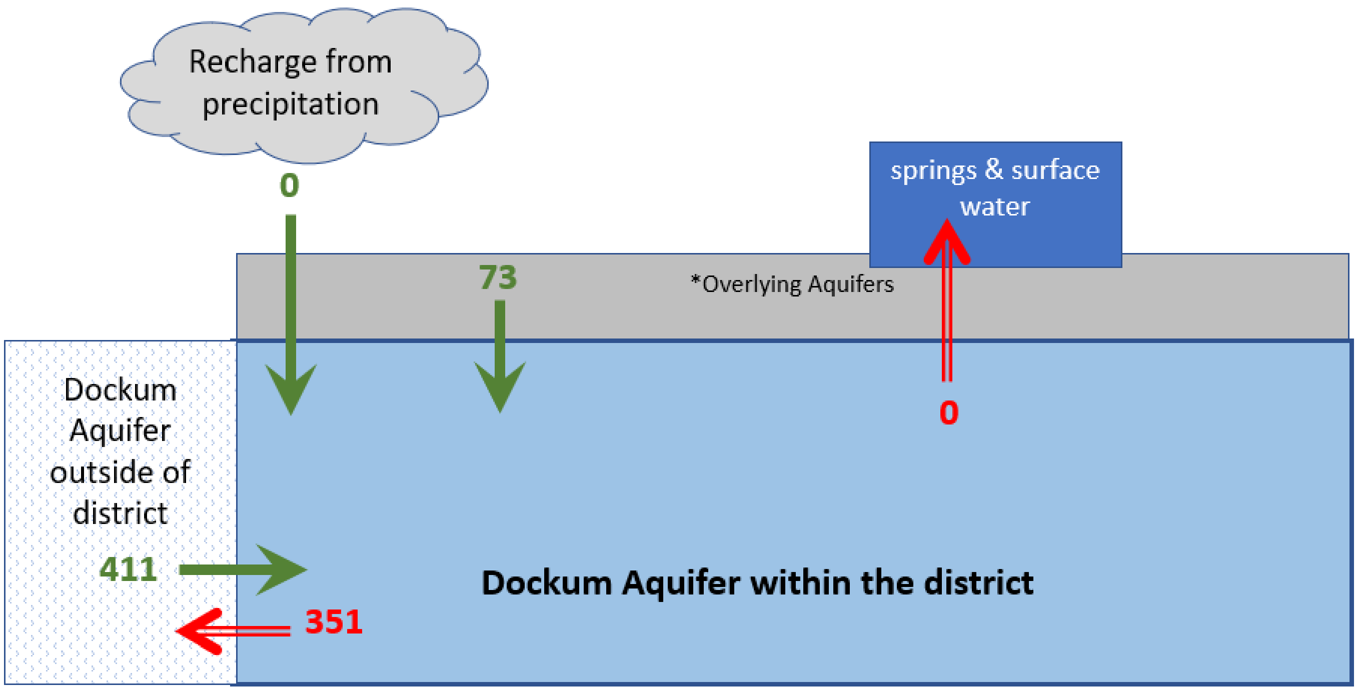


FIGURE 5: AREA OF THE HIGH PLAINS AQUIFER SYSTEM GROUNDWATER AVAILABILITY MODEL FROM WHICH THE INFORMATION IN TABLE 3 WAS EXTRACTED (THE DOCKUM AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).



*Flow from Overlying units includes net flow of 211 acre-feet per year to the Pecos Valley Aquifer and net flow of 284 acre-feet per year from Edwards – Trinity (Plateau)

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 REEVES COUNTY GROUNDWATER CONSERVATION DISTRICT. FLOW VALUES EXPRESSED IN ACRE-FEET PER YEAR.

TABLE 4: SUMMARIZED INFORMATION FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER THAT IS NEEDED FOR THE REEVES 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	Edwards-Trinity (Plateau) Aquifer	16,037
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	0
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	29,331
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	6
Estimated net annual volume of flow between each aquifer in the district	From the Edwards-Trinity (Plateau) Aquifer to the Pecos Valley Aquifer	42,647
	From the Edwards-Trinity (Plateau) Aquifer to the Edwards-Trinity (Plateau) Aquifer Equivalent	1,093

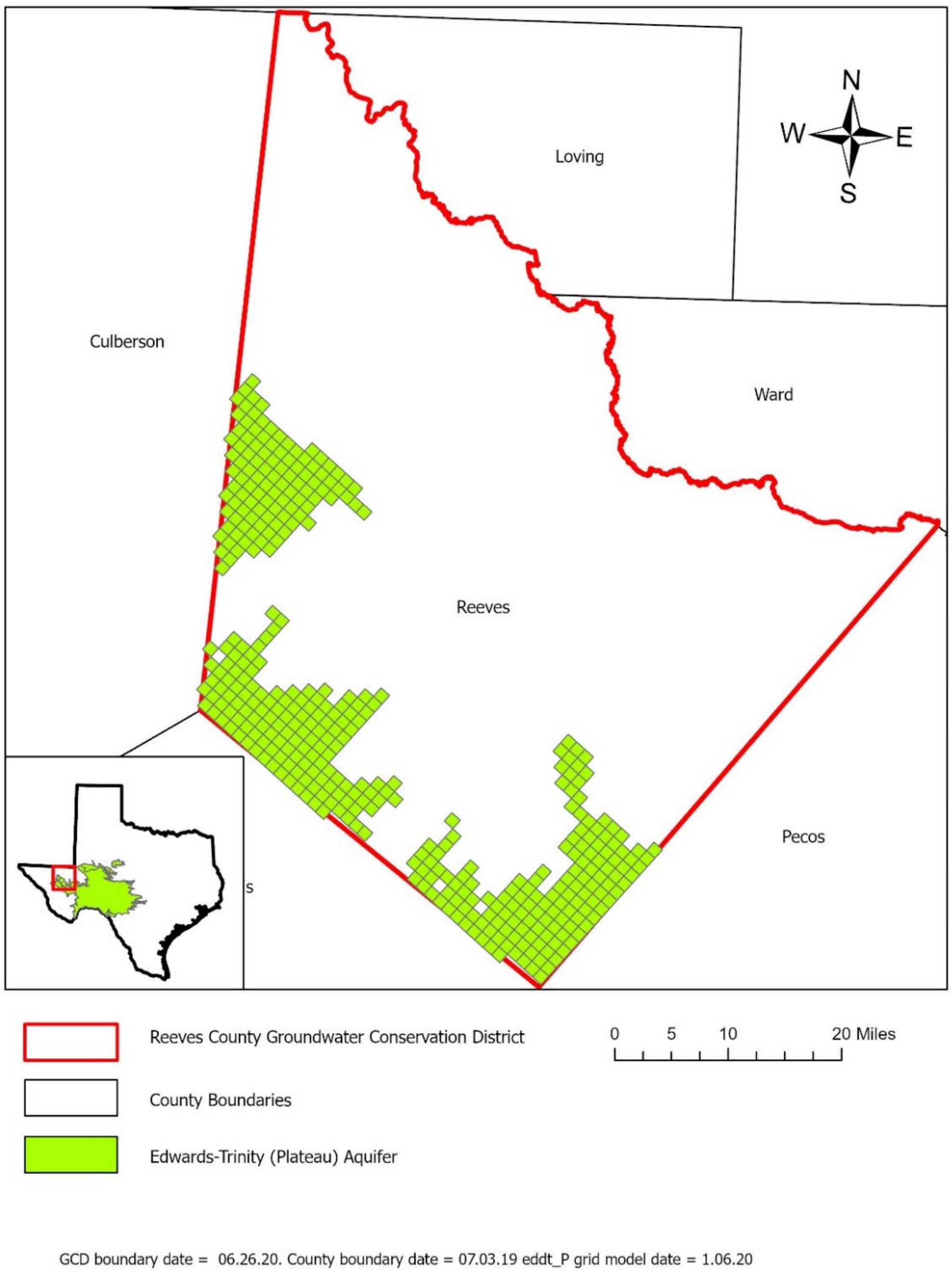
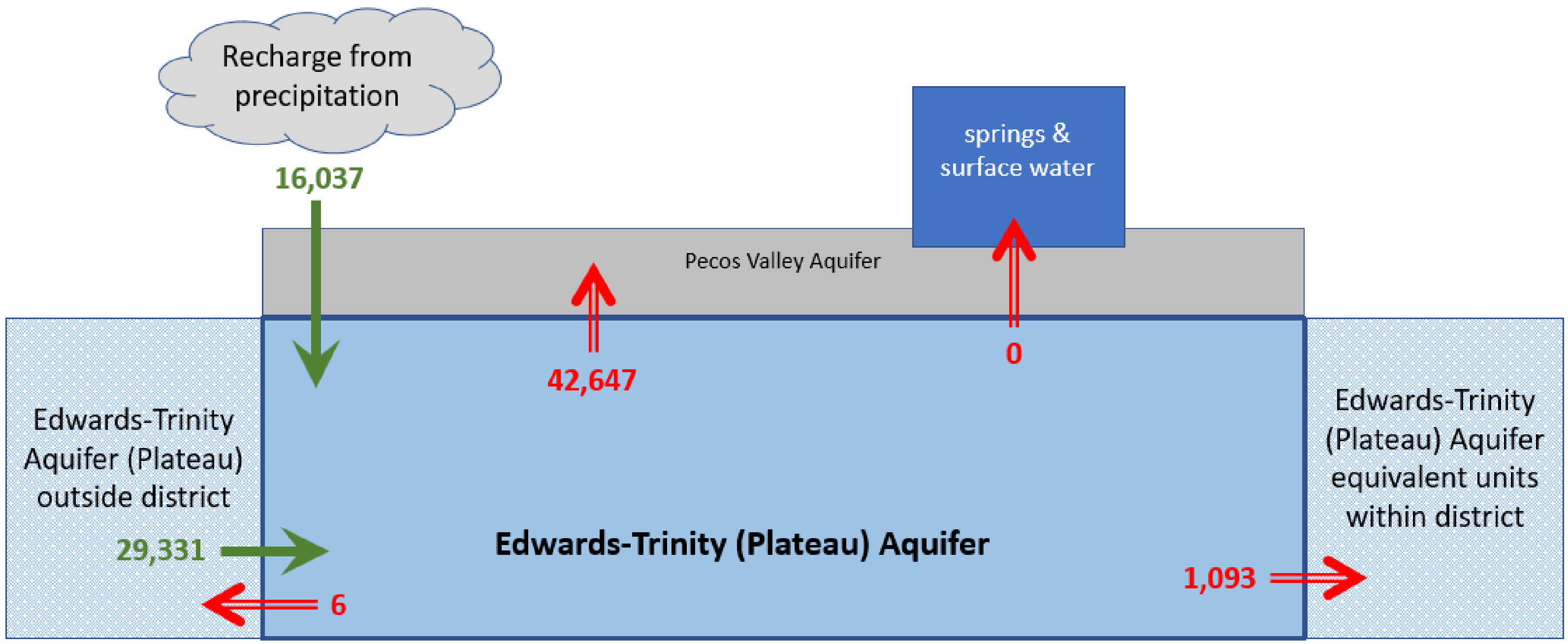


FIGURE 7: AREA OF THE EDWARDS-TRINITY (PLATEAU) AND PECOS VALLEY AQUIFERS GROUNDWATER AVAILABILITY MODEL FROM WHICH THE INFORMATION IN TABLE 4 WAS EXTRACTED (THE EDWARDS-TRINITY (PLATEAU) AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).



Caveat: This diagram only includes the water budget items provided in Table 4. 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 8: GENERALIZED DIAGRAM OF THE SUMMARIZED BUDGET INFORMATION FROM TABLE 4, REPRESENTING DIRECTIONS OF FLOW FOR THE EDWARDS-TRINITY (PLATAEU) AQUIFER WITHIN REEVES COUNTY GROUNDWATER CONSERVATION DISTRICT. FLOW VALUES EXPRESSED IN ACRE-FEET PER YEAR.

TABLE 5: SUMMARIZED INFORMATION FOR THE PECOS VALLEY AQUIFER THAT IS NEEDED FOR THE REEVES 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	Pecos Valley Aquifer	65,480
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Pecos Valley Aquifer	51,531
Estimated annual volume of flow into the district within each aquifer in the district	Pecos Valley Aquifer	12,279
Estimated annual volume of flow out of the district within each aquifer in the district	Pecos Valley Aquifer	17,948
Estimated net annual volume of flow between each aquifer in the district	To the Pecos Valley Aquifer from the Edwards-Trinity (Plateau) Aquifer	42,647
	To the Pecos Valley Aquifer from the Edwards-Trinity (Plateau) Aquifer equivalent units	1,403

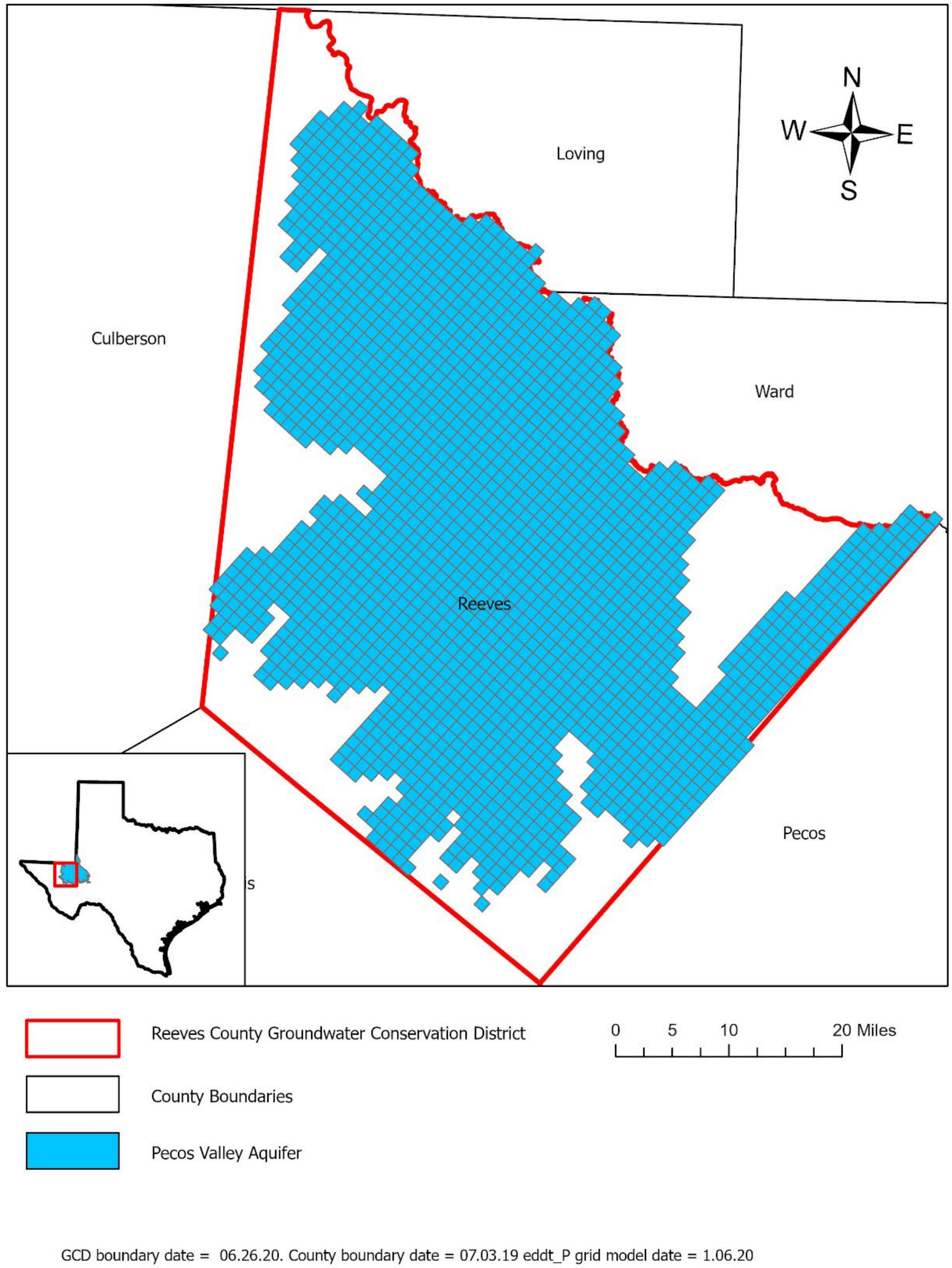
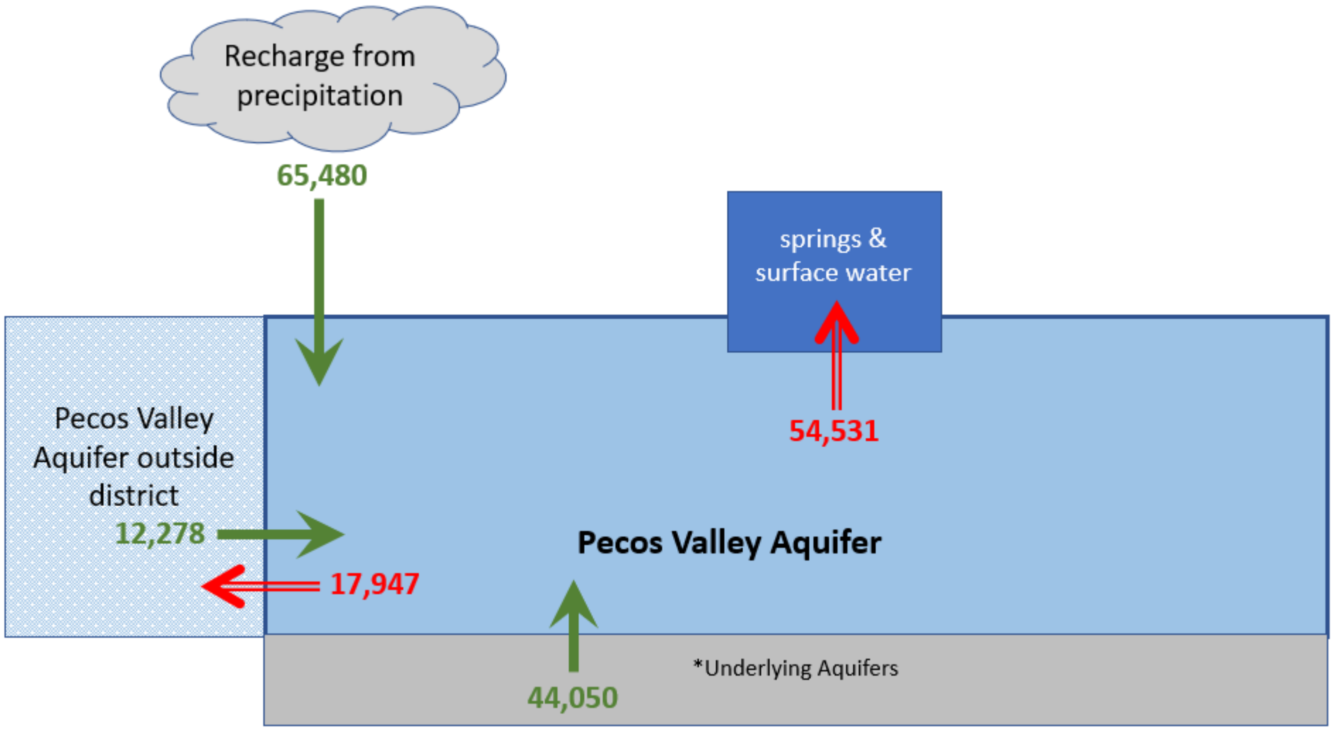


FIGURE 9: AREA OF THE EDWARDS-TRINITY (PLATEAU) AND PECOS VALLEY AQUIFERS GROUNDWATER AVAILABILITY MODEL FROM WHICH THE INFORMATION IN TABLE 5 WAS EXTRACTED (THE PECOS VALLEY AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).



*Flow from Underlying units includes net flow of 42,647 acre-feet per year to Pecos Valley Aquifer from Edwards-Trinity (Plateau), 1,403 acre-feet per year to Pecos Valley Aquifer from Edwards-Trinity (Plateau) equivalent

Caveat: This diagram only includes the water budget items provided in Table 5. 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 10: GENERALIZED DIAGRAM OF THE SUMMARIZED BUDGET INFORMATION FROM TABLE 5, REPRESENTING DIRECTIONS OF FLOW FOR THE PECOS VALLEY AQUIFER WITHIN REEVES COUNTY GROUNDWATER CONSERVATION DISTRICT. FLOW VALUES 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 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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