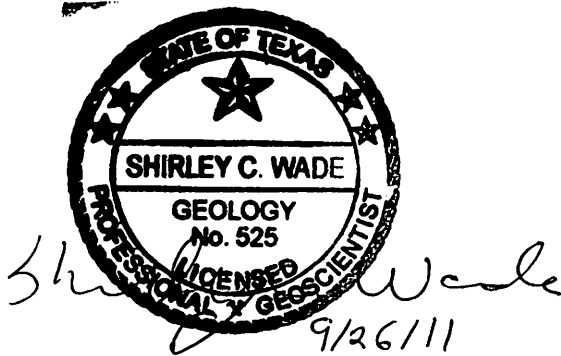

GAM RUN 11-004: PRAIRIELANDS GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN

by Shirley Wade, Ph.D., P.G.
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Groundwater Resources Division
Groundwater Availability Modeling Section
September 26, 2011



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EXECUTIVE SUMMARY:

Texas Water Code, Section 36.1071, Subsection (h), 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 for review and comment to the Executive Administrator before being used in the plan. Information for your groundwater management plan that was derived from groundwater availability model(s) in this report 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 from the Texas Water Development Board to Prairielands Groundwater Conservation District required for its groundwater management plan. The groundwater management plan for Prairielands Groundwater Conservation District is due for approval by the Executive Administrator of the Texas Water Development Board before September 1, 2012.

This report discusses the method, assumptions, and results from a model run using a groundwater model for the northern part of the Trinity Aquifer and the Woodbine Aquifer. Tables 1 and 2 summarize the groundwater model data required by the statute, and figures 1 and 2 show the areas of the model from which the values in the respective tables were extracted. If after review of the figures, Prairielands 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:

A groundwater model for the northern part of the Trinity Aquifer and the Woodbine Aquifer was run for this analysis. Water budgets for the transient model period were extracted and 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 portions of the aquifers located within the district are summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Northern part of the Trinity Aquifer and the Woodbine Aquifer

- Version 1.01 of the groundwater availability model for the northern part of the Trinity Aquifer and the Woodbine Aquifer (Bené and others, 2004) was used for these simulations.
- The model has seven layers which represent the Woodbine Aquifer (Layer 1), the Washita and Fredericksburg Confining Unit (Layer 2), and the Trinity Aquifer (Layer 3 through 7).
- The mean absolute error (a measure of the difference between simulated and actual water levels during model calibration) for individual aquifer layers in the model for the calibration and verification time period (1980 through 1999) ranged from approximately 37 to 75 feet. The root mean square error was less than 10 percent of the maximum change in water levels across the model (Bené and others, 2004).
- As described in Bené and others (2004), the evapotranspiration package used in the groundwater availability model represents evaporation,

transpiration, springs, seeps, and discharge to streams not modeled by the streamflow-routing package. Both the streamflow-routing package and the evapotranspiration package were used, as applicable, to extract information needed for discharges to surface water in this analysis.

- 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 components were extracted from the groundwater budget for the aquifers located within the district and averaged over the duration of the calibration and verification portion of the model runs in the district, as shown in tables 1 and 2. The components of the modified budget shown in tables 1 and 2 include:

- 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 drains (springs).
- Flow into and out of district—The lateral flow within the aquifer between the district and adjacent counties.
- Flow between aquifers—The vertical 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 tables 1 and 2. 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 (see figures 1 and 2).

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 streamflow are specific to a particular historic time period.

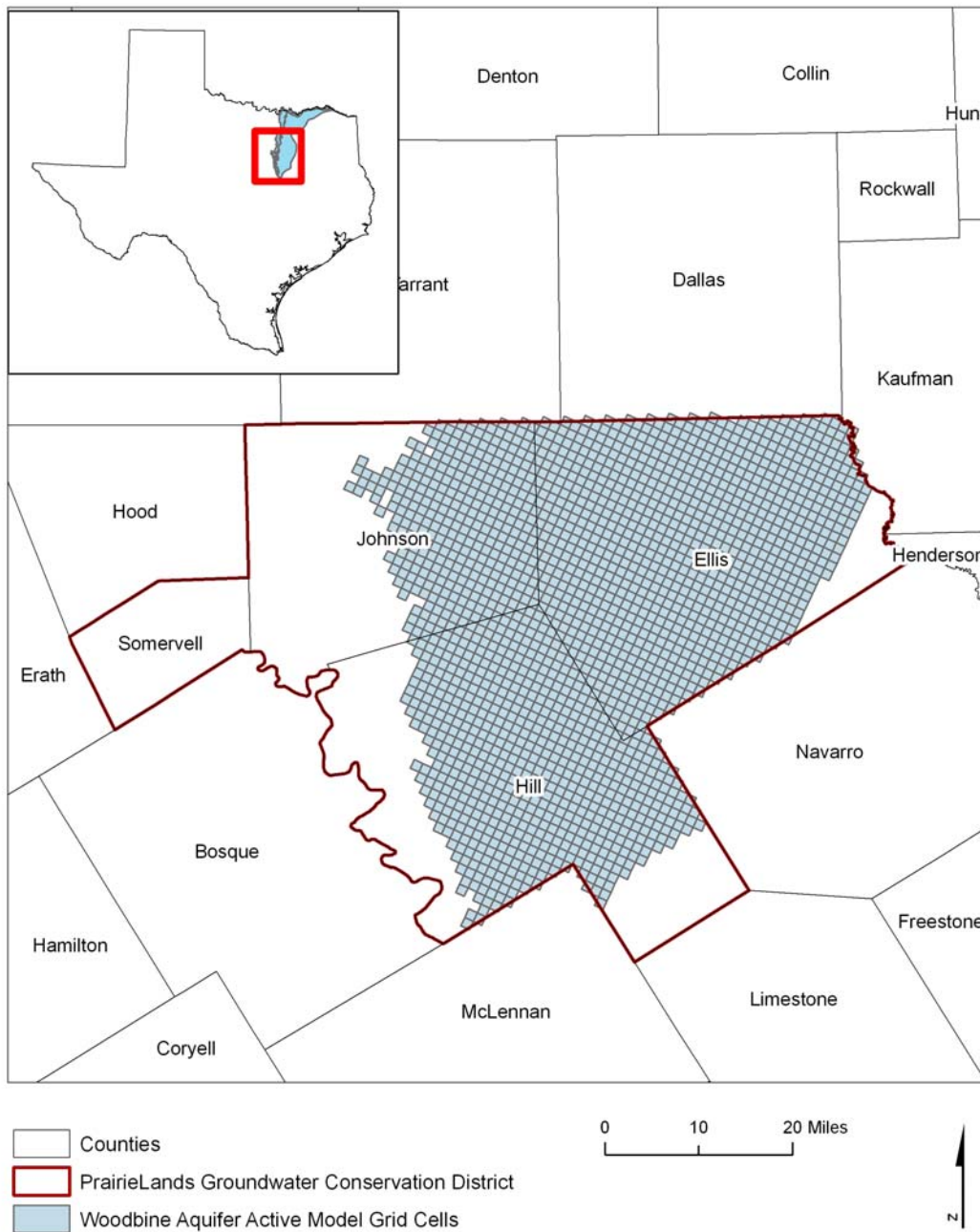
Because the application of the groundwater model was designed to address regional scale questions, the results are most effective on a regional scale. The TWDB makes no warranties or representations relating to the actual conditions of any aquifer at a particular location or at a particular time.

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.

TABLE 1: SUMMARIZED INFORMATION FOR THE WOODBINE AQUIFER THAT IS NEEDED FOR PRAIRIELANDS GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

| <i>Management Plan requirement</i> | <i>Aquifer or confining unit</i> | <i>Results</i> |
|--|--|----------------|
| Estimated annual amount of recharge from precipitation to the district | Woodbine Aquifer | 28,766 |
| Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers | Woodbine Aquifer | 3,618 |
| Estimated annual volume of flow into the district within each aquifer in the district | Woodbine Aquifer | 1,911 |
| Estimated annual volume of flow out of the district within each aquifer in the district | Woodbine Aquifer | 1,001 |
| Estimated net annual volume of flow between each aquifer in the district | From the Washita Fredericksburg Confining Unit into the Woodbine Aquifer | 194 |



god boundary date = 060211, county boundary date = 020211, trnt_n model grid date = 060611

FIGURE 1: AREA OF THE GROUNDWATER MODEL FOR THE WOODBINE AQUIFER (LAYER 1 OF THE MODEL FOR THE NORTHERN PART OF THE TRINITY AQUIFER) FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 2: SUMMARIZED INFORMATION FOR THE TRINITY AQUIFER THAT IS NEEDED FOR PRAIRIELANDS GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

| <i>Management Plan requirement</i> | <i>Aquifer or confining unit</i> | <i>Results</i> |
|--|---|----------------|
| Estimated annual amount of recharge from precipitation to the district | Trinity Aquifer | 11,748 |
| Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers | Trinity Aquifer | 3,912 |
| Estimated annual volume of flow into the district within each aquifer in the district | Trinity Aquifer | 14,261 |
| Estimated annual volume of flow out of the district within each aquifer in the district | Trinity Aquifer | 10,240 |
| Estimated net annual volume of flow between each aquifer in the district | From the Washita Fredericksburg Confining Unit into the Trinity Aquifer | 658 |

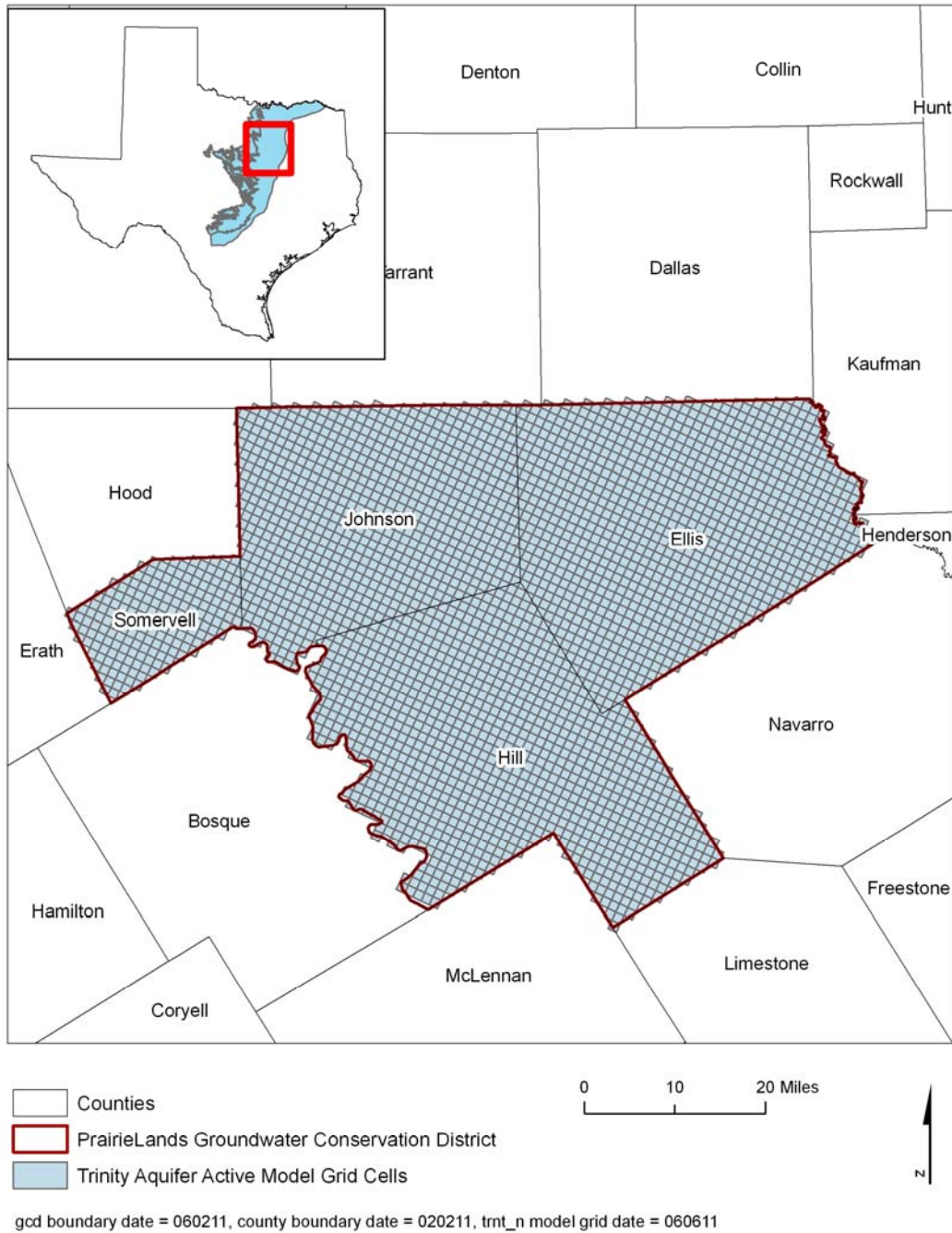


FIGURE 2: AREA OF THE GROUNDWATER MODEL FOR THE NORTHERN PART OF THE TRINITY AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

REFERENCES:

- Bené, J., Harden, B., O'Rourke, D., Donnelly, A., and Yelderman, J., 2004, Northern Trinity/Woodbine Groundwater Availability Model: contract report to the Texas Water Development Board by R.W. Harden and Associates, 391 p., http://www.twdb.state.tx.us/gam/trnt_n/trnt_n.htm.
- Harbaugh, A.W., and McDonald, M.G., 1996. User's Documentation for MODFLOW-96, an Update to the U.S. Geological Survey Modular Finite-Difference Ground-Water Flow Model, U.S. Geological Survey, Open-File Report 96-485, 56 p.
- National Research Council, 2007. Models in Environmental Regulatory Decision Making. Committee on Models in the Regulatory Decision Process, National Academies Press, Washington D.C., 287 p., http://www.nap.edu/catalog.php?record_id=11972.