GAM Run 13-020: Brewster County Groundwater Conservation District Groundwater Management Plan

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Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 463-5076
October 7, 2013

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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, groundwater conservation districts shall use groundwater availability modeling information provided by the executive administrator of the Texas Water Development Board in conjunction with any available site-specific information provided by the district to the executive administrator for review and comment. Information derived from groundwater availability models that shall be used 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.

The purpose of this report is to provide Part 2 of a two-part package of information to Brewster County Groundwater Conservation District for its groundwater management plan. Part 1 of the two-part package is the Historical Water Use/State Water Plan data report. The District should have received, or will receive, Part 1 from the TWDB Groundwater Technical Assistance Section. Questions about Part 1 can be directed to Mr. Stephen Allen, stephen.allen@twdb.texas.gov, (512) 463-7317.

The groundwater management plan for Brewster County Groundwater Conservation District should be adopted by the district on or before March 13, 2014 and submitted to the executive administrator of the TWDB on or before April 12, 2014. The current management plan for Brewster County Groundwater Conservation District expires on June 11, 2014.

This report discusses the methods and results from a model run using the Groundwater Availability Models for the Edwards-Trinity (Plateau) Aquifer (Anaya and Jones,2009), the Igneous and parts of the West Texas Bolsons (Wild Horse Flat, Michigan Flat, Ryan Flat and Lobo Flat) Aquifers (Beach and Others, 2004), and the Rustler Aquifer (Ewing and Others, 2012). This model run replaces the results of GAM Run 07-008 (Smith, 2007). GAM Run 13-020 meets current standards set after the release of GAM Run 07-008.

Tables 1, 2 and 3 summarize the groundwater availability model data for the official aquifers required by the statute. Figures 1, 2, and 3 show the areas of the models from which the values in the tables were extracted. If, after review of the figure, Brewster County Groundwater Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the Texas Water Development Board immediately.

Although the Capitan Reef Complex Aquifer and the Marathon Aquifer are also within the Brewster County Groundwater Conservation District, groundwater availability models for these two aquifers have not been developed at this time. The district may request information for these aquifers from the Groundwater Technical Assistance Section of the Texas Water Development Board.

METHODS:

In accordance with the provisions of the Texas State Water Code, Section 36.1071, Subsection (h), the groundwater availability models for the Edwards-Trinity (Plateau) Aquifer (Anaya and Jones, 2009), the Igneous and parts of the West Texas Bolsons (Wild Horse Flat, Michigan Flat, Ryan Flat and Lobo Flat) Aquifers (Beach and Others, 2004), and the Rustler Aquifer (Ewing and Others, 2012) were run for this analysis. Brewster County Groundwater Conservation District water budgets for selected historical periods were extracted from MODFLOW cell-by-cell flow budget files using ZONEBUDGET Version 3.01 (Harbaugh, 2009). The average annual water budget values for recharge, surface water outflow, lateral inflow to the district, lateral outflow from the district, and flow between aquifers/geologic units located within the district were then calculated and summarized in this report.

Edwards-Trinity (Plateau) Aquifer

- The Edwards-Trinity (Plateau) Aquifer Groundwater Availability Model (Anaya and Jones, 2009) was used for this management plan data analysis. The model contained 21 stress periods. Stress Period 1 was 1,000 years long representing a pseudo steady-state condition which simulated the hydraulic transition from pre-development condition to the end of 1980. Stress Periods 2 through 21 were one year long each representing the transient conditions from 1981 through 2000. Thus, only the data from 1981 through 2000 were extracted for the management plan analysis.

- The model has two active model layers representing the Edwards (Layer 1) and Trinity (Layer 2) hydrogeologic units. Thus, Layers 1 and 2 were lumped together as the Edwards-Trinity (Plateau) Aquifer for the management plan analysis. The distribution of the simulated Edwards-Trinity (Plateau) Aquifer in Brewster County Groundwater Conservation District is shown in Figure 1.

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

Igneous Aquifer

- The Igneous Aquifer Groundwater Availability Model (Beach and Others 2004) was used for this management plan data analysis. The model contained 52 stress periods. Stress Period 1 was 10,000,000 days long representing a pseudo steady-state condition which simulated the hydraulic transition from pre-development condition to the end of 1949. Stress Periods 2 through 52 were one year long each representing the transient conditions from 1950 through 2000. However, only the data from 1980 through 2000 were extracted for the management plan analysis. These dates were used to avoid skewing the data as a result of the drought of the 1950s. The period from 1980 to 2000 includes both drought and wet climatic conditions.

- The model has three active model layers representing the Salt Basin Bolson (Layer 1), Igneous Aquifer (Layer 2), and Underlying Cretaceous and Permian Units (Layer 3). Thus, Model Layer 2 was used for the management plan analysis. The distribution of the simulated Igneous Aquifer in Brewster County Groundwater Conservation District is shown in Figure 2. Please note that the Salt Basin Bolson Aquifer is not present in Brewster County Groundwater Conservation District.

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

Rustler Aquifer

- The Rustler Aquifer Groundwater Availability Model (Ewing and Others 2012) was used for this management plan data analysis. The model contained 91 stress periods. Stress Period 1 was a steady state to produce an initial head condition by the end of 1918 for the transient periods. Stress Periods 2 through 91 were one year long each representing the transient conditions from 1919 through 2008. However, only the data from 1980 through 2008 were extracted for the management plan analysis. These dates were used to avoid skewing the data as a result of the drought of the 1950s. The period from 1980 to 2008 includes both drought and wet climatic conditions.

- The model has two active layers representing the Dewey Lake Formation and Dockum Aquifer (Layer 1) and the Rustler Aquifer (Layer 2). Thus, Model Layer 2 was used for the management plan analysis. The distribution of the simulated Rustler Aquifer in Brewster County Groundwater Conservation District is shown in Figure 3. Please note that the Dockum Aquifer is not present in Brewster County Groundwater Conservation District.

- The model was run with MODFLOW-2000 (Harbaugh and Others, 2000).

RESULTS:

A groundwater budget summarizes the amount of water entering and leaving the aquifer. Selected components were extracted from the MODFLOW water budget files. These selected components are:

- Precipitation recharge — The spatially-distributed recharge due to precipitation within the district.

- Surface water outflow — The total water discharging from the aquifers to surface water features such as streams, reservoirs, and springs.

- Flow into and out of district — The lateral flow within the aquifers between the district and adjacent counties and other areas.

- Flow between aquifers — The net flow between 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.

The information needed for the District's management plan is summarized in Table 1 for the Edwards-Trinity (Plateau) Aquifer, Table 2 for the Igneous Aquifer, and Table 3 for the Rustler 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 district or county boundaries, 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 (Figures 1, 2 and 3).

LIMITATIONS

The groundwater model used for this analysis is the best available scientific tool to meet the stated objective. 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 streamflow are specific to a particular historic time period.

Because the application of the groundwater model was designed to address regional scale questions, the results are most effective on a regional scale. The TWDB makes

no warranties or representations relating 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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Texas Water Code, 2011, http://www.statutes.legis.state.tx.us/docs/WA/pdf/WA.36.pdf

TABLE 1: SUMMARIZED INFORMATION FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER THAT IS NEEDED FOR BREWSTER COUNTY GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE APPROXIMATE AND REPORTED IN ACRE-FEET PER YEAR.

Management Plan requirement	Aquifer and other units	Edwards-Trinity (Plateau) GAM Model (1981–2000)
Estimated annual amount of recharge from precipitation to the district	Edwards-Trinity (Plateau) Aquifer	5,002
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	8,263
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	8,643
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	6,454
Estimated net annual volume of flow between each aquifer in the district	Not Applicable*	Not Applicable*

*: The groundwater flow model assumed no flow between the Edwards-Trinity (Plateau) Aquifer and the underlying units.

TABLE 2: SUMMARIZED INFORMATION FOR THE IGNEOUS AQUIFER THAT IS NEEDED FOR BREWSTER COUNTY GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE APPROXIMATE AND REPORTED IN ACRE-FEET PER YEAR.

Management Plan requirement	Aquifer and other units	Igneous and Parts of West Texas Bolsons Aquifers GAM Model (1980–2000)
Estimated annual amount of recharge from precipitation to the district	Igneous Aquifer	6,584
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Igneous Aquifer	136
Estimated annual volume of flow into the district within each aquifer in the district	Igneous Aquifer	1,118
Estimated annual volume of flow out of the district within each aquifer in the district	Igneous Aquifer	1,364
Estimated net annual volume of flow between each aquifer in the district	From Igneous Aquifer to Cretaceous and Permian Units	3,472

TABLE 3: SUMMARIZED INFORMATION FOR THE RUSTLER AQUIFER THAT IS NEEDED FOR BREWSTER COUNTY GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE APPROXIMATE AND REPORTED IN ACRE-FEET PER YEAR.

Management Plan requirement	Aquifer and other units	Rustler Aquifer GAM Model (1980-2008)
Estimated annual amount of recharge from precipitation to the district	Rustler Aquifer	0
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	15*
Estimated annual volume of flow out of the district within each aquifer in the district	Rustler Aquifer	15
Estimated net annual volume of flow between each aquifer in the district	Between Rustler Aquifer and overlying units	0

*: Include flows from Jeff Davis County to the west and Davis Mountains to the south.

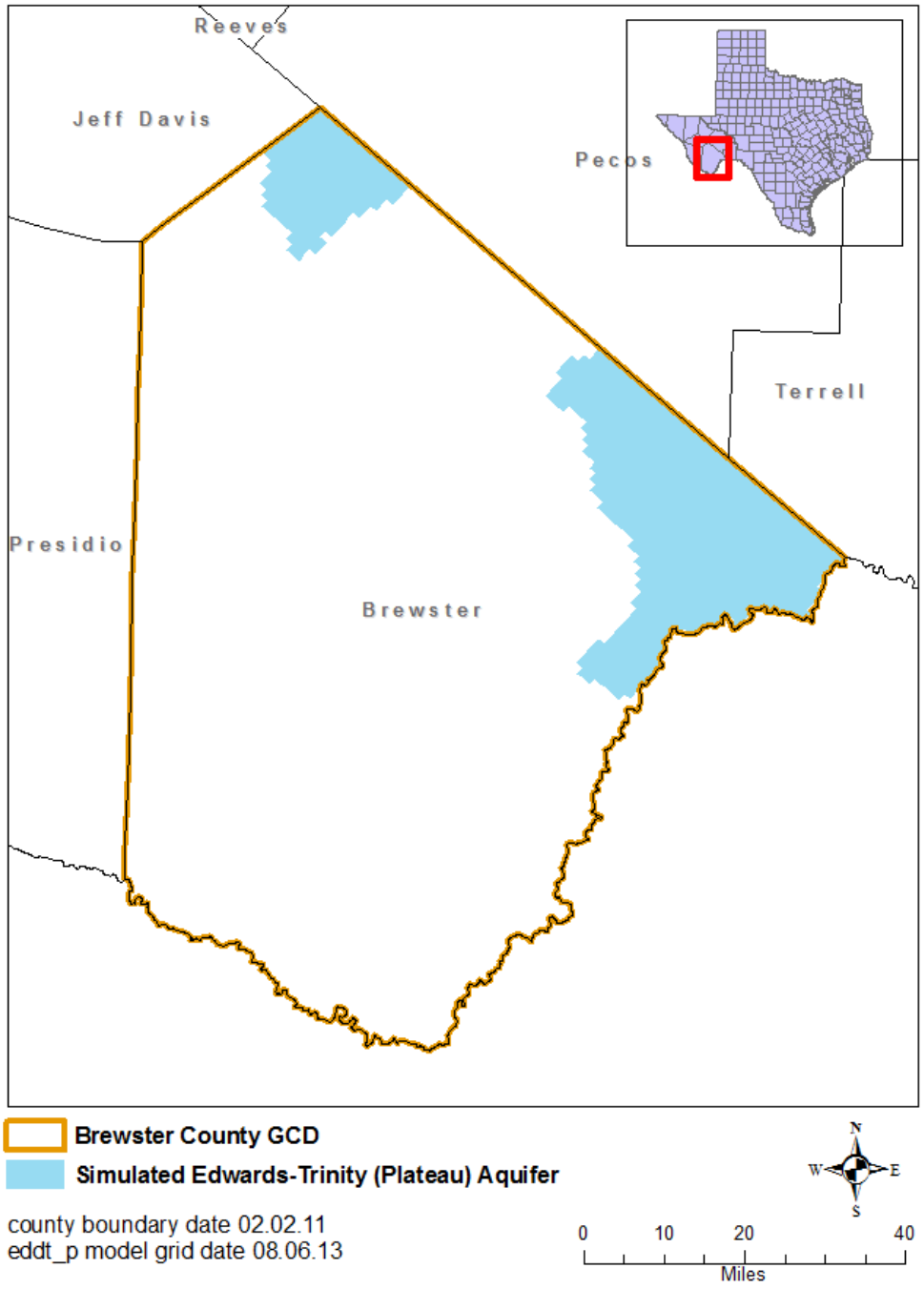

FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED FOR THE BREWSTER COUNTY GROUNDWATER CONSERVATION DISTRICT (GCD) MANAGEMENT PLAN.

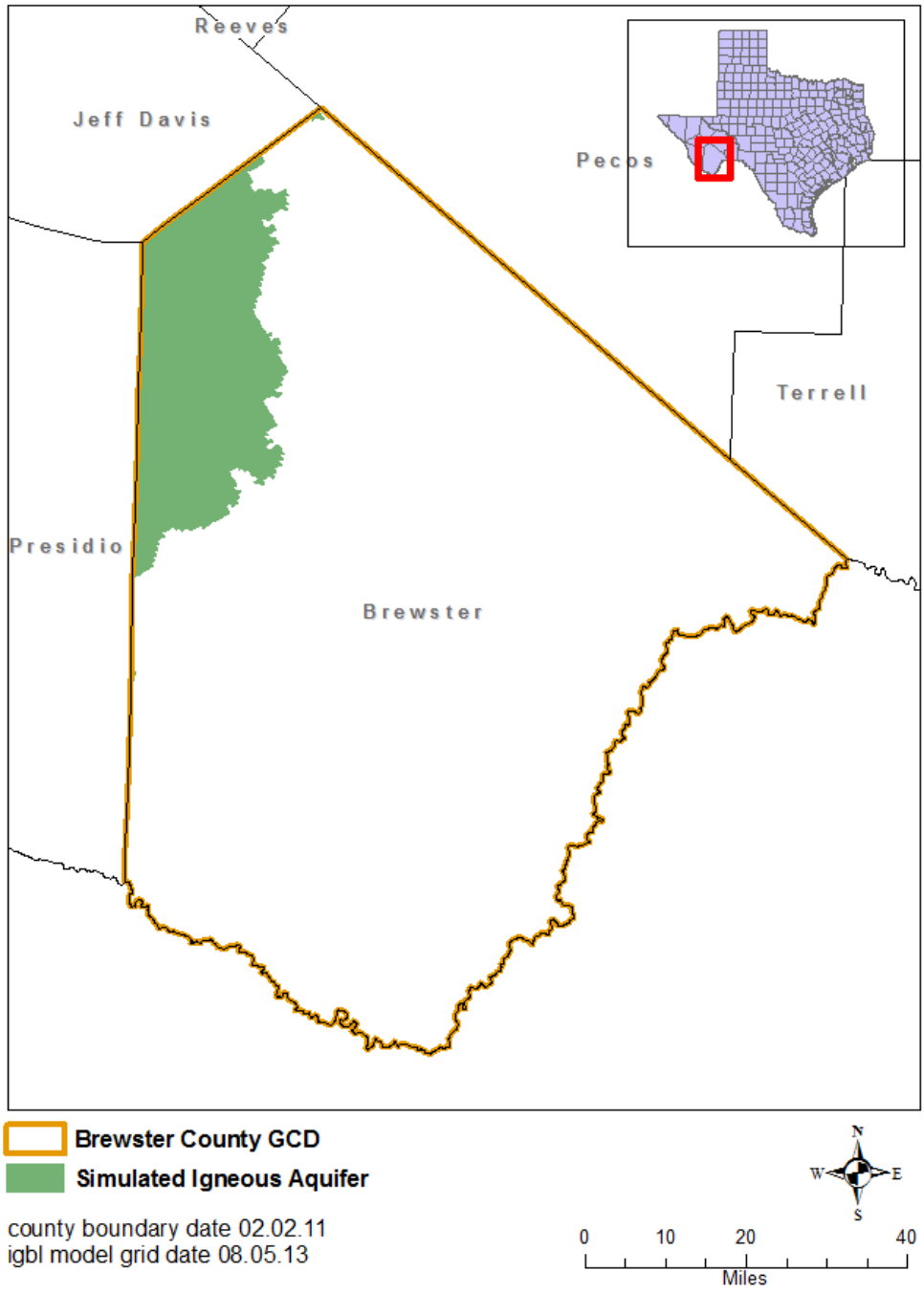

FIGURE 2: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE IGNEOUS AQUIFER AND PARTS OF THE WEST TEXAS BOLSONS (WILD HORSE FLAT, MICHIGAN FLAT, RYAN FLAT AND LOBO FLAT) AQUIFERS FROM WHICH THE INFORMATION IN TABLE 2 FOR THE IGNEOUS AQUIFER WAS EXTRACTED FOR THE BREWSTER COUNTY GROUNDWATER CONSERVATION DISTRICT (GCD) MANAGEMENT PLAN.

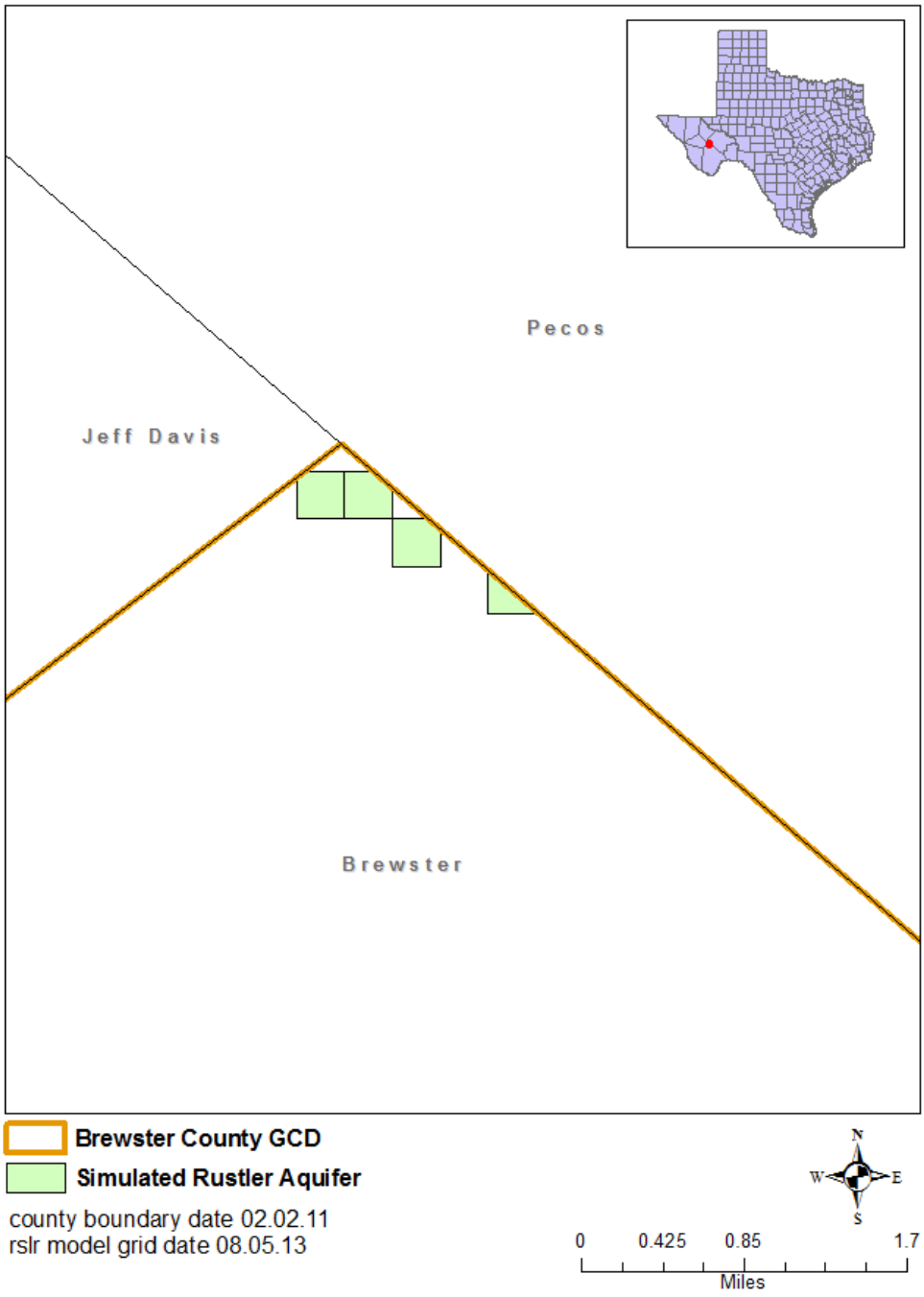

FIGURE 3: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE RUSTLER AQUIFER FROM WHICH THE INFORMATION IN TABLE 3 WAS EXTRACTED FOR THE BREWSTER COUNTY GROUNDWATER CONSERVATION DISTRICT (GCD) MANAGEMENT PLAN.