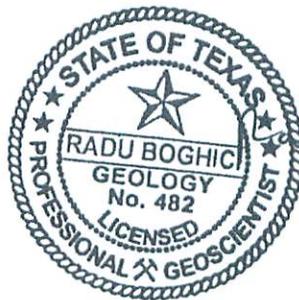


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# GAM RUN 13-009: PLATEAU UNDERGROUND WATER CONSERVATION AND SUPPLY DISTRICT MANAGEMENT PLAN

by Radu Boghici, P.G.  
Texas Water Development Board  
Groundwater Resources Division  
Groundwater Availability Modeling Section  
(512) 463-5808  
July 3, 2013



*Radu Boghici*  
*7/3/2013*

*The seal appearing on this document was authorized by Radu Boghici, P.G. 482 on July 3, 2013.*

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## ***EXECUTIVE SUMMARY:***

Texas State Water Code, Section 36.1071, Subsection (h), 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 Plateau Underground Water Conservation and Supply District) fulfills the requirements noted above. Part 1 of the 2-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](mailto:Stephen.Allen@twdb.texas.gov), (512) 463-7317.

The groundwater management plan for the Plateau Underground Water Conservation and Supply District should be adopted by the district on or before January 24, 2014 and submitted to the executive administrator of the TWDB on or before February 23, 2014. The current management plan for the Plateau Underground Water Conservation and Supply District expires on April 24, 2014.

This report discusses the methods, assumptions, and results from model runs using the groundwater availability model (version 1.01) for the Edwards-Trinity (Plateau) and Pecos Valley aquifers (Anaya and Jones, 2009), and the groundwater availability model (version 1.01) for the Lipan Aquifer (Beach and others, 2004). Tables 1 and 2 summarize the groundwater availability model data required by the statute for each aquifer, and Figures 1 and 2 show the areas of the models from which the values in the tables were extracted. This model run replaces the results of GAM Run 08-051. GAM Run 13-009 meets current standards set after the release of GAM Run 08-051 including a refinement of using the extent of the official aquifers boundaries within the district. The water budget values listed in the two model runs may differ because of this change in methodology. If, after review of the figures, Plateau Underground Water Conservation and Supply District determines that the district boundaries used in the assessment do not reflect current conditions, the District should notify the Texas Water Development Board immediately. Per statute, TWDB is required to provide the districts with data from the official groundwater availability models; however, the TWDB has also approved, for planning purposes, an alternative model for the Edwards-Trinity (Plateau) Aquifer that can have water budget information extracted for the district. The alternative model is the 1-layer alternative model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers (Hutchison and others, 2011). Please contact the author of this report if a comparison table using this model is desired.

## ***METHODS:***

In accordance with the provisions of the Texas State Water Code, Section 36.1071, Subsection (h), the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers and the groundwater availability model for the Lipan Aquifer were run for this analysis. Plateau Underground Water Conservation and Supply District Water budgets for the historical model periods were extracted 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, 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:**

### ***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 the boundaries of the Plateau Underground Water and Supply District, and therefore no groundwater budget values are included for it in this report.
- This groundwater availability model includes two layers within the boundaries of the Plateau Underground Water and Supply District, 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).
- For Plateau Underground Water and Supply District, groundwater in the Edwards-Trinity (Plateau) Aquifer ranges from fresh to saline, with total dissolved solids of less than 1,000 milligrams per liter in nearly 99 percent of the wells in the TWDB groundwater database. (TWDB Groundwater Database, queried June 2013).
- The model was run with MODFLOW-96 (Harbaugh and McDonald, 1996).

### ***Lipan Aquifer***

- We used version 1.01 of the groundwater availability model for the Lipan Aquifer for this analysis. See Beach and others (2004) for assumptions and limitations of the model.
- The Lipan Aquifer model includes one layer representing the Quaternary Leona Formation, portions of the underlying Permian Formations, and the Edwards-Trinity (Plateau) Aquifer to the west, south, and north.
- There are no groundwater quality data in the TWDB groundwater database for Plateau Underground Water and Supply District. Twenty miles north of the district, in Tom Green County, groundwater in the Lipan Aquifer is brackish, with total dissolved solids ranging from 1,200 to 2,900 milligrams per liter. (TWDB Groundwater Database, queried June 2013).

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

## **RESULTS:**

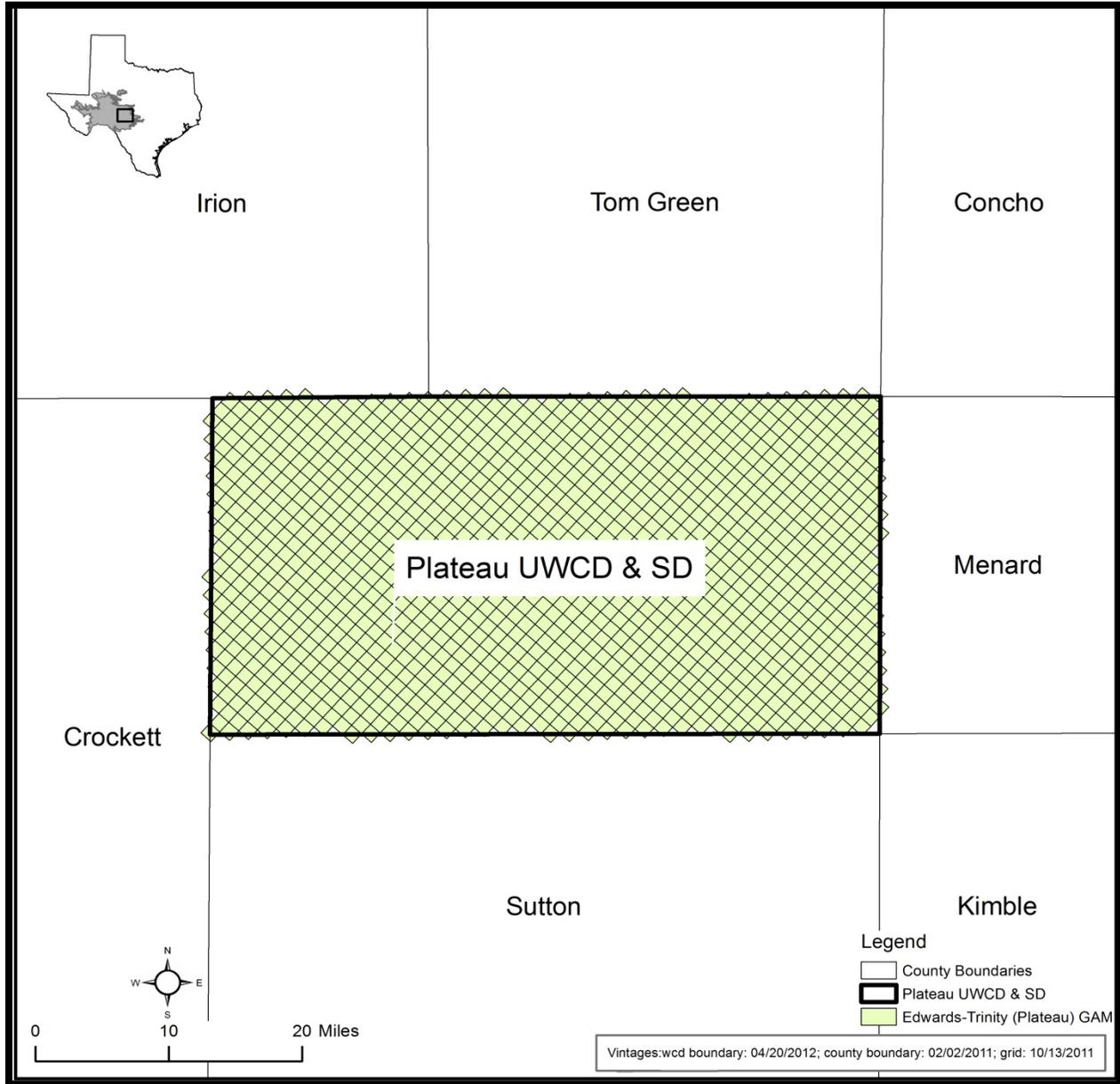
A groundwater budget summarizes the amount of water entering and leaving the aquifer according to the groundwater availability model. Selected groundwater budget components listed below were extracted from the model results for the aquifers located within the district and averaged over the duration of the calibration and verification portion of the model runs in the district, as shown in Table 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.
- 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 net 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. “Inflow” to an aquifer from an overlying or underlying aquifer will always equal the “Outflow” from the other aquifer.

The information needed for the District’s management plan is summarized in Table 1. 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 THE PLATEAU UNDERGROUND WATER CONSERVATION AND SUPPLY DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.**

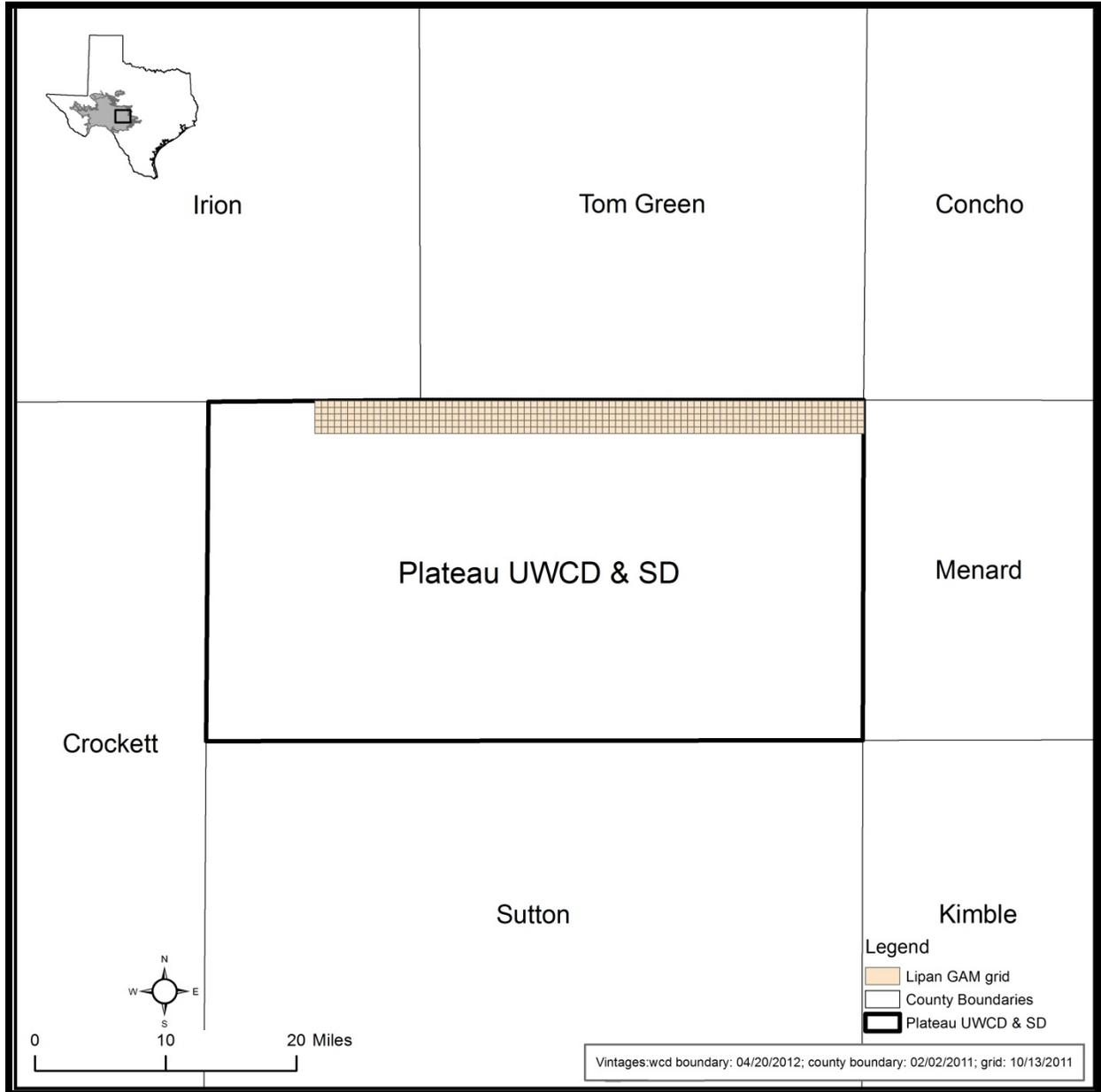
<i>Management Plan requirement</i>	<i>Aquifer or confining unit</i>	<i>Results</i>
Estimated annual amount of recharge from precipitation to the district	Edwards-Trinity (Plateau) Aquifer	22,337
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Edwards-Trinity (Plateau) Aquifer	8,317
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	7,791
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	28,701
Estimated net annual volume of flow between each aquifer in the district	Edwards-Trinity (Plateau) Aquifer into/from adjacent formations	Not applicable



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

**TABLE 2: SUMMARIZED INFORMATION FOR THE LIPAN AQUIFER THAT IS NEEDED FOR THE PLATEAU UNDERGROUND WATER CONSERVATION AND SUPPLY 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	Lipan Aquifer	397
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Lipan Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Lipan Aquifer	18
Estimated annual volume of flow out of the district within each aquifer in the district	Lipan Aquifer	413
Estimated net annual volume of flow between each aquifer in the district	Lipan Aquifer into/from the underlying formations	Not Applicable



**FIGURE 2: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE LIPAN AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED FOR THE EXTENT OF THE LIPAN AQUIFER 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.

## **REFERENCES:**

- Anaya, R., and Jones, I., 2009, Groundwater Availability Model for the Edwards-Trinity (Plateau) and Pecos Valley Aquifers, 103 p., [http://www.twdb.texas.gov/groundwater/models/gam/eddt\\_p/ET-Plateau\\_Full.pdf](http://www.twdb.texas.gov/groundwater/models/gam/eddt_p/ET-Plateau_Full.pdf)
- Beach, James A., Burton, Stuart, and Kolarik, Barry, 2004, Groundwater availability model for the Lipan Aquifer in Texas: final report prepared for the Texas Water Development Board by LBG-Guyton Associates, 246 p., <http://www.twdb.texas.gov/groundwater/models/gam/lipn/lipn.asp>
- Harbaugh, A. W., 2009, Zonebudget Version 3.01, A computer program for computing subregional water budgets for MODFLOW ground-water flow models, U.S. Geological Survey Groundwater Software.
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- Hutchison, W. R., Jones, I., and Anaya, R., 2011, Update of the Groundwater Availability Model for the Edwards-Trinity (Plateau) and Pecos Valley Aquifers of Texas, 60 p., [http://www.twdb.texas.gov/groundwater/models/alt/eddt\\_p\\_2011/alt1\\_eddt\\_p.asp](http://www.twdb.texas.gov/groundwater/models/alt/eddt_p_2011/alt1_eddt_p.asp)
- 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.
- TWDB Groundwater Database, 2013, Texas Water Development Board, <http://www.twdb.texas.gov/groundwater/data/index.asp>.