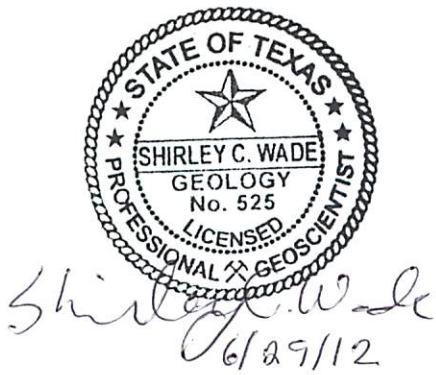
# GAM Run 10-064 MAG

**by Wade Oliver and Shirley Wade**

Texas Water Development Board
Groundwater Availability Modeling Section
(512) 936-0883
June 29, 2012

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## EXECUTIVE SUMMARY:

The modeled available groundwater for the Woodbine Aquifer as a result of the desired future conditions adopted by the districts of Groundwater Management Area 8 is approximately 44,900 acre-feet per year. This is shown divided by county, regional water planning area, and river basin in Table 1 for use in the regional water planning process. Modeled available groundwater is summarized by county, regional water planning area, river basin, and groundwater conservation district in tables 2 through 5. The estimates were extracted from Groundwater Availability Model Run 07-30 (Wade, 2007) which simulates the desired future conditions adopted by the districts of Groundwater Management Area 8. The modeled available groundwater estimates presented in this report are intended to replace the estimates previously reported in GAM Run 08-14mag which included estimates for non-relevant areas.

## REQUESTOR:

Mr. Eddy Daniel of North Texas Groundwater Conservation District on behalf of Groundwater Management Area 8

## DESCRIPTION OF REQUEST:

In a letter dated August 31, 2011, Mr. Eddy Daniel provided the Texas Water Development Board (TWDB) with a resolution dated June 23, 2011 to retain the previously adopted desired future conditions of the Woodbine Aquifer adopted by the districts of Groundwater Management Area 8 [on December 17, 2007], except for the Southern Trinity Groundwater Conservation District, which adopted a resolution dated June 23, 2011 to declare the Woodbine Aquifer non-relevant for joint planning purposes [within their district]. Therefore, the relevant desired future conditions, adopted December 27, 2007 and re-adopted June 23, 2011, are shown below:

- From estimated year 2000 conditions, the average drawdown should not exceed approximately 154 feet after 50 years in Collin County.
- From estimated year 2000 conditions, the average drawdown should not exceed approximately 0 feet after 50 years in Cooke County.
- From estimated year 2000 conditions, the average drawdown should not exceed approximately 112 feet after 50 years in Dallas County.
- From estimated year 2000 conditions, the average drawdown should not exceed approximately 16 feet after 50 years in Denton County.
- From estimated year 2000 conditions, the average drawdown should not exceed approximately 102 feet after 50 years in Ellis County.
- From estimated year 2000 conditions, the average drawdown should not exceed approximately 186 feet after 50 years in Fannin County.
- From estimated year 2000 conditions, the average drawdown should not exceed approximately 28 feet after 50 years in Grayson County.
- From estimated year 2000 conditions, the average drawdown should not exceed approximately 87 feet after 50 years in Hill County.

- From estimated year 2000 conditions, the average drawdown should not exceed approximately 353 feet after 50 years in Hunt County.
- From estimated year 2000 conditions, the average drawdown should not exceed approximately 4 feet after 50 years in Johnson County.
- From estimated year 2000 conditions, the average drawdown should not exceed approximately 211 feet after 50 years in Kaufman County.
- From estimated year 2000 conditions, the average drawdown should not exceed approximately 297 feet after 50 years in Lamar County.
- From estimated year 2000 conditions, the average drawdown should not exceed approximately 177 feet after 50 years in Navarro County.
- From estimated year 2000 conditions, the average drawdown should not exceed approximately 202 feet after 50 years in Red River County.
- From estimated year 2000 conditions, the average drawdown should not exceed approximately 241 feet after 50 years in Rockwall County.
- From estimated year 2000 conditions, the average drawdown should not exceed approximately 2 feet after 50 years in Tarrant County.

In response to receiving the adopted desired future conditions, the TWDB completed Groundwater Availability Model (GAM) Run 08-14mag in May 2008, which reported the "managed available groundwater" that achieves the above desired future conditions (Wade, 2008). However, GAM Run 08-14mag also included estimates for Delta, Limestone, and McLennan counties. We excluded those estimates from this report since Delta and Limestone counties were never issued a desired future condition for the Woodbine Aquifer and the Woodbine Aquifer was declared non-relevant in McLennan County.

## METHODS:

The location of Groundwater Management Area 8, the Woodbine Aquifer, and the groundwater availability model cells that represent the aquifer are shown in Figure 1.

### Modeled Available Groundwater and Permitting

As defined in Chapter 36 of the Texas Water Code, "modeled available groundwater" is the estimated average amount of water that may be produced annually to achieve a desired future condition. This is distinct from "managed available groundwater," shown in the draft version of this report dated December 20, 2010, which was a permitting value and accounted for the estimated use of the aquifer exempt from permitting. This change was made to reflect changes in statute by the 82$^{nd}$ Texas Legislature, effective September 1, 2011.

Groundwater conservation districts are required to consider modeled available groundwater, along with several other factors, when issuing permits in order to manage groundwater production to achieve the desired future condition(s). The other factors districts must consider include annual precipitation and production patterns, the estimated amount of pumping exempt from permitting, existing permits, and a reasonable estimate of actual groundwater production under existing permits. The estimated amount of pumping exempt from permitting, which the TWDB is now required to develop after soliciting input from applicable groundwater

conservation districts, will be provided in a separate report. It should be noted that groundwater conservation district boundaries have also been updated since GAM Run 08-14mag. The results presented here correspond to the official district boundaries as of the date of this report.

**PARAMETERS AND ASSUMPTIONS:**

The groundwater availability model for the northern portion of the Trinity Aquifer and the Woodbine Aquifer was used for the results presented in this report. The parameters and assumptions for this model are described below:

- The results for total pumping presented here are based on the results reported as "managed available groundwater" in GAM Run 08-14mag (Wade, 2008). See GAM Run 08-14mag for a full description of the methods and assumptions associated with the model simulation. Because GAM Run 08-14mag presented constant pumping from 2000 to 2050, it was assumed for the purposes of this analysis that pumping from 2051 to 2060 was also constant at this same level. As described above, desired future conditions were defined by the groundwater conservation districts in Groundwater Management Area 8 for 2050. It is expected that pumping from 2051 to 2060 would cause additional drawdown, but this analysis does not estimate drawdown in 2060. Pumping estimates were extended to 2060 for the purposes of regional water planning.

- Version 1.01 of the groundwater availability model for the northern portion of the Trinity Aquifer and the Woodbine Aquifer was used for this analysis. See Bené and others (2004) for assumptions and limitations of the model.

- The model includes seven layers which generally correspond to the Woodbine Aquifer (Layer 1), the Washita and Fredericksburg Groups (Layer 2), the Paluxy Formation (Layer 3), the Glen Rose Formation (Layer 4), the Hensell Formation (Layer 5), the Pearsall/Cow Creek/Hammett/Sligo Members (Layer 6), and the Hosston Formation (Layer 7).

- The mean absolute error (a measure of the difference between simulated and measured water levels during model calibration) for the four main aquifers in the model (Woodbine, Paluxy, Hensell, and Hosston) for the calibration and verification time periods (1980 to 2000) ranged from approximately 38 to 75 feet. The root mean squared error was less than ten percent of the maximum change in water levels across the model (Bené and others, 2004).

**RESULTS:**

The estimated total pumping from the Woodbine Aquifer in Groundwater Management Area 8 that achieves the above desired future conditions is approximately 44,900 acre-feet per year between 2010 and 2060. This pumping has been divided by county, regional water planning area, and river basin for each decade between 2010 and 2060 for use in the regional water planning process (Table 1). These areas are shown in Figure 2.

Tables 2, 3, 4, and 5 show the total pumping summarized by county, regional water planning area, river basin, and groundwater conservation district, respectively. Notice in Table 5 that the pumping is totaled both excluding and including areas outside of a groundwater conservation district.

***LIMITATIONS:***

The groundwater model 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 the impacts of future pumping is the need to make assumptions about the location in the aquifer where future pumping will occur. As actual pumping changes in the future, it will be necessary to evaluate the amount of that pumping as well as its location in the context of the assumptions associated with this analysis. Evaluating the amount and location of future pumping is as important as evaluating the changes in groundwater levels, spring flows, and other metrics that describe the impacts of that pumping. This analysis does not assess the possible impacts of pumping such as reduced water quality or land surface subsidence.

In addition, certain assumptions have been made regarding future precipitation, recharge, and streamflow in evaluating the impacts of future pumping. Those assumptions also need to be considered and compared to actual future data.

Given these limitations, users of this information are cautioned that the results should not be considered a definitive, permanent prediction of the changes in groundwater storage, streamflow, and spring flow. Because the application of the groundwater availability 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 future groundwater pumping and overall conditions of the aquifer. Because of the limitations of the groundwater availability 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.

**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.

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.

Texas Water Development Board, 2007, Water for Texas – 2007—Volumes I-III; Texas Water Development Board Document No. GP-8-1, 392 p.

Wade, S.C., 2007, GAM07-30 Final Report, Texas Water Development Board GAM Run Report, October 26, 2007, 25 p.

Wade, S., 2008, GAM Run 08-14mag, Texas Water Development Board GAM Run 08-14mag Report, 7 p.

Table 1. Modeled available groundwater in acre-feet per year for the Woodbine Aquifer in Groundwater Management Area 8 by county, regional water planning area, and river basin.

| County | Regional Water Planning Area | River Basin | Year | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| Collin | C | Sabine | 40 | 40 | 40 | 40 | 40 | 40 |
| | | Trinity | 2,469 | 2,469 | 2,469 | 2,469 | 2,469 | 2,469 |
| Cooke | C | Red | 18 | 18 | 18 | 18 | 18 | 18 |
| | | Trinity | 136 | 136 | 136 | 136 | 136 | 136 |
| Dallas | C | Trinity | 2,313 | 2,313 | 2,313 | 2,313 | 2,313 | 2,313 |
| Denton | C | Trinity | 4,126 | 4,126 | 4,126 | 4,126 | 4,126 | 4,126 |
| Ellis | C | Trinity | 5,441 | 5,441 | 5,441 | 5,441 | 5,441 | 5,441 |
| Fannin | C | Red | 2,676 | 2,676 | 2,676 | 2,676 | 2,676 | 2,676 |
| | | Sulphur | 21 | 21 | 21 | 21 | 21 | 21 |
| | | Trinity | 600 | 600 | 600 | 600 | 600 | 600 |
| Grayson | C | Red | 6,590 | 6,590 | 6,590 | 6,590 | 6,590 | 6,590 |
| | | Trinity | 5,497 | 5,497 | 5,497 | 5,497 | 5,497 | 5,497 |
| Hill | G | Brazos | 1,249 | 1,249 | 1,249 | 1,249 | 1,249 | 1,249 |
| | | Trinity | 1,012 | 1,012 | 1,012 | 1,012 | 1,012 | 1,012 |
| Hunt | D | Sabine | 1,867 | 1,867 | 1,867 | 1,867 | 1,867 | 1,867 |
| | | Sulphur | 849 | 849 | 849 | 849 | 849 | 849 |
| | | Trinity | 124 | 124 | 124 | 124 | 124 | 124 |
| Johnson | G | Brazos | 141 | 141 | 141 | 141 | 141 | 141 |
| | | Trinity | 4,591 | 4,591 | 4,591 | 4,591 | 4,591 | 4,591 |
| Kaufman | C | Sabine | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Trinity | 200 | 200 | 200 | 200 | 200 | 200 |
| Lamar | D | Red | 1,910 | 1,910 | 1,910 | 1,910 | 1,910 | 1,910 |
| | | Sulphur | 1,734 | 1,734 | 1,734 | 1,734 | 1,734 | 1,734 |
| Navarro | C | Trinity | 300 | 300 | 300 | 300 | 300 | 300 |
| Red River | D | Red | 162 | 162 | 162 | 162 | 162 | 162 |
| | | Sulphur | 4 | 4 | 4 | 4 | 4 | 4 |
| Rockwall | C | Sabine | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Trinity | 144 | 144 | 144 | 144 | 144 | 144 |
| Tarrant | C | Trinity | 632 | 632 | 632 | 632 | 632 | 632 |
| **Total** | | | **44,846** | **44,846** | **44,846** | **44,846** | **44,846** | **44,846** |

Table 2. Modeled available groundwater for the Woodbine Aquifer summarized by county in Groundwater Management Area 8 for each decade between 2010 and 2060. Results are in acre-feet per year.

| County | Year | | | | | |
|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| Collin | 2,509 | 2,509 | 2,509 | 2,509 | 2,509 | 2,509 |
| Cooke | 154 | 154 | 154 | 154 | 154 | 154 |
| Dallas | 2,313 | 2,313 | 2,313 | 2,313 | 2,313 | 2,313 |
| Denton | 4,126 | 4,126 | 4,126 | 4,126 | 4,126 | 4,126 |
| Ellis | 5,441 | 5,441 | 5,441 | 5,441 | 5,441 | 5,441 |
| Fannin | 3,297 | 3,297 | 3,297 | 3,297 | 3,297 | 3,297 |
| Grayson | 12,087 | 12,087 | 12,087 | 12,087 | 12,087 | 12,087 |
| Hill | 2,261 | 2,261 | 2,261 | 2,261 | 2,261 | 2,261 |
| Hunt | 2,840 | 2,840 | 2,840 | 2,840 | 2,840 | 2,840 |
| Johnson | 4,732 | 4,732 | 4,732 | 4,732 | 4,732 | 4,732 |
| Kaufman | 200 | 200 | 200 | 200 | 200 | 200 |
| Lamar | 3,644 | 3,644 | 3,644 | 3,644 | 3,644 | 3,644 |
| Navarro | 300 | 300 | 300 | 300 | 300 | 300 |
| Red River | 166 | 166 | 166 | 166 | 166 | 166 |
| Rockwall | 144 | 144 | 144 | 144 | 144 | 144 |
| Tarrant | 632 | 632 | 632 | 632 | 632 | 632 |
| **Total** | **44,846** | **44,846** | **44,846** | **44,846** | **44,846** | **44,846** |

Table 3. Modeled available groundwater for the Woodbine Aquifer summarized by regional water planning area in Groundwater Management Area 8 for each decade between 2010 and 2060. Results are in acre-feet per year.

| Regional Water Planning Area | Year | | | | | |
|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| C | 31,203 | 31,203 | 31,203 | 31,203 | 31,203 | 31,203 |
| D | 6,650 | 6,650 | 6,650 | 6,650 | 6,650 | 6,650 |
| G | 6,993 | 6,993 | 6,993 | 6,993 | 6,993 | 6,993 |
| **Total** | **44,846** | **44,846** | **44,846** | **44,846** | **44,846** | **44,846** |

Table 4. Modeled available groundwater for the Woodbine Aquifer summarized by river basin in Groundwater Management Area 8 for each decade between 2010 and 2060. Results are in acre-feet per year.

| River Basin | Year | | | | | |
|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| Brazos | 1,390 | 1,390 | 1,390 | 1,390 | 1,390 | 1,390 |
| Red | 11,356 | 11,356 | 11,356 | 11,356 | 11,356 | 11,356 |
| Sabine | 1,907 | 1,907 | 1,907 | 1,907 | 1,907 | 1,907 |
| Sulphur | 2,608 | 2,608 | 2,608 | 2,608 | 2,608 | 2,608 |
| Trinity | 27,585 | 27,585 | 27,585 | 27,585 | 27,585 | 27,585 |
| **Total** | **44,846** | **44,846** | **44,846** | **44,846** | **44,846** | **44,846** |

Table 5. Modeled available groundwater for the Woodbine Aquifer summarized by groundwater conservation district (GCD) in Groundwater Management Area 8 for each decade between 2010 and 2060. Results are in acre-feet per year.

| Groundwater Conservation District | Year | | | | | |
|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| North Texas GCD | 6,789 | 6,789 | 6,789 | 6,789 | 6,789 | 6,789 |
| Northern Trinity GCD | 632 | 632 | 632 | 632 | 632 | 632 |
| Prairielands GCD | 12,434 | 12,434 | 12,434 | 12,434 | 12,434 | 12,434 |
| Red River GCD | 15,384 | 15,384 | 15,384 | 15,384 | 15,384 | 15,384 |
| **Total (excluding non-district areas)** | **35,239** | **35,239** | **35,239** | **35,239** | **35,239** | **35,239** |
| No District | 9,607 | 9,607 | 9,607 | 9,607 | 9,607 | 9,607 |
| **Total (including non-district areas)** | **44,846** | **44,846** | **44,846** | **44,846** | **44,846** | **44,846** |

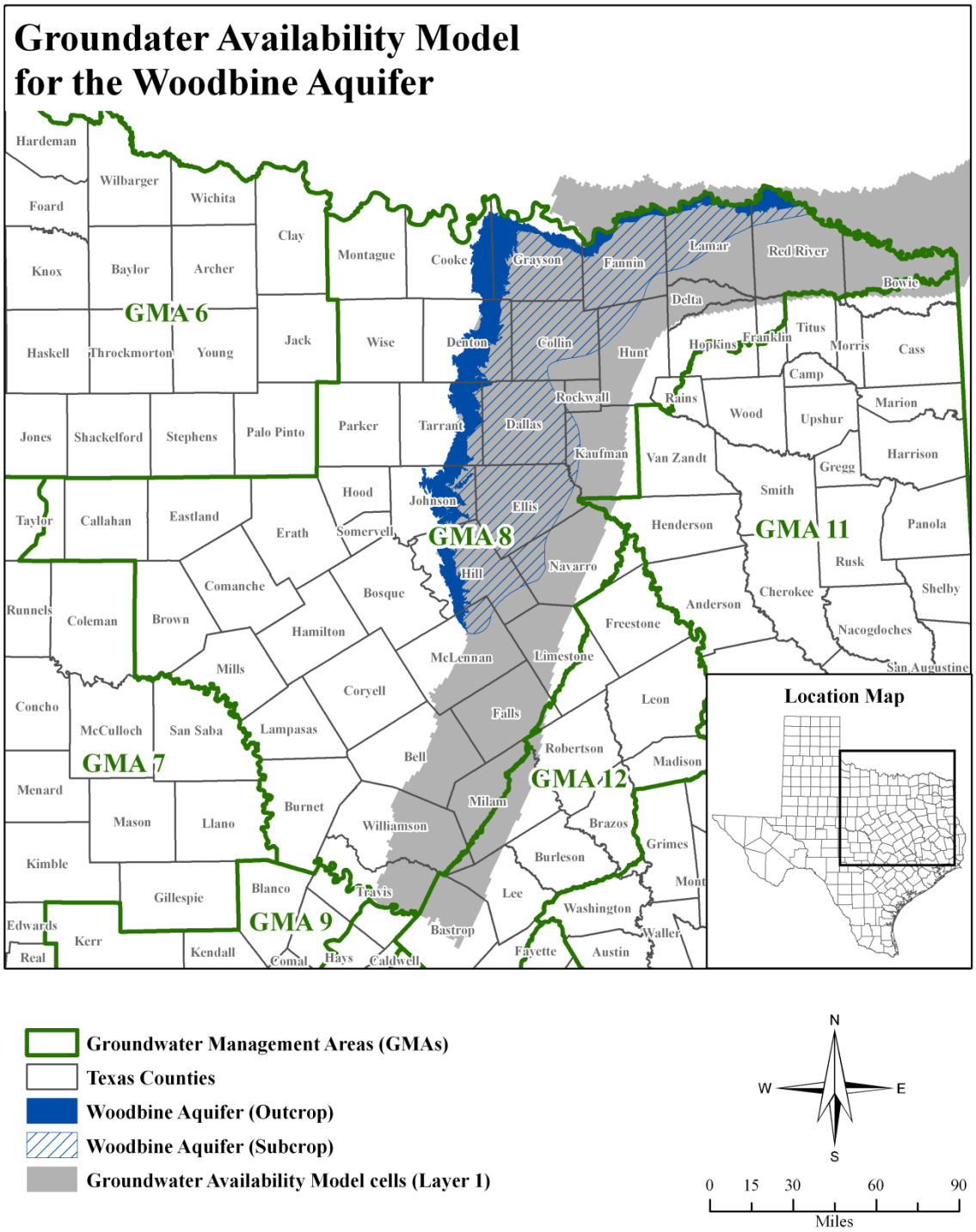


Figure 1. Map showing the areas of the groundwater availability model representing the Woodbine Aquifer and the boundary of Groundwater Management Area 8.

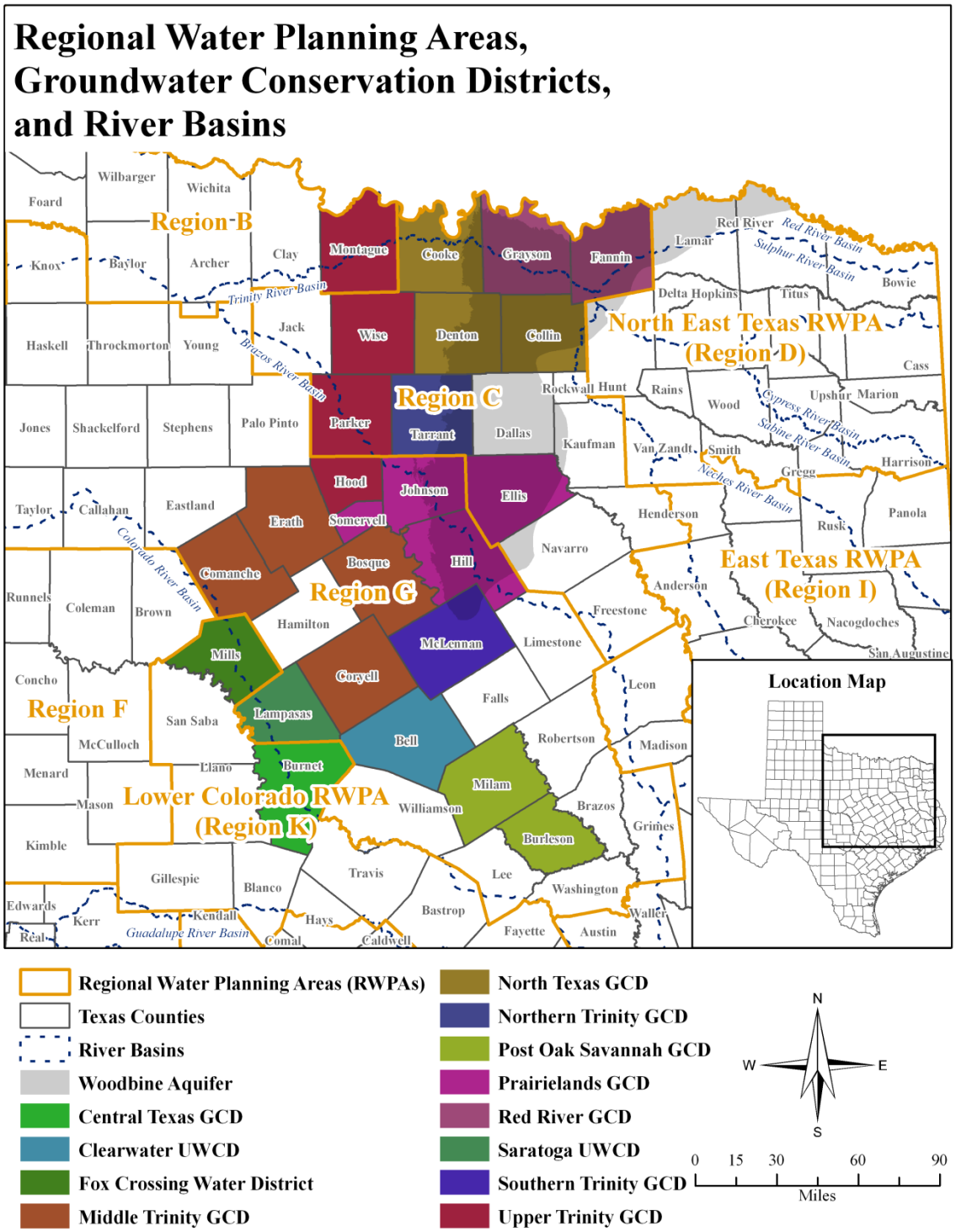


Figure 2. Map showing regional water planning areas (RWPAs), groundwater conservation districts (GCDs), counties, and river basins in and neighboring Groundwater Management Area 8.