GAM RUN 13-030: WES-TEX

GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN

by Rohit Raj Goswami, Ph.D.
Texas Water Development Board
Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 463-0495
February 18, 2014

Cynthia K. Ridgeway is the Manager of the Groundwater Availability Modeling Section and is responsible for oversight of work performed by Rohit Raj Goswami under her direct supervision. The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G. 471 on February 18, 2014.

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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. Information derived from groundwater availability models that shall be included 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.

This report—Part 2 of a two-part package of information from the TWDB to Wes-Tex Groundwater Conservation District—fulfills the requirements noted above. Part 1 of the two-part package is the Historical Water Use/State Water Plan data report. The District will receive this data report from the TWDB Groundwater Technical Assistance Section. Questions about the data report can be directed to Mr. Stephen Allen, stephen.allen@twdb.texas.gov, (512) 463-7317.

The groundwater management plan for Wes-Tex Groundwater Conservation District should be adopted by the district on or before January 7, 2015 and submitted to the executive administrator of the TWDB on or before February 6, 2015. The current management plan for Wes-Tex Groundwater Conservation District expires on April 7, 2015.

This report discusses the methods, assumptions, and results from a model run using the groundwater availability models for the Edwards-Trinity (Plateau) Aquifer, Dockum Aquifer, and Seymour and Blaine aquifers. This model run replaces the results of GAM Run 09-013 (Aschenbach, 2009). GAM Run 13-030 meets current standards set after the release of GAM Run 09-013 including use of the extent of the official aquifer boundaries within the district rather than the entire active area of the model within the district. Tables 1, 2 and 3 summarize the groundwater availability model data required by statute, and Figures 1, 2 and 3 show the area of the model from which the values in the table were extracted. If after review of the figures, Wes-Tex 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.

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, Dockum Aquifer, and Seymour and Blaine aquifers were run for this analysis. Wes-Tex Groundwater Conservation District water budgets were extracted using ZONEBUDGET Version 3.01 (Harbaugh, 2009) for the historical model period (1) 1981 through 2000 for the Edwards-Trinity (Plateau) Aquifer and Blaine Aquifer and (2) 1980 through1997 for the Dockum Aquifer. The average annual water budget values for recharge, surface water outflow, inflow to the district, outflow from the district, net inter-aquifer flow (upper), and net inter-aquifer flow (lower) for the portion of the aquifer located within the district is summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Edwards-Trinity (Plateau) Aquifer

- 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 Pecos Valley Aquifer does not occur within Nolan County and therefore no groundwater budget values are included for it in this report.

- This groundwater availability model includes two layers which generally represent the Edwards Group (Layer 1) and the Trinity Group (Layer 2) of the Edwards-Trinity (Plateau) Aquifer. Individual water budgets for the District were determined for the Edwards-Trinity (Plateau) Aquifer (Layer 1 and Layer 2 combined).

- The Edwards Group and equivalent limestone hydrostratigraphic units (Layer 1) are believed to be present in Nolan County, but they are not saturated. Therefore, no results are presented in Table 1 for this portion of the aquifer.

- The Edwards-Trinity (Plateau) Aquifer model assumes a no-flow boundary between the undifferentiated Trinity Group hydrostratigraphic units (Layer 2) and any underlying formations.

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

Dockum Aquifer

- Version 1.01 of the groundwater availability model for the Dockum Aquifer was used for this analysis. See Ewing and others (2008) for assumptions and limitations of the groundwater availability model.

- This groundwater availability model includes three layers which generally represent the Ogallala, Edwards-Trinity (High Plains), Edwards-Trinity (Plateau), Pecos Valley, and Rita Blanca aquifers (Layer 1), the upper portion of the Dockum Aquifer (Layer2), and the lower portion of the Dockum Aquifer (Layer 3).

- The aquifers represented in Layer 1 of the groundwater availability model are only included in the model for the purpose of more accurately representing flow between these units and the Dockum Aquifer. This model is not intended to explicitly simulate flow in these overlying units (Ewing and others, 2008).

- The upper portion of the Dockum Aquifer, represented by Layer 2 of the groundwater availability model, is not present within the district. Therefore, no results are presented in Table 2 for this portion of the aquifer.

- The MODFLOW Drain package was used to simulate both evapotranspiration and springs. However, there are no spring cells defined in the portion of the model grid that covers the district. Therefore, all flows determined by the Drain package for the district are considered to be evapotranspiration and are not included in the results for the surface water outflow presented in Table 2.

- The Dockum Aquifer is underlain by Permian-age sediments. Vertical flow between the Dockum Aquifer and the underlying Permian was assumed to be negligible and a no-flow boundary was set at the base of the Dockum Aquifer (Ewing and others, 2008).
- Groundwater in the Dockum Aquifer ranges from fresh to brine in composition (Ewing and others, 2008). Groundwater with total dissolved solids of less than 1,000 milligrams per liter are considered fresh, total dissolved solids of 1,000 to 10,000 milligrams per liter are considered brackish, and total dissolved solids greater than 35,000 milligrams per liter are considered brines.
- The model was run with MODFLOW-2000 (Harbaugh and others, 2000).

Blaine Aquifer

- We used version 1.01 of the groundwater availability model for the Seymour and Blaine aquifers. See Ewing and others (2004) for assumptions and limitations of the model.
- The model includes two layers representing the Seymour Aquifer (Layer 1) and the Blaine Aquifer and other Permian-age sediments (Layer 2). In areas where the Blaine Aquifer does not exist the model roughly replicates the various Permian units located in the study area.
- Seymour Aquifer, represented by Layer 1 of the groundwater availability model, is not present within the district. Therefore, no results are presented in Table 3 for this portion of the aquifer.
- Average annual recharge conditions were assumed in the simulation based on 1975 to 1999 climate data.
- 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 according to the groundwater availability model. Selected groundwater budget components listed below were extracted from the model results for the aquifers located within the district and averaged over the duration of the calibration and verification portion of the model run in the district, as presented in Tables 1, 2 and 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 district—The lateral flow within the aquifer between the district and adjacent counties.

- 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 or confining unit and aquifer properties of each aquifer or confining unit that define the amount of leakage that occurs. “Inflow” to an aquifer from an overlying or underlying aquifer will always equal the “Outflow” from the other 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 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 EDWARDS-TRINITY (PLATEAU) AQUIFER THAT IS NEEDED FOR WES-TEX 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	11,385
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	10,813
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	215
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	1,197
Estimated net annual volume of flow between each aquifer in the district	*Not Applicable (NA)	NA*

*Not applicable because model assumes a no-flow boundary at the base.

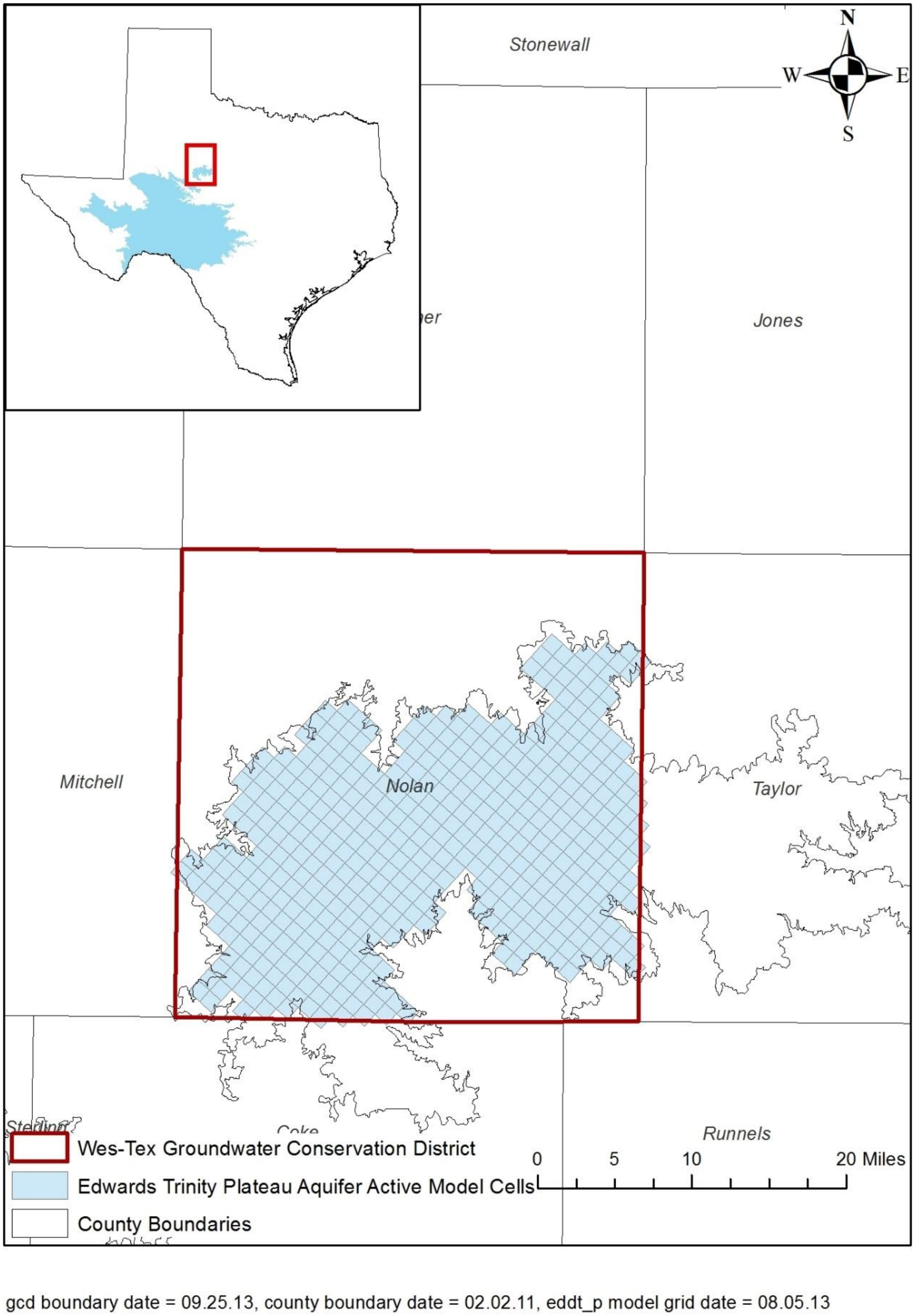


FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODELS FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE AQUIFER EXTENTS WITHIN THE DISTRICT BOUNDARY).

TABLE 2: SUMMARIZED INFORMATION FOR THE DOCKUM AQUIFER THAT IS NEEDED FOR WES-TEX 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	7,136
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Dockum Aquifer	516
Estimated annual volume of flow into the district within each aquifer in the district	Dockum Aquifer	84
Estimated annual volume of flow out of the district within each aquifer in the district	Dockum Aquifer	321
Estimated net annual volume of flow between each aquifer in the district	*Not Applicable	NA*

*Not applicable because model assumes a no-flow boundary at the base.

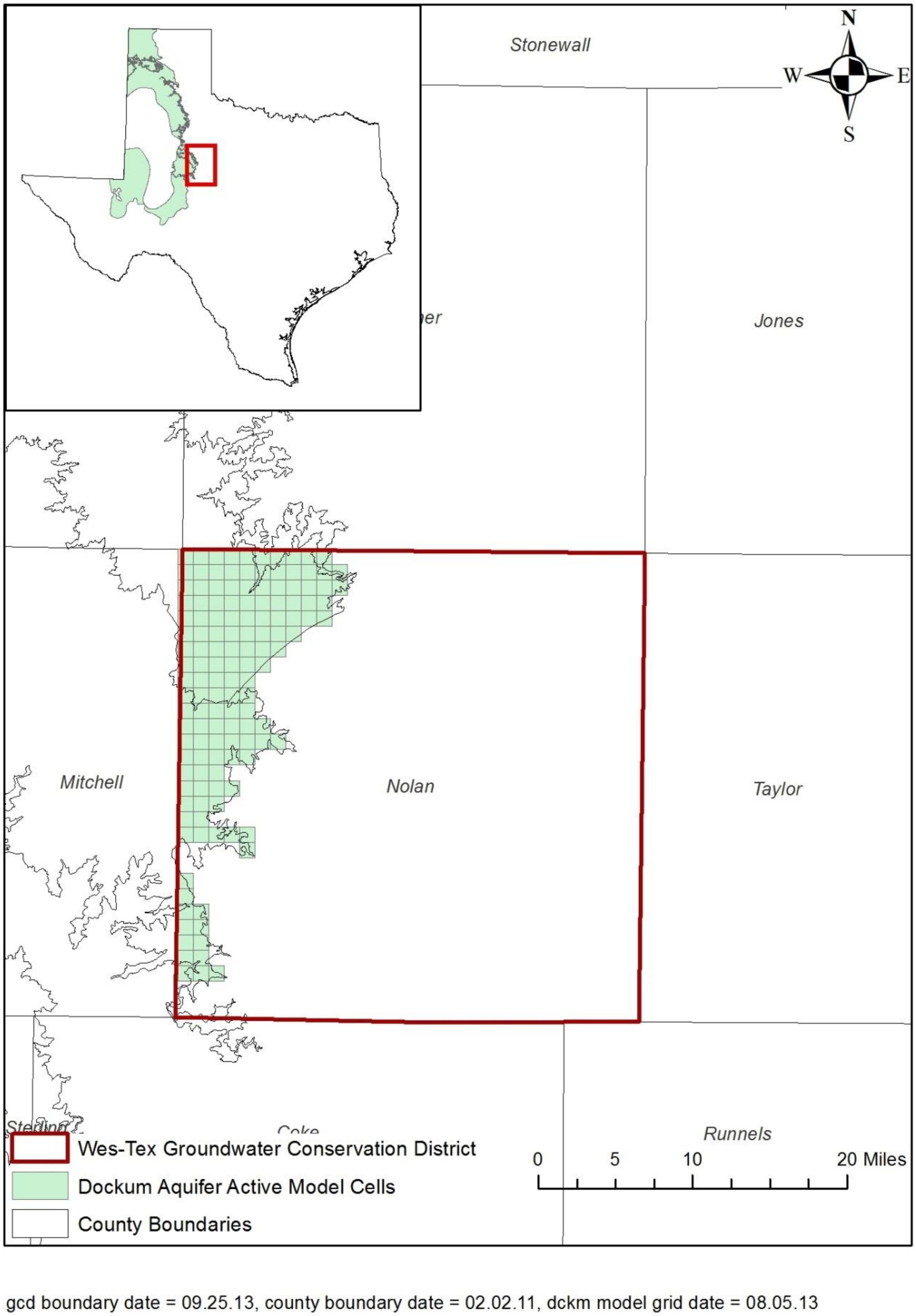
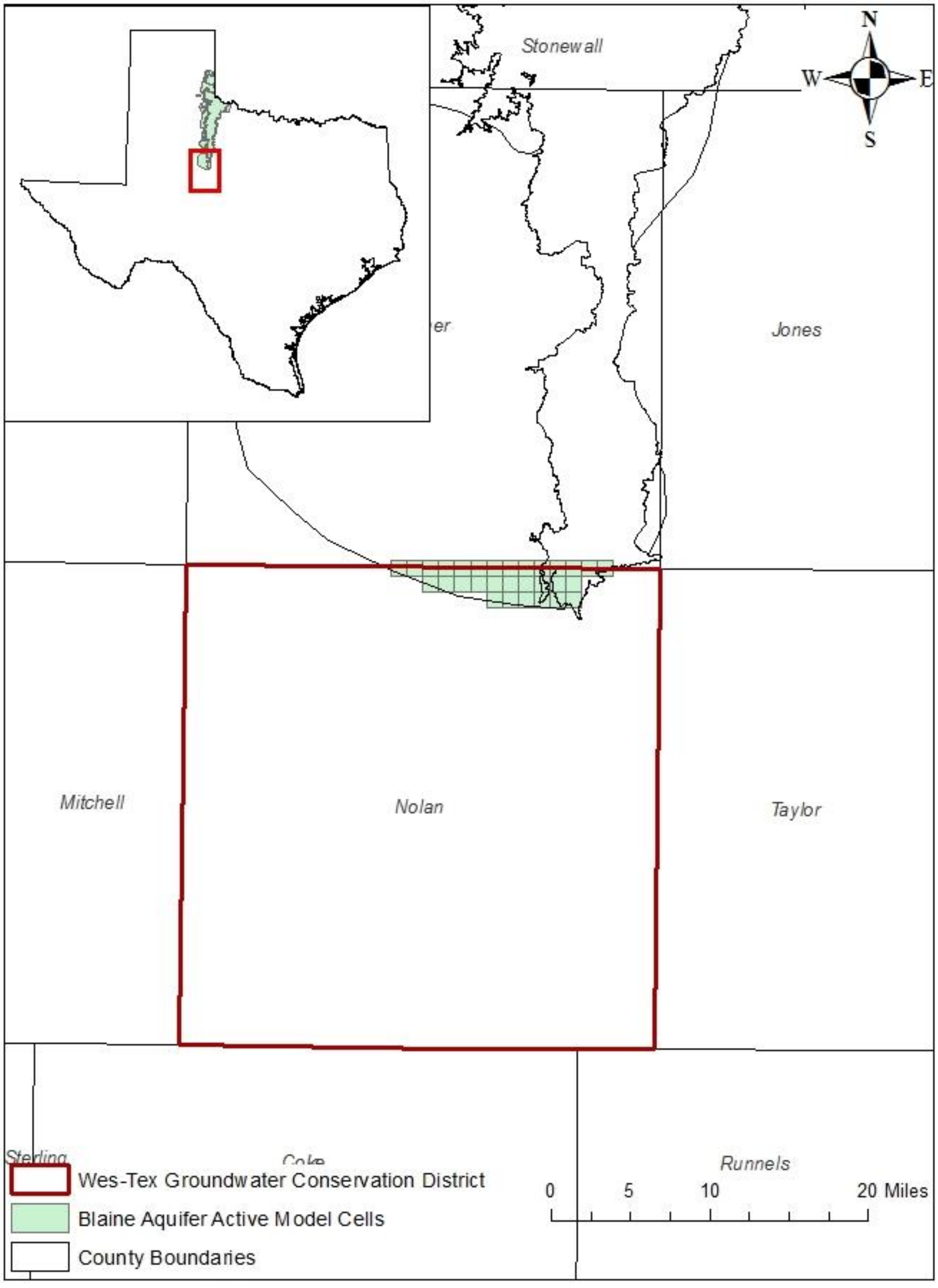


FIGURE 2: AREA OF THE GROUNDWATER AVAILABILITY MODELS FOR THE DOCKUM AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE AQUIFER EXTENTS WITHIN THE DISTRICT BOUNDARY).

TABLE 3: SUMMARIZED INFORMATION FOR THE *BLAINE AQUIFER THAT IS NEEDED FOR WES-TEX 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	Blaine Aquifer	459
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Blaine Aquifer	232
Estimated annual volume of flow into the district within each aquifer in the district	Blaine Aquifer	232
Estimated annual volume of flow out of the district within each aquifer in the district	Blaine Aquifer	593
Estimated net annual volume of flow between each aquifer in the district	From other Permian units to Blaine Aquifer	1737*

*The groundwater availability model for Seymour and Blaine Aquifers only partially represents the Blaine Aquifer. Therefore the values presented here are based on numerical approximations and should be used cautiously.



gcd boundary date = 09.25.13, county boundary date = 02.02.11, symr model grid date = 01.17.14

FIGURE 3: AREA OF THE GROUNDWATER AVAILABILITY MODELS FOR THE BLAINE AQUIFER FROM WHICH THE INFORMATION IN TABLE 3 WAS EXTRACTED (THE AQUIFER EXTENTS WITHIN THE DISTRICT BOUNDARY).

LIMITATIONS:

The groundwater model(s) used in completing this analysis is the best available scientific tool that can be used to meet the stated objective(s). 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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