GAM RUN 21-011 MAG:
MODELED AVAILABLE GROUNDWATER FOR THE AQUIFERS IN GROUNDWATER MANAGEMENT AREA 6

Jevon Harding, P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-463-7979

November 14, 2022

STATE OF TEXAS
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EXECUTIVE SUMMARY:

The Texas Water Development Board (TWDB) estimated the modeled available groundwater values for the following relevant aquifers in Groundwater Management Area 6:

- Seymour Aquifer – The modeled available groundwater ranges from 157,895 to 181,289 acre-feet per year during the period from 2020 to 2080. Values are summarized by groundwater conservation district, county, and Seymour Aquifer pod in Table 1, and by county, regional water planning area, river basin, and Seymour Aquifer pod in Table 2.
- Blaine Aquifer – The modeled available groundwater ranges from 70,924 to 74,029 acre-feet per year during the period from 2020 to 2080. Values are summarized by groundwater conservation district and county in Table 3, and by county, regional water planning area, and river basin in Table 4.
- Ogallala Aquifer – The modeled available groundwater remains at 409 acre-feet per year throughout the period from 2020 to 2080. Values are summarized by groundwater conservation district and county in Table 5, and by county, regional water planning area, and river basin in Table 6.
- Dockum Aquifer – The modeled available groundwater ranges from 171 to 172 acre-feet per year during the period from 2020 to 2080. Values are summarized by groundwater conservation district and county in Table 7, and by county, regional water planning area, and river basin in Table 8.

Figure 1 shows the county and groundwater conservation district boundaries represented by the divisions in Tables 1, 3, 5, and 7. Figure 2 shows the regional water planning area, river basin, and county boundaries represented by the divisions in Tables 2, 4, 6, and 8.

The modeled available groundwater estimates are based on the revised desired future conditions for the Seymour, Blaine, Ogallala, and Dockum aquifers adopted by groundwater conservation district (or district) representatives in Groundwater Management Area 6 on September 29, 2022.

The district representatives declared the following aquifers to be non-relevant for purposes of joint planning: the entire Cross Timbers Aquifer; the Blaine Aquifer in Motley, Knox, Dickens, Kent, Jones, Stonewall, and Wilbarger counties; the Ogallala Aquifer in Collingsworth and Dickens counties; the Dockum Aquifer in Dickens and Kent counties. Additionally, the following portions of the Seymour Aquifer were also declared non-relevant for the purposes of joint planning: the entirety of Pods 5, 9, 10, 12, 13, 14, 15; the portion of Pod 3 in Briscoe County; the portion of Pod 4 in Wichita and Wilbarger counties; the portion of Pod 7 in Stonewall County; the portion of Pod 8 in Throckmorton and Young counties; the portion of Pod 11 in Jones and Stonewall counties.

The TWDB determined that the explanatory report and other materials submitted by the district representatives were administratively complete on November 10, 2022.

REQUESTOR:

Mr. Mike McGuire, General Manager of Rolling Plains Groundwater Conservation District and Groundwater Management Area 6 Coordinator.

DESCRIPTION OF REQUEST:

In a letter dated January 17, 2022, Mr. Mike McGuire provided the TWDB with the desired future conditions of the Seymour, Blaine, Ogallala, and Dockum aquifers. The desired future conditions were first adopted on November 18, 2021 by district representatives in Groundwater Management Area 6 as part of the joint planning process. After review of the submittal, the TWDB sent an email to Mr. McGuire on June 7, 2022 requesting missing model files, confirmation of the methodology and assumptions used, and clarifications on minor inconsistencies in the wording of the desired future conditions and non-relevant statements. On June 16, 2022, Mr. McGuire and the Groundwater Management Area 6 consultants provided the missing model files and responses to clarifications (Appendix A). They provided confirmation that the assumptions used by the TWDB were consistent with those used by Groundwater Management Area 6. To address the TWDB clarifications, they also provided a new version of the desired future conditions resolution that corrected clerical errors and included additional non-relevant aquifer statements. District representatives in Groundwater Management Area 6 signed and adopted revised desired future conditions resolutions September 29, 2022. The final desired future conditions are:

Seymour Aquifer (as stated in Resolution 21-005)

a. *The Desired Future Condition for Pod 1 in Childress & Collingsworth Counties, located in the Mesquite and Gateway Groundwater Conservation Districts, is that condition whereby the total decline in water levels will be no more than 33 feet during the period from 2010 - 2080*
b. *The Desired Future Condition for Pod 2 in Hall County, located in Mesquite Groundwater Conservation District is that condition whereby the total decline in water levels will be no more than 15 feet during the period from 2010 - 2080*
c. *The Desired Future Condition for Pod 3 in Briscoe, Hall & Motley Counties, located in the Mesquite and Gateway Groundwater Conservation Districts, is that condition whereby the total decline in water levels will be no more than 15 feet during the period from 2010 - 2080*
d. *The Desired Future Condition for Pod 4 in Childress, Foard, and Hardeman counties, located in the Mesquite and Gateway Groundwater Conservation Districts, is that condition whereby the total decline in water levels will be no more than 1 foot during the period from 2010 - 2080*
e. *The Desired Future Condition for Pod 6 in Knox County, located in Rolling Plains Groundwater Conservation District is that condition whereby the total decline in water levels will be no more than 18 feet during the period from 2010 – 2080*
f. *The Desired Future Condition for that part of Pod 7 Baylor, Haskell. and Knox Counties, located in Rolling Plains Groundwater Conservation District is that condition whereby the total decline in water levels will be no more than 18 feet during the period from 2010 - 2080*
g. *The Desired Future Condition for that part of Pod 8 in Baylor County, located in Rolling Plains Groundwater Conservation District is that condition whereby the total water level decline will be no more than 18 feet during the period from 2010 - 2080*
h. *The Desired Future Condition for that part of Pod 11 in Fisher County, located in Clear Fork Groundwater Conservation District is that condition whereby the total water level decline will be no more than 1 foot during the period from 2010 - 2080*
i. *The Seymour Aquifer Pods 5, 9, 10, 12, 13, 14, 15, that part of 3 in Briscoe County, that part of 4 in Wichita and Wilbarger counties, that part of 7 in Stonewall County, that part of 8 in Throckmorton and Young counties, and that part of 11 in Jones and Stonewall counties have been determined to be non-relevant for joint planning purposes.*

Blaine Aquifer (as stated in Resolution 21-004)

a. *The Desired Future Condition for that part of Childress County North of the Red River, located in the Mesquite Groundwater Conservation District, all of Collingsworth and Hall Counties, also located within the Mesquite Groundwater Conservation District; and that part of Childress County North of the Red River located in the Gateway Groundwater Conservation District is that condition whereby the total decline in water levels will be no more than 9 feet during the period from 2010-2080*
b. *The Desired Future Condition for that part of Childress County south of the Red River located in the Mesquite & Gateway Groundwater Conservation Districts; and all of Cottle and Hardeman Counties, also located within the Gateway Groundwater Conservation District, is that condition whereby the total decline in water levels will be no more than 2 feet during the period from 2010-2080*
c. *The Desired Future Condition for Fisher County, located within the Clear Fork Groundwater Conservation District, is that condition whereby the total decline in water levels will be no more than 4 feet during the period from 2010-2080*
d. *The Desired Future Condition for King County, located within the Gateway Groundwater Conservation District, is that condition whereby the total decline in water levels will be no more than 7 feet during the period from 2010-2080*
e. *The Desired Future Condition for Foard County, located within the Gateway Groundwater Conservation District, is that condition whereby the total decline in water levels will be no more than 10 feet during the period from 2010-2080*
f. *The Blaine Aquifer in Motley County, located within the Gateway Groundwater Conservation District, and in Knox County, located within the Rolling Plains Groundwater Conservation District, has been determined to be non-relevant for joint planning purposes*
g. *The Blaine Aquifer in Dickens, Kent, Jones, Stonewall and Wilbarger Counties, not located within a Groundwater Conservation District, has been determined to be non-relevant for joint planning purposes.*

Ogallala Aquifer (as stated in Resolution 21-003)

a. *The Desired Future Condition for Motley County. located in the Gateway Groundwater Conservation District. is that condition with average drawdown of up to 28 feet between 2013 and 2080.*
b. *The Ogallala Aquifer in Collingsworth County. located in the Mesquite Groundwater Conservation District. is insignificant or nonexistent, and is determined to be non-relevant for joint planning purposes*
c. *The Ogallala Aquifer in Dickens County. not located within a Groundwater Conservation District, is determined to be non-relevant for joint planning purposes.*

Dockum Aquifer (as stated in Resolution 21-001)

a. The Desired Future Condition for Fisher County, located in the Clear Fork Groundwater Conservation District is that condition whereby the total decline in water levels will be no more than 28 feet during the period from 2013 - 2080
b. The Desired Future Condition for Motley County, located in the Gateway Groundwater Conservation District is that condition whereby the total decline in water levels will be no more than 28 feet during the period from 2013 - 2080
c. The Dockum Aquifer in Dickens & Kent Counties, not located within a Groundwater Conservation District, has been determined to be non-relevant for joint planning purposes.

Cross Timbers Aquifer (as stated in Resolution 21-002)

The Cross Timbers Aquifers within Groundwater Management Area 6 have been determined to be non-relevant for joint planning purposes.

METHODS:

The desired future conditions for Groundwater Management Area 6 are based on water-level declines, or drawdowns, defined as the difference in water levels between a baseline year and 2080. Depending on the aquifer, one of three groundwater availability models were used to estimate drawdowns over the specified time interval and to calculate modeled available groundwater.

The groundwater availability model for the Seymour Aquifer in Baylor, Haskell, and Knox counties (Jigmond and others, 2014) was used for Pod 7 of the Seymour Aquifer and the groundwater availability model for the Seymour and Blaine aquifers (Version 1.01; Ewing and others, 2004) was used for the remainder of the Seymour Aquifer and the Blaine Aquifer. Both models were run using predictive model files submitted with the explanatory report (Brady, 2022).

Modeled water levels for these two models were extracted for the years 2010 and 2080 and drawdown was calculated as the difference in water level between those two years. Drawdown averages were calculated by aquifer for each area specified in the desired future conditions. The calculated drawdown averages were compared with the desired future conditions and TWDB staff verified that the pumping scenario in the submitted model files achieved the desired future conditions.

The groundwater availability model for the High Plains Aquifer System (Version 1.01; Deeds and Jigmond, 2015) was used for calculations in the Ogallala and Dockum aquifers. This model was run using the predictive model files for "Scenario 19" submitted with the explanatory report for Groundwater Management Area 2 (Hutchison 2021a, 2021b). Modeled water levels for this model were extracted for the years 2013 and 2080 and drawdown calculated as the difference in water level between those two years. Drawdown averages were calculated by aquifer for each area specified in the desired future conditions. The calculated drawdown averages were compared with the desired future conditions and TWDB staff verified that the pumping scenario in the submitted model files achieved the desired future conditions.

The modeled available groundwater values for all three models were determined by extracting pumping rates by decade from the model results using ZONEBUDGET Version 3.01 (Harbaugh, 2009). Tables 1, 3, 5, and 7 present modeled available groundwater by county and groundwater conservation district for the Seymour, Blaine, Ogallala, and Dockum aquifers, respectively. Tables 2, 4, 6, and 8 present modeled available groundwater for regional planning purposes by county, river basin, and regional water planning area for the Seymour, Blaine, Ogallala, and Dockum aquifers, respectively.

Modeled Available Groundwater and Permitting

As defined in Chapter 36 of the Texas Water Code (2011), "modeled available groundwater" is the estimated average amount of water that may be produced annually to achieve a desired future condition. 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.

PARAMETERS AND ASSUMPTIONS:

The parameters and assumptions for the modeled available groundwater estimates are described below:

Seymour Aquifer (Pod 7)

- The groundwater availability model for the Seymour Aquifer in Haskell, Knox, and Baylor Counties was the base model for this analysis. See Jigmond and others (2014) for the assumptions and limitations of the historical calibrated model. Groundwater

Management Area 6 constructed a predictive model simulation to extend the base model to 2080 for planning purposes. See Brady (2022) for the assumptions of this predictive model simulation.

- This groundwater availability model includes one layer, which represents the Seymour Aquifer.
- The model was run with MODFLOW-2000 (Harbaugh and others, 2000).
- Drawdown was calculated as the difference in modeled head (water level) between the baseline year 2010 (stress period 347) and the final year 2080 (stress period 418). Average drawdowns were calculated as the sum of drawdowns for all model cells within a specified area divided by the number of cells in that specified area.
- Although the original groundwater availability model was only calibrated to 2005, an analysis during the previous round of joint planning (Shi, 2017; Appendix A) verified that the measured water levels did not change significantly for the period from 2005 to 2010. For this reason, the TWDB considers it acceptable to use 2010 as the reference year for drawdown calculations.
- Cells in which the modeled head (water level) was below the bottom of the cell are considered “dry.” Cells that were already dry during the baseline year were not included in the drawdown calculation. In cells that became dry during the simulation, the drawdown calculation used the elevation of the bottom of the cell, rather than the modeled head. In this model, transmissivity of “dry” cells remains constant and pumping from those cells continues, so the modeled available groundwater calculation can include pumping in cells where the modeled head is below the bottom of the cell.
- The most recent TWDB model grid file dated January 6, 2020 (symr_hkb_grid_poly010620.csv) was used to assign model cells to counties, groundwater management areas, groundwater conservation districts, river basins, and regional water planning areas.
- The drawdown averages and modeled available groundwater values were calculated using the active model extent of Layer 1 for Pod 7 of the Seymour Aquifer. The modeled extent of Pod 7 of the Seymour Aquifer is coincident with the official TWDB Seymour Aquifer boundary of Pod 7, shown in Figure 3.
- The modeled available groundwater was calculated based on the pumping scenario provided with the Groundwater Management Area 6 Explanatory Report (Brady, 2022).

- Estimates of modeled available groundwater from the model simulation were rounded to whole numbers.

Seymour Aquifer (except Pod 7) and Blaine Aquifer

- Version 1.01 of the groundwater availability model for the Seymour and Blaine aquifers was the base model for this analysis. See Ewing and others (2004) for the assumptions and limitations of the historical calibrated model. Groundwater Management Area 6 constructed a predictive model simulation to extend the base model to 2080 for planning purposes. See Brady (2022) for the assumptions of this predictive model simulation.
- The model has two layers that represent the Seymour Aquifer (Layer 1) and the Blaine Aquifer as well as other geologic units that underlie the Seymour Aquifer (Layer 2).
- The model was run with MODFLOW-2000 (Harbaugh and others, 2000).
- Drawdown was calculated as the difference in modeled head (water level) between the baseline year 2010 (initial heads) and the final year 2080 (stress period 70). Average drawdowns were calculated as the sum of drawdowns for all model cells within a specified area divided by the number of cells in that specified area.
- Although the original groundwater availability model was only calibrated to 1999, an analysis during the previous round of joint planning (Shi, 2017; Appendix A) verified that the measured water levels did not change significantly for the period from 1999 to 2010. For this reason, the TWDB considers it acceptable to use 2010 as the reference year for drawdown calculations.
- Cells in which the head (water level) was below the bottom of the cell were considered “dry.” Cells that were already dry during the baseline year were not included in the drawdown calculation. In cells that became dry during the simulation, the drawdown calculation used the elevation of the bottom of the cell, rather than the modeled head. Pumping in dry cells was excluded from the modeled available groundwater calculations for the decades after the cell went dry.
- The most recent TWDB model grid file dated January 6, 2020 (symr_grid_poly010620.csv) was used to assign model cells to counties, groundwater management areas, groundwater conservation districts, river basins, and regional water planning areas. Cells that intersected a particular Seymour Aquifer pod were assigned to that pod.

- To be consistent with the desired future conditions defined by district representatives in Groundwater Management Area 6, the drawdown averages and modeled available groundwater values were calculated using the active model extent of Layers 1 and 2 for the Seymour and Blaine aquifers, respectively. The modeled extent of the Seymour Aquifer is coincident with the official TWDB Seymour Aquifer boundary, shown in Figure 3. The modeled extent of Layer 2 extends significantly beyond the official TWDB Blaine Aquifer boundary (Figure 4) and includes formations that are not equivalent to the Blaine Aquifer. However, since the modeled pumping was only implemented in areas roughly coincident with the official TWDB Blaine Aquifer boundary, the TWDB considers this an acceptable simplification.
- The modeled available groundwater was calculated based on the pumping scenario provided with the Groundwater Management Area 6 Explanatory Report (Brady, 2022).
- Estimates of modeled available groundwater from the model simulation were rounded to whole numbers.

Ogallala and Dockum aquifers

- Version 1.01 of the groundwater availability model for the High Plains Aquifer System was the base model for this analysis. See Deeds and Jigmond (2015) for the assumptions and limitations of the historical calibrated model. Groundwater Management Area 6 used the predictive model simulation "Scenario 19" constructed by Groundwater Management Area 2 to extend the base model to 2080 for planning purposes. See Hutchison (2021a, 2021b) for the assumptions of this predictive model simulation.
- The model has four layers which represent the Ogallala and Pecos Valley Alluvium aquifers (Layer 1); the Edwards-Trinity (High Plains), Rita Blanca, and Edwards-Trinity (Plateau) aquifers (Layer 2); the Upper Dockum Aquifer (Layer 3); and the Lower Dockum Aquifer (Layer 4).
- The model was run with MODFLOW-NWT (Niswonger and others, 2011).
- Drawdown was calculated as the difference in modeled head between the baseline year 2013 (initial heads) and the final year 2080 (stress period 68). Average drawdowns were calculated as the sum of drawdowns for all model cells within a specified area divided by the number of cells in that specified area.
- To be consistent with the desired future conditions defined by district representatives in Groundwater Management Area 6, the drawdown averages and

modeled available groundwater values were calculated using the active model extent of Layer 1 and the combination of Layers 3 and 4 for the Ogallala and Dockum aquifers, respectively. Within Groundwater Management Area 6, the modeled extent of the Ogallala and Dockum aquifers are coincident with the official TWDB aquifer boundaries, shown in Figures 5 and 6, respectively.

- MODFLOW-NWT can be used to simulate the declining production of a well as saturated thickness decreases because it will automatically reduce pumping when heads (water levels) drop to a level defined by the user. Typically, the user-specified level at which the model reduces pumping is defined as a fraction of cell thickness. Deeds and Jigmond (2015) slightly modified the MODFLOW-NWT code to use a particular saturated thickness value (30 feet), rather than a fraction, as the threshold for reducing pumping. The modeled available groundwater calculation thus includes reduced pumping values in cells where modeled head drops below the 30-foot saturated thickness threshold and zero pumping in cells when modeled head drops below the bottom of the cell. The average drawdown calculation includes cells where the modeled head drops below the bottom of the cell.
- Pass-through cells exist in layers 2 and 3 where the Upper Dockum Aquifer was absent, but the cells provided a pathway for flow between the Lower Dockum and the Ogallala or Edwards-Trinity (High Plains) aquifers vertically. These pass-through cells were excluded from the calculations for average drawdown and modeled available groundwater.
- The most recent TWDB model grid file dated January 6, 2020 (hpas_grid_poly010620.csv) was used to assign model cells to counties, groundwater management areas, groundwater conservation districts, river basins, and regional water planning areas.
- The modeled available groundwater was calculated based on the pumping scenario (“Scenario 19”) provided with the Groundwater Management Area 2 Explanatory Report (Hutchison, 2021a, 2021b).
- Estimates of modeled drawdown and available groundwater from the model simulation were rounded to whole numbers.

RESULTS:

The modeled available groundwater values for the relevant aquifers in Groundwater Management Area 6 are as follows:

- Seymour Aquifer – The modeled available groundwater ranges from 157,895 to 181,289 acre-feet per year during the period from 2020 to 2080. Values are summarized by groundwater conservation district, county, and Seymour Aquifer pod in Table 1, and by county, regional planning area, river basin, and Seymour Aquifer pod in Table 2.

- Blaine Aquifer – The modeled available groundwater ranges from 70,924 to 74,029 acre-feet per year during the period from 2020 to 2080. Values are summarized by groundwater conservation district and county in Table 3, and by county, regional planning area, and river basin in Table 4.
- Ogallala Aquifer – The modeled available groundwater remains at 409 acre-feet per year throughout the period from 2020 to 2080. Values are summarized by groundwater conservation district and county in Table 5, and by county, regional planning area, and river basin in Table 6.
- Dockum Aquifer – The modeled available groundwater ranges from 171 to 172 acre-feet per year during the period from 2020 to 2080. Values are summarized by groundwater conservation district and county in Table 7, and by county, regional planning area, and river basin in Table 8.

District representatives in Groundwater Management Area 6 determined the Cross Timbers Aquifer was non-relevant for the purposes of joint planning; therefore, modeled available groundwater values were not calculated for that aquifer. Additionally, the modeled available groundwater values provided in this report do not include those portions of the Seymour, Blaine, Ogallala, and Dockum aquifers that district representatives in Groundwater Management Area 6 declared non-relevant for the purposes of joint planning.

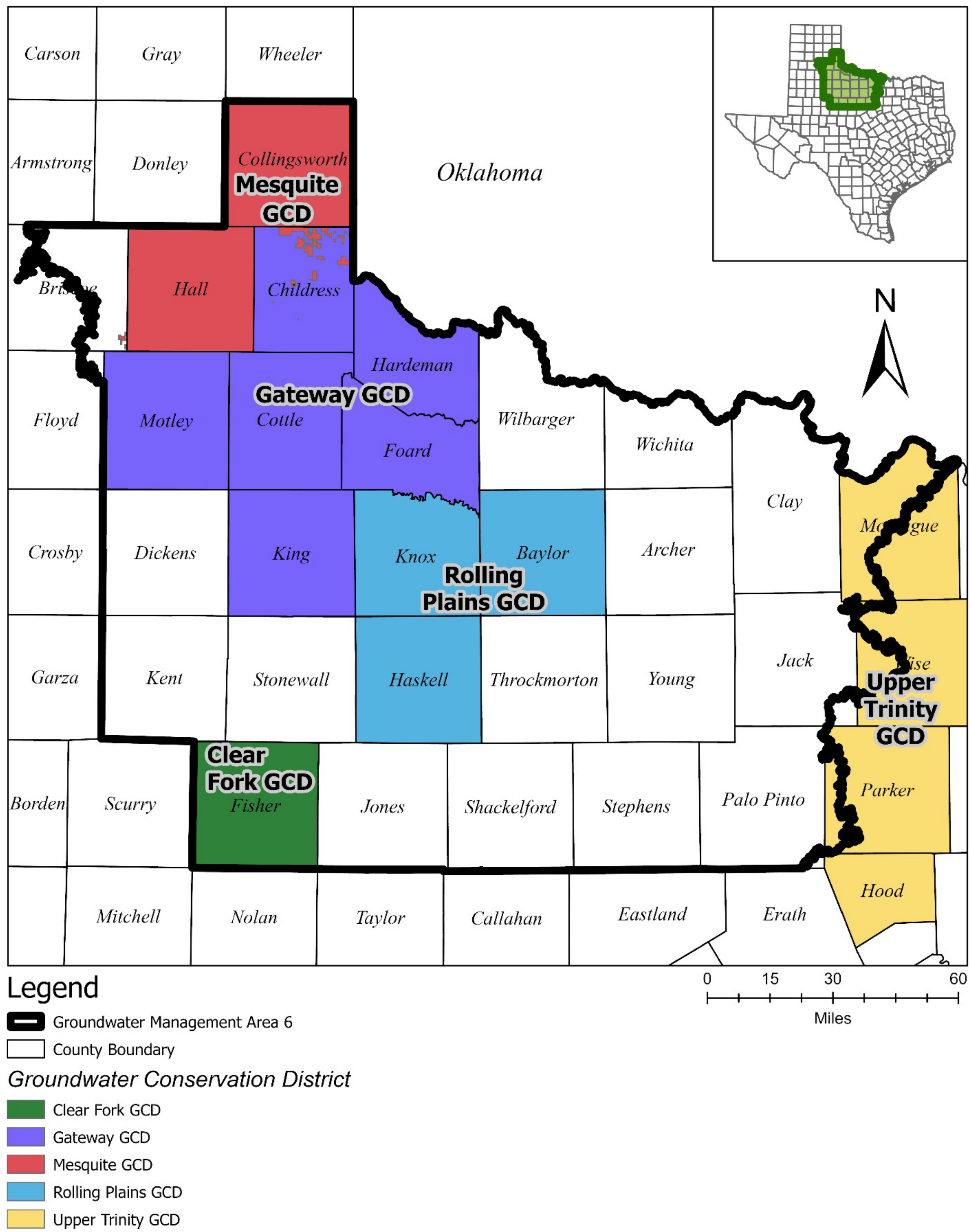

FIGURE 1. COUNTIES AND GROUNDWATER CONSERVATION DISTRICTS WITHIN GROUNDWATER MANAGEMENT AREA 6.

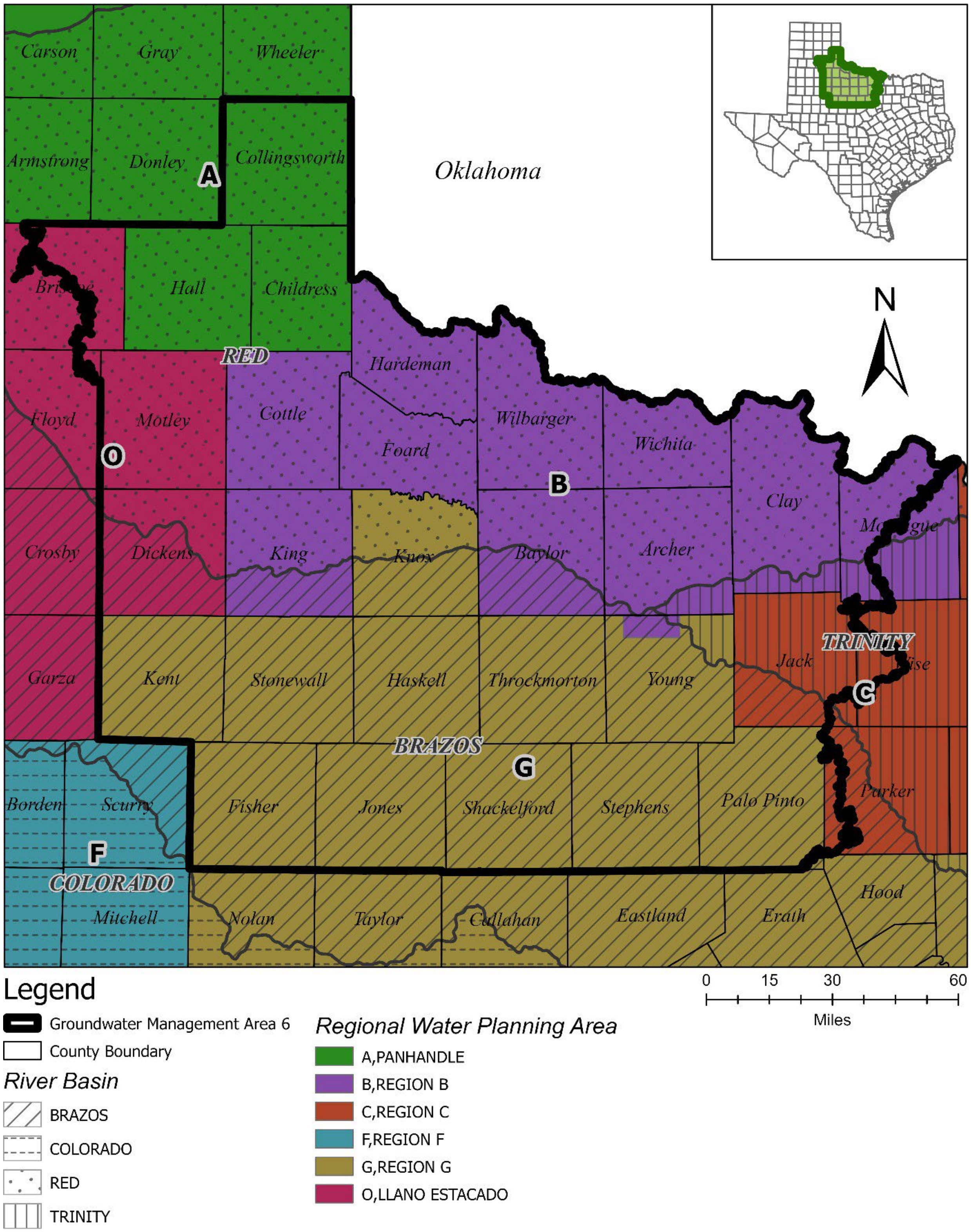

FIGURE 2. REGIONAL WATER PLANNING AREAS, RIVER BASINS, AND COUNTIES WITHIN GROUNDWATER MANAGEMENT AREA 6.

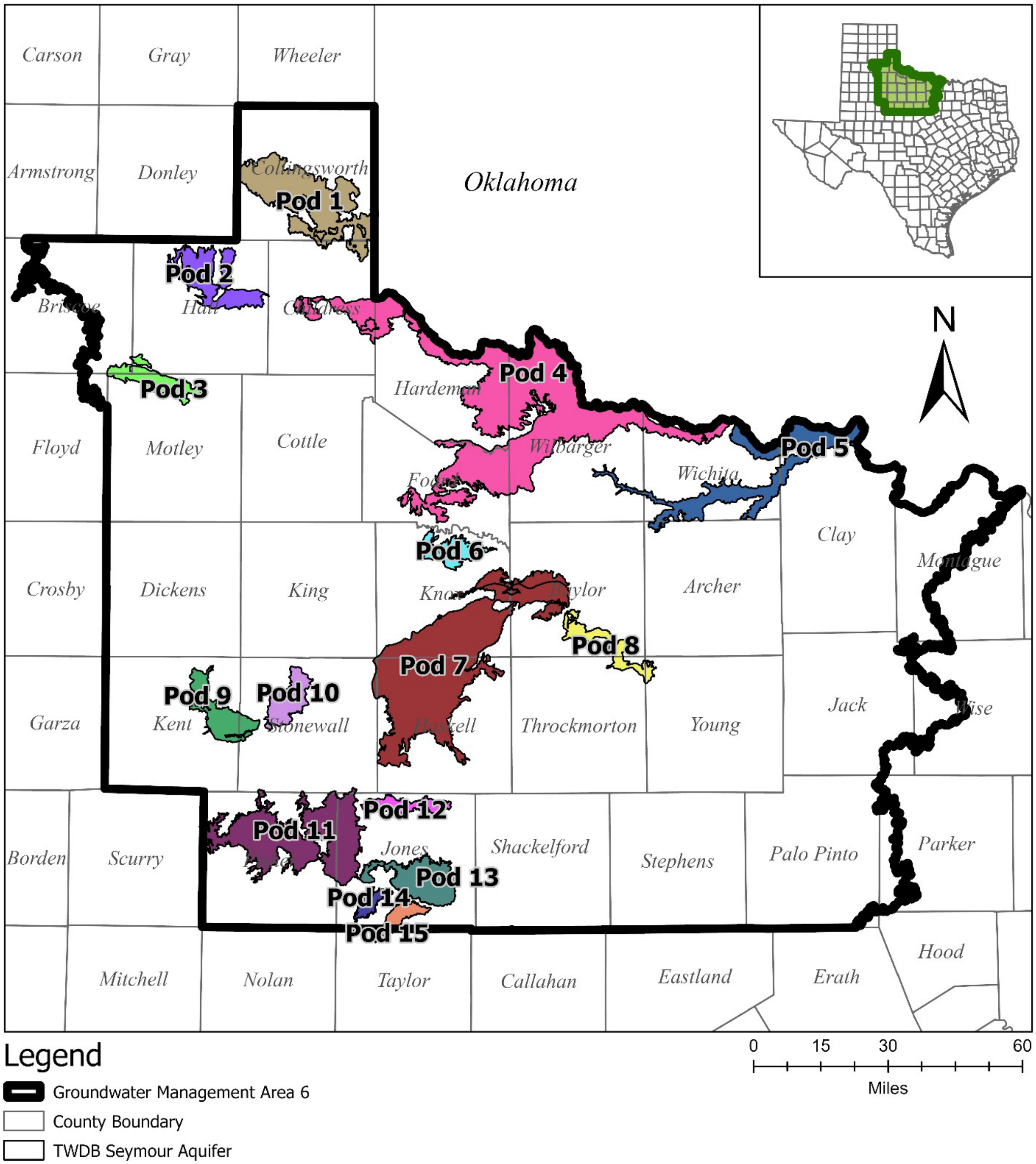

FIGURE 3. EXTENT OF THE SEYMOUR AQUIFER IN GROUNDWATER MANAGEMENT AREA 6.

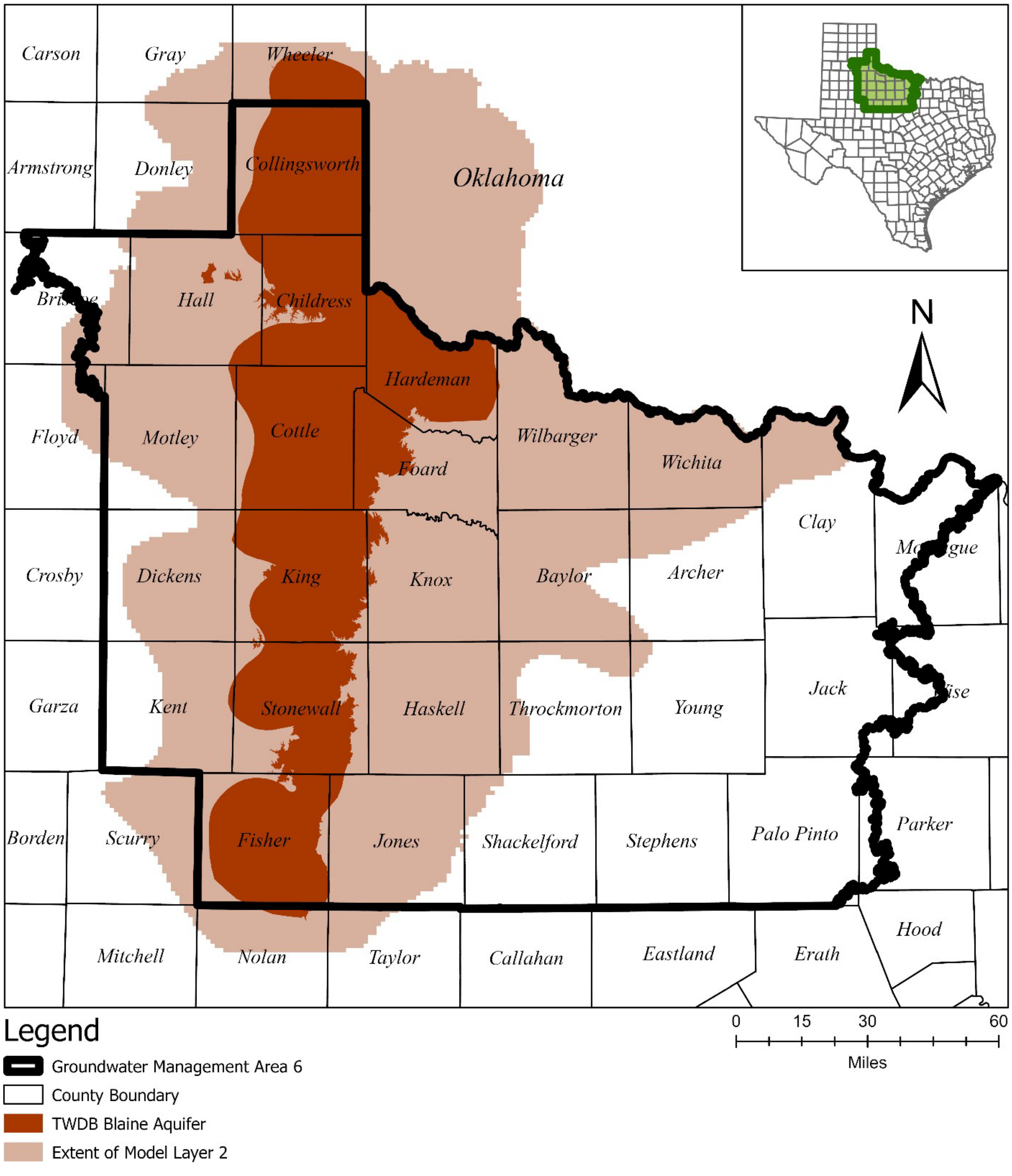

FIGURE 4. EXTENT OF THE BLAINE AQUIFER IN GROUNDWATER MANAGEMENT AREA 6 OVERLAIN ON THE MODELED EXTENT OF LAYER 2 IN THE GROUNDWATER AVAILABILITY MODEL FOR THE SEYMOUR AND BLAINE AQUIFERS.

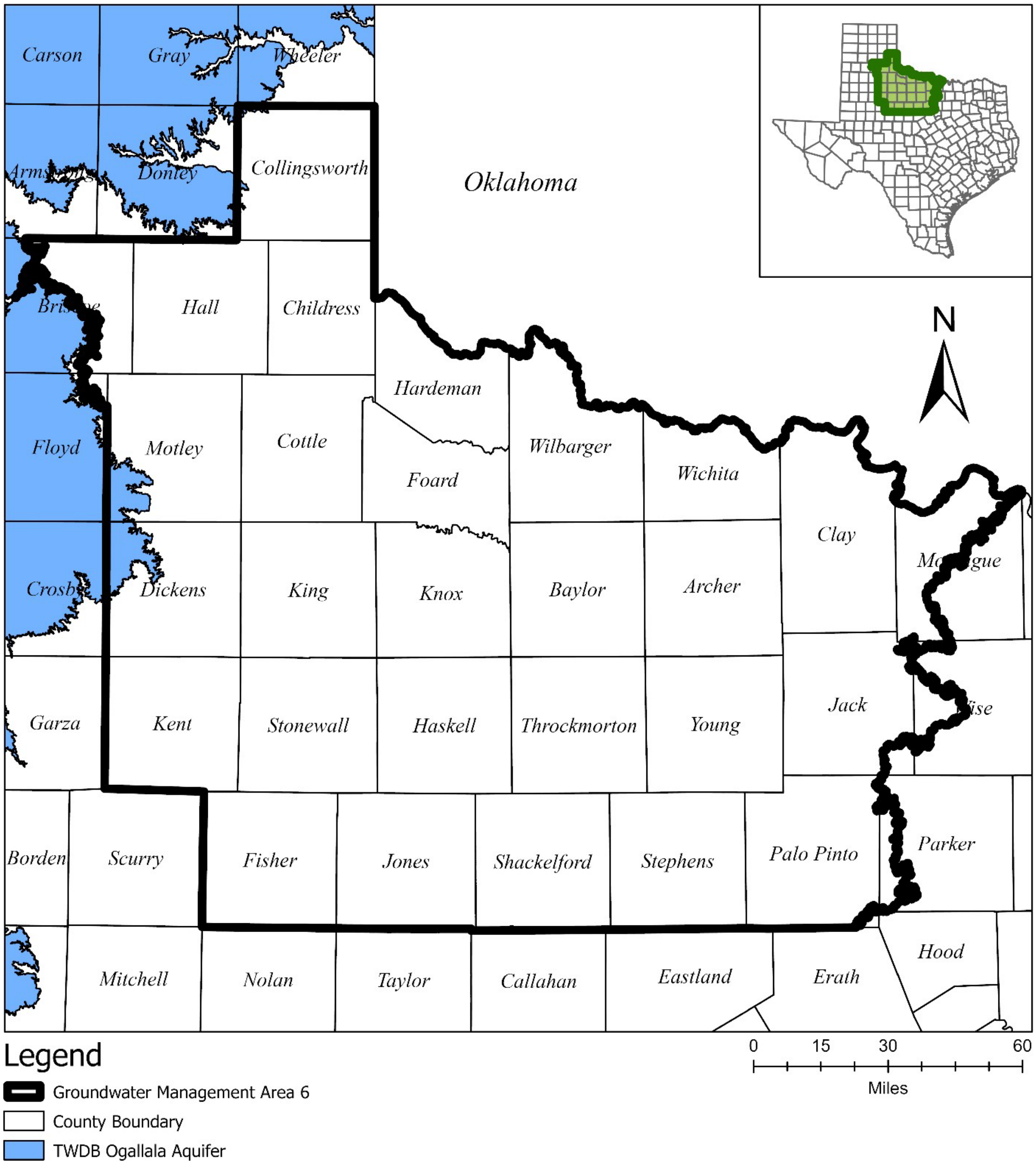

FIGURE 5. EXTENT OF OGALLALA AQUIFER IN GROUNDWATER MANAGEMENT AREA 6.

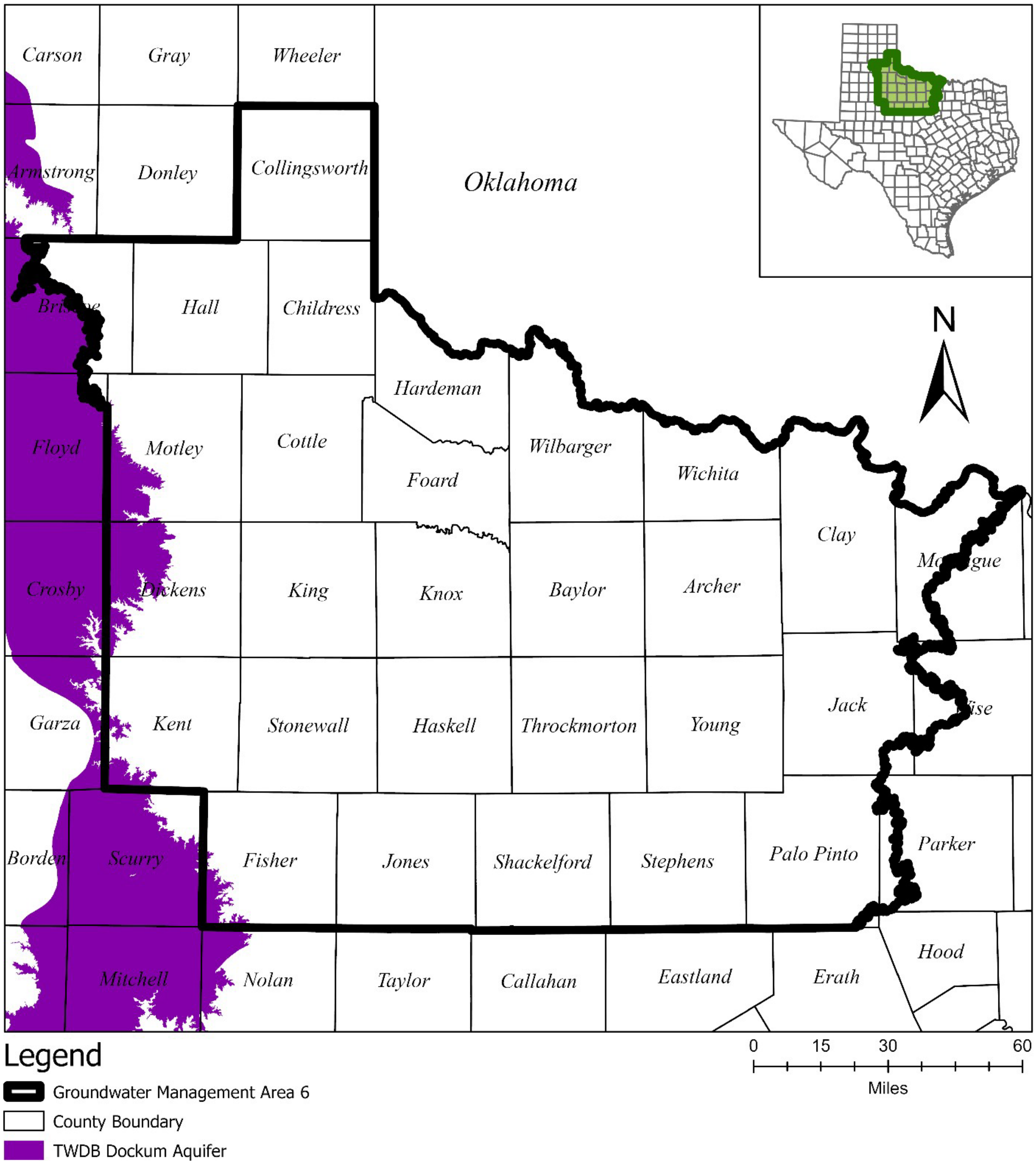

FIGURE 6. EXTENT OF DOCKUM AQUIFER IN GROUNDWATER MANAGEMENT AREA 6

TABLE 1. MODELED AVAILABLE GROUNDWATER FOR THE SEYMOUR AQUIFER IN GROUNDWATER MANAGEMENT AREA 6 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2080. VALUES ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District	County	Aquifer	Pod Number	2020	2030	2040	2050	2060	2070	2080
Clear Fork GCD	Fisher	Seymour	11	6,700	6,132	6,132	6,472	6,473	6,131	5,900
Clear Fork GCD Total		Seymour		**6,700**	**6,132**	**6,132**	**6,472**	**6,473**	**6,131**	**5,900**
Gateway GCD	Childress	Seymour	1	50	61	61	61	61	50	50
Gateway GCD	Childress	Seymour	4	2,818	3,169	3,231	3,231	3,231	3,231	3,231
Gateway GCD	Foard	Seymour	4	10,699	3,779	4,209	6,900	6,628	2,777	4,049
Gateway GCD	Hardeman	Seymour	4	21,492	14,209	20,002	18,689	21,116	34,037	26,577
Gateway GCD	Motley	Seymour	3	4,830	6,679	4,830	4,830	3,961	3,961	4,830
Gateway GCD Total		Seymour		**39,889**	**27,897**	**32,333**	**33,711**	**34,997**	**44,056**	**38,737**
Mesquite GCD	Childress	Seymour	1	81	11	11	11	11	11	11
Mesquite GCD	Childress	Seymour	4	4	4	4	4	4	4	4
Mesquite GCD	Collingsworth	Seymour	1	41,232	31,492	28,579	27,165	22,334	22,769	29,639
Mesquite GCD	Hall	Seymour	2	10,961	12,307	14,886	18,417	20,437	18,417	15,391
Mesquite GCD	Hall	Seymour	3	4,444	4,444	4,726	4,444	5,353	6,178	4,726
Mesquite GCD Total		Seymour		**56,722**	**48,258**	**48,206**	**50,041**	**48,139**	**47,379**	**49,771**
Rolling Plains GCD	Baylor	Seymour	7*	1,430	1,427	1,430	1,427	1,430	1,427	1,430
Rolling Plains GCD	Baylor	Seymour	8	5,769	5,903	5,532	5,304	5,163	5,503	4,292
Rolling Plains GCD	Haskell	Seymour	7*	41,752	41,638	41,752	41,638	41,752	41,638	41,752
Rolling Plains GCD	Knox	Seymour	6	3,315	998	510	888	3,445	1,331	1,095
Rolling Plains GCD	Knox	Seymour	7*	25,712	25,642	25,712	25,642	25,712	25,642	25,712
Rolling Plains GCD Total		Seymour		**77,978**	**75,608**	**74,936**	**74,899**	**77,502**	**75,541**	**74,281**
Groundwater Management Area 6 Total				**181,289**	**157,895**	**161,607**	**165,123**	**167,111**	**173,107**	**168,689**

** Pod 7 values are calculated from the groundwater availability model for the Seymour Aquifer in Haskell, Knox, and Baylor (Jigmond and others, 2014). All other values are calculated from the groundwater availability model for the Seymour and Blaine aquifers (Ewing and others, 2004).*

TABLE 2. MODELED AVAILABLE GROUNDWATER FOR THE SEYMOUR AQUIFER IN GROUNDWATER MANAGEMENT AREA 6 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), RIVER BASIN, AND POD FOR EACH DECADE BETWEEN 2030 AND 2080. VALUES ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Aquifer	Pod Number	2030	2040	2050	2060	2070	2080
Baylor	B	Brazos	Seymour	7*	1,133	1,136	1,133	1,136	1,133	1,136
Baylor	B	Brazos	Seymour	8	5,903	5,532	5,304	5,163	5,503	4,292
Baylor	B	Red	Seymour	7*	294	294	294	294	294	294
Childress	A	Red	Seymour	1	72	72	72	72	61	61
Childress	A	Red	Seymour	4	3,173	3,235	3,235	3,235	3,235	3,235
Collingsworth	A	Red	Seymour	1	31,492	28,579	27,165	22,334	22,769	29,639
Fisher	G	Brazos	Seymour	11	6,132	6,132	6,472	6,473	6,131	5,900
Foard	B	Red	Seymour	4	3,779	4,209	6,900	6,628	2,777	4,049
Hall	A	Red	Seymour	2	12,307	14,886	18,417	20,437	18,417	15,391
Hall	A	Red	Seymour	3	4,444	4,726	4,444	5,353	6,178	4,726
Hardeman	B	Red	Seymour	4	14,209	20,002	18,689	21,116	34,037	26,577
Haskell	G	Brazos	Seymour	7*	41,638	41,752	41,638	41,752	41,638	41,752
Knox	G	Brazos	Seymour	7*	25,629	25,699	25,629	25,699	25,629	25,699
Knox	G	Red	Seymour	6	998	510	888	3,445	1,331	1,095
Knox	G	Red	Seymour	7*	13	13	13	13	13	13
Motley	O	Red	Seymour	3	6,679	4,830	4,830	3,961	3,961	4,830
Groundwater Management Area 6 Total					**157,895**	**161,607**	**165,123**	**167,111**	**173,107**	**168,689**

** Pod 7 values are calculated from the groundwater availability model for the Seymour Aquifer in Haskell, Knox, and Baylor (Jigmond and others, 2014). All other values are calculated from the groundwater availability model for the Seymour and Blaine aquifers (Ewing and others, 2004).*

TABLE 3. MODELED AVAILABLE GROUNDWATER FOR THE BLAINE AQUIFER IN GROUNDWATER MANAGEMENT AREA 6 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2080. VALUES ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District	County	Aquifer	2020	2030	2040	2050	2060	2070	2080
Clear Fork GCD	Fisher	Blaine	12,820	12,820	12,820	12,820	12,820	12,820	12,820
Clear Fork GCD Total		**Blaine**	**12,820**	**12,820**	**12,820**	**12,820**	**12,820**	**12,820**	**12,820**
Gateway GCD	Childress	Blaine	17,570	17,570	17,570	17,570	17,570	17,570	17,570
Gateway GCD	Cottle	Blaine	14,726	11,621	11,621	11,621	11,621	11,621	11,621
Gateway GCD	Foard	Blaine	6,565	6,565	6,565	6,565	6,565	6,565	6,565
Gateway GCD	Hardeman	Blaine	8,465	8,465	8,465	8,465	8,465	8,465	8,465
Gateway GCD	King	Blaine	49	49	49	49	49	49	49
Gateway GCD	Motley	Blaine	0	0	0	0	0	0	0
Gateway GCD Total		**Blaine**	**47,375**	**44,270**	**44,270**	**44,270**	**44,270**	**44,270**	**44,270**
Mesquite GCD	Childress	Blaine	5,940	5,940	5,940	5,940	5,940	5,940	5,940
Mesquite GCD	Collingsworth	Blaine	2,054	2,054	2,054	2,054	2,054	2,054	2,054
Mesquite GCD	Hall	Blaine	5,840	5,840	5,840	5,840	5,840	5,840	5,840
Mesquite GCD Total		**Blaine**	**13,834**	**13,834**	**13,834**	**13,834**	**13,834**	**13,834**	**13,834**
Groundwater Management Area 6 Total			**74,029**	**70,924**	**70,924**	**70,924**	**70,924**	**70,924**	**70,924**

TABLE 4. MODELED AVAILABLE GROUNDWATER FOR THE BLAINE AQUIFER IN GROUNDWATER MANAGEMENT AREA 6 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2030 AND 2080. VALUES ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Aquifer	2030	2040	2050	2060	2070	2080
Childress	A	Red	Blaine	23,510	23,510	23,510	23,510	23,510	23,510
Collingsworth	A	Red	Blaine	2,054	2,054	2,054	2,054	2,054	2,054
Cottle	B	Red	Blaine	11,621	11,621	11,621	11,621	11,621	11,621
Fisher	G	Brazos	Blaine	12,820	12,820	12,820	12,820	12,820	12,820
Foard	B	Red	Blaine	6,565	6,565	6,565	6,565	6,565	6,565
Hall	A	Red	Blaine	5,840	5,840	5,840	5,840	5,840	5,840
Hardeman	B	Red	Blaine	8,465	8,465	8,465	8,465	8,465	8,465
King	B	Brazos	Blaine	0	0	0	0	0	0
King	B	Red	Blaine	49	49	49	49	49	49
Groundwater Management Area 6 Total				**70,924**	**70,924**	**70,924**	**70,924**	**70,924**	**70,924**

TABLE 5. MODELED AVAILABLE GROUNDWATER FOR THE OGALLALA AQUIFER IN GROUNDWATER MANAGEMENT AREA 6 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2080. VALUES ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District	County	Aquifer	2020	2030	2040	2050	2060	2070	2080
Gateway GCD	Motley	Ogallala	409	409	409	409	409	409	409
Groundwater Management Area 6 Total			**409**	**409**	**409**	**409**	**409**	**409**	**409**

TABLE 6. MODELED AVAILABLE GROUNDWATER FOR THE OGALLALA AQUIFER IN GROUNDWATER MANAGEMENT AREA 6 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2030 AND 2080. VALUES ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Aquifer	2030	2040	2050	2060	2070	2080
Motley	O	Red	Ogallala	409	409	409	409	409	409
Groundwater Management Area 6 Total				**409**	**409**	**409**	**409**	**409**	**409**

TABLE 7. MODELED AVAILABLE GROUNDWATER FOR THE DOCKUM AQUIFER IN GROUNDWATER MANAGEMENT AREA 6 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2080. VALUES ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District	County	Aquifer	2020	2030	2040	2050	2060	2070	2080
Clear Fork GCD	Fisher	Dockum	79	79	79	79	79	79	79
Gateway GCD	Motley	Dockum	93	93	92	92	92	92	92
Groundwater Management Area 6 Total			**172**	**172**	**171**	**171**	**171**	**171**	**171**

TABLE 8. MODELED AVAILABLE GROUNDWATER FOR THE DOCKUM AQUIFER IN GROUNDWATER MANAGEMENT AREA 6 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2030 AND 2080. VALUES ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Aquifer	2030	2040	2050	2060	2070	2080
Fisher	G	Brazos	Dockum	79	79	79	79	79	79
Motley	O	Red	Dockum	93	92	92	92	92	92
Groundwater Management Area 6 Total				**172**	**171**	**171**	**171**	**171**	**171**

LIMITATIONS:

The groundwater model used in completing this analysis is the best available scientific tool that can be used to meet the stated objectives. 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 groundwater levels in 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.

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Appendix A

TWDB Clarifications sent to Mike McGuire on June 7, 2022 with Responses from Groundwater Management Area 6

Critical Clarifications (need action):
We recommend re-wording to the Ogallala Aquifer DFC from “28 feet” to “no more than 28 feet.” Otherwise, the Ogallala DFC is unattainable. Note that this alternate wording will make it consistent with the GMA 6 DFCs in other aquifers.
GMA 6 response [6/16/22]: Ogallala Aquifer DFC Resolution has been reworded.

In the model files provided for the Seymour Pod 7 model, both the pumping file (titled “symr_hkb_ext2080.wel”) and the recharge file (“symr_hkb_ext2080.rch”) are blank. Please provide the correct versions of these files.
GMA 6 response [6/16/22]: These files have been resubmitted to TWDB via the OneDrive folder.

Please either provide a non-relevant statement or a DFC for the areas listed in the table below. This can be done by either adding additional sections to the DFC Resolutions or by making the changes listed in the “Recommendations” column.

Aquifer	Pod	County	GCD	Recommendations
Seymour	Pod 3	Briscoe	No District	
	Pod 4	Childress	Mesquite GCD	We recommend adding “and in Mesquite GCD” to the Pod 4 DFC definition [section d on pg 3 of Seymour DFC Resolution]- this definition produces drawdown values consistent with the Tech Memo.
Blaine		Wilbarger	No District	We recommend fixing the typo in the non-relevant definition [last paragraph on pg 2 of Blaine DFC Resolution] by replacing “Wheeler” County (not in GMA 6) with “Wilbarger” County

GMA 6 response [6/16/22]:
Pod 3 Briscoe No district has been added to the non-relevant portion of the resolution.
Pod 4 Mesquite GCD was added to the resolution

The Wheeler County reference is correct, we considered the DFC of GMA 1 in the Blaine Aquifer.

Other Clarifications (need acknowledgement):

Seymour & Blaine Aquifers:

We will provide MAG values calculated directly from the model files provided in the GMA 6 DFC Submittal packet. These MAG values will be lower than the maximum pumping theoretically available under the higher drawdown conditions allowable under GMA 6-defined DFCs. Please confirm that this methodology is acceptable to the GMA. Otherwise, please contact TWDB to request additional MAG value calculations.
GMA 6 response [6/16/22]: Please provide MAG values calculated directly from the model files provided in the GMA 6 DFC Submittal packet.

Please confirm that the Seymour/Blaine model input files for initial heads ("hed1999_lay1.dat" & "hed1999_lay2.dat") and for recharge ("AVG_RECH_sp241_sp300.dat") used during the current planning cycle are the same as the one submitted during the last planning cycle. The current GMA 6 submittal packet did not include these files but using the previous versions of the input files provides drawdown values consistent with the current values provided in the Technical Memo Appendix of the 2021 Explanatory Report.
GMA 6 response [6/16/22]: Confirm

Please confirm that the phrase "total decline in water levels during the period from 2010 - 2080" in the DFC Resolution means "the average water level decline in 2080, as compared to 2010 water levels." This method produces values consistent with those provided in the Technical Memo Appendix of the Explanatory Report.
GMA 6 response [6/16/22]: Confirm

Please confirm that the GMA accepts the following assumptions for calculating modeled drawdown: 1) exclude cells that start dry and 2) replace the head value in dry cells with the bottom elevation value of the cell. This method produces values consistent with those provided in the Technical Memo Appendix of the Explanatory Report.
GMA 6 response [6/16/22]: Confirm GMA accepts the assumptions.

Ogallala & Dockum Aquifers:

We will provide MAG values calculated directly from the model files provided in the GMA 2 DFC Submittal packet (consistent with Scenario 19, Technical Memorandum 20-01 (Hutchison)). These MAG values will be lower than the maximum pumping theoretically

available under the higher drawdown conditions allowable by GMA 6-defined DFCs. Please confirm that this methodology is acceptable to the GMA. Otherwise, please contact TWDB to request additional MAG value calculations.
GMA 6 response [6/16/22]: Confirm that this methodology is acceptable.

Please confirm that the phrase "average drawdown between 2013 and 2080" in the Ogallala DFC Resolution means "the average water level decline in 2080, as compared to 2013 water levels" (as opposed to an average annual drawdown for every year between 2013 and 2080).
GMA 6 response [6/16/22]: Confirm that the phrase means "the average water level decline in 2080, as compared to 2013 water levels".

Please confirm that the phrase "total decline in water levels during the period from 2013 - 2080" in the Dockum DFC Resolution means "the average water level decline in 2080, as compared to 2013 water levels."
GMA 6 response [6/16/22]: Conform [sic] that the phrase means "the average water level decline in 2080… ...."

Optional Clarifications**:
Typos in Adopted DFC table in Explanatory Report (does not match DFC Resolutions):
Blaine Aquifer
DFC in Foard County incorrectly listed as "2 ft" instead of "10 ft"
GMA 6 response [6/16/22]: Foard County Blaine DFC corrected in Explanatory Report

DFC in King County incorrectly listed as "7 ft" instead of "4 ft"
GMA 6 response [6/16/22]: King County Blaine DFC was corrected in the Resolution, it is supposed to be 7'

Missing entries for non-relevant counties: Dickens, Jones, Kent, Knox, Motley
GMA 6 response [6/16/22]: Non-relevant Counties were added to the Blaine DFC chart in the Explanatory Report.

**Note: Since TWDB considers the DFC Resolution documents, rather than the Explanatory Report, as the official definition of DFCs, TWDB does not officially require corrections to the Explanatory Report. However, because the Explanatory Report is often used as a simplified, more-readable summary of the legal DFC Resolution documents, we recommend correcting the Explanatory Report to match the DFC Resolutions in order to avoid confusion.*

Informational:

Please note that the following slivers of aquifer exist within GMA 6 but are so small that TWDB does not require a DFC or non-relevant statement.

Aquifer	Pod	County	GCD	Area
Seymour	Pod 2	Childress	Gateway GCD	0.02 mi^2
	Pod 3	Floyd	No District	0.06 mi^2
	Pod 7	King	Gateway GCD	0.03 mi^2
Ogallala		Hall	Mesquite GCD	0.12 mi^2