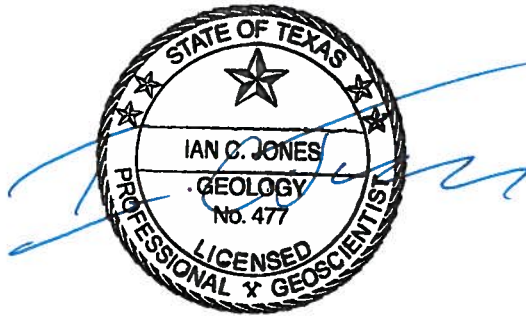


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# GAM RUN 11-015: ANDERSON COUNTY UNDERGROUND WATER CONSERVATION DISTRICT MANAGEMENT PLAN

by Ian C. Jones, Ph.D., P.G.  
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Groundwater Resources Division  
Groundwater Availability Modeling Section  
(512) 463-6641  
November 18, 2011



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## *EXECUTIVE SUMMARY:*

Texas State 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. 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.

The purpose of this report is to provide Part 2 of a two-part package of information from the Texas Water Development Board to Anderson County Underground Water Conservation District management plan to fulfill the requirements noted above. The groundwater management plan for Anderson County Underground Water Conservation District is due for approval by the Executive Administrator of the Texas Water Development Board before September 9, 2012.

This report discusses the method, assumptions, and results from model runs using the groundwater availability models for the northern part of the Carrizo-Wilcox, Queen City, and Sparta aquifers. Tables 1 and 2 summarize the groundwater availability model data required by the statute, and Figures 1 and 2 show the area of each model from which the values in the respective tables were extracted. This model run replaces the results of GAM Run 07-07. GAM Run 11-015 meets current standards set after the release of GAM Run 07-07. Slight differences in the results of the two model runs are due to differences in the method of extracting data from the model. The Anderson County Underground Water Conservation District can use either GAM Run 07-07 or GAM Run 11-015 in their groundwater management plan. If after review of the figures, Anderson County Underground Water 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:***

The groundwater availability model for the northern part of the Carrizo-Wilcox, Queen City, and Sparta aquifers (1980 through 1999) was run for this analysis. Water budgets for each year of 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:***

#### ***Carrizo-Wilcox, Queen City, and Sparta aquifers***

- Version 2.01 of the groundwater availability model for the northern part of the Carrizo-Wilcox, Queen City, and Sparta aquifers was used for this analysis. See Fryar and others (2003) and Kelley and others (2004) for assumptions and limitations of the groundwater availability model for the northern part of the Carrizo-Wilcox, Queen City, and Sparta aquifers.
- This groundwater availability model includes eight layers, which generally correspond to (from top to bottom):
  1. the Sparta Aquifer,

2. the Weches Confining Unit,
  3. the Queen City Aquifer,
  4. the Reklaw Confining Unit,
  5. the Carrizo Aquifer,
  6. the Upper Wilcox Aquifer (Calvert Bluff Formation),
  7. the Middle Wilcox Aquifer (Simsboro Formation), and
  8. the Lower Wilcox Aquifer (Hooper Formation).
- Of the eight layers listed above, individual water budgets for the district were determined for the Queen City Aquifer (Layer 3), and the combined layers of the Carrizo-Wilcox Aquifer (Layers 5 through 8).
  - The root mean square error (a measure of the difference between simulated and actual water levels during model calibration) in the groundwater availability model is 21 feet for the Sparta Aquifer, 28 feet for the Queen City Aquifer, 34 feet for the Carrizo Aquifer, 28 feet for the Upper Wilcox Aquifer, 34 feet for the Middle Wilcox Aquifer, and 24 feet for the Lower Wilcox Aquifer for the calibration period (1980 to 1990) and 21, 31, 41, 34, 37, and 31 feet for the same aquifers, respectively, in the verification period (1991 to 1999) (Kelley and others, 2004). These root mean square errors are between four and eleven percent of the range of measured water levels (Kelley and others, 2004).
  - Groundwater in the Carrizo-Wilcox, Queen City, and Sparta aquifers ranges from fresh to brackish in composition (Kelley and others, 2004). Groundwater with total dissolved solids of less than 1,000 milligrams per liter are considered fresh and total dissolved solids of 1,000 to 10,000 milligrams per liter are considered brackish.
  - Groundwater Vistas Version 5 (Environmental Simulations, Inc. 2007) was used as the interface to process model output.

## ***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 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 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 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 (see Figures 1 and 2).

**TABLE 1: SUMMARIZED INFORMATION FOR THE QUEEN CITY AQUIFER THAT IS NEEDED FOR ANDERSON COUNTY UNDERGROUND WATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT. THESE FLOWS INCLUDE BRACKISH WATERS.**

<i>Management Plan requirement</i>	<i>Aquifer or confining unit</i>	<i>Results</i>
Estimated annual amount of recharge from precipitation to the district	Queen City Aquifer	2,902
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Queen City Aquifer	1,388
Estimated annual volume of flow into the district within each aquifer in the district	Queen City Aquifer	335
Estimated annual volume of flow out of the district within each aquifer in the district	Queen City Aquifer	530
Estimated net annual volume of flow between each aquifer in the district	Queen City Aquifer into the Reklaw Formation confining unit and overlying units	119

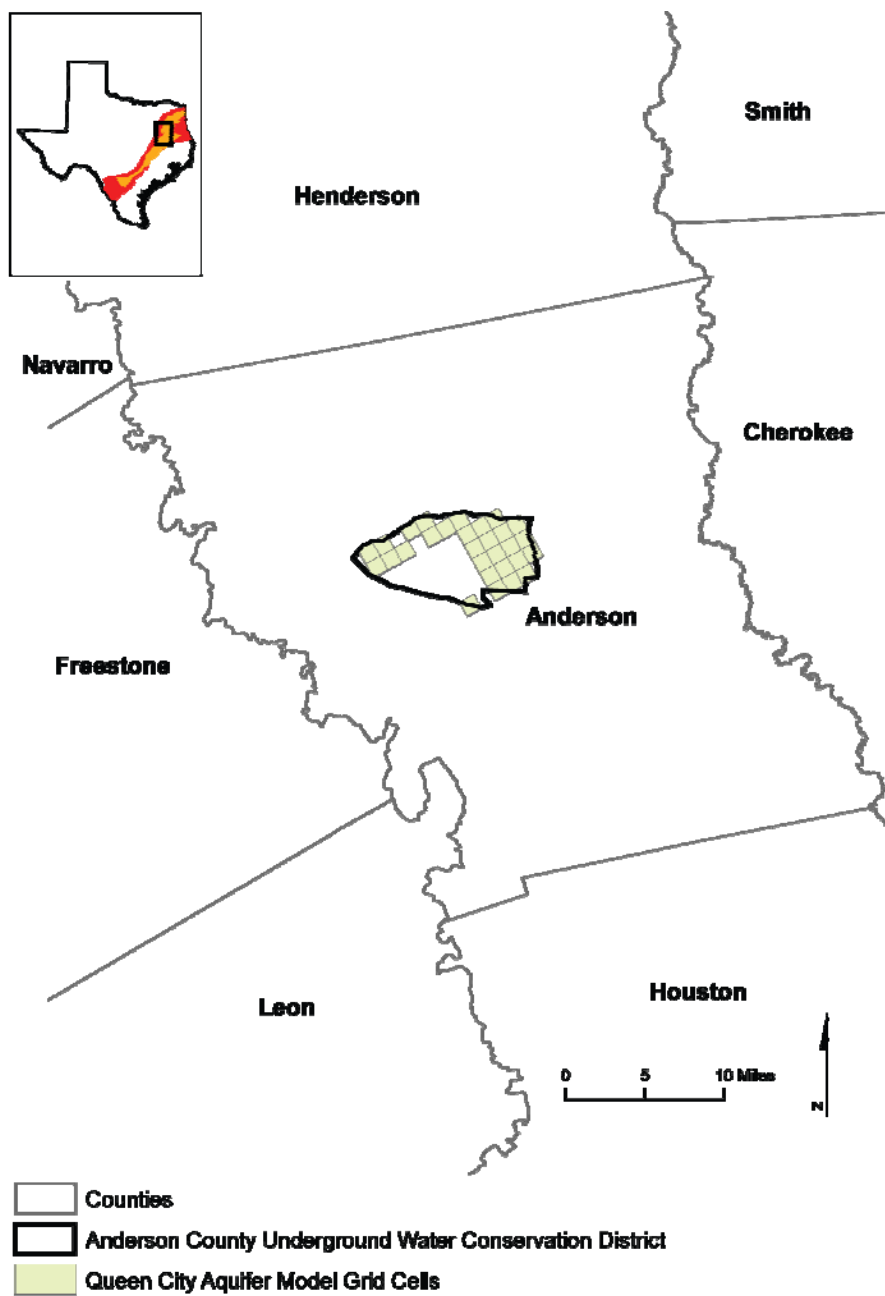


FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE NORTHERN PORTION OF THE QUEEN CITY AQUIFER FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).



**TABLE 2: SUMMARIZED INFORMATION FOR THE CARRIZO-WILCOX AQUIFER THAT IS NEEDED FOR ANDERSON COUNTY UNDERGROUND WATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT. THESE FLOWS MAY INCLUDE FRESH AND BRACKISH WATERS.**

<i>Management Plan requirement</i>	<i>Aquifer</i>	<i>Results</i>
Estimated annual amount of recharge from precipitation to the district	Carrizo-Wilcox Aquifer	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Carrizo-Wilcox Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Carrizo-Wilcox Aquifer	1,661
Estimated annual volume of flow out of the district within each aquifer in the district	Carrizo-Wilcox Aquifer	1,499
Estimated net annual volume of flow between each aquifer in the district	Carrizo-Wilcox Aquifer from the Reklaw Formation confining unit	128

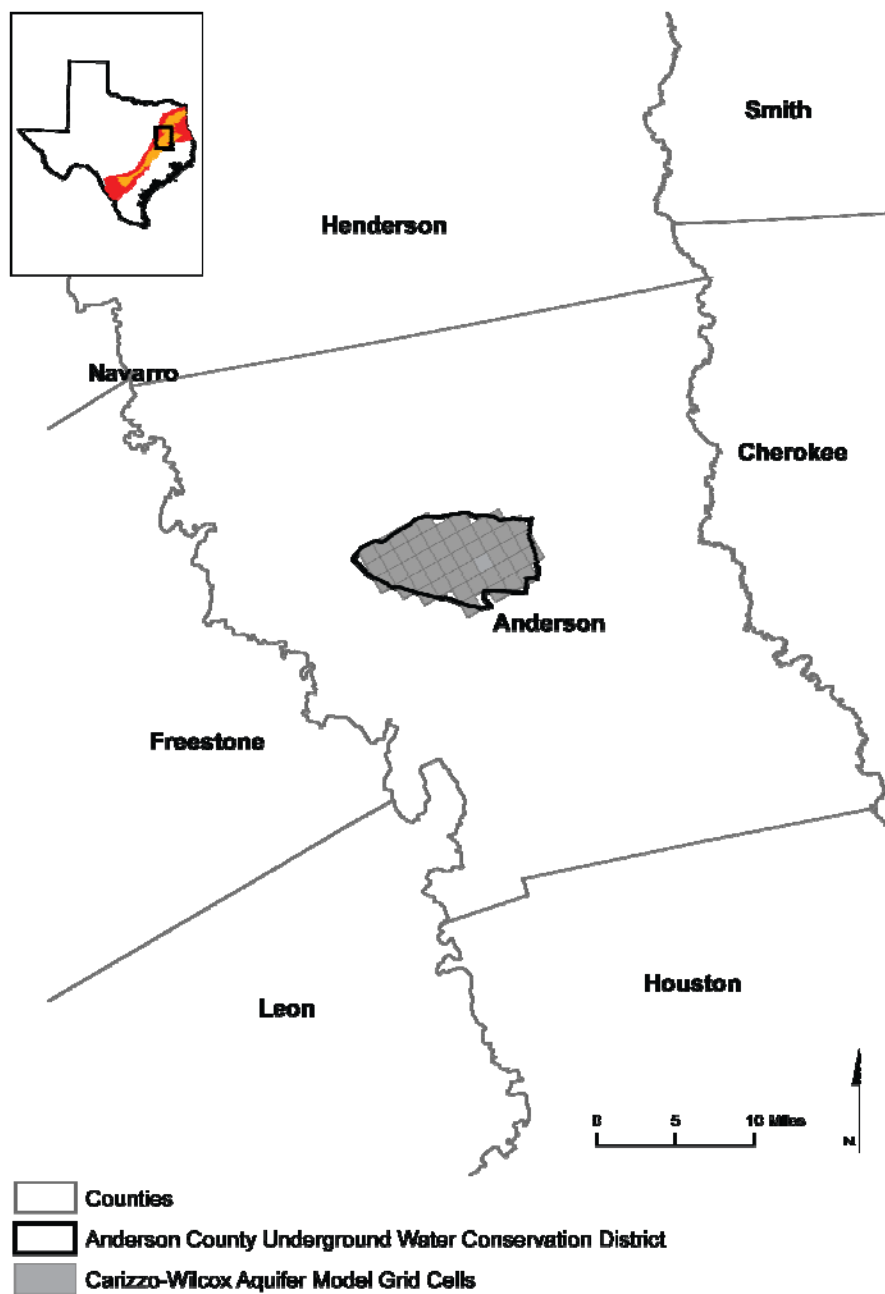


FIGURE 2: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE CARRIZO-WILCOX AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

## ***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 model 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:***

Fryar, D., Senger, R., Deeds, N., Pickens, J., Jones, T., Whallon, A.J., and Dean, K.E., 2003, Groundwater Availability Model for the Northern Carrizo-Wilcox Aquifer: Contract report to the Texas Water Development Board, 528 p., [http://www.twdb.state.tx.us/gam/czwx\\_n/CZWX\\_N\\_Full\\_Report.pdf](http://www.twdb.state.tx.us/gam/czwx_n/CZWX_N_Full_Report.pdf) .

Environmental Simulations, Inc., 2007, Guide to Using Groundwater Vistas Version 5, 381 p.

Kelley, V.A., Deeds, N.E., Fryar, D.G., and Nicot, J.P., 2004, Groundwater availability models for the Queen City and Sparta aquifers: Contract report to the Texas Water Development Board, 867 p., [http://www.twdb.state.tx.us/gam/qc\\_sp/qc\\_sp.htm](http://www.twdb.state.tx.us/gam/qc_sp/qc_sp.htm).

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.