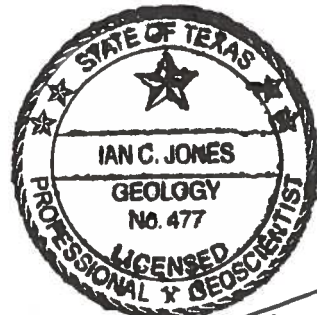

GAM RUN 18-001: REEVES COUNTY GROUNDWATER CONSERVATION DISTRICT GROUNDWATER MANAGEMENT PLAN

Ian C. Jones, Ph.D., P.G.
Texas Water Development Board
Groundwater Division
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May 11, 2018



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April 30, 2018

EXECUTIVE SUMMARY:

Texas State Water Code, Section 36.1071, Subsection (h) (Texas Water Code, 2015), 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 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 Reeves County Groundwater Conservation District should be adopted by the district on or before August 5, 2018, and submitted to the Executive Administrator of the TWDB on or before September 4, 2018. The management

plan for the Reeves County Groundwater Conservation District must be approved by the TWDB on or before November 3, 2018.

We used four groundwater availability models to estimate the management plan information for the aquifers within the Reeves County Groundwater Conservation District. 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). 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 Rustler Aquifer is from version 1.01 of the groundwater availability model for the Rustler Aquifer (Ewing and others, 2012). Information for the Capitan Reef Complex Aquifer is from version 1.01 of the groundwater availability model for the Capitan Reef Complex Aquifer (Jones, 2016). 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.

Tables 1 through 5 summarize the groundwater availability model data required by statute and Figures 1 through 4 show the area of the models from which the values in the tables were extracted. 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.

METHODS:

In accordance with the provisions of the Texas State Water Code, Section 36.1071, Subsection (h), the groundwater availability models for the aquifer mentioned above were used to estimate information for the Reeves County Groundwater Conservation District management plan. Water budgets were extracted for the historical model period using ZONEBUDGET Version 3.01 (Harbaugh, 2009). The historical model periods used were 1981 through 2000 for the Edwards-Trinity (Plateau) and Pecos Valley aquifers, 1980 through 2012 for the Dockum Aquifer, 1980 through 2008 for the Rustler Aquifer, and 1980 through 2005 for the Capitan Reef Complex Aquifer. 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) and Pecos Valley Aquifers

- 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 groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers.
- The Edwards-Trinity (Plateau) and Pecos Valley aquifers model includes two active layers; however, in the area underlying the district, Layer 1 represents the Pecos Valley alluvium, the Edwards Group and equivalent limestone hydrostratigraphic units, and the undifferentiated Trinity Group hydrostratigraphic units. We assumed certain model cells are assigned to the Pecos Valley Aquifer and the remaining cells are assigned to the Edwards-Trinity (Plateau) Aquifer.
- The model was run with MODFLOW-96 (Harbaugh and McDonald, 1996).

Dockum Aquifer

- We used version 1.01 of the groundwater availability model for the High Plains Aquifer System. See Deeds and Jigmond (2015) for assumptions and limitations of the model.
- The groundwater availability model for the High Plains Aquifer System contains four layers:
 - Layer 1—the Ogallala Aquifer and the Pecos Valley Alluvium Aquifer.
 - Layer 2—the Rita Blanca Aquifer, the Edwards-Trinity (High Plains) Aquifer, the Edwards-Trinity (Plateau) Aquifer.
 - Layer 3—the upper Dockum Group.
 - Layer 4—the lower Dockum Group.
- While the model for the High Plains Aquifer System includes the Pecos Valley Alluvium and Edwards-Trinity (Plateau) aquifers, the focus of the model run was to extract information for the Dockum Aquifer.
- The model was run with MODFLOW-NWT (Niswonger and others, 2011).

Rustler Aquifer

- We used version 1.01 of the groundwater availability model for the Rustler Aquifer Groundwater Availability Model (Ewing and Others, 2012). 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.
- The model was run with MODFLOW-2000 (Harbaugh and Others, 2000).

Capitan Reef Complex Aquifer

- We used version 1.01 of the groundwater availability model for the Capitan Reef Complex Aquifer Groundwater Availability Model (Jones, 2016). 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 (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.
- The model was run with MODFLOW-2005 (Harbaugh, 2005).

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 Pecos Valley, Edwards-Trinity (Plateau), Dockum, Rustler, and Capitan Reef

Complex aquifers located within Reeves County Groundwater Conservation District and averaged over the historical calibration periods, 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. 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 PECOS VALLEY AQUIFER FOR 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	65,380
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	12,033
Estimated annual volume of flow out of the district within each aquifer in the district	Pecos Valley Aquifer	18,111
Estimated net annual volume of flow between each aquifer in the district	Flow from Edwards-Trinity (Plateau) Aquifer to the Pecos Valley Aquifer	44,055
	Flow from the Rustler Aquifer to the Pecos Valley Aquifer	979*

* - From the groundwater availability model for the Rustler Aquifer.

TABLE 2. SUMMARIZED INFORMATION FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER FOR 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	16,343
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	29,335
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	Flow from Edwards-Trinity (Plateau) Aquifer to the Pecos Valley Aquifer	44,055
	Flow from the Rustler Aquifer to the Edwards-Trinity (Plateau) Aquifer	522*

* - From the groundwater availability model for the Rustler Aquifer.

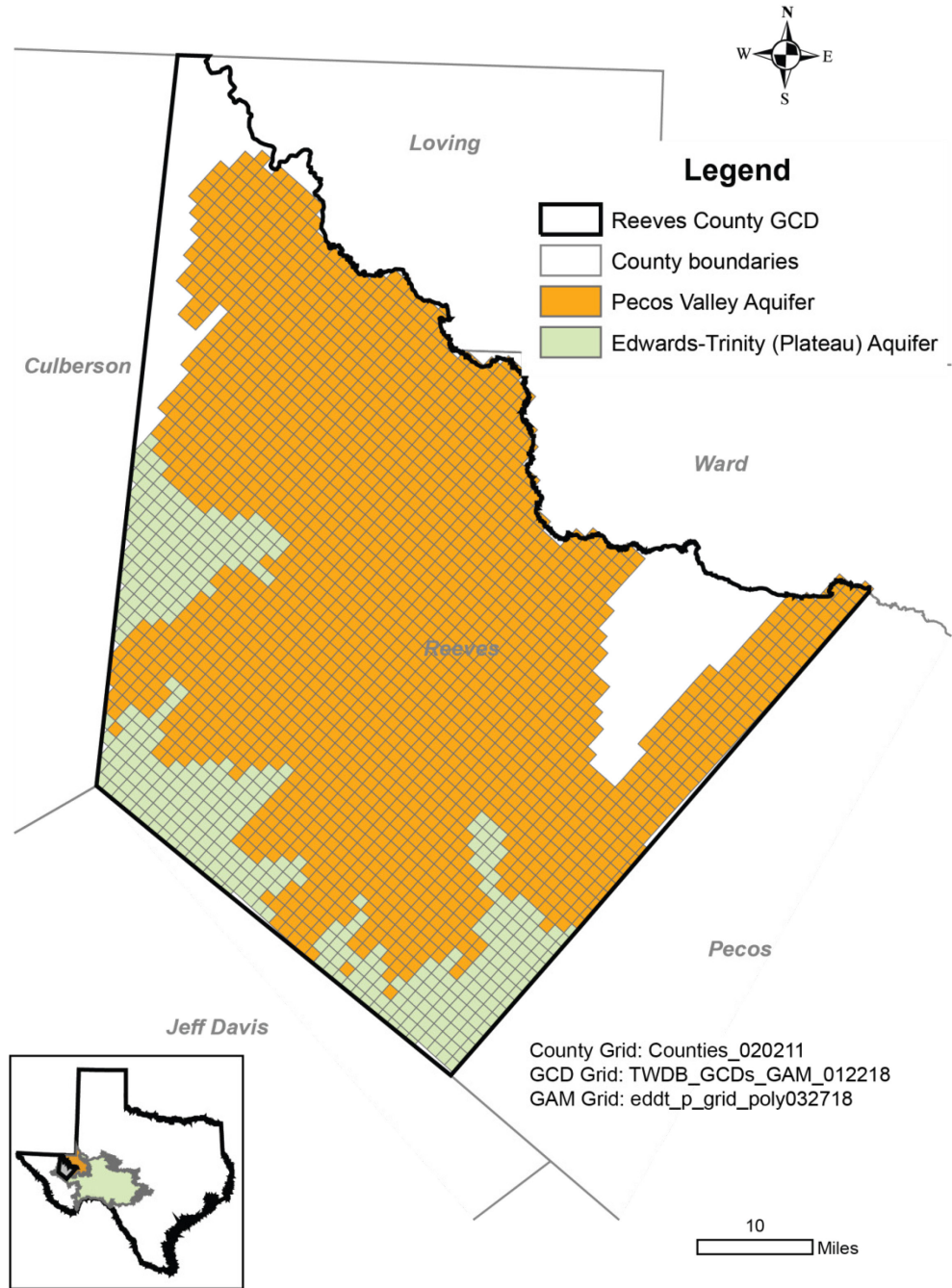


FIGURE 1. AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AND PECOS VALLEY AQUIFERS FROM WHICH THE INFORMATION IN TABLES 1 AND 2 WAS EXTRACTED (THE EDWARDS-TRINITY (PLATEAU) AND PECOS VALLEY AQUIFERS EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 3. SUMMARIZED INFORMATION FOR THE DOCKUM AQUIFER FOR 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	Dockum Aquifer	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface-water body including lakes, streams, and rivers	Dockum Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Dockum Aquifer	648
Estimated annual volume of flow out of the district within each aquifer in the district	Dockum Aquifer	490
Estimated net annual volume of flow between each aquifer in the district	Flow from Edwards-Trinity (Plateau) and Pecos Valley aquifers to underlying Dockum Aquifer	72
	Flow from Rustler Aquifer to Dockum Aquifer	1,446*

* - From the groundwater availability model for the Rustler Aquifer.

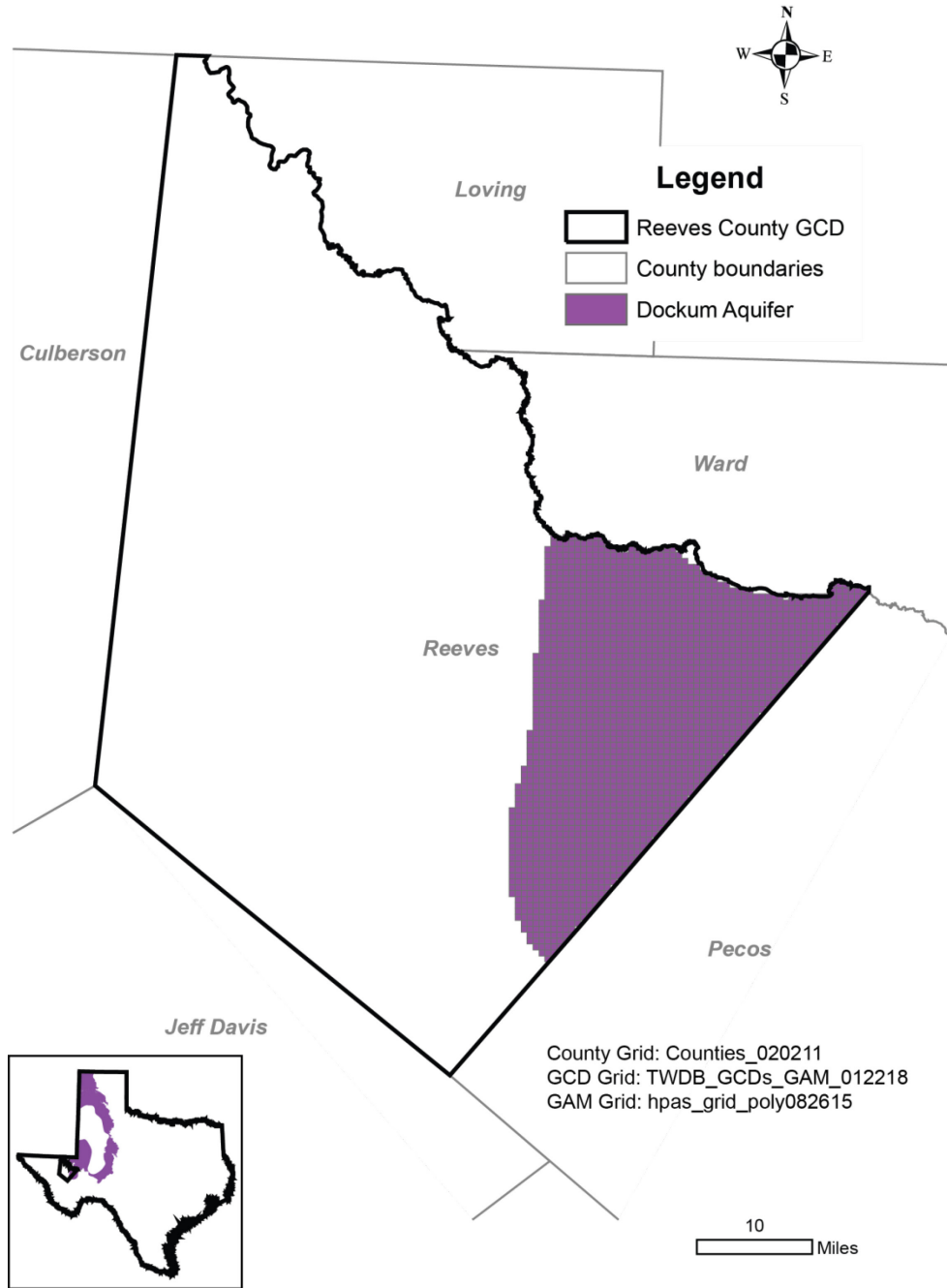


FIGURE 2. AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE HIGH PLAINS AQUIFER SYSTEM FROM WHICH THE INFORMATION IN TABLE 3 WAS EXTRACTED (THE DOCKUM AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 4. SUMMARIZED INFORMATION FOR THE RUSTLER AQUIFER FOR 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	146
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	1,498
Estimated annual volume of flow out of the district within each aquifer in the district	Rustler Aquifer	281
Estimated net annual volume of flow between each aquifer in the district	Flow from Rustler Aquifer to Dockum Aquifer	1,446
	Flow from Rustler Aquifer to Edwards-Trinity (Plateau) Aquifer	522
	Flow from Rustler Aquifer to Pecos Valley Aquifer	979
	Flow from overlying stratigraphic units to Rustler Aquifer	163
	From Rustler Aquifer to saline Rustler Formation	38

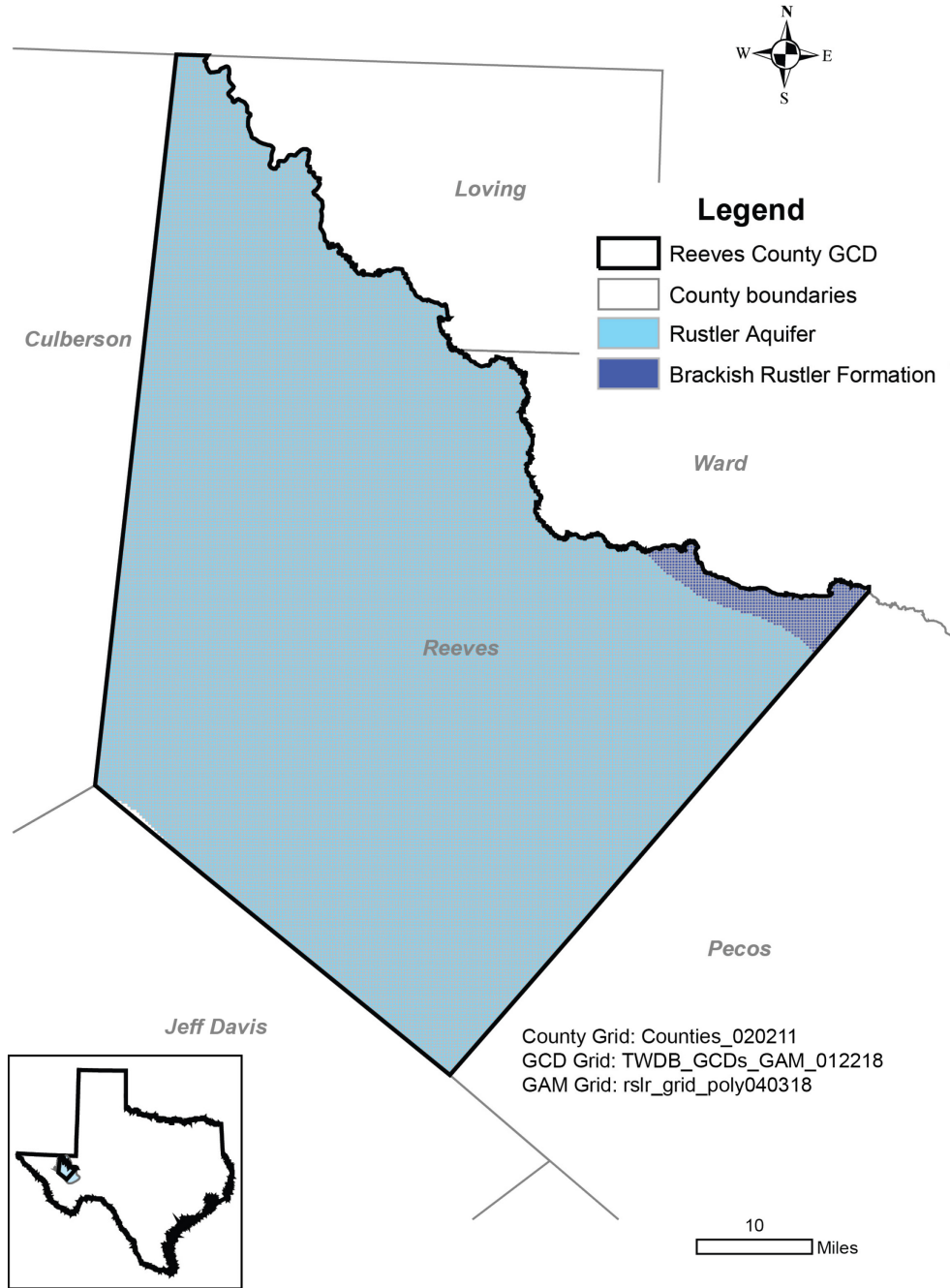


FIGURE 3. AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE RUSTLER AQUIFER FROM WHICH THE INFORMATION IN TABLE 4 WAS EXTRACTED (THE RUSTLER AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 5. SUMMARIZED INFORMATION FOR THE CAPITAN REEF COMPLEX AQUIFER FOR 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	859
Estimated annual volume of flow out of the district within each aquifer in the district	Capitan Reef Complex Aquifer	755
Estimated net annual volume of flow between each aquifer in the district	Flow from Capitan Reef Complex Aquifer to overlying stratigraphic units	114
	From Capitan Reef Complex Aquifer to Delaware Mountain Group	1

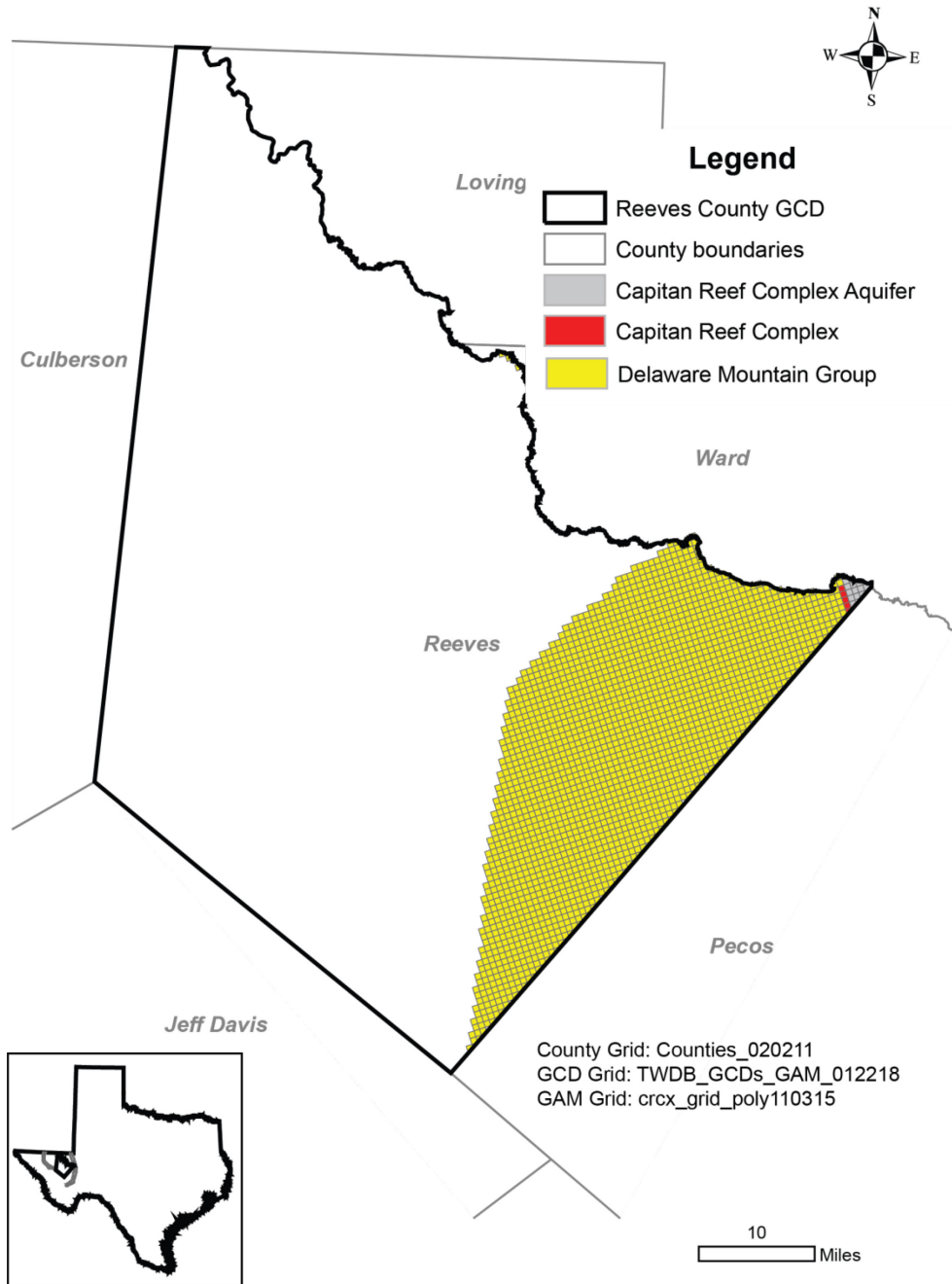


FIGURE 4. AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE CAPITAN REEF COMPLEX AQUIFER FROM WHICH THE INFORMATION IN TABLE 5 WAS EXTRACTED (THE CAPITAN REEF COMPLEX AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

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 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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