GAM Run 10-001

by Mr. Wade Oliver

Texas Water Development Board
Groundwater Availability Modeling Section
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Cynthia K. Ridgeway is the Manager of the Groundwater Availability Modeling Section and is responsible for oversight of work performed by employees under her direct supervision. The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G. 471 on June 21, 2010.

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EXECUTIVE SUMMARY:

The recently modified groundwater model for the Dockum Aquifer was used to estimate drawdown from 2010 and 2060 using annual pumping values requested by Groundwater Management Area 7 for Nolan and Mitchell counties. This request included 14,018 acre-feet per year of pumping in Mitchell County and 5,750 acre-feet per year of pumping in Nolan County.

For comparison, the annual pumping for this “base” scenario was adjusted up and down between roughly half (40 percent) and twice (190 percent) the base value to provide insight into how the drawdown results change under different pumping scenarios.

Results indicate that average drawdown in Mitchell County after 51 years (2010 to 2060) is significantly less than the drawdown for Nolan County. For the baseline run, drawdown in Mitchell County is approximately 3 feet while drawdown in Nolan County is 39 feet. This difference is primarily because the Dockum Aquifer in Mitchell County is predominantly outcrop while it is mostly subcrop in Nolan County. The Dockum Aquifer also covers a much smaller area of Nolan County than Mitchell County, which leaves less area over which to spread the requested pumping.

For the runs with pumping adjusted between 40 percent and 190 percent of the base scenario, drawdown after 51 years are 1 to 7 feet for Mitchell County and 12 to 84 feet for Nolan County.

REQUESTOR:

Ms. Caroline Runge of Menard County Underground Water District on behalf of Groundwater Management Area 7.

DESCRIPTION OF REQUEST:

Ms. Runge requested a groundwater availability model run of the Dockum Aquifer with base pumping of 14,018 acre-feet per year in Mitchell County and 5,750 acre-feet per year in Nolan County. She then requested that we adjust this base pumping up and down in order to provide drawdown results under various pumping scenarios. The Dockum Aquifer and associated groundwater management areas are shown in Figure 1.

METHODS:

The recently modified groundwater model of the Dockum Aquifer (Oliver and Hutchison, 2010) was used to simulate future conditions as specified in the request. This model is a modification to the groundwater availability model documented in Ewing and others (2008) and was completed in order to more effectively simulate predictive conditions. The pumping between 2010 and 2060 in Mitchell and Nolan counties was specified by members of Groundwater Management Area 7. In portions of Groundwater Management Area 7 outside of Mitchell and Nolan counties, pumping was held at the levels present for the last stress period of the historical-calibration portion of the model (1997).

After the above model run (referred to in this report as the "base" scenario), the pumping for each county was systematically adjusted up and down to show how drawdown through time changes under different pumping scenarios. More details on pumping in the model are given in the Pumping section below.

The historical-calibration period of the model ends in 1997 while the predictive simulation documented here begins in 2010. To estimate the appropriate level of pumping between 1998 and 2009, the interim period leading up to the predictive simulation, a preliminary analysis of water levels in a few selected wells in Groundwater Management Area 7 was performed. As shown in Appendix A, these hydrographs do not indicate significant trends in water levels that indicate large changes in pumping during this time period. For this reason, the pumping levels and distribution for the last year of the historical-calibration portion of the model were considered to be appropriate for the interim period. Pumping was, therefore, held constant at 1997 levels between 1998 and 2009.

PARAMETERS AND ASSUMPTIONS:

The parameters and assumptions for the model run using the modified groundwater model for the Dockum Aquifer are described below:

- We used the modified groundwater model for the Dockum Aquifer described in Oliver and Hutchison (2008). This model is an modification to the previously developed groundwater availability model for the Dockum Aquifer described in Ewing and others (2008) in order to more effectively simulate predictive conditions. See Oliver and Hutchison (2010) and Ewing and others (2008) for assumptions and limitations of the model.

- The model includes two active layers which represent the upper and lower portions of the Dockum Aquifer. Layer 2 represents the upper portion of the Dockum Aquifer. Layer 3 represents the lower portion of the Dockum Aquifer. Layer 1, which is active in version 1.01 of the model documented in Ewing and others (2008), was inactivated in the modified model as described in Oliver and Hutchison (2010).

- The mean absolute error (a measure of the difference between simulated and measured water levels during model calibration) for the lower portion of the Dockum Aquifer between 1980 and 1997 is 53 feet. This represents 2.5 percent of the hydraulic head drop across the model area.

- The MODFLOW General-Head Boundary package was used to simulate flow between the Dockum Aquifer and overlying aquifers. The water levels in the overlying aquifers were applied as described in Oliver and Hutchison (2010) using Groundwater Availability Model Run 09-001 (Smith, 2009) for the northern portion of the Ogallala Aquifer and Groundwater Availability Model Run 09-023 (Oliver, 2010b) for the southern portion of the Ogallala Aquifer.

- Cells were assigned to individual counties and groundwater conservation districts as shown in the September 14, 2009 version of the model grid for the Dockum Aquifer. Because this model grid predates the development of the modified model, care was taken to ensure that only those fields in the model grid that were valid for the modified model were used for analyzing model results.

- The recharge used for the model run represents average recharge as described in Ewing and others (2008).

- Pumping used for the predictive simulations was specified to match the requested rate by members of Groundwater Management Area 7. Details on this pumpage are given below.

Pumping

The pumping between 2010 and 2060 for the base scenario was requested by members of Groundwater Management Area 7. To meet this request, pumping was uniformly increased from the 1997 level uniformly over all model cells that contained pumping in 1997 (the last stress period of the historical-calibration portion of the model).

With the exception of Groundwater Management Area 1, the pumping in areas outside Groundwater Management Area 7 was held constant at 1997 levels through the predictive period. Pumping in Groundwater Management Area 1 was also adjusted, at their request, to match a specified drawdown rate of 1-foot per year. Results for Groundwater Management Area 1 are presented in GAM Run 09-014 (Oliver, 2010a).

As mentioned in the Methods section above, the base pumping scenario was also adjusted up and down in order to provide insight into the relationship between pumping and drawdown in the Dockum Aquifer. The pumping input to the model was multiplied by factors to increase (factors of 1.3, 1.6 and 1.9) or decrease (factors of 0.8, 0.6, and 0.4) the pumping over the model as a whole. These values were chosen to provide a range of pumping values between roughly half and twice the base scenario above. The relationships generated are presented in the Results section below.

RESULTS:

As described above, the pumping distribution for the last year of the historical-calibration portion of the model was held constant between 1998 and 2009 and then set to levels to meet the requested pumping between 2010 and 2060. The average drawdown for each decade between 2010 and 2060 for the base scenario is shown in tables 1 and 2 for each county, groundwater conservation district, and groundwater management area for the upper and lower portions of the Dockum Aquifer, respectively. Table 2 also includes pumping output from the model which accounts for pumping lost due to cells going inactive. A model cell goes inactive when the water level in a cell drops below the bottom of the aquifer. In this situation, pumping can no longer occur. Table 1 does not include pumping because no pumping occurs in the upper portion of the Dockum Aquifer in the model.

As shown in Figure 1, the upper portion of the Dockum Aquifer within Groundwater Management Area 7 is limited to Ector and Midland counties. Water level drawdowns over the 51-year predictive period for these counties are 6 and 29 feet, respectively (Table 1).

Table 2 shows pumping and average drawdown for the lower portion of the Dockum Aquifer for the base scenario. Drawdown in Groundwater Management Area 7 as a whole increases steadily, but slowly, to about 5 feet after 51 years. This rate varies by county, however. For Mitchell and Nolan counties, the two counties with requested pumping, drawdown after 51 years is 3 and 39 feet, respectively. The primary reason for this difference is that the Dockum Aquifer outcrops over a large area of Mitchell County while there is less outcrop area in Nolan County. In the outcrop areas, a decline in the water level means that the aquifer is being dewatered. This is in contrast to the subcrop, where a decline in water level is a result of a reduction in pressure. Another factor is that the Dockum Aquifer covers a smaller area of Nolan County than Mitchell County.

As described in the Pumping section above, the base pumping distribution was adjusted up and down to provide insight into how the aquifer responds under different levels of pumping. Tables similar to tables 1 and 2, but showing pumping and drawdown results based on these pumping adjustments are shown in Appendix B. In addition, Figure 2 shows the drawdown in the lower portion of the Dockum Aquifer in Mitchell County through time for the various pumping scenarios. For the model run with 40 percent of the base scenario pumping, drawdown in Mitchell County is approximately 1 foot after 51 years. For the model run with 190 percent of the base scenario pumping, drawdown in Mitchell County is approximately 7 feet after 51 years.

Figure 3 shows the drawdown in Nolan County through time in the lower portion of the Dockum Aquifer for the various pumping scenarios. For the model run with 40 percent of the base scenario pumping, drawdown in Nolan County is approximately 12 feet after 51 years. For the model run with 190 percent of the base scenario pumping, drawdown in Nolan County is approximately 84 feet after 51 years.

To better illustrate how the model responds through time during the base run, Appendix C contains charts for each of the major water budget terms for each year of the predictive model run. Note that these charts only reflect the lower portion of the Dockum Aquifer within Groundwater Management Area 7. Appendix D contains water budget tables for each county, groundwater conservation district, and groundwater management area for the last stress period of the model run. The components of the water budget are described below:

- Recharge— areally distributed recharge due to precipitation falling on the outcrop areas of the aquifer. Recharge is always shown as “Inflow” into the water budget. Recharge is modeled using the MODFLOW Recharge package.

- Pumping—water produced from wells in the aquifer. This component is always shown as “Outflow” from the water budget. Pumping is modeled using the MODFLOW Well package.

- Change in Storage—changes in the water stored in the aquifer. This component of the budget is often seen as water both going into and out of the aquifer because water levels may decline in some areas (water is being removed from storage) and rise in others (water is being added to storage).

- Overlying Aquifers—water that flows into (or out of) the aquifer due to interaction with overlying units. Interaction with overlying aquifers is modeled using the MODFLOW General-Head Boundary package. For areas overlain by the Ogallala Aquifer, the water level input to the general-head boundary package comes from predictive GAM runs 09-001 and 09-023 using the models for the northern and southern portions of the Ogallala Aquifer, respectively (Smith, 2009; Oliver, 2010b).

- Springs and Evapotranspiration—water that naturally discharges from the aquifer when water levels rise above the elevation of the spring or when it is close enough to the surface to evaporate or be taken up by plants. This component is always shown as "Outflow," or discharge, in the water budget. Spring and evapotranspiration outflows are simulated collectively in the model using the MODFLOW Drain package.

- Stream Interaction—water that flows between streams and the aquifer. The direction and amount of flow depends on the relationship between the water levels in the stream and the aquifer. Where the water level in the stream is higher than the water level in the aquifer, water flows into the aquifer and is shown as "Inflow" in the budget. Where the water level in the stream is lower than the water level in the aquifer, water flows out of the aquifer and is shown as "Outflow" in the budget. Streams are modeled using the MODFLOW Stream package.

- Lateral flow—describes lateral flow within the aquifer between one area and an adjacent area (for example, lateral flow into and out of a groundwater management area).

- Vertical flow or leakage (upper or lower)—describes the vertical flow, or leakage, between two aquifers, or, in the case of this model, between the upper and lower portions of the Dockum Aquifer. This flow is controlled by the water levels in each unit and aquifer properties that define the amount of leakage that can occur. "Upper" refers to interaction between an aquifer and the aquifer overlying it. "Lower" refers to interaction between an aquifer and the aquifer below it. For this model, vertical flow between the upper and lower portions of the Dockum Aquifer is reported separately from interaction of the Dockum Aquifer with the overlying aquifers described above (which is, strictly speaking, also vertical flow).

Figure C-1 in Appendix C shows the recharge through time. Recharge is constant through time for both the historical period of the model to which it was calibrated (not shown) and the predictive period. Recharge into the Dockum Aquifer in Groundwater Management Area 7 is approximately 47,000 acre-feet per year.

Figure C-2 shows pumping through time for the base scenario. Beginning in 2010, the pumping requested by Groundwater Management Area 7 is applied, totaling about 23,800 acre-feet per year. Most of this (over 80 percent) occurs in Mitchell and Nolan counties (Table D-1 in Appendix D).

Figure C-3 shows the Net Change in Storage in the modified groundwater model. Note that the amount of water removed from storage increases dramatically in 2010 due to the increase in pumping shown in Figure C-2. The rate that water is removed from storage annually then slowly declines through the remainder of the simulation period as the aquifer slowly adjusts to the new levels of pumping.

Figure C-4 shows the net inflow from overlying aquifers to the lower portion of the Dockum Aquifer in Groundwater Management Area 7. Inflow from the overlying aquifers is relatively steady through the period, with only small declines. These declines are likely due to reductions in the water level in the overlying Ogallala Aquifer in Ector, Midland, and Glasscock counties.

Figure C-5 shows the outflow to springs and by evapotranspiration. Outflows decline through time beginning in 2010 due to declining water levels in the Dockum Aquifer. Figure C-6, showing net outflow to streams, exhibits a very similar response as the springs and evapotranspiration shown in Figure C-5 for the same reason.

Figure C-7 shows the net lateral flow between Groundwater Management Area 7 and adjacent areas. Notice that throughout the predictive period flow is always a net outflow, but declines in magnitude as water levels in Groundwater Management Area 7 decline relative to surrounding areas.

Figure C-8 shows the magnitude and direction of vertical flow between the upper and lower portions of the Dockum Aquifer. Through the predictive period there is a net downward flow from the upper portion of the Dockum Aquifer to the lower portion. However, this rate declines through time for most of the predictive period corresponding to a drop in the inflow from the overlying Ogallala Aquifer in Ector and Midland counties.

It is important to acknowledge the limitations of the precision of the sub-regional water budgets that is associated with 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 (for example, a county) 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.

REFERENCES AND ASSOCIATED MODEL RUNS:

Ewing, J.E., Jones, T.L., Yan, T., Vreugdenhil, A.M., Fryar, D.G., Pickens, J.F., Gordon, K., Nicot, J.P., Scanlon, B.R., Ashworth, J.B., Beach, J., 2008, Groundwater Availability Model for the Dockum Aquifer – Final Report: contract report to the Texas Water Development Board, 510 p.

Oliver, W., Hutchison, W.R., 2010, Modification and recalibration of the Groundwater Availability Model of the Dockum Aquifer: Texas Water Development Board, 114 p.

Oliver, W., 2010a, GAM Run 09-014: Texas Water Development Board, GAM Run 09-014 Draft Report, 44 p.

Oliver, W., 2010b, GAM Run 09-023: Texas Water Development Board, GAM Run 09-023 Draft Report, 30 p.

Smith, R., 2009, GAM Run 09-001: Texas Water Development Board, GAM Run 09-001 Draft Report, 28 p.

Table 1. Average drawdown for the upper portion of the Dockum Aquifer by decade for each county and groundwater management area (GMA). Drawdown is in feet. Groundwater conservation districts are not shown because none exist for the upper portion of the Dockum Aquifer in Groundwater Management Area 7.

Base Scenario: Upper Dockum	**Base**					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
County						
Ector	0	2	4	6	6	6
Midland	1	8	15	21	26	29
GMA						
Out-of-State	0	0	1	1	1	1
GMA 1	0	3	7	12	16	19
GMA 2	1	15	27	35	40	42
GMA 3	0	0	0	0	1	1
GMA 7	0	5	9	13	15	16

Table 2. Pumping and average drawdown for the lower portion of the Dockum Aquifer by decade for each county, groundwater conservation district (GCD), and groundwater management area (GMA). Pumping is in acre-feet per year. Drawdown is in feet. The abbreviation for Underground Water Conservation District is UWCD and Water Conservation District is WCD.

Base Scenario: Lower Dockum	Pumping						Average Drawdown					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
County												
Coke	0	0	0	0	0	0	0	0	0	0	0	0
Crockett	2	2	2	2	2	2	0	2	2	3	3	3
Ector	528	528	528	528	528	528	0	1	3	4	5	5
Glasscock	0	0	0	0	0	0	0	0	1	1	2	2
Irion	0	0	0	0	0	0	0	1	2	2	2	2
Midland	0	0	0	0	0	0	0	3	7	11	14	16
Mitchell	14,018	14,018	14,018	14,018	14,018	14,018	0	1	2	3	3	3
Nolan	5,750	5,750	5,750	5,750	5,750	5,750	23	29	32	35	37	39
Pecos	777	777	777	777	777	777	0	0	0	0	0	0
Reagan	2,064	2,064	2,064	2,064	2,064	2,064	1	4	5	6	6	7
Scurry	1,209	1,209	1,209	1,209	1,209	1,209	0	0	0	0	0	0
Sterling	10	10	10	10	10	10	0	0	0	1	1	1
Tom Green	0	0	0	0	0	0	0	2	2	3	3	3
Upton	219	219	219	219	219	219	0	2	2	3	3	4
GCD												
Coke County UWCD	0	0	0	0	0	0	0	0	0	0	0	0
Crockett County GCD	2	2	2	2	2	2	0	2	2	3	3	3
Glasscock GCD	1,027	1,027	1,027	1,027	1,027	1,027	0	1	1	2	2	3
Irion County WCD	0	0	0	0	0	0	0	1	2	2	2	2
Lone Wolf GCD	14,018	14,018	14,018	14,018	14,018	14,018	0	1	2	3	3	3
Middle Pecos GCD	777	777	777	777	777	777	0	0	0	0	0	0
Santa Rita UWCD	1,037	1,037	1,037	1,037	1,037	1,037	1	4	5	6	6	7
Sterling County UWCD	10	10	10	10	10	10	0	0	0	1	1	1
Wes-Tex GCD	5,750	5,750	5,750	5,750	5,750	5,750	23	29	32	35	37	39
GMA												
Out-of-State	7,793	7,793	7,793	7,793	7,793	7,793	0	1	1	2	2	3
GMA 1	13,419	19,177	26,940	40,099	64,566	107,175	1	11	21	31	41	51
GMA 2	9,598	9,598	9,598	9,598	9,598	9,598	1	10	20	29	34	37
GMA 3	4,231	4,231	4,231	4,231	4,231	4,231	0	0	0	0	0	0
GMA 6	69	69	69	69	69	69	0	1	2	2	3	4
GMA 7	23,802	23,802	23,802	23,802	23,802	23,802	1	2	3	4	5	5

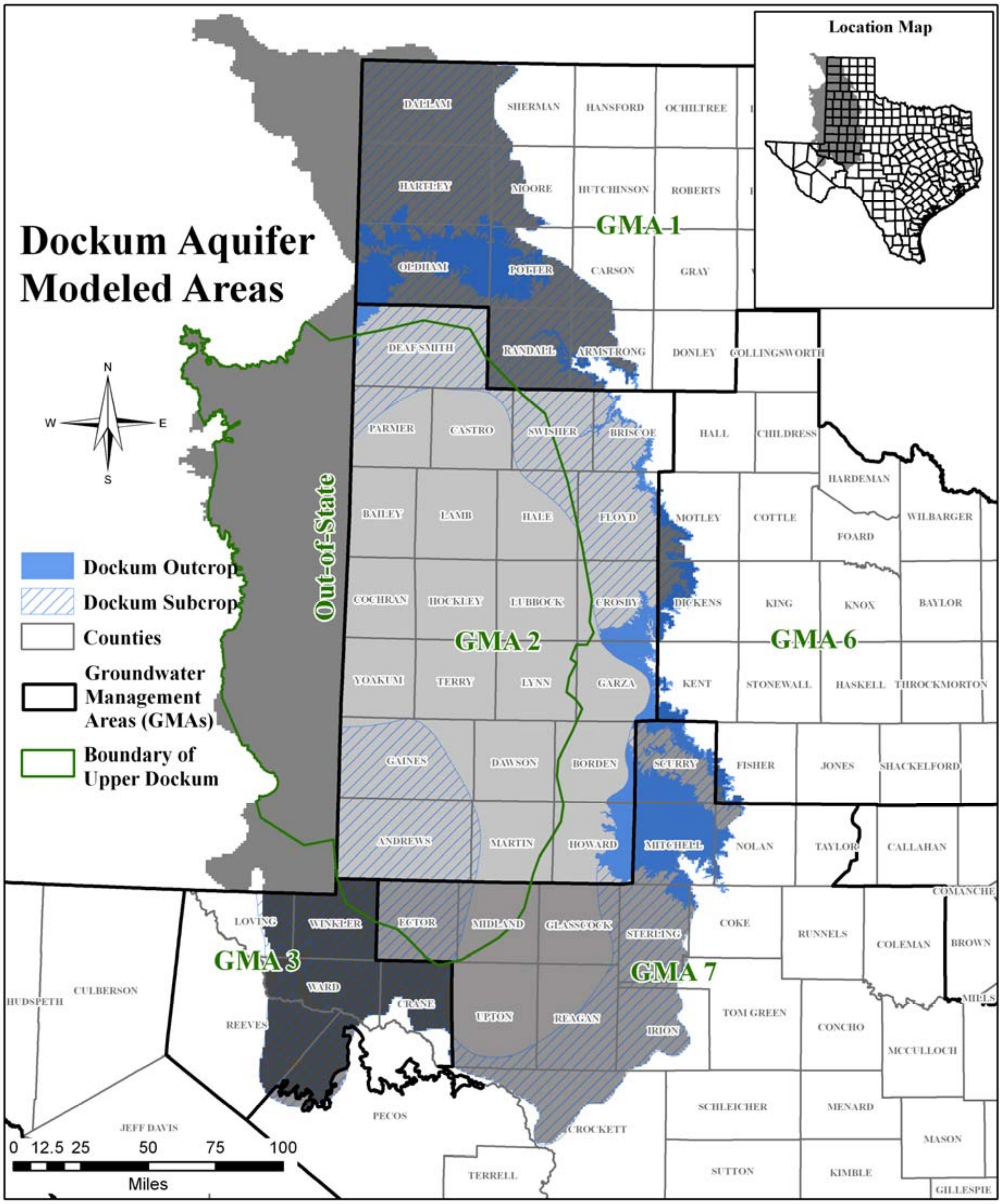

Figure 1. Location map showing model grid cells representing the Dockum Aquifer, groundwater management areas, the official Dockum Aquifer boundary, and the boundary of the upper portion of the Dockum Aquifer.

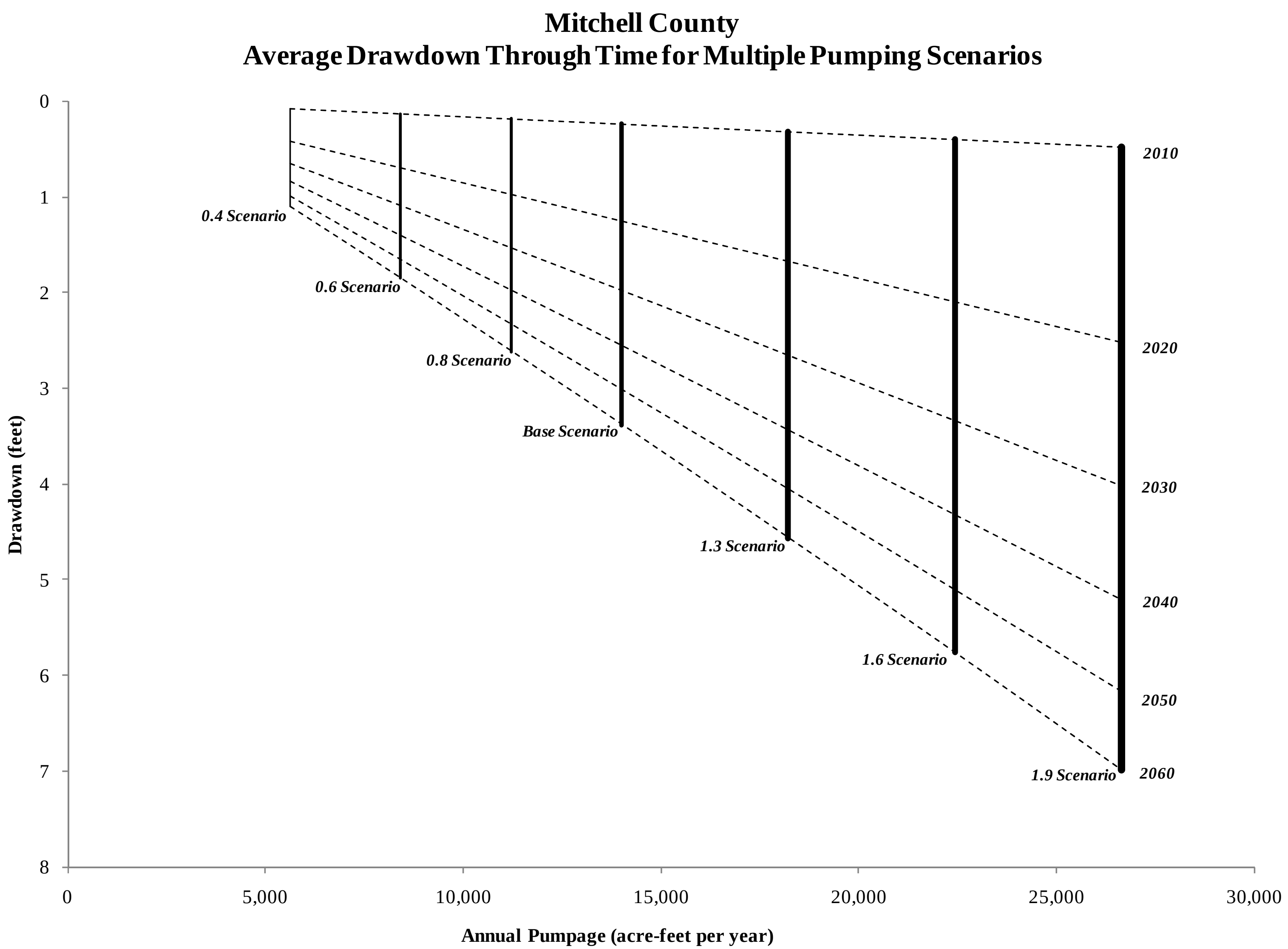

Figure 2. Average drawdown for the lower portion of the Dockum Aquifer in Mitchell County through time for multiple pumping scenarios.

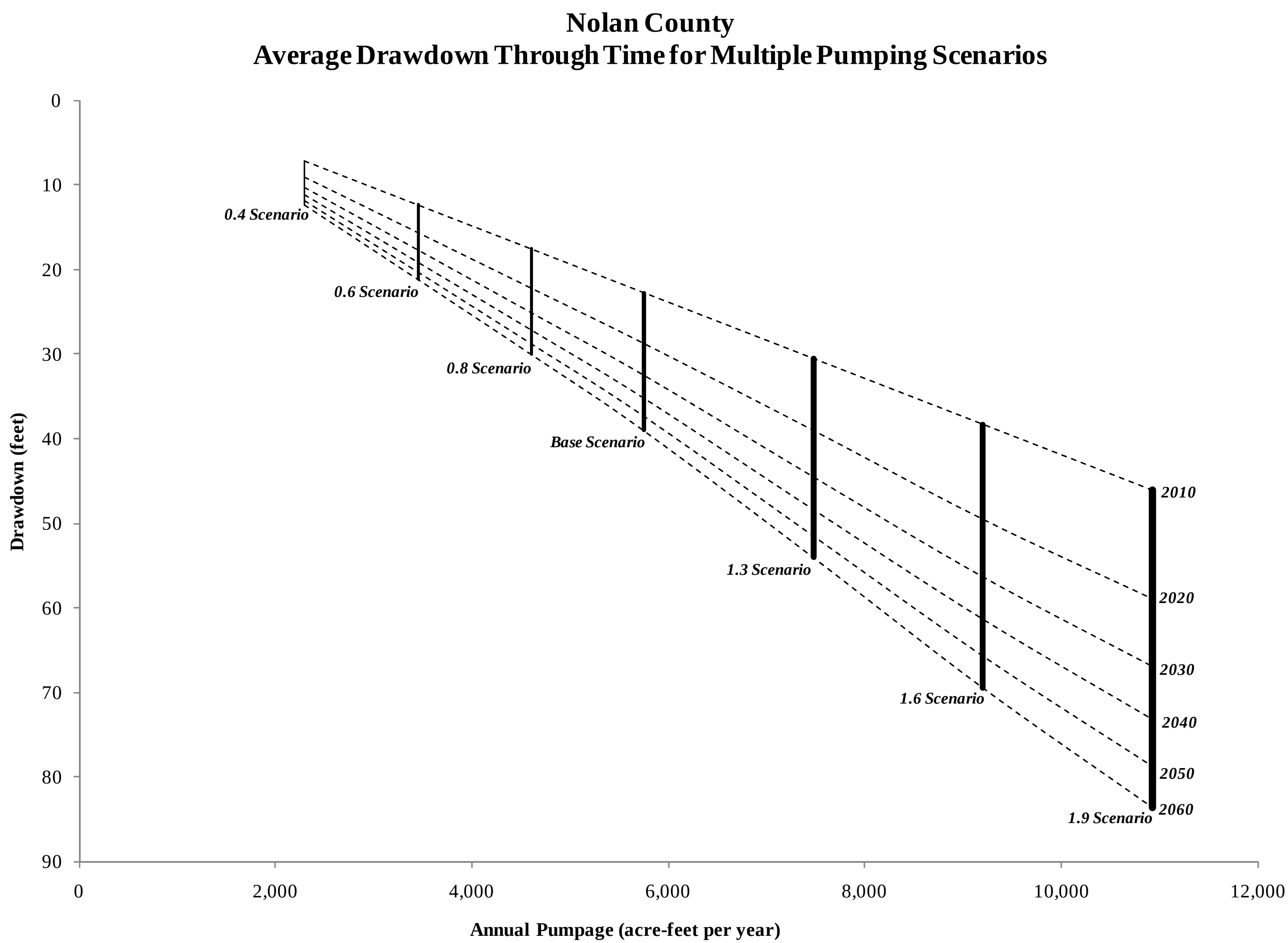

Figure 3. Average drawdown for the lower portion of the Dockum Aquifer in Nolan County through time for multiple pumping scenarios.

Appendix A

Selected hydrographs between 1980 and 2009 for the Dockum Aquifer in Groundwater Management Area 7

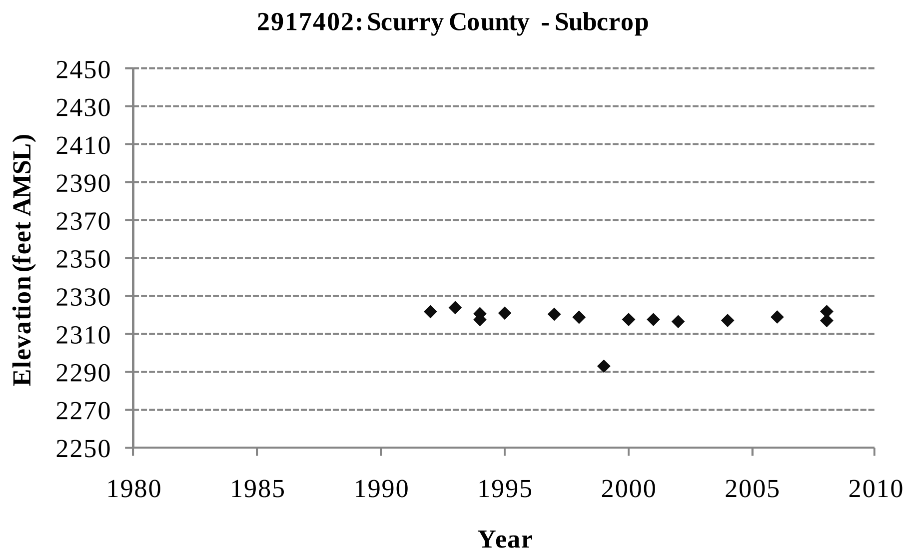

Figure A-1. Hydrograph of state well 2917402 located in the subcrop portion of the Dockum Aquifer in Scurry County.

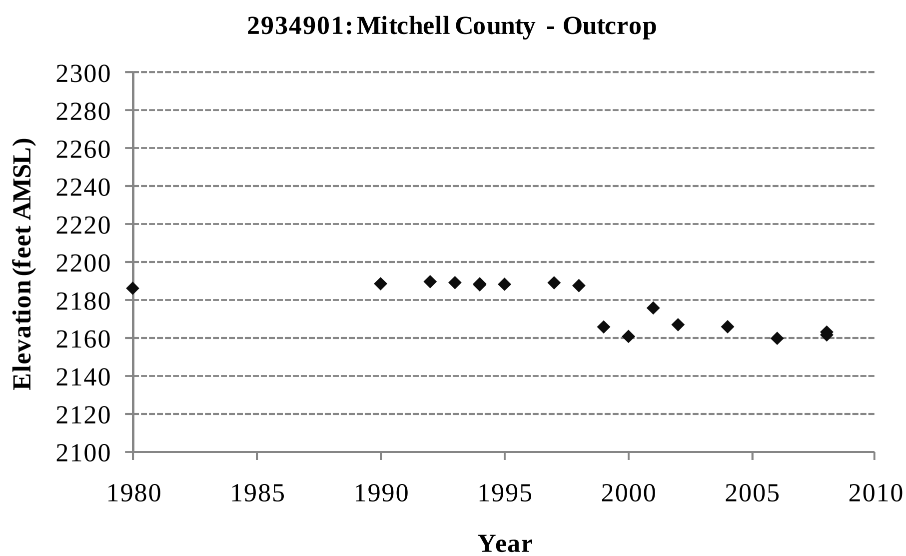

Figure A-2. Hydrograph of state well 2934901 located in the outcrop portion of the Dockum Aquifer in Mitchell County.

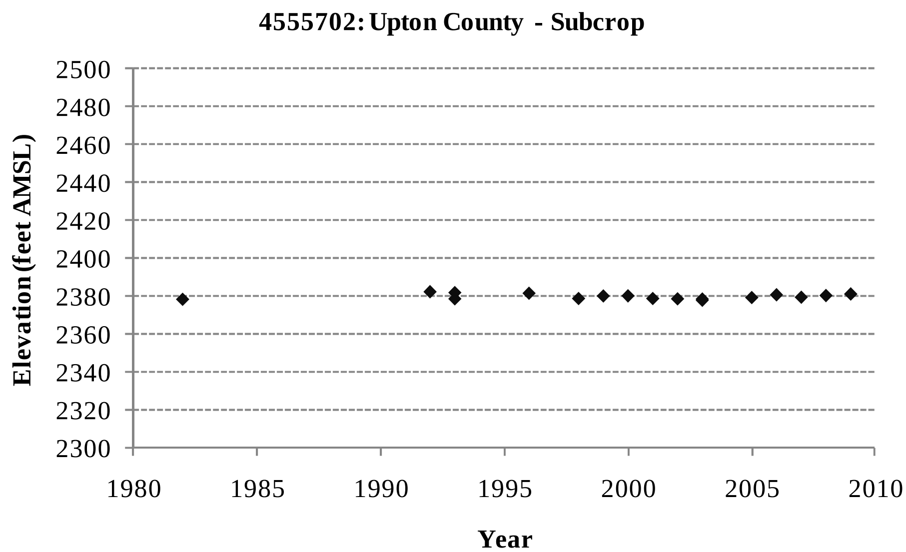

Figure A-3. Hydrograph of state well 4555702 located in the subcrop portion of the Dockum Aquifer in Upton County.

Appendix B

Pumping and drawdown for each pumping scenario by decade

Table B-1. Average drawdown in the lower portion of the Dockum Aquifer resulting from pumping decreased to 40 percent of the base scenario by decade by county, groundwater conservation district (GCD), and groundwater management area (GMA). Pumping is in acre-feet per year. Drawdown is in feet. The abbreviation for Underground Water Conservation District is UWCD and Water Conservation District is WCD. Negative values indicate a water level rise.

Pumping 40 Percent of Base Scenario	Pumping						Average Drawdown					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
County												
Coke	0	0	0	0	0	0	0	0	0	0	0	0
Crockett	1	1	1	1	1	1	0	-5	-7	-8	-8	-8
Ector	211	211	211	211	211	211	0	1	2	3	5	5
Glasscock	0	0	0	0	0	0	-1	-3	-3	-3	-2	-2
Irion	0	0	0	0	0	0	0	0	-1	-2	-2	-2
Midland	0	0	0	0	0	0	0	2	6	10	13	15
Mitchell	5,607	5,607	5,607	5,607	5,607	5,607	0	0	1	1	1	1
Nolan	2,300	2,300	2,300	2,300	2,300	2,300	7	9	10	11	12	12
Pecos	311	311	311	311	311	311	-1	-2	-2	-2	-2	-2
Reagan	826	826	826	826	826	826	-3	-18	-23	-25	-25	-25
Scurry	484	484	484	484	484	484	0	0	0	0	0	0
Sterling	4	4	4	4	4	4	0	0	-1	-1	-1	-1
Tom Green	0	0	0	0	0	0	0	-1	-3	-4	-4	-4
Upton	88	88	88	88	88	88	0	-3	-4	-5	-5	-5
GCD												
Coke County UWCD	0	0	0	0	0	0	0	0	0	0	0	0
Crockett County GCD	1	1	1	1	1	1	0	-5	-7	-8	-8	-8
Glasscock GCD	411	411	411	411	411	411	-2	-7	-8	-8	-8	-7
Irion County WCD	0	0	0	0	0	0	0	0	-1	-2	-2	-2
Lone Wolf GCD	5,607	5,607	5,607	5,607	5,607	5,607	0	0	1	1	1	1
Middle Pecos GCD	311	311	311	311	311	311	-1	-2	-2	-2	-2	-2
Santa Rita UWCD	415	415	415	415	415	415	-2	-15	-20	-22	-22	-23
Sterling County UWCD	4	4	4	4	4	4	0	0	-1	-1	-1	-1
Wes-Tex GCD	2,300	2,300	2,300	2,300	2,300	2,300	7	9	10	11	12	12
GMA												
Out-of-State	3,117	3,117	3,117	3,117	3,117	3,117	-1	-2	-2	-2	-1	-1
GMA 1	5,368	7,673	10,782	16,048	25,835	42,878	-3	2	11	19	28	37
GMA 2	3,839	3,839	3,839	3,839	3,839	3,839	0	9	19	27	32	35
GMA 3	1,692	1,692	1,692	1,692	1,692	1,692	-1	-2	-2	-2	-2	-2
GMA 6	28	28	28	28	28	28	0	0	1	1	2	2
GMA 7	9,521	9,521	9,521	9,521	9,521	9,521	0	-3	-3	-3	-3	-3

Table B-2. Average drawdown in the lower portion of the Dockum Aquifer resulting from pumping decreased to 60 percent of the base scenario by decade by county, groundwater conservation district (GCD), and groundwater management area (GMA). Pumping is in acre-feet per year. Drawdown is in feet. The abbreviation for Underground Water Conservation District is UWCD and Water Conservation District is WCD. Negative values indicate a water level rise.

Pumping 60 Percent of Base Scenario	Pumping						Average Drawdown					
	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
County												
Coke	0	0	0	0	0	0	0	0	0	0	0	0
Crockett	1	1	1	1	1	1	0	-3	-4	-4	-4	-4
Ector	317	317	317	317	317	317	0	1	2	4	5	5
Glasscock	0	0	0	0	0	0	0	-2	-2	-1	-1	-1
Irion	0	0	0	0	0	0	0	0	0	0	-1	-1
Midland	0	0	0	0	0	0	0	3	6	10	13	16
Mitchell	8,411	8,411	8,411	8,411	8,411	8,411	0	1	1	1	2	2
Nolan	3,450	3,450	3,450	3,450	3,450	3,450	12	16	18	19	20	21
Pecos	466	466	466	466	466	466	-1	-1	-1	-1	-1	-1
Reagan	1,238	1,238	1,238	1,238	1,238	1,238	-2	-11	-13	-14	-15	-15
Scurry	725	725	725	725	725	725	0	0	0	0	0	0
Sterling	6	6	6	6	6	6	0	0	0	0	0	0
Tom Green	0	0	0	0	0	0	0	0	-1	-2	-2	-2
Upton	131	131	131	131	131	131	0	-1	-2	-2	-2	-2
GCD												
Coke County UWCD	0	0	0	0	0	0	0	0	0	0	0	0
Crockett County GCD	1	1	1	1	1	1	0	-3	-4	-4	-4	-4
Glasscock GCD	616	616	616	616	616	616	-1	-4	-5	-5	-4	-4
Irion County WCD	0	0	0	0	0	0	0	0	0	-1	-1	-1
Lone Wolf GCD	8,411	8,411	8,411	8,411	8,411	8,411	0	1	1	1	2	2
Middle Pecos GCD	466	466	466	466	466	466	-1	-1	-1	-1	-1	-1
Santa Rita UWCD	622	622	622	622	622	622	-1	-9	-12	-12	-13	-13
Sterling County UWCD	6	6	6	6	6	6	0	0	0	0	0	0
Wes-Tex GCD	3,450	3,450	3,450	3,450	3,450	3,450	12	16	18	19	20	21
GMA												
Out-of-State	4,676	4,676	4,676	4,676	4,676	4,676	0	-1	-1	0	0	0
GMA 1	8,052	11,510	16,169	24,065	38,745	64,311	-2	6	15	24	33	43
GMA 2	5,759	5,759	5,759	5,759	5,759	5,759	1	9	19	27	33	36
GMA 3	2,538	2,538	2,538	2,538	2,538	2,538	0	-1	-1	-1	-1	-1
GMA 6	41	41	41	41	41	41	0	0	1	2	2	3
GMA 7	14,281	14,281	14,281	14,281	14,281	14,281	0	-1	-1	-1	0	0

Table B-3. Average drawdown in the lower portion of the Dockum Aquifer resulting from pumping decreased to 80 percent of the base scenario by decade by county, groundwater conservation district (GCD), and groundwater management area (GMA). Pumping is in acre-feet per year. Drawdown is in feet. The abbreviation for Underground Water Conservation District is UWCD and Water Conservation District is WCD. Negative values indicate a water level rise.

Pumping 80 Percent of Base Scenario	Pumping						Average Drawdown					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
County												
Coke	0	0	0	0	0	0	0	0	0	0	0	0
Crockett	2	2	2	2	2	2	0	0	-1	-1	-1	-1
Ector	422	422	422	422	422	422	0	1	2	4	5	5
Glasscock	0	0	0	0	0	0	0	-1	0	0	0	1
Irion	0	0	0	0	0	0	0	1	1	1	1	1
Midland	0	0	0	0	0	0	0	3	7	10	14	16
Mitchell	11,214	11,214	11,214	11,214	11,214	11,214	0	1	2	2	2	3
Nolan	4,600	4,600	4,600	4,600	4,600	4,600	18	22	25	27	29	30
Pecos	622	622	622	622	622	622	0	-1	-1	-1	-1	-1
Reagan	1,651	1,651	1,651	1,651	1,651	1,651	-1	-3	-4	-4	-4	-4
Scurry	967	967	967	967	967	967	0	0	0	0	0	0
Sterling	8	8	8	8	8	8	0	0	0	0	0	0
Tom Green	0	0	0	0	0	0	0	1	1	0	0	0
Upton	175	175	175	175	175	175	0	0	0	1	1	1
GCD												
Coke County UWCD	0	0	0	0	0	0	0	0	0	0	0	0
Crockett County GCD	2	2	2	2	2	2	0	0	-1	-1	-1	-1
Glasscock GCD	822	822	822	822	822	822	0	-2	-2	-1	-1	-1
Irion County WCD	0	0	0	0	0	0	0	1	1	1	1	1
Lone Wolf GCD	11,214	11,214	11,214	11,214	11,214	11,214	0	1	2	2	2	3
Middle Pecos GCD	622	622	622	622	622	622	0	-1	-1	-1	-1	-1
Santa Rita UWCD	830	830	830	830	830	830	0	-3	-3	-3	-3	-3
Sterling County UWCD	8	8	8	8	8	8	0	0	0	0	0	0
Wes-Tex GCD	4,600	4,600	4,600	4,600	4,600	4,600	18	22	25	27	29	30
GMA												
Out-of-State	6,234	6,234	6,234	6,234	6,234	6,234	0	0	0	1	1	2
GMA 1	10,735	15,344	21,555	32,082	51,655	85,743	0	9	18	28	38	48
GMA 2	7,678	7,678	7,678	7,678	7,678	7,678	1	10	20	28	34	37
GMA 3	3,385	3,385	3,385	3,385	3,385	3,385	0	0	-1	-1	-1	-1
GMA 6	55	55	55	55	55	55	0	1	1	2	3	3
GMA 7	19,042	19,042	19,042	19,042	19,042	19,042	0	0	1	1	2	2

Table B-4. Average drawdown in the lower portion of the Dockum Aquifer resulting from pumping increased to 130 percent of the base scenario by decade by county, groundwater conservation district (GCD), and groundwater management area (GMA). Pumping is in acre-feet per year. Drawdown is in feet. The abbreviation for Underground Water Conservation District is UWCD and Water Conservation District is WCD.

Pumping 130 Percent of Base Scenario	**Pumping**						**Average Drawdown**					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
County												
Coke	0	0	0	0	0	0	0	0	0	0	0	0
Crockett	3	3	3	3	3	3	1	7	10	11	12	12
Ector	686	686	686	686	686	686	0	1	3	5	6	6
Glasscock	0	0	0	0	0	0	0	1	2	2	3	3
Irion	0	0	0	0	0	0	0	5	7	8	9	9
Midland	0	0	0	0	0	0	0	3	7	11	14	17
Mitchell	18,223	18,223	18,223	18,223	18,223	18,223	0	2	3	3	4	5
Nolan	7,475	7,475	7,475	7,475	7,475	7,475	31	39	44	48	51	54
Pecos	1,010	1,010	1,010	1,010	1,010	1,010	1	1	1	1	1	1
Reagan	2,683	2,683	2,683	2,683	2,683	2,683	3	20	26	28	29	30
Scurry	1,572	1,572	1,572	1,572	1,572	1,572	0	0	0	1	1	1
Sterling	13	13	13	13	13	13	0	1	1	1	2	2
Tom Green	0	0	0	0	0	0	0	4	7	8	8	8
Upton	285	285	285	285	285	285	0	4	6	7	8	9
GCD												
Coke County UWCD	0	0	0	0	0	0	0	0	0	0	0	0
Crockett County GCD	3	3	3	3	3	3	1	7	10	11	12	12
Glasscock GCD	1,145	1,145	1,145	1,145	1,145	1,145	1	3	4	5	5	6
Irion County WCD	0	0	0	0	0	0	0	5	7	8	9	9
Lone Wolf GCD	18,223	18,223	18,223	18,223	18,223	18,223	0	2	3	3	4	5
Middle Pecos GCD	1,010	1,010	1,010	1,010	1,010	1,010	1	1	1	1	1	1
Santa Rita UWCD	1,539	1,539	1,539	1,539	1,539	1,539	3	20	26	28	29	30
Sterling County UWCD	13	13	13	13	13	13	0	1	1	1	2	2
Wes-Tex GCD	7,475	7,475	7,475	7,475	7,475	7,475	31	39	44	48	51	54
GMA												
Out-of-State	10,131	10,131	10,131	10,131	10,131	10,131	0	3	4	4	5	5
GMA 1	17,440	24,926	35,018	52,125	83,931	139,324	2	14	25	35	45	55
GMA 2	12,478	12,478	12,478	12,478	12,478	12,478	1	11	21	30	35	38
GMA 3	5,492	5,492	5,492	5,492	5,492	5,492	1	1	1	1	1	1
GMA 6	90	90	90	90	90	90	0	1	2	3	4	4
GMA 7	30,950	30,950	30,950	30,950	30,950	30,950	1	5	7	9	10	10

Table B-5. Average drawdown in the lower portion of the Dockum Aquifer resulting from pumping increased to 160 percent of the base scenario by decade by county, groundwater conservation district (GCD), and groundwater management area (GMA). Pumping is in acre-feet per year. Drawdown is in feet. The abbreviation for Underground Water Conservation District is UWCD and Water Conservation District is WCD.

Pumping 160 Percent of Base Scenario	Pumping						Average Drawdown					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
County												
Coke	0	0	0	0	0	0	0	0	0	0	0	1
Crockett	3	3	3	3	3	3	1	12	17	19	20	21
Ector	845	845	845	845	845	845	0	2	4	5	6	7
Glasscock	0	0	0	0	0	0	0	2	3	4	4	4
Irion	0	0	0	0	0	0	1	9	13	15	15	16
Midland	0	0	0	0	0	0	0	3	7	11	15	17
Mitchell	22,428	22,428	22,428	22,428	22,428	22,428	0	2	3	4	5	6
Nolan	9,200	9,200	9,200	9,200	9,200	9,200	38	50	56	61	66	69
Pecos	1,243	1,243	1,243	1,243	1,243	1,243	1	2	2	2	2	2
Reagan	3,302	3,302	3,302	3,302	3,302	3,302	6	36	46	50	52	53
Scurry	1,934	1,934	1,934	1,934	1,934	1,934	0	0	1	1	1	1
Sterling	16	16	16	16	16	16	0	1	2	2	2	3
Tom Green	0	0	0	0	0	0	1	7	11	13	13	14
Upton	350	350	350	350	350	350	1	6	9	11	12	13
GCD												
Coke County UWCD	0	0	0	0	0	0	0	0	0	0	0	1
Crockett County GCD	3	3	3	3	3	3	1	12	17	19	20	21
Glasscock GCD	1,262	1,262	1,262	1,262	1,262	1,262	1	6	7	8	9	9
Irion County WCD	0	0	0	0	0	0	1	9	13	15	15	16
Lone Wolf GCD	22,428	22,428	22,428	22,428	22,428	22,428	0	2	3	4	5	6
Middle Pecos GCD	1,243	1,243	1,243	1,243	1,243	1,243	1	2	2	2	2	2
Santa Rita UWCD	2,040	2,040	2,040	2,040	2,040	2,040	6	36	46	50	52	53
Sterling County UWCD	16	16	16	16	16	16	0	1	2	2	2	3
Wes-Tex GCD	9,200	9,200	9,200	9,200	9,200	9,200	38	50	56	61	66	69
GMA												
Out-of-State	12,468	12,468	12,468	12,468	12,468	12,468	1	5	6	7	8	8
GMA 1	21,462	30,675	43,096	64,151	103,297	171,472	4	18	28	39	49	58
GMA 2	15,358	15,358	15,358	15,358	15,358	15,358	1	12	22	31	36	39
GMA 3	6,754	6,754	6,754	6,754	6,754	6,754	1	2	2	2	3	3
GMA 6	110	110	110	110	110	110	0	2	3	3	4	5
GMA 7	38,097	38,097	38,097	38,097	38,097	38,097	2	9	12	14	15	16

Table B-6. Average drawdown in the lower portion of the Dockum Aquifer resulting from pumping increased to 190 percent of the base scenario by decade by county, groundwater conservation district (GCD), and groundwater management area (GMA). Pumping is in acre-feet per year. Drawdown is in feet. The abbreviation for Underground Water Conservation District is UWCD and Water Conservation District is WCD.

Pumping 190 Percent of Base Scenario	**Pumping**						**Average Drawdown**					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
County												
Coke	0	0	0	0	0	0	0	0	0	0	1	1
Crockett	4	4	4	4	4	4	1	17	24	27	29	30
Ector	1,003	1,003	1,003	1,003	1,003	1,003	0	2	4	6	7	7
Glasscock	0	0	0	0	0	0	1	3	4	5	5	6
Irion	0	0	0	0	0	0	1	12	18	21	22	22
Midland	0	0	0	0	0	0	0	4	8	12	15	18
Mitchell	26,633	26,633	26,633	26,633	26,633	26,633	0	3	4	5	6	7
Nolan	10,925	10,925	10,925	10,925	10,925	10,925	46	59	67	73	79	84
Pecos	1,476	1,476	1,476	1,476	1,476	1,476	2	3	3	3	3	3
Reagan	3,921	3,921	3,921	3,921	3,921	3,921	9	52	66	72	75	76
Scurry	2,297	2,297	2,297	2,297	2,297	2,297	0	1	1	1	1	1
Sterling	19	19	19	19	19	19	0	2	3	3	3	3
Tom Green	0	0	0	0	0	0	1	10	15	18	19	19
Upton	416	416	416	416	416	416	1	8	12	15	17	18
GCD												
Coke County UWCD	0	0	0	0	0	0	0	0	0	0	1	1
Crockett County GCD	4	4	4	4	4	4	1	17	24	27	29	30
Glasscock GCD	1,379	1,379	1,379	1,379	1,379	1,379	2	8	10	11	12	13
Irion County WCD	0	0	0	0	0	0	1	13	19	21	22	23
Lone Wolf GCD	26,633	26,633	26,633	26,633	26,633	26,633	0	3	4	5	6	7
Middle Pecos GCD	1,476	1,476	1,476	1,476	1,476	1,476	2	3	3	3	3	3
Santa Rita UWCD	2,542	2,542	2,542	2,542	2,542	2,542	9	52	66	72	75	76
Sterling County UWCD	19	19	19	19	19	19	0	2	3	3	3	3
Wes-Tex GCD	10,925	10,925	10,925	10,925	10,925	10,925	46	59	67	73	79	84
GMA												
Out-of-State	14,806	14,806	14,806	14,806	14,806	14,806	1	7	9	10	10	11
GMA 1	25,483	36,424	51,173	76,177	122,663	203,620	5	20	31	41	52	60
GMA 2	18,239	18,239	18,239	18,239	18,239	18,239	1	12	23	31	37	40
GMA 3	8,016	8,016	8,016	8,016	8,016	8,016	2	3	3	4	4	4
GMA 6	131	131	131	131	131	131	1	2	3	4	5	6
GMA 7	45,244	45,244	45,244	45,244	45,244	45,244	2	12	16	19	20	21

Table B-7. Average drawdown in the upper portion of the Dockum Aquifer resulting from changes to the base pumping scenario. Results are shown by decade by county, groundwater conservation district (GCD), and groundwater management area (GMA). Pumping is not shown because no pumping exists in the upper portion of the Dockum Aquifer in the model. Drawdown is in feet. The abbreviation for Underground Water Conservation District is UWCD and Water Conservation District is WCD. Negative values indicate a water level rise.

Base Scenario: Upper Dockum	**40 Percent of Base Pumping**						**60 Percent of Base Pumping**						**80 Percent of Base Pumping**					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
County																		
Ector	0	2	4	5	6	6	0	2	4	6	6	6	0	2	4	6	6	6
Midland	1	8	15	21	25	28	1	8	15	21	26	29	1	8	15	21	26	29
GMA																		
Out-of-State	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
GMA 1	0	2	4	7	10	13	0	2	5	8	12	16	0	3	6	10	14	18
GMA 2	1	15	26	34	39	40	1	15	27	35	39	41	1	15	27	35	39	41
GMA 3	0	-1	-1	-1	-1	-1	0	0	-1	-1	0	0	0	0	0	0	0	0
GMA 7	0	5	9	12	14	16	0	5	9	12	15	16	0	5	9	12	15	16

Table B-7. Continued.

Base Scenario: Upper Dockum	**130 Percent of Base Pumping**						**160 Percent of Base Pumping**						**190 Percent of Base Pumping**					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
County																		
Ector	0	2	4	6	6	6	0	3	5	6	7	7	0	3	5	7	7	7
Midland	1	8	15	21	26	29	1	8	15	22	26	29	1	8	15	22	26	29
GMA																		
Out-of-State	0	1	1	1	1	1	0	1	2	2	2	2	0	2	2	2	3	3
GMA 1	1	5	9	14	18	21	1	6	11	16	19	22	1	8	13	17	20	23
GMA 2	1	16	27	36	40	42	2	16	28	36	41	43	2	16	28	36	41	43
GMA 3	0	1	2	2	2	2	1	3	3	3	3	4	1	4	4	5	5	5
GMA 7	0	5	9	13	15	16	0	5	9	13	15	16	0	5	9	13	15	17

Appendix C

Water budgets for each stress period of the predictive model run

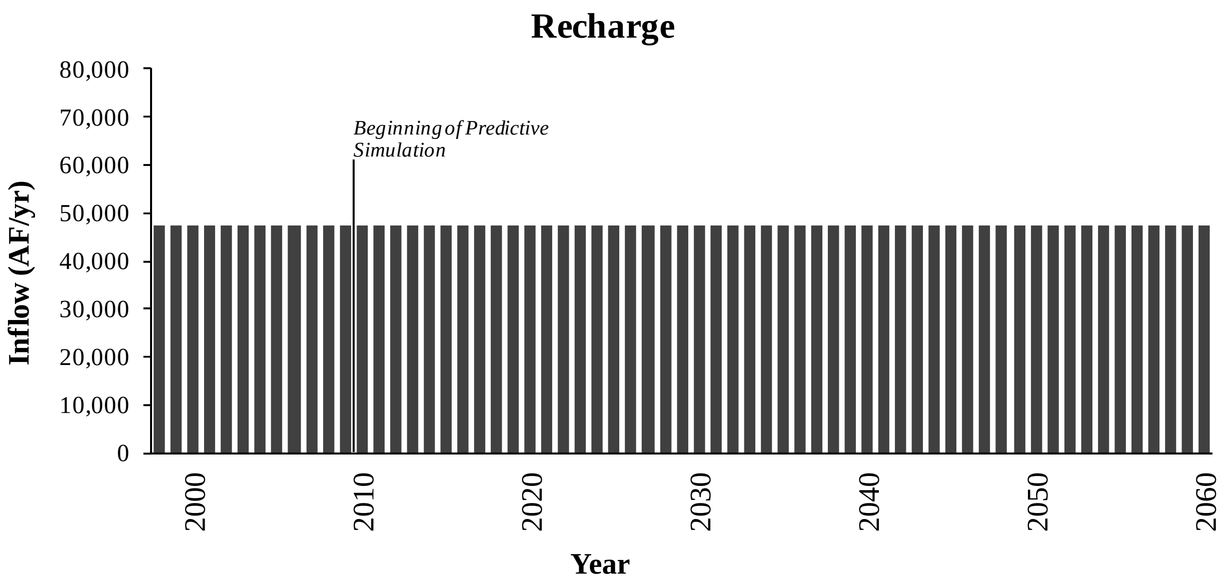

Figure C-1. Net recharge to the Dockum Aquifer by year in the model for Groundwater Management Area 7. AF/yr is acre-feet per year.

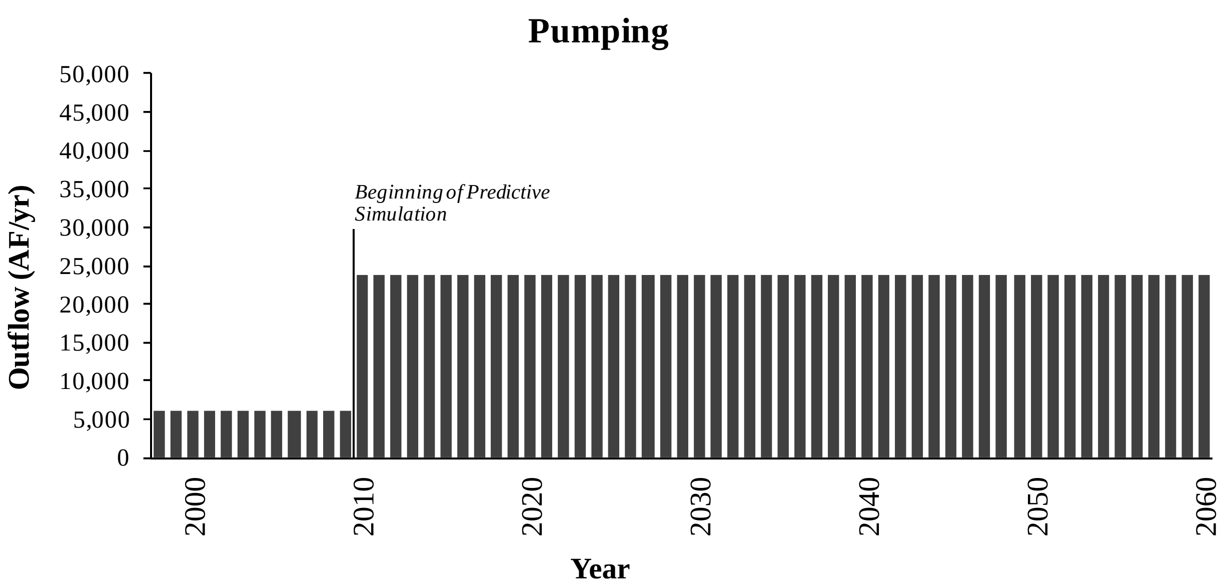

Figure C-2. Pumping output from the Dockum Aquifer by year in the model for Groundwater Management Area 7. AF/yr is acre-feet per year.

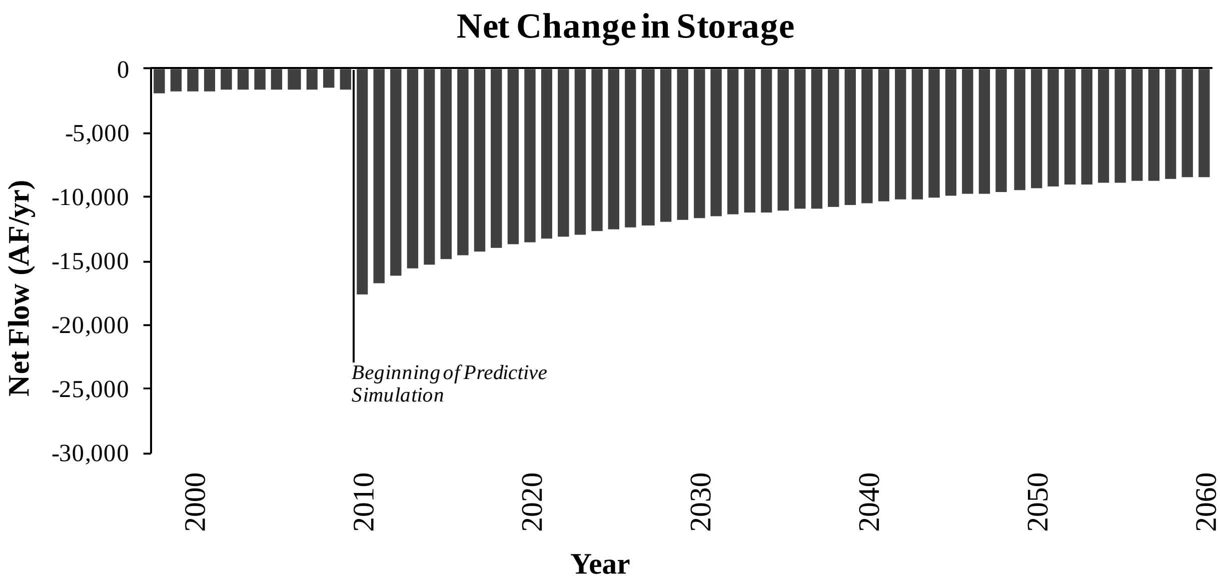

Figure C-3. Net change in storage (the volume of water stored in the aquifer) by year in the lower portion of the Dockum Aquifer for Groundwater Management Area 7. Negative values for the net change in storage indicate water level declines. AF/yr is acre-feet per year.

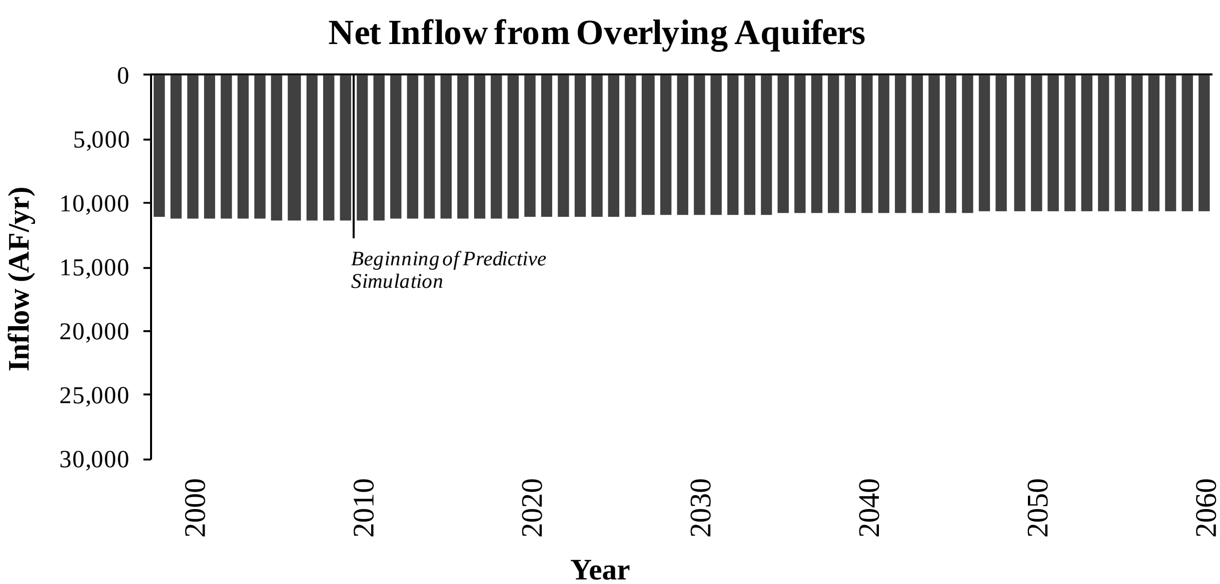

Figure C-4. Net inflow from overlying aquifers to the lower portion of the Dockum Aquifer in Groundwater Management Area 7. AF/yr is acre-feet per year.

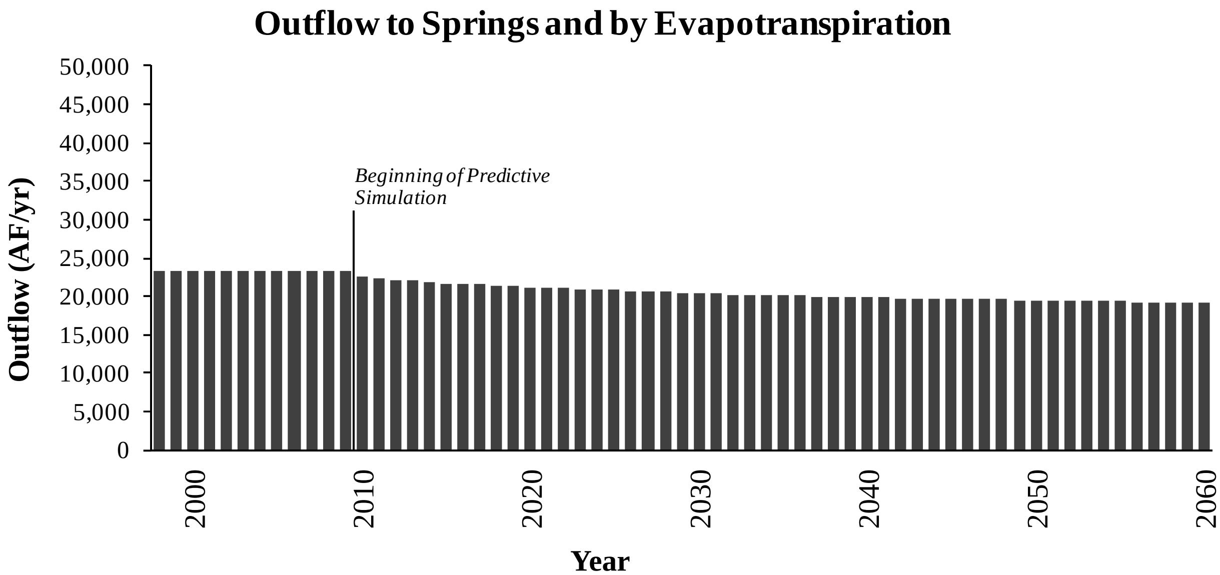

Figure C-5. Outflow from the Dockum Aquifer in Groundwater Management Area 7 to springs and by evapotranspiration. AF/yr is acre-feet per year.

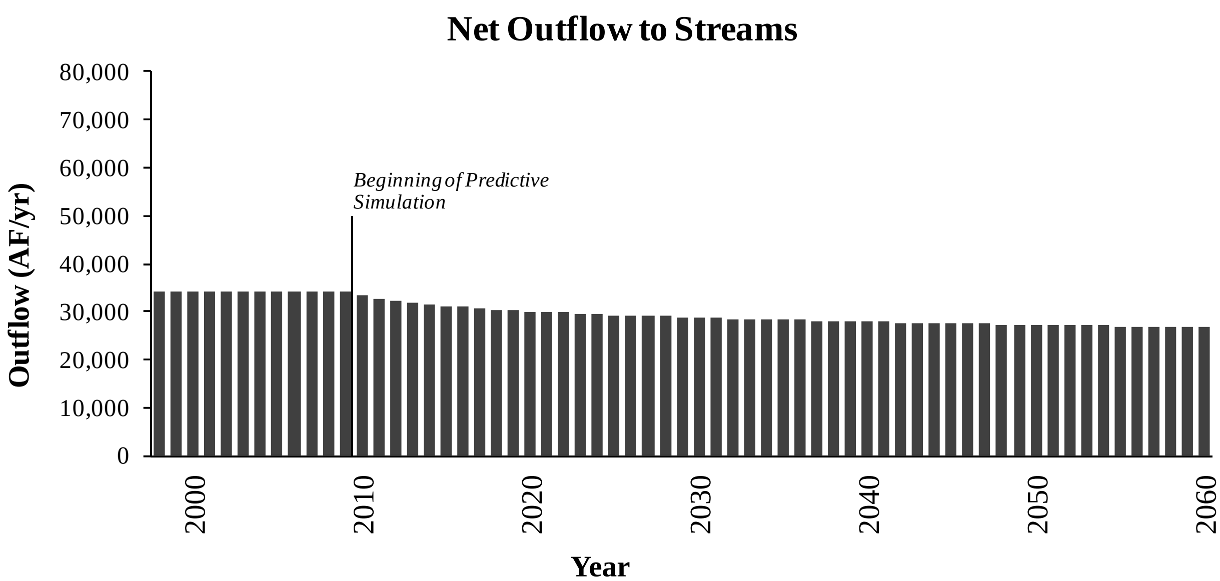

Figure C-6. Net outflow to streams from the Dockum Aquifer in Groundwater Management Area 7. AF/yr is acre-feet per year.

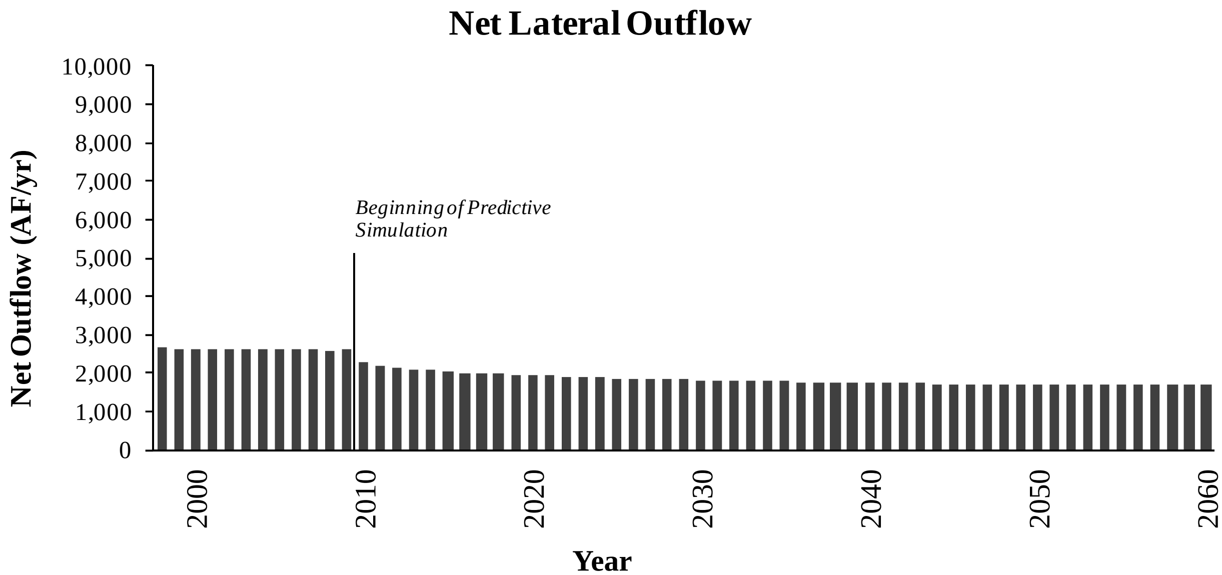

Figure C-7. Net lateral outflow to adjacent areas from the lower portion of the Dockum Aquifer in Groundwater Management Area 7. AF/yr is acre-feet per year.

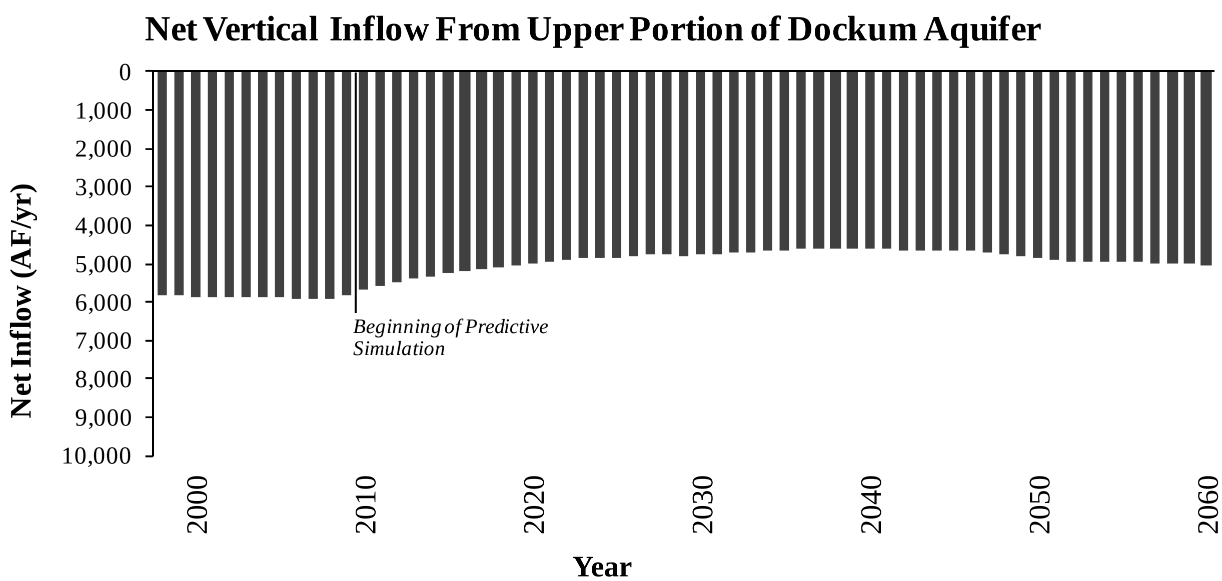

Figure C-8. Net vertical inflow from the upper portion of the Dockum Aquifer to the lower portion of the Dockum Aquifer in Groundwater Management Area 7. AF/yr is acre-feet per year.

Appendix D

Water budget tables by county, groundwater conservation district, and groundwater management area for 2060 in the predictive model run

Table D-1. Water budgets by county in Groundwater Management Area 7 for the last stress period of the groundwater model run (2060). All values are reported in acre-feet per year.

	Coke		Crockett		Ector		Glasscock		Irion		Midland		Mitchell	
	Upper	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**
Inflow														
Drains	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Overlying Aquifers	0	33	0	226	4,094	2,742	0	2,673	0	48	1,883	561	0	172
Recharge	0	105	0	0	0	0	0	0	0	0	0	0	0	19,472
Stream Interaction	0	0	0	0	0	0	0	0	0	0	0	0	0	5,924
Vertical Leakage Upper	-	0	-	0	-	4,074	-	0	-	0	-	1,891	-	0
Vertical Leakage Lower	0	-	0	-	529	-	0	-	0	-	379	-	0	-
Lateral Flow	0	49	0	103	56	196	0	4,725	0	104	68	2,148	0	21,834
Total Inflow	*0*	*187*	*0*	*329*	*4,679*	*7,012*	*0*	*7,398*	*0*	*152*	*2,330*	*4,600*	*0*	*47,402*
Outflow														
Wells	0	0	0	2	0	528	0	0	0	0	0	0	0	14,018
Springs and Evapotranspiration	0	0	0	0	0	0	0	0	0	0	0	0	0	9,686
Overlying Aquifers	0	2	0	306	694	0	0	3	0	149	575	27	0	0
Stream Interaction	0	0	0	0	0	0	0	0	0	0	0	0	0	26,796
Vertical Leakage Upper	0	0	0	0	0	529	0	0	0	0	0	379	0	0
Vertical Leakage Lower	0	-	0	-	4,074	-	0	-	0	-	1,891	-	0	-
Lateral Flow	0	190	0	22	96	6,098	0	8,535	0	3	17	5,783	0	67
Total Outflow	*0*	*192*	*0*	*330*	*4,864*	*7,155*	*0*	*8,538*	*0*	*152*	*2,483*	*6,189*	*0*	*50,567*
Inflow - Outflow	**0**	**-5**	**0**	**-1**	**-185**	**-143**	**0**	**-1,140**	**0**	**0**	**-153**	**-1,589**	**0**	**-3,165**
Storage Change	**0**	**-5**	**0**	**-1**	**-184**	**-143**	**0**	**-1,139**	**0**	**0**	**-153**	**-1,587**	**0**	**-3,168**
Model Error	**0**	**0**	**0**	**0**	**-1**	**0**	**0**	**-1**	**0**	**0**	**0**	**-2**	**0**	**3**
Model Error (percent)	**0.00**	**0.00**	**0.00**	**0.00**	**0.02**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.03**	**0.00**	**0.01**

Table D-1. Continued.

	Nolan		Pecos		Reagan		Scurry		Sterling		Tom Green		Upton	
	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
Inflow														
Drains	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Overlying Aquifers	0	0	0	2,659	0	758	0	0	0	1,859	0	9	0	1,632
Recharge	0	7,135	0	0	0	0	0	20,229	0	439	0	0	0	0
Stream Interaction	0	289	0	0	0	0	0	4,479	0	84	0	0	0	0
Vertical Leakage Upper	-	0	-	0	-	0	-	0	-	0	-	0	-	0
Vertical Leakage Lower	0	-	0	-	0	-	0	-	0	-	0	-	0	-
Lateral Flow	0	206	0	1,007	0	1,438	0	3,813	0	4,470	0	31	0	885
Total Inflow	*0*	*7,630*	*0*	*3,666*	*0*	*2,196*	*0*	*28,521*	*0*	*6,852*	*0*	*40*	*0*	*2,517*
Outflow														
Wells	0	5,750	0	777	0	2,064	0	1,209	0	10	0	0	0	219
Springs and Evapotranspiration	0	25	0	0	0	0	0	9,512	0	0	0	0	0	0
Overlying Aquifers	0	0	0	1,703	0	16	0	0	0	344	0	17	0	134
Stream Interaction	0	464	0	0	0	0	0	10,053	0	185	0	0	0	0
Vertical Leakage Upper	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vertical Leakage Lower	0	-	0	-	0	-	0	-	0	-	0	-	0	-
Lateral Flow	0	2,903	0	1,186	0	121	0	8,053	0	6,659	0	24	0	2,337
Total Outflow	*0*	*9,142*	*0*	*3,666*	*0*	*2,201*	*0*	*28,827*	*0*	*7,198*	*0*	*41*	*0*	*2,690*
Inflow - Outflow	**0**	**-1,512**	**0**	**0**	**0**	**-5**	**0**	**-306**	**0**	**-346**	**0**	**-1**	**0**	**-173**
Storage Change	**0**	**-1,512**	**0**	**0**	**0**	**-5**	**0**	**-306**	**0**	**-345**	**0**	**0**	**0**	**-173**
Model Error	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**-1**	**0**	**-1**	**0**	**0**
Model Error (percent)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**2.47**	**0.00**	**0.00**

Table D-2. Water budgets by groundwater conservation district (GCD) in Groundwater Management Area 7 for the last stress period of the groundwater model run (2060). All values are reported in acre-feet per year. The abbreviation for Underground Water Conservation District is UWCD and Water Conservation District is WCD.

	Coke County UWCD		Crockett County GCD		Glasscock GCD		Irion County WCD		Lone Wolf GCD	
	Upper	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**
Inflow										
Overlying Aquifers	0	33	0	226	0	2,778	0	51	0	172
Recharge	0	105	0	0	0	0	0	0	0	19,472
Stream Interaction	0	0	0	0	0	0	0	0	0	5,924
Vertical Leakage Upper	-	0	-	0	-	0	-	0	-	0
Vertical Leakage Lower	0	-	0	-	0	-	0	-	0	-
Lateral Flow	0	49	0	103	0	6,292	0	109	0	21,834
Total Inflow	*0*	*187*	*0*	*329*	*0*	*9,070*	*0*	*160*	*0*	*47,402*
Outflow										
Wells	0	0	0	2	0	1,027	0	0	0	14,018
Springs and Evapotranspiration	0	0	0	0	0	0	0	0	0	9,686
Overlying Aquifers	0	2	0	306	0	3	0	149	0	0
Stream Interaction	0	0	0	0	0	0	0	0	0	26,796
Vertical Leakage Upper	0	0	0	0	0	0	0	0	0	0
Vertical Leakage Lower	0	-	0	-	0	-	0	-	0	-
Lateral Flow	0	190	0	22	0	9,180	0	11	0	67
Total Outflow	*0*	*192*	*0*	*330*	*0*	*10,210*	*0*	*160*	*0*	*50,567*
Inflow - Outflow	**0**	**-5**	**0**	**-1**	**0**	**-1,140**	**0**	**0**	**0**	**-3,165**
Storage Change	**0**	**-5**	**0**	**-1**	**0**	**-1,139**	**0**	**0**	**0**	**-3,168**
Model Error	**0**	**0**	**0**	**0**	**0**	**-1**	**0**	**0**	**0**	**3**
Model Error (percent)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.01**

Table D-2. Continued.

	Middle Pecos GCD		Santa Rita UWCD		Sterling County UWCD		Wes-Tex GCD	
	Upper	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**
Inflow								
Overlying Aquifers	0	2,659	0	653	0	1,859	0	0
Recharge	0	0	0	0	0	439	0	7,135
Stream Interaction	0	0	0	0	0	84	0	289
Vertical Leakage Upper	-	0	-	0	-	0	-	0
Vertical Leakage Lower	0	-	0	-	0	-	0	-
Lateral Flow	0	1,007	0	1,919	0	4,471	0	206
Total Inflow	*0*	*3,666*	*0*	*2,572*	*0*	*6,853*	*0*	*7,630*
Outflow								
Wells	0	777	0	1,037	0	10	0	5,750
Springs and Evapotranspiration	0	0	0	0	0	0	0	25
Overlying Aquifers	0	1,703	0	16	0	347	0	0
Stream Interaction	0	0	0	0	0	185	0	464
Vertical Leakage Upper	0	0	0	0	0	0	0	0
Vertical Leakage Lower	0	-	0	-	0	-	0	-
Lateral Flow	0	1,186	0	1,524	0	6,656	0	2,903
Total Outflow	*0*	*3,666*	*0*	*2,577*	*0*	*7,198*	*0*	*9,142*
Inflow - Outflow	**0**	**0**	**0**	**-5**	**0**	**-345**	**0**	**-1,512**
Storage Change	**0**	**0**	**0**	**-4**	**0**	**-345**	**0**	**-1,512**
Model Error	**0**	**0**	**0**	**-1**	**0**	**0**	**0**	**0**
Model Error (percent)	**0.00**	**0.00**	**0.00**	**0.04**	**0.00**	**0.00**	**0.00**	**0.00**

Table D-3. Water budgets by groundwater management area (GMA) for the last stress period of the groundwater model run (2060). All values are reported in acre-feet per year.

	Out-of-State		GMA 1		GMA 2		GMA 3		GMA 6		GMA 7	
	Upper	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**
Inflow												
Overlying Aquifers	34,181	19,726	510	25,803	15,885	3,505	1,064	9,499	0	341	5,977	11,690
Recharge	44	1,142	0	8,834	26	21,783	0	0	0	7,974	0	47,369
Stream Interaction	0	78	0	4,279	535	20,406	0	0	0	1,022	0	10,776
Vertical Leakage Upper	-	14,768	-	662	-	20,597	-	1,268	-	0	-	5,965
Vertical Leakage Lower	4,434	-	0	-	8,187	-	280	-	0	-	908	-
Lateral Flow	23	1,032	45	18,898	2,329	13,025	153	7,900	0	2,983	106	15,532
Total Inflow	*38,682*	*36,746*	*555*	*58,476*	*26,962*	*79,316*	*1,497*	*18,667*	*0*	*12,320*	*6,991*	*91,332*
Outflow												
Wells	0	7,793	0	107,175	0	9,598	0	4,231	0	69	0	23,802
Springs and Evapotranspiration	0	2,107	0	6,491	0	26,506	0	0	0	3,541	0	19,166
Overlying Aquifers	21,994	5,473	6	3,544	17,505	1,269	324	12,883	0	27	1,269	1,128
Stream Interaction	0	1,941	0	16,628	0	40,262	0	0	0	7,248	0	37,498
Vertical Leakage Upper	0	4,434	0	0	0	8,187	0	280	0	0	0	908
Vertical Leakage Lower	14,768	-	662	-	20,597	-	1,268	-	0	-	5,965	-
Lateral Flow	2,292	20,258	19	1,464	251	17,003	0	1,505	0	1,925	95	17,215
Total Outflow	*39,054*	*42,006*	*687*	*135,302*	*38,353*	*102,825*	*1,592*	*18,899*	*0*	*12,810*	*7,329*	*99,717*
Inflow - Outflow	**-372**	**-5,260**	**-132**	**-76,826**	**-11,391**	**-23,509**	**-95**	**-232**	**0**	**-490**	**-338**	**-8,385**
Storage Change	**-363**	**-5,254**	**-132**	**-76,806**	**-11,386**	**-23,499**	**-95**	**-231**	**0**	**-491**	**-337**	**-8,385**
Model Error	**-9**	**-6**	**0**	**-20**	**-5**	**-10**	**0**	**-1**	**0**	**1**	**-1**	**0**
Model Error (percent)	**0.02**	**0.01**	**0.00**	**0.01**	**0.01**	**0.01**	**0.00**	**0.01**	**0.00**	**0.01**	**0.01**	**0.00**