GAM TASK 13-032: TOTAL ESTIMATED RECOVERABLE STORAGE FOR AQUIFERS IN GROUNDWATER MANAGEMENT AREA 9

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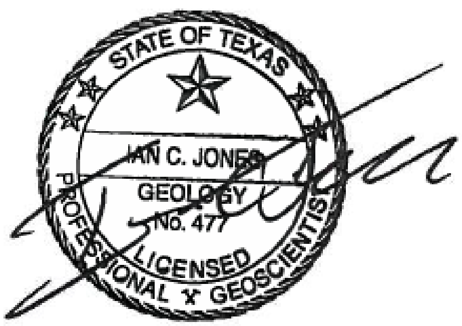
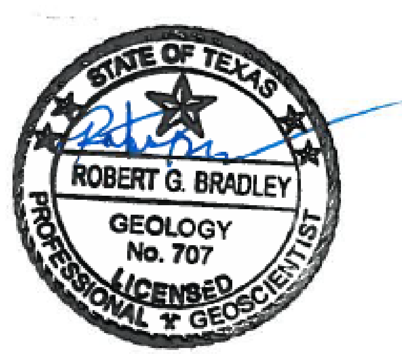
October 2, 2013





The seals appearing on this document were authorized by Ian C. Jones, Ph.D., P.G. 477, and Robert G. Bradley, P.G. 707 on October 2, 2013.

The total estimated recoverable storage in this report was calculated as follows: the Edwards-Trinity (Plateau), Edwards (Balcones Fault Zone), and Trinity aquifers (Ian Jones); and the Hickory, Ellenburger-San Saba, and Marble Falls aquifers (Robert Bradley).

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[1] This is the office telephone number for Ian Jones

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EXECUTIVE SUMMARY:

Texas Water Code, §36.108 (d) (Texas Water Code, 2011) states that, before voting on their proposed desired future conditions for a relevant aquifer within a groundwater management area, the groundwater conservation districts shall consider the total estimated recoverable storage as provided by the executive administrator of the Texas Water Development Board (TWDB) along with other factors listed in §36.108 (d). Texas Administrative Code Rule §356.10 (Texas Administrative Code, 2011) defines the total estimated recoverable storage as the estimated amount of groundwater within an aquifer that accounts for recovery scenarios that range between 25 percent and 75 percent of the porosity-adjusted aquifer volume.

This report discusses the methods, assumptions, and results of an analysis to estimate the total recoverable storage for the Hickory, Ellenburger-San Saba, Marble Falls, Trinity, Edwards-Trinity (Plateau), and Edwards (Balcones Fault Zone) aquifers within Groundwater Management Area 9. Tables 1 through 12 summarize the total estimated recoverable storage required by the statute. Figures 2 through 7 indicate the official extent of the aquifers in Groundwater Management Area 9 used to estimate the total recoverable storage.

DEFINITION OF TOTAL ESTIMATED RECOVERABLE STORAGE:

The total estimated recoverable storage is defined as the estimated amount of groundwater within an aquifer that accounts for recovery scenarios that range between 25 percent and 75

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[2] This is the office telephone number for Ian Jones

percent of the porosity-adjusted aquifer volume. In other words, we assume that between 25 and 75 percent of groundwater held within an aquifer can be removed by pumping.

The total recoverable storage was estimated for the portion of each aquifer within Groundwater Management Area 9 within the official lateral aquifer boundaries as delineated by George and others (2011). Total estimated recoverable storage values may include a mixture of water quality types, including fresh, brackish, and saline groundwater, because the available data and the existing groundwater availability models do not permit the differentiation between different water quality types. The total estimated recoverable storage values also do not take into account the effects of land surface subsidence, degradation of water quality, or changes to surface water-groundwater interaction that may occur due to pumping.

METHODS:

To estimate the total recoverable storage of an aquifer, we first calculated the total storage in an aquifer within the official aquifer boundary in the groundwater management area. The total storage is the volume of groundwater that can be released by completely draining the aquifer.

Aquifers can be either unconfined or confined (Figure 1). A well screened in an unconfined aquifer will have a water level equal to the water level outside the well—in the aquifer. Thus, unconfined aquifers have water levels within the aquifers. A confined aquifer is bounded by low permeable geologic units at the top and bottom, and the aquifer is under hydraulic pressure above the ambient atmospheric pressure. The water level in a well screened in a confined aquifer will be above the top of the aquifer. As a result, calculation of total storage is also different between unconfined and confined aquifers. For an unconfined aquifer, the total storage is equal to the volume of groundwater removed by pumping that makes the water level fall to the aquifer bottom. For a confined aquifer, the total storage contains two parts. The first part is the groundwater released from the aquifer when the water level falls from above the top of the aquifer to the top of the aquifer. The reduction of hydraulic pressure in the aquifer by pumping causes expansion of groundwater and deformation of aquifer solids. The aquifer is still fully saturated to this point. The second part, just like unconfined aquifer, is the groundwater released from the aquifer when the water level falls from the top to the bottom of the aquifer. Given the same aquifer area and water level drop, the amount of water released in the second part is much greater than the first part. The difference is quantified by two parameters: storativity related to confined aquifer and specific yield related to unconfined aquifer. For example, storativity values range from 10^{-5} to 10^{-3} for most confined aquifers, while the specific yield values can be 0.01 to 0.3 for most unconfined aquifers. The equations for calculating the total storage are presented below:

- for unconfined aquifers

$$Total\ Storage\ = V_{drained} = Area \times S_y \times (Water\ Level - Bottom)$$

- for confined aquifers

$$Total\ Storage\ = V_{confined} + V_{drained}$$

  - confined part

$$V_{confined} = \ Area \times [\ S \times (Water\ Level - Top)]$$

or

$$V_{confined} = \ Area \times [\ S_s\ \times (\mathrm{Top} - \mathrm{Bottom}) \times (Water\ Level - Top)]$$

  - unconfined part

$$V_{drained} = \ Area \times \left[S_y \times (Top - Bottom)\right]$$

where:

- $V_{drained}$ = storage volume due to water draining from the formation (acre-feet)
- $V_{confined}$ = storage volume due to elastic properties of the aquifer and water(acre-feet)
- *Area* = area of aquifer (acre)
- *Water Level* = groundwater elevation (feet above mean sea level)
- *Top* = elevation of aquifer top (feet above mean sea level)
- *Bottom* = elevation of aquifer bottom (feet above mean sea level)
- S_y = specific yield (no units)
- S_s = specific storage (1/feet)
- S = storativity or storage coefficient (no units)

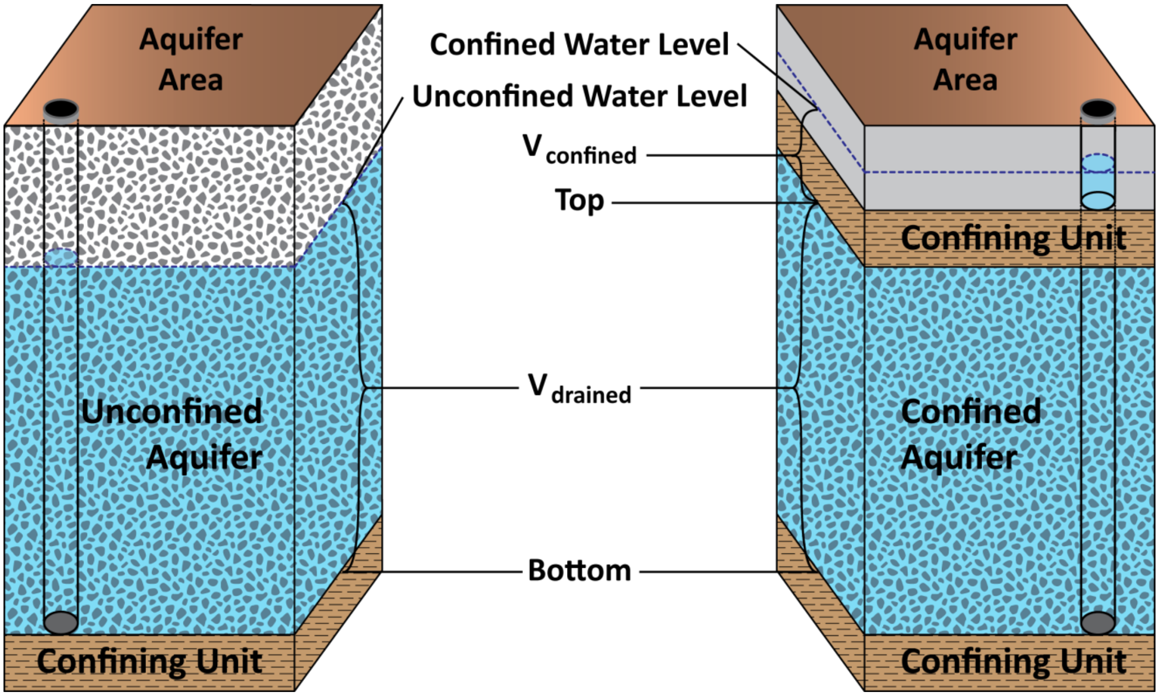

FIGURE 1. SCHEMATIC SHOWING THE DIFFERENCE BETWEEN UNCONFINED AND CONFINED AQUIFERS.

As presented in the equations, calculation of the total storage requires data, such as aquifer top, aquifer bottom, aquifer storage properties, and water level. For the Trinity, Edwards-Trinity (Plateau), and Edwards (Balcones Fault Zone) aquifers in Groundwater Management Area 9, we extracted this information from existing groundwater availability model input and output files on a cell-by-cell basis. For aquifers without groundwater availability model(s), an analogous approach is used.

The following methodology was used to estimate total recoverable storage for parts of the Trinity, and Edwards-Trinity (Plateau) aquifers in Groundwater Management Area 9 that were not included in the 1-layer alternative groundwater flow model covering these aquifers (Hutchison and others, 2011). The excluded parts of the respective aquifers are relatively thin, mostly located along the margins of the respective aquifers in Blanco County.

Recoverable storage in areas outside of the 1-layered alternative groundwater flow model but within the official aquifer boundaries is estimated by first establishing a relationship between aquifer thickness (difference between the elevations of the aquifer top and base) and saturated thickness (difference between the elevations of the water table and aquifer base). For the

Trinity and Edwards-Trinity (Plateau) aquifers within the area of the 1-layer alternative groundwater flow model there is a generally linear relationship between aquifer thickness and saturated thickness. The ratios between saturated thickness and aquifer thickness are 0.9 in the Edwards-Trinity (Plateau) Aquifer and 0.6 in the Trinity Aquifer, therefore, saturated thickness in the non-modeled areas of these aquifers is estimated using these ratios. The Edwards-Trinity (Plateau) Aquifer and the Hill Country portion of the Trinity Aquifer are generally unconfined based on evaluation of available data. Consequently, storage in each model cell representing parts of the respective aquifers excluded from the groundwater flow model is estimated using the following equation:

$$Total\ Storage = V_{drained} = Area \times S_y \times H_{sat}$$

where:

- $V_{drained}$ = storage volume due to water draining from the formation (acre-feet)
- $Area$ = area of aquifer (acre)
- S_y = specific yield (no units)
- H_{sat} = estimated saturated thickness (feet)

Storage volumes estimated using this method were added to the storage volumes from the remainder of the modeled area to estimate the total recoverable storage for the entire Edwards-Trinity (Plateau) and Trinity aquifers.

The water level data from the TWDB Groundwater Database were used to estimate total storage for the Hickory, Ellenburger-San Saba, and Marble Falls aquifers. These water-level measurements were used to construct a potentiometric surface grid using Surfer® software. The base of the Hickory and Ellenburger-San Saba aquifers outcrop were derived from the Source Water Assessment Project (SWAP) data created by United States Geological Survey (2002). These surfaces were re-created as grids in Surfer® software and used to calculate aquifer volumes. For the subcrop area, we used the top and bottom of the Hickory and Ellenburger-San Saba aquifers from Standen and others (2009). The confined volumes were calculated by first taking the difference in the potentiometric surface and tops of the respective aquifers in subcrop. This value was multiplied by a storage coefficient of 10^{-5} for the Hickory Aquifer and 0.0022 for the Ellenburger-San Saba Aquifer resulting in the total storage volume for the portion above the top of the aquifer. Zonal statistics in ArcMap 10.1 software summed the data from grid calculations by county and groundwater conservation district.

The delineated Marble Falls Aquifer within Groundwater Management Area 9 is approximately three square miles in area. Most of the wells within this area are low yield domestic and livestock wells (Blanco-Pedernales Groundwater Conservation District, 2008) and do not have water-level measurements. The only Marble Falls Aquifer well with a water-level measurement (Texas Department of Licensing and Regulation, 2013; tracking number 19406), had a saturated thickness of 45 feet in 2003. Based on this well, which is toward the down-dip part of the aquifer; the average saturated thickness for the aquifer was estimated as one-half of this measurement, or 23 feet.

PARAMETERS AND ASSUMPTIONS:

Hickory and Ellenburger-San Saba Aquifers

- The Hickory and Ellenburger-San Saba aquifers within Groundwater Management Area 9 are unconfined in outcrop and confined in the subcrop areas.
- Limited storage data are available, but because the calculations include all of the Hickory and Ellenburger-San Saba aquifers, we used a storage coefficient of 10^{-4} and a specific yield of 0.03 (Bluntzer, 1992).
- The unconfined drained volume was calculated by taking the aquifer thickness and multiplying by a specific yield of 0.03.

Marble Falls Aquifer

- The Marble Falls Aquifer—which only occurs in outcrop—is assumed to be unconfined.
- No storage data was located for the area, but the specific yield is estimated to be 3 percent (American Society of Civil Engineers, 1996).

Trinity, and Edwards-Trinity (Plateau) Aquifers

- We used the 1-layer alternative groundwater flow model for the Edwards-Trinity (Plateau) Aquifer. See Hutchison and others (2011) for assumptions and limitations of the 1-layer alternative numerical groundwater flow model.
- The 1-layer alternative groundwater flow model simulates groundwater flow through the Pecos Valley and Edwards-Trinity (Plateau) aquifers, and the Hill Country portion of the Trinity Aquifer. The framework for the 1-layer alternative groundwater flow model was more extensive in the areas where the aquifers were thin—especially along the Pecos River—and was used due to the more comprehensive extent of the aquifer geometry.

Edwards (Balcones Fault Zone) Aquifer

- We used version 1.01 of the groundwater availability model for the San Antonio segment of the Edwards (Balcones Fault Zone) Aquifer to estimate the total recoverable storage for the aquifer. See Lindgren and others (2004) for assumptions and limitations of the groundwater availability model.
- This groundwater availability model includes one layer which represents the Edwards (Balcones Fault Zone) Aquifer.
- The confined portion of the Edwards (Balcones Fault Zone) Aquifer includes water ranging in total dissolved solids concentration from 250 milligrams per liter (mg/L) to more than 250,000 mg/L (Lindgren and others, 2004). The down-dip boundary of the model is based on the 10,000 mg/L total dissolved solids concentration line and is assumed to represent the limit of groundwater flow in the confined zone of the aquifer (Lindgren and others, 2004).

RESULTS:

Tables 1 through 12 summarize the total estimated recoverable storage required by statute. The county and groundwater conservation district total estimates are rounded within two significant figures. Figures 2 through 7 indicates the extents of the Hickory, Ellenburger-San Saba, Marble Falls, Trinity, Edwards-Trinity (Plateau), and Edwards (Balcones Fault Zone) aquifers in Groundwater Management Area 9 used to estimate the total recoverable storage information.

TABLE 1. TOTAL ESTIMATED RECOVERABLE STORAGE BY COUNTY FOR THE HICKORY AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 9. COUNTY TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT FIGURES.

County	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Blanco	4,700,000	1,175,000	3,525,000
Hays	58,000	14,500	43,500
Kendall	2,100,000	525,000	1,575,000
Kerr	4,700,000	1,175,000	3,525,000
Travis	24,000	6,000	18,000
Total	11,582,000	2,895,500	8,686,500

TABLE 2. TOTAL ESTIMATED RECOVERABLE STORAGE BY GROUNDWATER CONSERVATION DISTRICT[3] FOR THE HICKORY AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 9. GROUNDWATER CONSERVATION DISTRICT TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT FIGURES.

Groundwater Conservation District (GCD)	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
No District	24,000	6,000	18,000
Blanco-Pedernales GCD	4,700,000	1,175,000	3,525,000
Cow Creek GCD	2,100,000	525,000	1,575,000
Hays Trinity GCD	58,000	14,500	43,500
Headwaters GCD	4,700,000	1,175,000	3,525,000
Total	11,582,000	2,895,500	8,686,500

[3] The total estimated recoverable storage values by groundwater conservation district and county for an aquifer may not be the same because the numbers have been rounded to two significant figures.

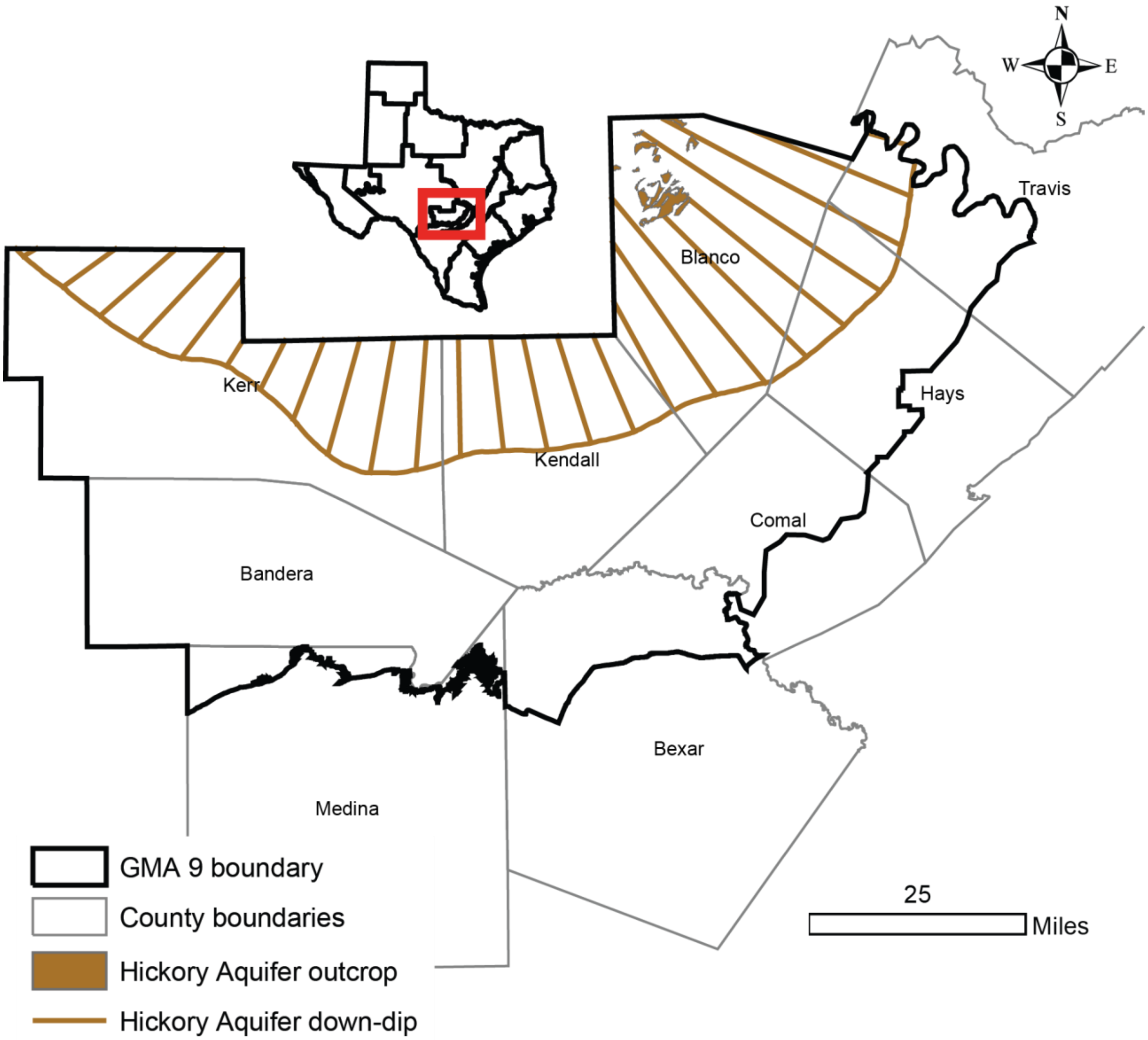

FIGURE 2. EXTENT OF THE HICKORY AQUIFER USED TO ESTIMATE TOTAL RECOVERABLE STORAGE WITHIN GROUNDWATER MANAGEMENT AREA (GMA) 9.

TABLE 3. TOTAL ESTIMATED RECOVERABLE STORAGE BY COUNTY FOR THE ELLENBURGER-SAN SABA AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 9. COUNTY TOTAL ESTIMATES ARE ROUNDED WITHIN TWO SIGNIFICANT FIGURES.

County	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Blanco	8,300,000	2,075,000	6,225,000
Kendall	3,500,000	875,000	2,625,000
Kerr	2,100,000	525,000	1,575,000
Total	13,900,000	3,475,000	10,425,000

TABLE 4. TOTAL ESTIMATED RECOVERABLE STORAGE BY GROUNDWATER CONSERVATION DISTRICT[4] FOR THE ELLENBURGER-SAN SABA AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 9. GROUNDWATER CONSERVATION DISTRICT TOTAL ESTIMATES ARE ROUNDED WITHIN TWO SIGNIFICANT FIGURES.

Groundwater Conservation District (GCD)	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Blanco-Pedernales GCD	8,300,000	2,075,000	6,225,000
Cow Creek GCD	3,500,000	875,000	2,625,000
Headwaters GCD	2,100,000	525,000	1,575,000
Total	13,900,000	3,475,000	10,425,000

[4] The total estimated recoverable storage values by groundwater conservation district and county for an aquifer may not be the same because the numbers have been rounded to two significant figures.

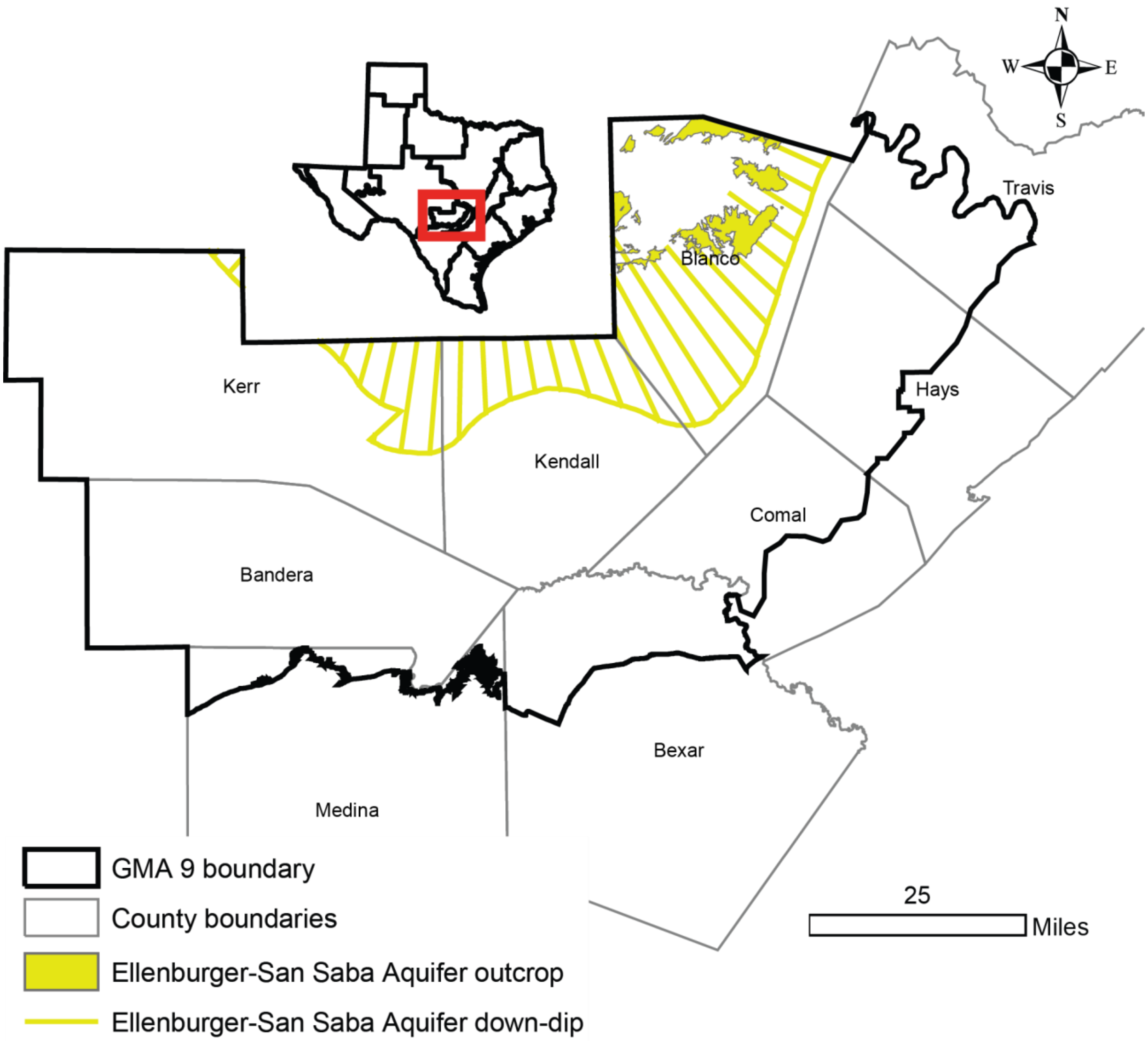

FIGURE 3. EXTENT OF THE ELLENBURGER-SAN SABA AQUIFER USED TO ESTIMATE TOTAL RECOVERABLE STORAGE WITHIN GROUNDWATER MANAGEMENT AREA (GMA) 9.

TABLE 5. TOTAL ESTIMATED RECOVERABLE STORAGE BY COUNTY FOR THE MARBLE FALLS AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 9. COUNTY TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT FIGURES.

County	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Blanco	1,300	325	975
Total	1,300	325	975

TABLE 6. TOTAL ESTIMATED RECOVERABLE STORAGE BY GROUNDWATER CONSERVATION DISTRICT[5] FOR THE MARBLE FALLS AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 9. GROUNDWATER CONSERVATION DISTRICT TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT FIGURES.

Groundwater Conservation District (GCD)	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Blanco-Pedernales GCD	1,300	325	975
Total	1,300	325	975

[5] The total estimated recoverable storage values by groundwater conservation district and county for an aquifer may not be the same because the numbers have been rounded to two significant figures.

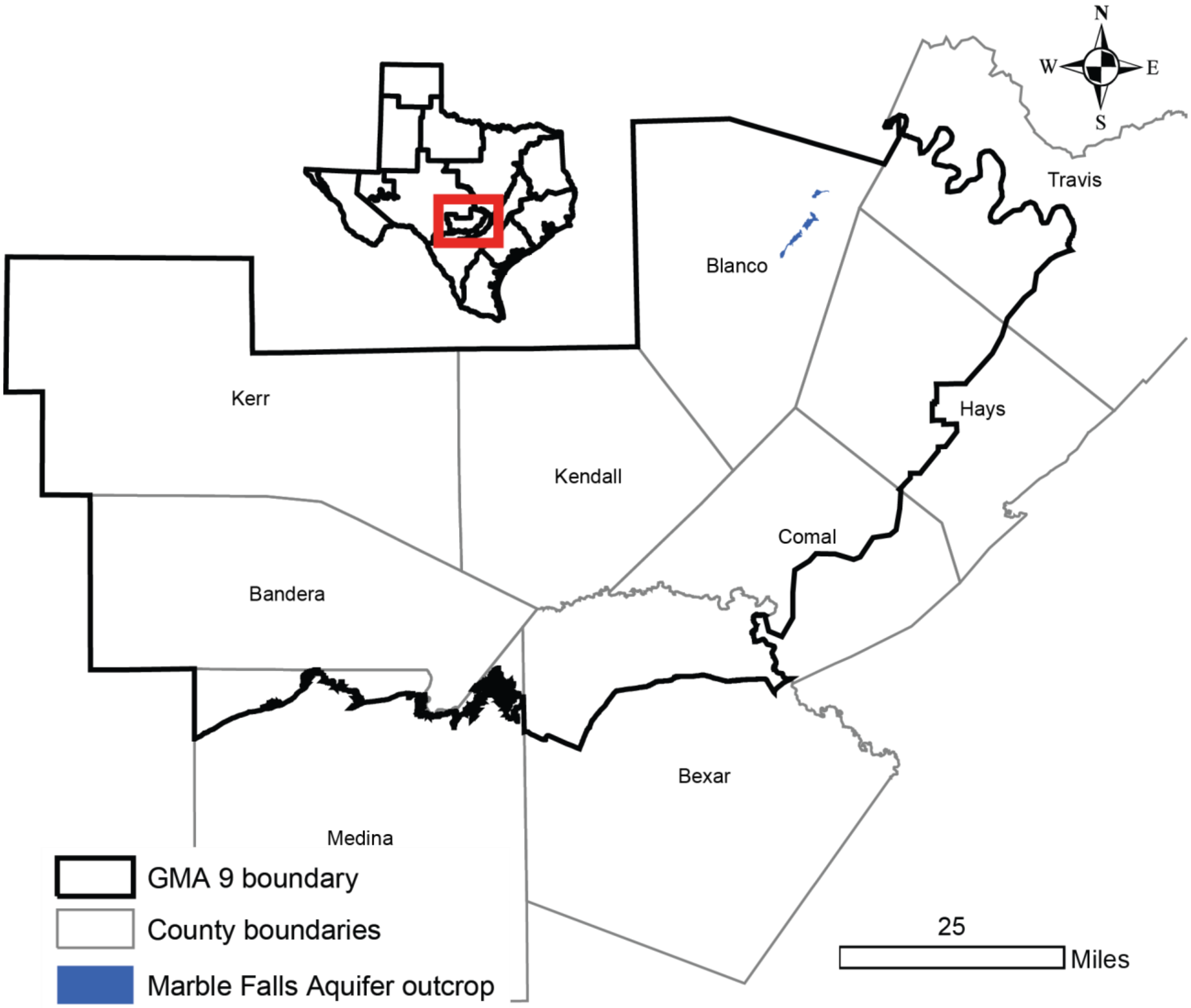

FIGURE 4. EXTENT OF THE MARBLE FALLS AQUIFER USED TO ESTIMATE TOTAL RECOVERABLE STORAGE WITHIN GROUNDWATER MANAGEMENT AREA (GMA) 9.

TABLE 7. TOTAL ESTIMATED RECOVERABLE STORAGE BY COUNTY FOR THE TRINITY AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 9. COUNTY TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT FIGURES.

County	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Bandera	1,200,000	300,000	900,000
Bexar	680,000	170,000	510,000
Blanco	420,000	105,000	315,000
Comal	620,000	155,000	465,000
Hays	550,000	137,500	412,500
Kendall	770,000	192,500	577,500
Kerr	340,000	85,000	255,000
Medina	370,000	92,500	277,500
Travis	330,000	82,500	247,500
Total	5,280,000	1,320,000	3,960,000

TABLE 8. TOTAL ESTIMATED RECOVERABLE STORAGE BY GROUNDWATER CONSERVATION DISTRICT[6] FOR THE TRINITY AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 9. GROUNDWATER CONSERVATION DISTRICT TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT FIGURES.

Groundwater Conservation District (GCD)	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
No District	910,000	227,500	682,500
Bandera County River Authority & Ground Water District	1,200,000	300,000	900,000
Barton Springs/Edwards Aquifer Conservation District	2,200	550	1,650
Blanco-Pedernales GCD	420,000	105,000	315,000
Cow Creek GCD	760,000	190,000	570,000
Edwards Aquifer Authority	37,000	9,250	27,750
Hays Trinity GCD	550,000	137,500	412,500
Headwaters GCD	340,000	85,000	255,000
Medina County GCD	370,000	92,500	277,500
Trinity Glen Rose GCD	680,000	170,000	510,000
Total	5,269,200	1,317,300	3,951,900

[6] The total estimated recoverable storage values by groundwater conservation district and county for an aquifer may not be the same because the numbers have been rounded to two significant figures.

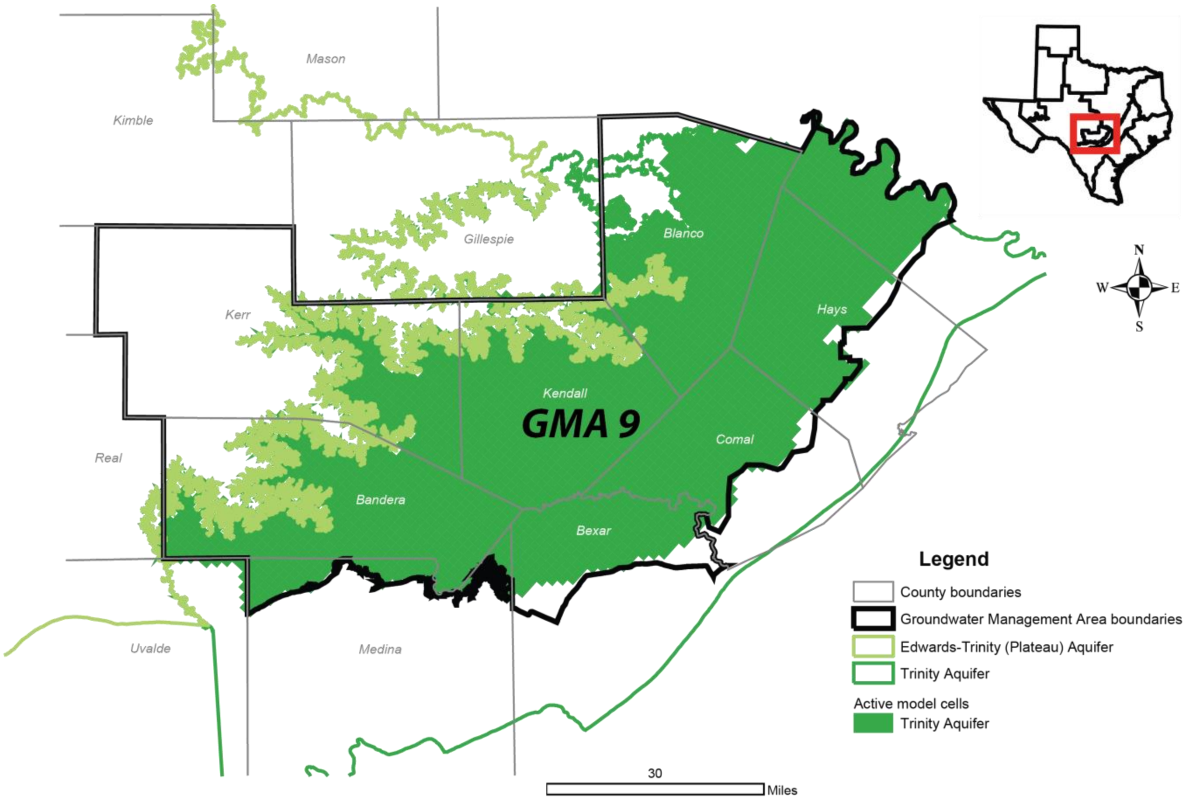

FIGURE 5. AREA OF THE TRINITY AQUIFER USED TO ESTIMATE TOTAL RECOVERABLE STORAGE WITHIN GROUNDWATER MANAGEMENT AREA (GMA) 9.

TABLE 9. TOTAL ESTIMATED RECOVERABLE STORAGE BY COUNTY FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 9. COUNTY TOTAL ESTIMATES ARE ROUNDED WITHIN TWO SIGNIFICANT FIGURES.

County	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Bandera	450,000	112,500	337,500
Blanco	12,000	3,000	9,000
Kendall	96,000	24,000	72,000
Kerr	1,800,000	450,000	1,350,000
Total	2,358,000	589,500	1,768,500

TABLE 10. TOTAL ESTIMATED RECOVERABLE STORAGE BY GROUNDWATER CONSERVATION DISTRICT[7] FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 9. GROUNDWATER CONSERVATION DISTRICT TOTAL ESTIMATES ARE ROUNDED WITHIN TWO SIGNIFICANT FIGURES.

Groundwater Conservation District (GCD)	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Bandera County River Authority & Ground Water District	450,000	112,500	337,500
Blanco-Pedernales GCD	12,000	3,000	9,000
Cow Creek GCD	96,000	24,000	72,000
Headwaters GCD	1,800,000	450,000	1,350,000
Total	2,358,000	589,500	1,768,500

[7] The total estimated recoverable storage values by groundwater conservation district and county for an aquifer may not be the same because the numbers have been rounded to to two significant figures.

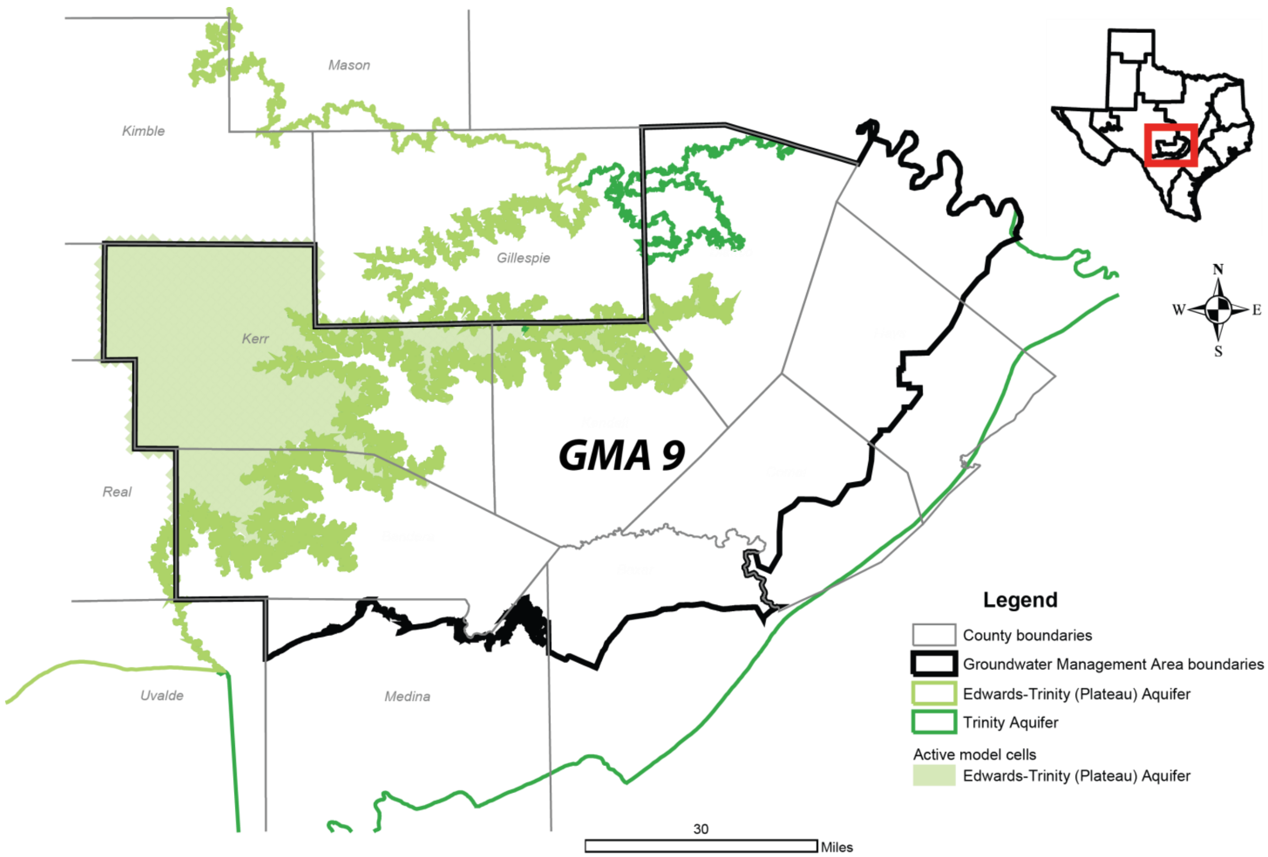

FIGURE 6. EXTENT OF THE GROUNDWATER AVAILABILITY MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER USED TO ESTIMATE TOTAL RECOVERABLE STORAGE FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER IN GROUNDWATER MANAGEMENT AREA (GMA) 9.

TABLE 11. TOTAL ESTIMATED RECOVERABLE STORAGE BY COUNTY FOR THE EDWARDS (BALCONES FAULT ZONE) AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 9. COUNTY TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT FIGURES.

County	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Bexar	150,000	37,500	112,500
Comal	90,000	22,500	67,500
Hays	14,000	3,500	10,500
Travis	6,700	1,675	5,025
Total	260,700	65,175	195,525

TABLE 12. TOTAL ESTIMATED RECOVERABLE STORAGE BY GROUNDWATER CONSERVATION DISTRICT[8] FOR THE EDWARDS (BALCONES FAULT ZONE) AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 9. GROUNDWATER CONSERVATION DISTRICT TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT FIGURES.

Groundwater Conservation District (GCD)	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
No District	24,000	6,000	18,000
Barton Springs/Edwards Aquifer Conservation District	15,000	3,750	11,250
Edwards Aquifer Authority	220,000	55,000	165,000
Hays Trinity GCD	4,500	1,125	3,375
Total	263,500	65,875	197,625

[8] The total estimated recoverable storage values by groundwater conservation district and county for an aquifer may not be the same because the numbers have been rounded to two significant figures.

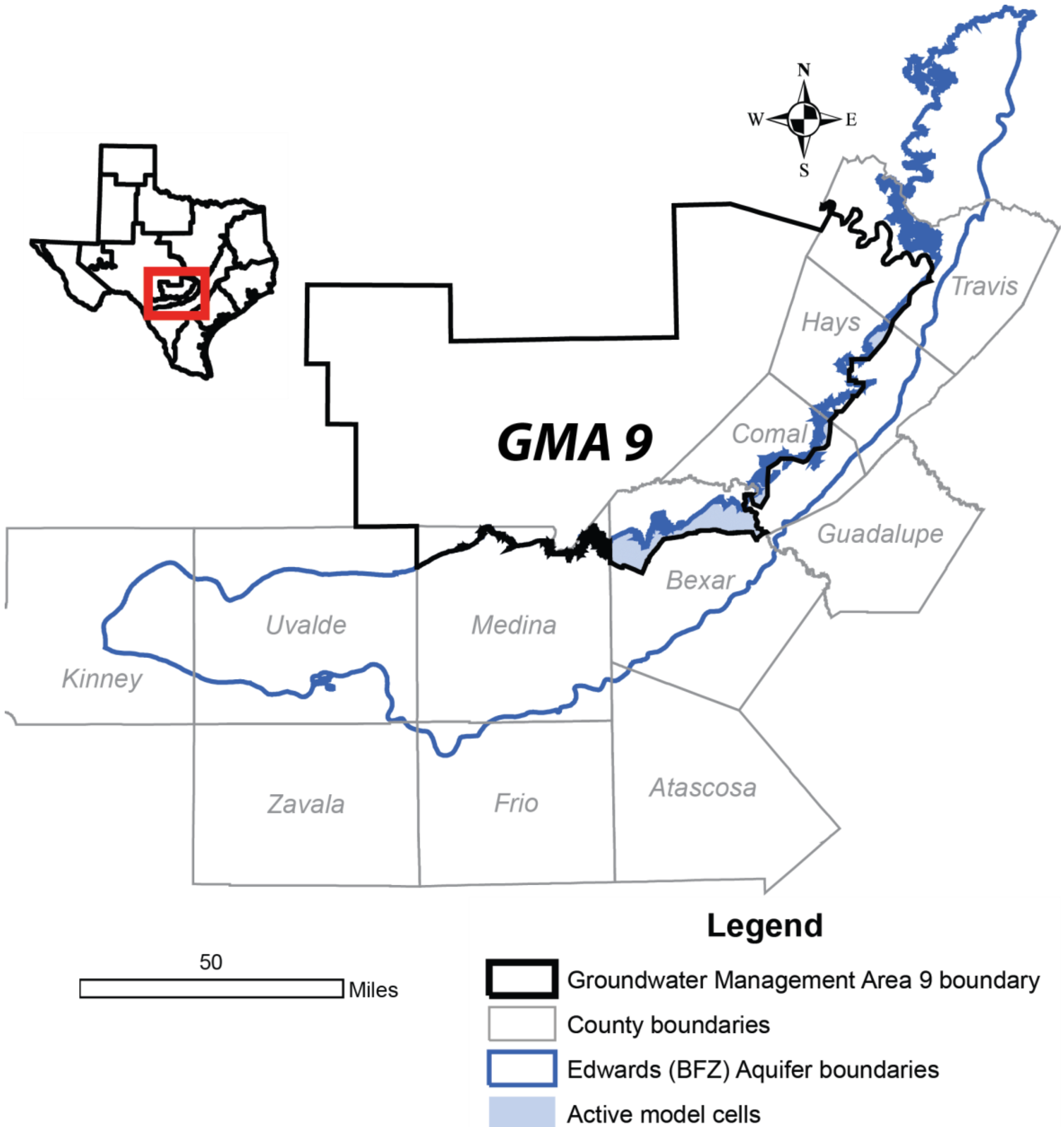

FIGURE 7. EXTENT OF THE GROUNDWATER AVAILABILITY MODEL FOR THE SAN ANTONIO SEGMENT OF THE EDWARDS (BALCONES FAULT ZONE) AQUIFER USED TO ESTIMATE TOTAL RECOVERABLE STORAGE WITHIN GROUNDWATER MANAGEMENT AREA (GMA) 9.

LIMITATIONS

The groundwater models used in completing this analysis are the best available scientific tools 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."*

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.

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