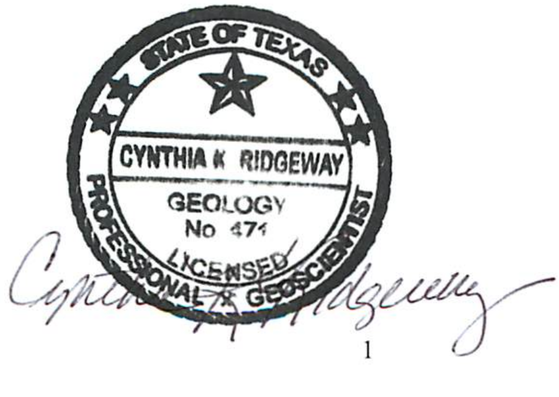
GAM Run 09-023

by Mr. Wade Oliver

Texas Water Development Board
Groundwater Availability Modeling Section
(512) 463-3132
May 21, 2010

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 May 21, 2010.



EXECUTIVE SUMMARY:

We ran the groundwater availability model for the southern portion of the Ogallala Aquifer (which includes the Edwards-Trinity High Plains Aquifer), adjusting annual pumpage to achieve a 50 percent decline in the Ogallala Aquifer volume in each county in Groundwater Management Area 2 between 2009 and 2060. For comparison, we also calculated the pumping volumes required to match the requested 50 percent decline using a water balance approach.

To set the initial volume of water for the model run and water balance investigation, the volume of water in the Ogallala Aquifer in the model for 2008 was compared to the volume of water calculated from water level measurements representing the same time period. The difference in calculated volume between the two approaches was approximately 8.7 percent. To account for this discrepancy, a correction factor was applied to the pumping output from the model in order to more closely reflect the most current conditions represented by the water level measurements.

Results from the model run indicate that the total pumping that yields a 50 percent reduction in the Ogallala Aquifer volume within Groundwater Management Area 2 will decline from approximately 2,227,000 acre-feet per year to 1,431,000 acre-feet per year between 2009 and 2060. The rate of decline in pumping is variable by county.

Using the water balance approach, the total pumping within Groundwater Management Area 2 for each year that achieves the requested 50 percent reduction in the Ogallala Aquifer volume is approximately 2,032,000 acre-feet per year using the initial volume calculated from water levels. This approach does not, however, account for the dynamic responses of the aquifer to pumping such as decreased spring flow and changes in lateral and vertical flows or likely decreases in pumping through time due to declining water levels.

REQUESTOR:

Mr. Jason Coleman of South Plains Underground Water Conservation District on behalf of Groundwater Management Area 2.

DESCRIPTION OF REQUEST:

Mr. Coleman asked us to perform a groundwater availability model run that results in a 50 percent decline in the volume of the southern portion of the Ogallala Aquifer in each county of Groundwater Management Area 2 by 2060. The southern portion of the Ogallala Aquifer and nearby groundwater management areas are shown in Figure 1.

METHODS:

In order to determine the pumping required to achieve the requested 50 percent reduction in the volume of the Ogallala Aquifer, we first used the groundwater availability model for the southern portion of the Ogallala Aquifer, which also includes the Edwards-Trinity (High Plains) Aquifer. The pumping between 2009 and 2060 was determined iteratively by adjusting the pumping values in each county to obtain the requested decline.

To set the initial volume of groundwater storage for the model run, the model was first run with pumping held constant at year 2000 levels (the last year of the historical/calibration portion of the model). The volume of water in the model for 2008 in the Ogallala Aquifer within Groundwater Management Area 2 was then calculated at approximately 134,730,000 acre feet.

For comparison, water levels for the same time period were taken from the Texas Water Development Board Groundwater Database and kriged to create a water level surface for the Ogallala Aquifer. The locations of these water level measurements and the resulting water level surface are shown in Figure 2. After merging the surface with the model grid, the volume of water in each grid cell was calculated using the storage properties and base of the Ogallala Aquifer from the model. The volume calculated from measured water levels was approximately 123,017,000 acre-feet, or 8.7 percent less than the volume calculated in the model.

Since the initial volume in the model was 8.7 percent more than the approach using measured water levels, the pumping output from the model for each decade was reduced by 8.7 percent to correct for the initial volume (described above).

A water balance approach was also employed for comparison to the model results. Using each of the initial volumes calculated above and average recharge (taken from the year 2008 in the model), the pumping required to achieve the requested 50 percent reduction in volume between 2009 and 2060 was calculated.

PARAMETERS AND ASSUMPTIONS:

The parameters and assumptions for the model run using the groundwater availability model for the southern portion of the Ogallala Aquifer are described below:

- We used version 2.01 of the groundwater availability model for the southern portion of the Ogallala Aquifer and the Edwards-Trinity (High Plains) Aquifer. This model is an expansion on and update to the previously developed groundwater availability model for the southern portion of the Ogallala Aquifer described in Blandford and others (2003). See Blandford and others (2008) and Blandford and others (2003) for assumptions and limitations of the groundwater availability model.

- The model includes four layers representing the southern portion of the Ogallala and Edwards-Trinity (High Plains) aquifers. The units comprising the Edwards-Trinity (High Plains) Aquifer (primarily Edwards, Comanche Peak, and Antlers Sand formations) are separated from the overlying Ogallala Aquifer by a layer of Cretaceous shale, where present.

- The mean absolute error (a measure of the difference between simulated and measured water levels during model calibration) for the Ogallala Aquifer in 2000 is 33 feet. The mean absolute error for the Edwards-Trinity (High Plains) Aquifer in 1997 is 25 feet (Blandford and others, 2008). This represents 1.8 and 3.0 percent of the hydraulic head drop across the model area for each aquifer, respectively.

- We used Groundwater Vistas version 5.36 Build 10 (Environmental Simulations, Inc., 2007) as the interface to process model output.

- Cells were assigned to individual counties and groundwater conservation districts as shown in the September 14, 2009 version of the model grid for the southern portion of the Ogallala Aquifer and the Edwards-Trinity (High Plains) Aquifer.

- The recharge used for the model run represents average recharge as described in Blandford and others (2003).

- The pumpage used for the predictive simulations was determined iteratively to match the requested decline in volume by members of Groundwater Management Area 2. Details on this pumpage are given below.

Pumpage

The pumpage values in the groundwater availability model in each county were determined using an iterative process. The pumpage in the model for the year 2000 (the last year of the historical/calibration portion of the model) was held constant between 2001 and 2008. Beginning in 2009, this pumping distribution was adjusted up or down and then held constant for each year through 2060. After running the model, the decline in the volume of the aquifer between 2009 and 2060 was calculated. Where a decrease in pumping was required, the pumpage value for each cell in the model was decreased by a uniform factor, preserving the original pumpage distribution. Where an increase in pumping was required, pumping was uniformly increased over all model cells that contained pumping during the last year of the historical/calibration portion of the model. This process was repeated until the decline in aquifer volume in each county matched the requested decline.

Pumping in areas outside Groundwater Management Area 2 was held constant at 2000 levels through the predictive period with the exception of Groundwater Management Area 7 (Ector, Midland, and Glasscock counties). Pumping in these counties was also adjusted, at the request of Groundwater Management Area 7, to match the 50 percent decline between 2009 and 2060. These results are presented in GAM Run 09-027 (Oliver, 2010).

In Gaines, Dawson, Terry, and Yoakum counties, the MODFLOW Multi-Node Well package was used to simulate wells that were completed into both the Ogallala and Edwards-Trinity (High Plains) aquifers. These wells were adjusted in the same way as those wells included in the MODFLOW Well package. However, pumping levels in wells solely in the Edwards-Trinity (High Plains) Aquifer were left unchanged from levels for the last year of the historical/calibration portion of the model. Since no changes were made to the Edwards-Trinity (High Plains) Aquifer except in the multi-node wells, results for this aquifer are not presented in this report except to describe its interaction with the Ogallala Aquifer.

The "base" pumping distribution that met the above request was also adjusted up and down in order to provide insight into the relationship between pumping and drawdown in Groundwater Management Area 2. The pumping input to the model in groundwater management areas 2 and 7 was multiplied by a factor to increase (factors of 1.3, 1.6 and 1.9) or decrease (factors of 0.8, 0.6, and 0.4) the pumping in these areas. 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 2001 and 2008 and then set to a level resulting in a decline in volume in the Ogallala Aquifer of 50 percent between 2009 and 2060. The pumping output from the model for each decade, which has been reduced by 8.7 percent to correct for the initial volume (described above) and accounts for pumping lost due to cells going inactive, is shown in Table 1 for each county, groundwater conservation district, and groundwater management area in the model. 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. Note that the percent declines by groundwater conservation district may not exactly match 50 percent if the district does not completely contain a county (for example, South Plains Underground Water Conservation District).

Table 1 also includes the percent volume remaining in each area and the average drawdown by decade. In each county in groundwater management areas 2 and 7, the percent volume remaining declines to 50 percent of the volume in 2008. The average county-wide drawdowns required to achieve this decline range from 14 feet in Yoakum County to 83 feet in Crosby County.

As described in the Pumpage section above, the base pumping distribution was adjusted up and down to provide insight into how the model responds under different levels of pumping. Tables similar to Table 1, but showing pumping, volume, and drawdown results for each of the scenarios where pumping was adjusted are shown in Appendix A. In addition, Figure 3 shows the percent volume remaining in Groundwater Management Area 2 through time for each of the pumping scenarios. Figure 4 shows the average drawdown in Groundwater Management Area 2 through time for each of the pumping scenarios. In Figure 3, notice that in the highest pumping scenario (the “1.9 Scenario” where pumping is increased to 190 percent of the base pumping), annual pumpage begins over 4,000,000 acre-feet per year, but declines rapidly to less than 850,000 acre-feet per year by 2060 due to cells going inactive, with approximately 10 percent of the 2008 aquifer volume remaining at the end of the model run. In the lowest pumping scenario, the amount of pumping also decreases through time due to cells going inactive, but the decline is from approximately 900,000 acre-feet per year to 800,000 acre-feet per year, with more than 90 percent of the 2008 aquifer volume remaining in 2060. A similar comparison can be made with drawdown in Figure 4, where the average drawdown in 2060 in Groundwater Management Area 2 ranges from 4 feet in the lowest pumping scenario to over 80 feet in the highest pumping scenario.

Table 2 shows the results of four separate water balance analyses for each county in Groundwater Management Area 2 and for the area as a whole. Two analyses were performed using the initial volume calculated from the water level measurements shown in Figure 2. The first shows the annual constant pumping in each county required to reduce the volume by 50 percent over 52 years (2009 to 2060), taking into account average recharge added to the county each year. The second analysis shows the percent of the original volume remaining using the pumping output from the "Base" model run for each year of the predictive simulation. This also takes into account the average recharge and includes the 8.7 percent correction factor. The second two analyses are similar to the first, except the original water volume comes from the model for the year 2008.

As mentioned above, the water balance analysis does not reflect spring flow or interaction of the aquifer with neighboring groundwater management areas or the underlying Edwards-Trinity (High Plains) Aquifer. Additionally, this approach does not show the decrease in pumping through time with decreasing water levels that one would expect. Despite this, over Groundwater Management Area 2 as a whole, the pumping calculated from the water balance analysis (2,032,469 acre feet per year) is similar to the pumping calculated from the model, which starts at just over 2,175,000 acre-feet per year and declines steadily to about 1,431,000 acre-feet per year. By comparing tables 1 and 2 at the county-level, it can be seen that there are some significant differences between the model and water balance methods. However, for most counties, the pumping calculated from the water balance analysis is within the range of pumping values in the model run.

To better illustrate how the model responds through time during the "Base" run, Appendix B 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 Ogallala Aquifer within Groundwater Management Area 2. Appendix C 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 as well as inflow to the aquifer from playa lakes. Recharge is always shown as "Inflow" into the water budget. Recharge is modeled using the MODFLOW Recharge package, except in Lubbock County, where it is also modeled using the MODFLOW well package (shown in Appendix C as Well inflow).

- Pumping—water produced from wells in the aquifer. This component is always shown as "Outflow" from the water budget, except in Lubbock County, where the MODFLOW Well package is also used to simulate recharge inflow from playa lakes. Pumping also occurs in Gaines, Dawson, Terry, and Yoakum counties using the MODFLOW Multi-Node Well package, which simulates wells that are completed into both the Ogallala and Edwards-Trinity (High Plains) aquifers. In Appendix C, pumping from the multi-node well package is shown as "multi-node well" outflow.

- Springs and Seeps—water that naturally discharges from an aquifer when water levels rise above the elevation of the spring or seep. This component is always shown as "Outflow," or discharge, in the water budget. Spring and seep outflows are simulated in the model using the MODFLOW Drain package. In Appendix B, outflow to springs and seeps is subtracted from recharge to show "Net Recharge."

- Change in Storage—changes in the water stored in the aquifer. Storage can be either an "inflow" (that is, water levels decline) or an "outflow" (that is, water levels increase). 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).

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

- Vertical flow or leakage (upper or lower)—describes the vertical flow, or leakage, between two aquifers. This flow is controlled by the water levels in each aquifer 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 run, only those results for the Ogallala – and its interaction with the underlying Edwards-Trinity (High Plains) Aquifer – are shown.

Figure B-1 in Appendix B shows the pumping through time for the "Base" scenario, which meets the requested volume remaining in 2060. Note that the pumping values in this figure have not been adjusted using the 8.7 percent correction factor.

Figure B-2 shows Net Recharge in the groundwater availability model for each year. Here, "Net Recharge" refers to recharge sourced from precipitation minus outflow to springs and seeps. Though recharge from precipitation input to the model is constant, as water levels decline and cells become inactive, the amount of water entering the aquifer through precipitation and removed from the aquifer by springs and seeps is reduced.

Figure B-3 shows the Net Change in Storage in the groundwater availability model. Note that the amount of water removed from storage increases in 2009 due to the increase in pumping shown in Figure B-1.

Figure B-4 shows the net lateral flow between Groundwater Management Area 2 and adjacent areas. Notice that from 2009 to 2060, flow is consistently toward Groundwater Management Area 2 and increases through time due to declining water levels. However, the total amount of later inflow is minor (between 500 and 2000 acre-feet per year) relative to the other water budget terms.

Figure B-5 shows the magnitude and direction of vertical flow between the Ogallala Aquifer and the underlying Edwards-Trinity (High Plains) Aquifer. Through the predictive period there is a net downward outflow from the Ogallala Aquifer. However, the magnitude of this outflow decreases through time due to declining water levels in the Ogallala Aquifer.

It is important to note that sub-regional water budgets are not exact. This is due to the size of the model cells and the approach used to extract data from the model. To avoid double accounting, a model cell that straddles a political boundary (e.g. 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:

Blandford, T.N., Blazer, D.J., Calhoun, K.C., Dutton, A.R., Naing, T., Reedy, R.C., and Scanlon, B.R., 2003, Groundwater availability of the southern Ogallala aquifer in Texas and New Mexico—Numerical simulations through 2050: Final report prepared for the Texas Water Development Board by Daniel B. Stephens & Associates, Inc., 158 p.

Blandford, T.N., Kuchanur, M., Standen, A., Ruggiero, R., Calhoun, K.C., Kirby, P., and Shah, G., 2008, Groundwater availability model of the Edwards-Trinity (High Plains) Aquifer in Texas and New Mexico: Final report prepared for the Texas Water Development Board by Daniel B. Stephens & Associates, Inc., 176 p.

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

Oliver, W., 2010, GAM run 09-027: Texas Water Development Board, GAM Run 09-027 Report, 30 p.

Table 1. Pumping (reduced by an 8.7 percent correction factor), remaining volume, and drawdown by decade for each county, groundwater conservation district, and groundwater management area in the model. Pumping is in acre-feet per year. Drawdown is in feet. UWCD is Underground Water Conservation District, GCD is Groundwater Conservation District, and GMA is Groundwater Management Area.

Base scenario	Pumping reduced by 8.7 percent correction ractor						Percent volume remaining						Average drawdown					
	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
County																		
Andrews	61,133	55,840	50,828	46,612	42,975	36,534	98	86	76	66	58	50	1	7	12	17	22	26
Armstrong	6,067	6,067	6,067	6,067	6,067	6,067	99	91	84	77	71	64	1	8	15	21	28	34
Bailey	62,571	41,340	34,937	30,093	24,048	21,429	96	82	71	62	55	50	1	6	10	13	15	17
Borden	4,996	4,996	4,914	4,702	4,449	4,113	98	88	78	68	59	50	1	7	13	18	24	30
Briscoe	33,629	26,464	19,728	14,226	13,043	11,938	97	82	71	63	56	50	2	9	15	19	23	28
Castro	127,426	127,306	126,511	125,819	123,284	118,002	98	88	78	69	59	50	2	11	20	29	37	46
Cochran	48,346	36,663	33,642	30,696	28,220	25,415	97	85	75	66	57	50	1	6	10	14	18	22
Crosby	135,582	135,399	135,399	135,399	135,399	135,399	98	88	79	69	60	50	3	19	35	51	67	83
Dawson	124,572	123,580	121,546	119,472	114,210	104,286	97	87	77	68	58	50	2	12	22	31	40	47
Deaf Smith	129,131	118,728	106,838	97,599	80,876	66,635	97	86	75	65	57	50	1	8	14	20	24	27
Dickens	3,083	3,083	3,083	3,083	3,083	3,083	100	98	96	93	90	88	0	3	5	8	11	14
Ector	8,665	8,026	7,730	7,171	7,135	6,727	98	88	78	68	59	50	1	5	10	14	18	22
Floyd	155,716	150,092	146,069	139,063	130,454	124,898	98	87	77	67	58	50	3	18	32	47	60	74
Gaines	198,621	143,161	105,482	83,691	68,059	59,914	96	80	69	61	55	50	3	13	20	25	29	33
Garza	19,099	18,969	18,839	18,710	18,063	17,029	98	88	78	68	59	50	2	11	19	28	35	42
Glasscock	21,773	21,322	20,875	19,691	17,289	14,868	98	87	77	67	58	50	2	15	27	39	50	62
Hale	130,611	129,806	128,007	126,003	120,127	112,250	98	88	78	68	59	50	2	10	19	28	37	45
Hockley	96,973	93,816	89,259	85,346	77,610	67,466	98	87	77	67	58	50	1	9	15	22	27	32
Howard	31,027	26,974	24,248	20,520	18,000	16,309	97	85	74	65	57	50	1	7	14	20	26	32
Lamb	147,357	137,607	125,457	111,501	95,689	85,184	97	85	75	65	57	50	2	11	20	27	33	38
Lubbock	124,449	120,231	115,282	108,747	100,702	90,781	98	87	77	67	58	50	2	10	19	27	34	40
Lynn	105,723	105,456	104,657	101,804	93,960	85,305	98	87	77	67	58	50	1	8	15	21	27	31
Martin	81,087	80,766	76,220	71,089	65,172	60,689	98	87	77	67	58	50	2	11	20	29	37	46
Midland	39,149	38,388	36,824	34,623	32,693	31,325	98	87	77	68	58	50	2	9	17	24	31	38
Motley	1,433	1,433	1,433	1,433	1,433	1,433	100	98	96	94	92	89	0	2	4	6	9	12
Oldham	4,207	3,357	3,141	2,942	2,942	2,551	100	99	98	97	96	95	0	1	1	2	2	2
Parmer	68,703	63,430	56,590	52,156	45,626	40,986	97	86	75	65	57	50	1	6	11	15	18	21
Potter	4,950	2,982	1,980	1,091	764	764	97	84	77	72	69	67	2	9	12	13	14	15
Randall	48,215	47,501	46,411	45,299	42,365	39,566	99	92	85	78	73	67	1	5	9	13	17	20
Swisher	110,939	107,605	101,015	84,830	73,860	64,309	98	86	75	65	57	50	2	11	20	27	34	39
Terry	117,139	116,401	110,101	89,813	70,497	60,773	97	85	73	63	56	50	1	9	15	20	22	25
Yoakum	60,448	46,560	34,312	26,855	23,309	21,157	96	80	69	61	55	50	1	6	8	10	12	14
District																		
Garza County UWCD	19,099	18,969	18,839	18,710	18,063	17,029	98	88	78	68	59	50	2	11	19	28	35	42
Glasscock GCD	21,773	21,322	20,875	19,691	17,289	14,868	98	87	77	67	58	50	2	15	27	39	50	62
High Plains UWCD No. 1	1,362,075	1,286,941	1,227,878	1,167,659	1,076,500	991,970	98	87	76	66	57	49	2	11	20	28	36	43
Llano Estacado UWCD	198,621	143,161	105,482	83,691	68,059	59,914	96	80	69	61	55	50	3	13	20	25	29	33
Mesa UWCD	124,572	123,580	121,546	119,472	114,210	104,286	97	87	77	68	58	50	2	12	22	31	40	47
Panhandle GCD	147	147	147	147	147	147	99	98	96	95	93	92	1	2	2	3	4	5
Permian Basin UWCD	110,562	106,426	99,298	90,694	82,430	76,449	98	87	76	67	58	50	2	10	18	26	34	42
Sandy Land UWCD	60,448	46,560	34,312	26,855	23,309	21,157	96	80	69	61	55	50	1	6	8	10	12	14
South Plains UWCD	117,775	117,037	110,737	90,449	71,133	61,409	98	85	74	64	56	51	1	9	15	20	22	25
Management Area																		
Out-of-State	76,367	64,864	55,689	49,005	43,016	39,786	100	98	97	95	95	94	0	1	1	1	1	2
GMA 1	63,440	59,908	57,600	55,398	52,139	48,948	99	93	88	83	79	75	1	4	7	10	12	14
GMA 2	2,175,279	2,011,192	1,869,880	1,724,743	1,567,632	1,430,799	98	86	76	66	58	50	2	10	18	25	32	38
GMA 6	4,516	4,516	4,516	4,516	4,516	4,516	100	98	96	94	91	89	0	2	5	7	10	13
GMA 7	69,587	67,737	65,429	61,485	57,117	52,919	98	87	77	67	58	50	2	10	17	25	32	39

Table 2. Recharge, pumping and groundwater storage volume analysis for each county in Groundwater Management Area 2 using the initial volume calculated from water levels and the initial volume calculated from the model. Pumping and Recharge are in acre-feet per year. Volume is in acre-feet.

Volume source		**Water levels**				**Model**			
Pumping source			**Calculated to match 50 percent volume**		**Model run**		**Calculated to match 50 percent volume**		**Model Run**
	Recharge	**Volume**	**Pumping**	**Percent remaining**	**Percent remaining**	**Volume**	**Pumping**	**Percent remaining**	**Percent Remaining**
GMA 2	849,695	123,017,061	2,032,469	50	60	134,730,313	2,145,178	50	63
Andrews	4,379	4,554,489	48,171	50	48	5,336,408	55,691	50	56
Bailey	18,740	5,212,506	68,852	50	84	2,618,890	43,922	50	68
Borden	2,378	497,640	7,163	50	75	321,765	5,472	50	62
Briscoe	6,617	2,176,460	27,547	50	69	2,044,793	26,279	50	67
Castro	56,807	8,247,353	136,110	50	57	8,957,900	142,941	50	60
Cochran	13,217	2,988,223	41,952	50	65	2,813,001	40,265	50	63
Crosby	39,717	7,566,321	112,478	50	34	11,260,567	147,992	50	56
Dawson	58,228	7,495,371	130,315	50	57	7,869,022	133,892	50	60
Deaf Smith	47,633	9,311,469	137,182	50	70	7,560,719	120,332	50	63
Floyd	37,376	7,363,195	108,167	50	27	12,502,355	157,591	50	57
Gaines	75,996	10,479,352	176,767	50	84	10,389,421	175,894	50	84
Garza	8,321	878,049	16,767	50	39	1,131,780	19,203	50	53
Hale	66,033	7,607,930	139,198	50	60	8,480,209	147,574	50	64
Hockley	43,392	3,900,080	80,926	50	43	5,924,473	100,358	50	63
Howard	4,103	1,929,335	22,658	50	49	2,316,232	26,375	50	58
Lamb	67,444	6,640,665	131,313	50	61	7,674,973	141,241	50	66
Lubbock	58,906	5,540,614	112,181	50	51	6,922,832	125,471	50	61
Lynn	65,012	4,026,482	103,729	50	54	5,425,019	117,176	50	66
Martin	7,131	4,714,059	52,459	50	27	7,274,361	77,077	50	53
Parmer	39,460	7,290,108	109,557	50	89	2,994,521	68,253	50	73
Swisher	32,670	5,374,834	84,351	50	43	7,493,088	104,719	50	59
Terry	66,655	4,599,524	110,881	50	67	5,265,423	117,284	50	71
Yoakum	29,479	4,623,002	73,931	50	94	2,152,561	50,177	50	87

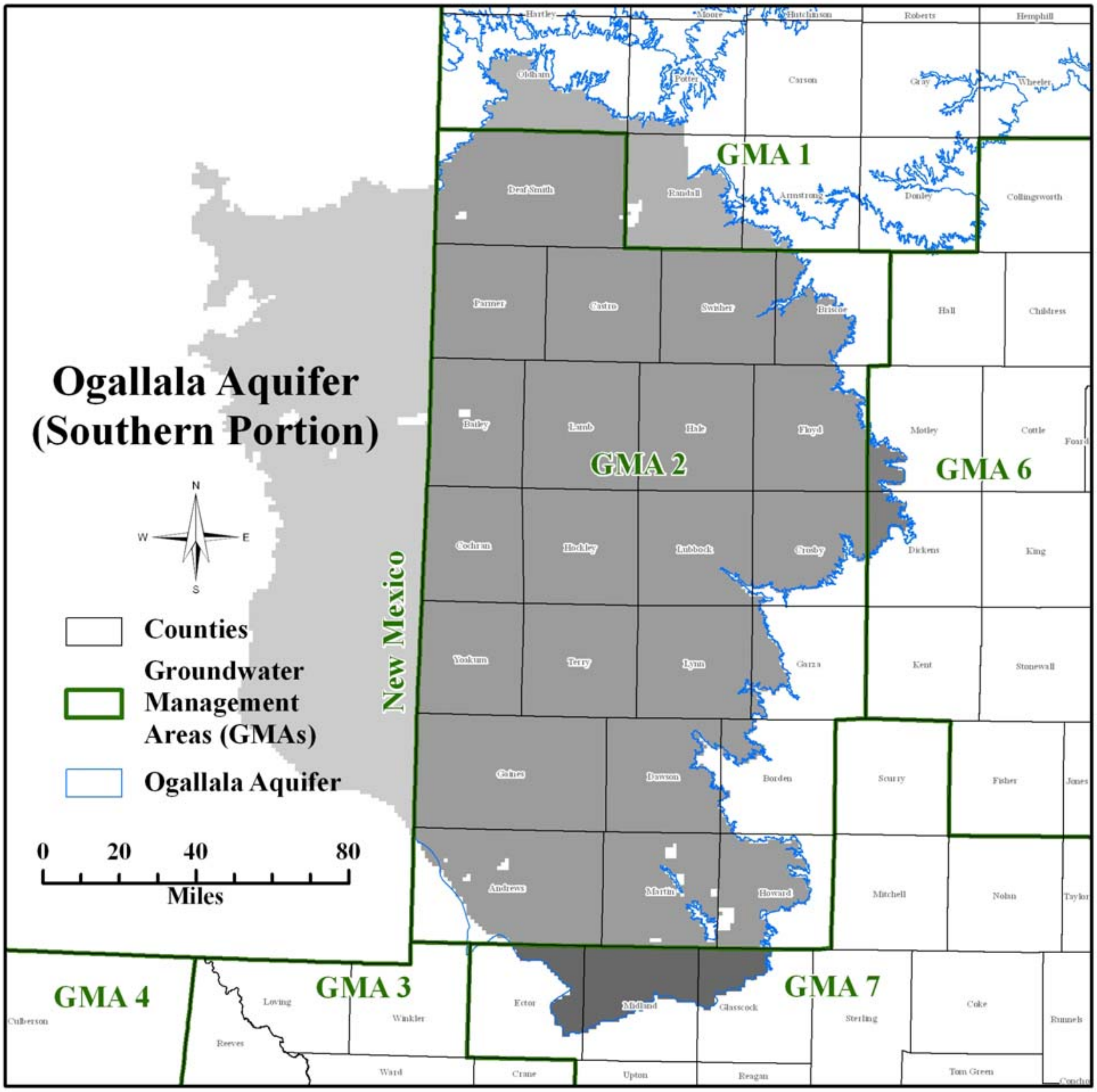


Figure 1. Location map showing model grid cells representing the southern portion of the Ogallala Aquifer, groundwater management areas, and the Ogallala Aquifer boundary.

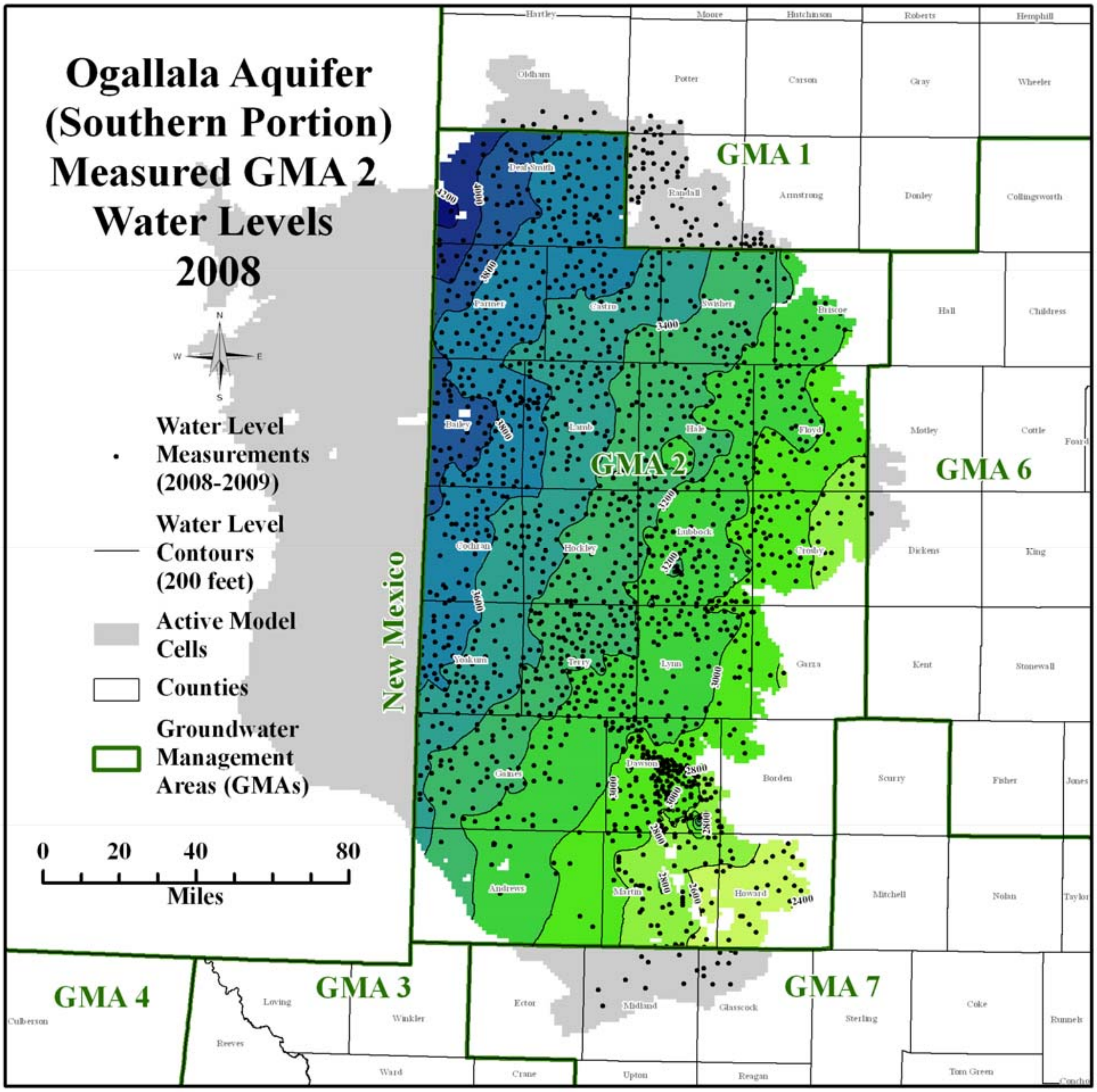


Figure 2. Water level measurements used to create a surface representing 2008 water levels and to estimate the initial Ogallala Aquifer volume within Groundwater Management Area 2.

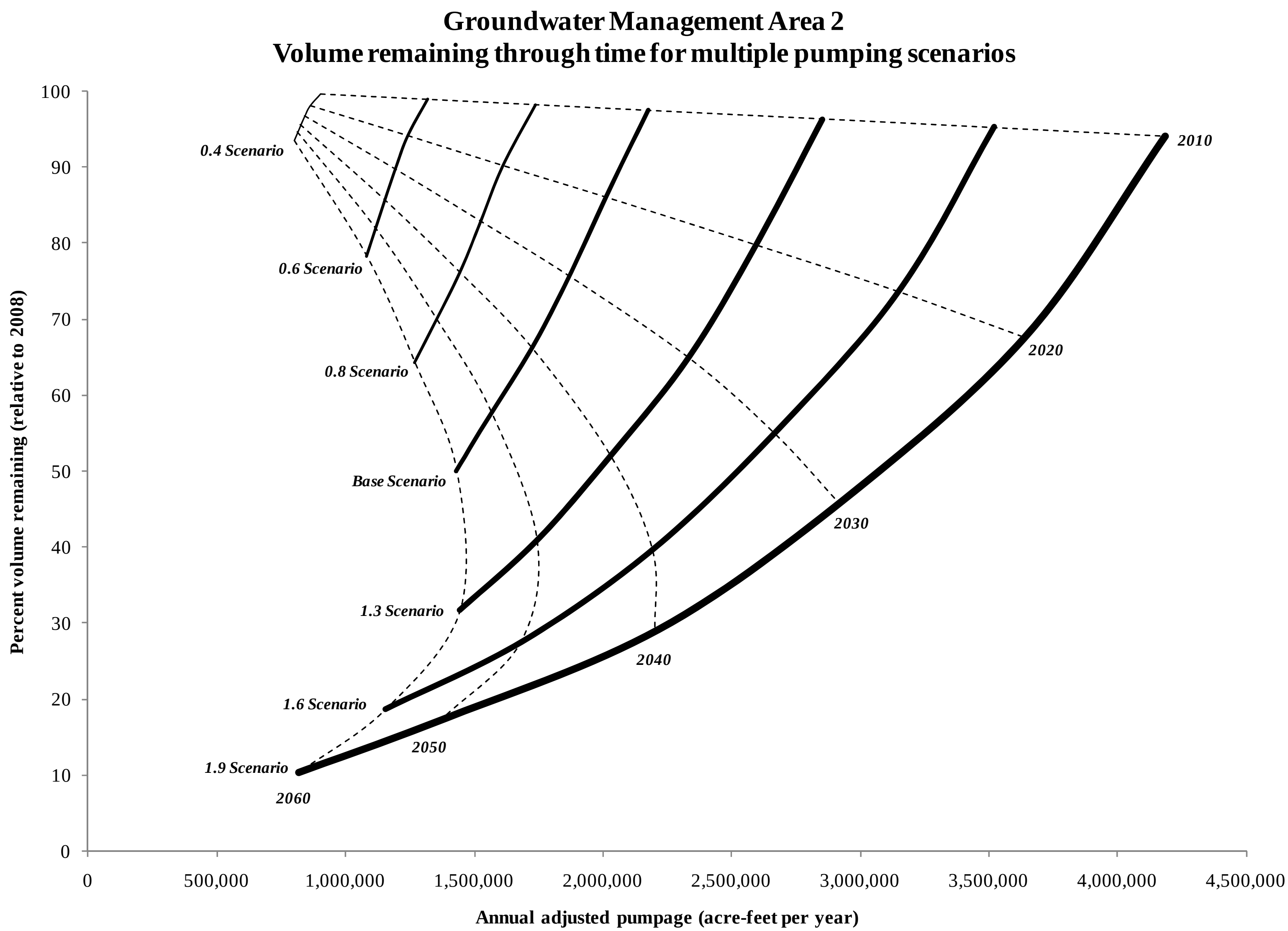


Figure 3. Percent of the Ogallala Aquifer volume remaining through time for each pumping scenario for Groundwater Management Area 2.

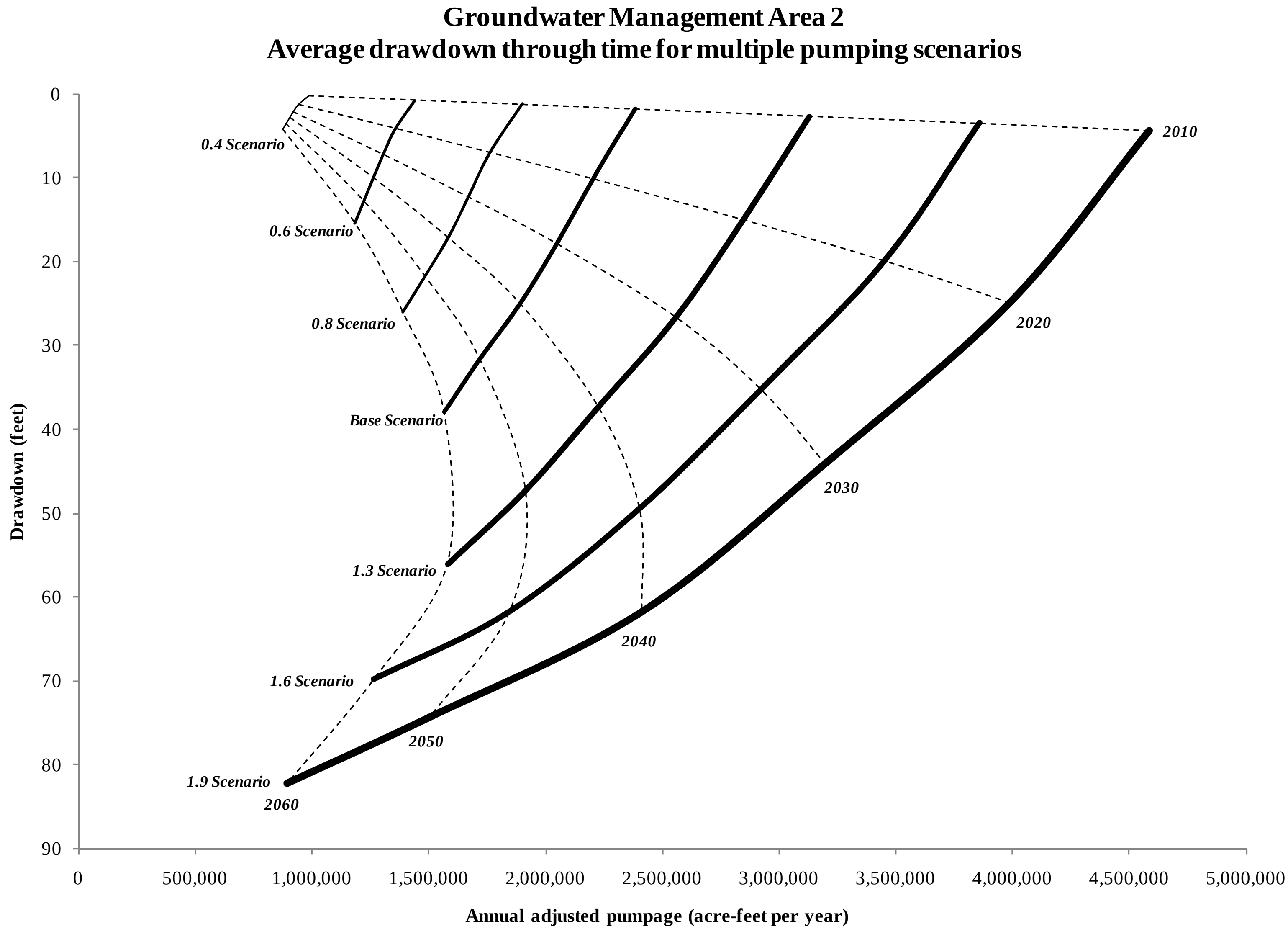


Figure 4. Average drawdown (decline in water levels) for the Ogallala Aquifer through time for each pumping scenario for Groundwater Management Area 2.

Appendix A

Pumping, remaining volume, and drawdown for each pumping scenario by decade

Table A-1. Pumping (reduced by an 8.7 percent correction factor), remaining volume, and average drawdown for the 0.4 pumping scenario (pumping decreased to 40 percent of the base pumping shown in Table 1) by decade for each county, groundwater conservation district, and groundwater management area in the model. Pumping is in acre-feet per year. Volume is a percent of the 2008 volume in the model. Drawdown is in feet.

Pumping 40 percent of base scenario	**Pumping reduced by 8.7 percent correction ractor**						**Percent volume remaining**						**Average drawdown**					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
County																		
Andrews	24,696	22,047	21,218	19,141	17,117	16,218	99	95	92	88	86	83	0	2	4	5	6	7
Armstrong	6,067	6,067	6,067	6,067	6,067	6,067	99	92	85	79	72	66	1	8	14	20	26	32
Bailey	22,923	20,340	18,550	16,554	15,527	14,604	99	97	96	95	94	94	0	1	1	1	1	1
Borden	1,975	1,975	1,975	1,975	1,975	1,975	100	101	103	104	105	107	0	-1	-1	-2	-3	-3
Briscoe	12,978	11,342	9,981	8,913	8,040	6,545	99	94	90	86	83	80	1	3	5	7	8	9
Castro	50,970	50,970	50,970	50,970	50,970	50,970	100	99	99	99	98	98	0	1	1	1	2	2
Cochran	11,535	9,890	8,768	7,391	7,013	6,739	100	100	100	101	102	103	0	0	0	-1	-1	-2
Crosby	54,269	54,269	54,269	54,269	54,269	54,269	100	98	96	94	92	90	1	4	7	10	13	16
Dawson	54,283	53,837	53,466	53,384	52,602	52,472	100	99	98	97	97	96	0	1	2	2	3	4
Deaf Smith	52,608	52,128	51,719	51,474	51,075	50,600	100	98	97	95	94	93	0	1	2	3	3	4
Dickens	3,083	3,083	3,083	3,083	3,083	3,083	100	98	97	95	94	93	0	2	4	5	7	8
Ector	1,907	1,371	1,371	1,371	1,260	1,260	100	98	97	95	93	92	0	1	1	2	3	3
Floyd	61,760	61,081	59,553	59,056	58,622	58,245	99	97	94	92	89	87	1	5	8	12	15	18
Gaines	114,316	86,472	76,571	70,897	65,695	60,509	99	90	84	80	76	72	1	6	10	13	15	18
Garza	7,559	7,559	7,559	7,559	7,559	7,559	100	101	102	103	103	104	0	-1	-1	-2	-3	-4
Glasscock	7,426	7,426	7,355	7,355	7,279	7,242	99	96	92	89	85	82	1	5	9	13	16	20
Hale	52,334	52,327	52,321	52,302	52,205	52,124	100	101	101	101	101	102	0	0	-1	-1	-1	-2
Hockley	38,852	38,712	38,599	38,599	38,471	38,471	100	100	99	99	99	99	0	0	0	1	1	1
Howard	11,492	11,174	10,696	10,437	9,980	9,318	99	96	92	89	86	83	0	2	4	5	7	9
Lamb	59,917	59,518	59,270	58,893	58,768	58,524	100	100	100	100	100	100	0	0	0	0	0	0
Lubbock	49,981	49,981	49,981	49,981	49,655	49,546	100	101	101	102	102	102	0	0	-1	-1	-1	-1
Lynn	42,221	42,198	42,198	42,198	42,198	42,198	100	102	104	106	108	110	0	-1	-3	-4	-5	-6
Martin	32,596	32,479	31,980	31,117	30,812	29,390	99	96	92	89	86	83	1	4	6	9	12	14
Midland	15,067	15,003	14,973	14,851	14,516	13,887	99	96	92	89	85	82	1	3	6	8	11	13
Motley	1,433	1,433	1,433	1,433	1,433	1,433	100	99	97	96	95	94	0	2	3	4	5	6
Oldham	4,207	3,357	3,141	2,942	2,942	2,942	100	99	98	97	96	95	0	1	1	1	2	2
Parmer	28,279	28,122	28,122	28,001	28,001	28,001	101	103	106	108	110	113	0	-1	-3	-4	-5	-6
Potter	4,950	2,982	1,980	1,091	764	764	97	84	77	72	69	67	2	9	12	13	14	15
Randall	48,215	47,501	46,515	45,299	42,756	40,377	99	92	85	79	74	69	1	5	9	13	16	19
Swisher	44,655	44,312	44,312	44,156	43,831	43,791	100	97	95	93	91	89	0	2	4	5	7	9
Terry	48,262	48,160	48,068	48,003	47,967	47,958	100	102	104	106	108	110	0	-1	-2	-4	-5	-6
Yoakum	23,574	21,623	20,510	19,588	19,454	19,139	100	101	103	104	106	108	0	0	-1	-2	-2	-3
District																		
Garza County UWCD	7,559	7,559	7,559	7,559	7,559	7,559	100	101	102	103	103	104	0	-1	-1	-2	-3	-4
Glasscock GCD	7,426	7,426	7,355	7,355	7,279	7,242	99	96	92	89	85	82	1	5	9	13	16	20
High Plains UWCD No. 1	576,648	567,894	560,707	553,975	548,200	543,361	100	99	98	97	96	95	0	1	2	3	3	4
Llano Estacado UWCD	114,316	86,472	76,571	70,897	65,695	60,509	99	90	84	80	76	72	1	6	10	13	15	18
Mesa UWCD	54,283	53,837	53,466	53,384	52,602	52,472	100	99	98	97	97	96	0	1	2	2	3	4
Panhandle GCD	147	147	147	147	147	147	99	98	97	95	94	93	1	1	2	3	3	4
Permian Basin UWCD	43,454	43,105	42,162	41,040	40,315	38,230	99	96	92	89	86	83	1	3	6	8	10	13
Sandy Land UWCD	23,574	21,623	20,510	19,588	19,454	19,139	100	101	103	104	106	108	0	0	-1	-2	-2	-3
South Plains UWCD	48,315	48,213	48,121	48,056	48,020	48,011	100	102	104	106	108	110	0	-1	-2	-3	-5	-6
Management Area																		
Out-of-State	76,367	65,085	55,689	48,816	43,548	39,876	100	98	97	96	95	94	0	1	1	1	1	2
GMA 1	63,440	59,908	57,703	55,398	52,530	50,150	99	93	89	84	80	76	1	4	7	9	11	13
GMA 2	902,035	860,519	840,656	824,860	811,808	799,164	100	98	97	96	95	94	0	1	2	3	4	4
GMA 6	4,516	4,516	4,516	4,516	4,516	4,516	100	98	97	96	95	93	0	2	3	5	6	7
GMA 7	24,401	23,800	23,699	23,577	23,056	22,390	99	96	93	89	86	83	1	3	5	8	10	12

Table A-2. Pumping (reduced by an 8.7 percent correction factor), remaining volume, and average drawdown for the 0.6 pumping scenario (pumping decreased to 60 percent of the base pumping shown in Table 1) by decade for each county, groundwater conservation district, and groundwater management area in the model. Pumping is in acre-feet per year. Volume is a percent of the 2008 volume in the model. Drawdown is in feet.

Pumping 60 percent of base scenario	Pumping reduced by 8.7 percent correction ractor						Percent volume remaining						Average drawdown					
	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
County																		
Andrews	36,935	33,791	31,218	28,560	27,675	26,013	99	92	86	81	76	71	1	4	6	9	11	14
Armstrong	6,067	6,067	6,067	6,067	6,067	6,067	99	92	85	79	72	66	1	8	14	20	26	32
Bailey	33,717	25,957	19,922	18,344	16,756	15,185	99	93	90	87	85	84	1	2	3	4	4	5
Borden	2,982	2,982	2,982	2,982	2,982	2,982	100	97	94	92	89	87	0	2	3	5	6	8
Briscoe	19,049	14,710	11,136	6,928	5,154	3,601	98	91	85	81	79	77	1	4	7	8	9	9
Castro	76,455	76,455	76,455	76,455	76,327	76,267	99	96	92	89	85	81	1	4	7	10	14	17
Cochran	17,303	10,138	8,901	8,150	7,026	6,989	99	98	98	98	98	99	0	0	0	0	0	-1
Crosby	81,390	81,390	81,390	81,390	81,362	81,362	99	95	90	86	81	77	2	9	16	24	31	38
Dawson	77,714	77,220	76,779	75,906	75,138	74,248	99	95	91	87	84	80	1	5	8	12	15	19
Deaf Smith	78,552	75,834	73,086	70,831	68,096	65,736	99	94	89	84	80	76	1	3	6	9	11	14
Dickens	3,083	3,083	3,083	3,083	3,083	3,083	100	98	97	95	93	92	0	2	4	6	8	10
Ector	4,047	3,457	3,457	3,328	3,146	2,892	99	95	91	86	82	78	0	2	4	6	7	9
Floyd	92,809	89,684	88,599	87,115	84,376	81,392	99	94	88	83	79	74	2	9	16	23	29	36
Gaines	143,012	109,150	90,007	77,975	67,569	60,711	98	87	79	72	67	63	2	9	14	18	21	24
Garza	11,406	11,406	11,406	11,258	11,258	11,258	99	96	94	91	88	86	1	3	5	8	10	12
Glasscock	12,209	12,086	11,960	11,775	11,715	11,188	99	93	87	81	76	70	1	8	15	21	28	34
Hale	78,502	78,487	78,284	78,175	77,955	77,642	99	97	93	90	87	83	0	3	6	9	12	15
Hockley	58,069	57,109	56,199	54,961	54,084	52,924	99	95	92	88	85	82	1	3	5	8	10	12
Howard	18,048	16,982	15,805	15,107	13,709	12,927	99	92	86	80	75	70	1	4	7	10	13	16
Lamb	89,277	87,186	85,876	83,875	80,964	79,134	99	95	91	87	83	80	1	4	7	10	12	15
Lubbock	74,971	74,541	72,995	72,540	72,010	71,292	99	96	93	90	86	83	1	3	6	9	11	14
Lynn	63,373	63,373	63,253	63,206	63,112	62,560	100	97	95	93	91	89	0	2	3	5	6	7
Martin	48,894	48,597	48,000	46,382	43,604	41,967	99	93	87	82	76	71	1	6	11	16	21	25
Midland	23,150	23,005	22,411	22,048	21,087	20,344	99	93	87	81	76	71	1	5	9	14	18	21
Motley	1,433	1,433	1,433	1,433	1,433	1,433	100	99	97	96	95	93	0	2	3	4	6	7
Oldham	4,207	3,357	3,141	2,942	2,942	2,551	100	99	98	97	96	95	0	1	1	1	2	2
Parmer	41,818	40,614	39,615	38,758	38,300	37,673	100	97	95	92	90	88	0	1	2	3	4	5
Potter	4,950	2,982	1,980	1,091	764	764	97	84	77	72	69	67	2	9	12	13	14	15
Randall	48,215	47,501	46,515	45,299	42,756	40,141	99	92	85	79	73	68	1	5	9	13	16	19
Swisher	66,861	65,602	64,961	62,780	60,102	55,854	99	94	89	84	79	74	1	5	9	13	17	20
Terry	71,340	70,796	70,698	70,197	69,717	66,424	99	97	94	91	88	86	0	2	4	5	6	7
Yoakum	33,687	27,983	25,239	20,832	19,239	18,076	99	96	93	92	91	91	0	1	2	1	1	1
District																		
Garza County UWCD	11,406	11,406	11,406	11,258	11,258	11,258	99	96	94	91	88	86	1	3	5	8	10	12
Glasscock GCD	12,209	12,086	11,960	11,775	11,715	11,188	99	93	87	81	76	70	1	8	15	21	28	34
High Plains UWCD No. 1	833,189	805,088	786,923	774,051	757,792	742,991	99	95	91	86	83	79	1	4	8	11	14	17
Llano Estacado UWCD	143,012	109,150	90,007	77,975	67,569	60,711	98	87	79	72	67	63	2	9	14	18	21	24
Mesa UWCD	77,714	77,220	76,779	75,906	75,138	74,248	99	95	91	87	84	80	1	5	8	12	15	19
Panhandle GCD	147	147	147	147	147	147	99	98	97	95	94	93	1	1	2	3	3	4
Permian Basin UWCD	66,002	64,751	63,025	60,759	56,671	54,287	99	93	87	81	76	71	1	5	10	14	18	22
Sandy Land UWCD	33,687	27,983	25,239	20,832	19,239	18,076	99	96	93	92	91	91	0	1	2	1	1	1
South Plains UWCD	71,419	70,875	70,777	70,276	69,796	66,504	99	97	94	91	89	86	0	2	4	5	6	7
Management Area																		
Out-of-State	76,367	65,085	55,689	49,090	43,176	39,876	100	98	97	96	95	94	0	1	1	1	1	2
GMA 1	63,440	59,908	57,703	55,398	52,530	49,524	99	93	88	84	80	76	1	4	7	9	11	13
GMA 2	1,316,163	1,239,989	1,192,806	1,152,708	1,116,516	1,082,217	99	94	90	86	82	78	1	4	7	10	13	15
GMA 6	4,516	4,516	4,516	4,516	4,516	4,516	100	98	97	95	94	92	0	2	3	5	7	9
GMA 7	39,405	38,549	37,828	37,151	35,948	34,424	99	93	87	82	77	72	1	5	9	13	17	21

Table A-3. Pumping (reduced by an 8.7 percent correction factor), remaining volume, and average drawdown for the 0.8 pumping scenario (pumping decreased to 80 percent of the base pumping shown in Table 1) by decade for each county, groundwater conservation district, and groundwater management area in the model. Pumping is in acre-feet per year. Volume is a percent of the 2008 volume in the model. Drawdown is in feet.

Pumping 80 percent of base scenario	**Pumping reduced by 8.7 percent correction ractor**						**Percent volume remaining**						**Average drawdown**					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
County																		
Andrews	49,118	45,033	41,727	38,074	35,765	32,624	98	89	81	73	66	60	1	5	9	13	16	20
Armstrong	6,067	6,067	6,067	6,067	6,067	6,067	99	92	85	78	72	66	1	8	14	20	27	32
Bailey	43,688	27,218	23,022	19,338	17,088	13,494	98	90	85	81	78	76	1	3	5	5	6	6
Borden	3,989	3,989	3,989	3,924	3,860	3,860	99	93	86	80	74	67	1	4	8	12	15	19
Briscoe	26,307	20,543	15,717	10,935	8,832	8,172	97	87	78	72	68	64	1	7	11	13	15	17
Castro	101,941	101,941	101,845	101,323	100,939	100,594	99	92	85	78	72	65	1	7	14	20	26	32
Cochran	26,796	16,518	14,967	14,246	13,284	12,659	99	94	92	90	88	86	1	2	3	4	4	5
Crosby	108,486	108,381	108,381	108,381	108,381	108,381	99	91	84	77	70	63	2	14	26	37	49	61
Dawson	101,143	100,229	99,692	98,149	96,227	92,424	98	91	84	77	71	65	2	9	15	21	28	33
Deaf Smith	104,344	97,512	91,465	86,494	80,721	75,532	98	90	82	74	67	61	1	6	10	15	19	22
Dickens	3,083	3,083	3,083	3,083	3,083	3,083	100	98	96	94	92	90	0	2	5	7	9	12
Ector	6,356	5,742	5,694	5,311	5,008	5,008	98	91	84	77	70	64	1	4	7	10	13	16
Floyd	124,263	119,982	117,786	113,909	108,457	103,980	98	90	83	75	68	62	2	13	24	35	45	55
Gaines	171,815	124,824	97,403	79,349	67,050	56,604	97	83	74	67	61	57	2	11	17	21	25	28
Garza	15,252	15,252	15,049	15,049	15,049	14,643	99	92	86	79	73	68	1	7	12	18	23	27
Glasscock	16,991	16,818	16,380	16,209	15,314	13,612	98	90	82	74	66	59	2	11	21	30	39	48
Hale	104,489	104,133	103,602	102,924	101,688	100,501	99	92	86	79	72	66	1	7	13	19	25	31
Hockley	77,476	75,317	71,665	69,744	65,678	60,479	98	91	84	78	72	66	1	6	10	14	18	21
Howard	24,538	22,149	20,373	18,288	16,366	14,759	98	88	80	72	65	59	1	6	10	15	20	24
Lamb	118,537	113,299	106,586	102,564	95,816	88,426	98	90	82	75	69	63	1	8	13	19	24	28
Lubbock	99,809	97,268	95,303	93,580	89,142	84,474	99	92	85	78	72	66	1	7	12	18	23	28
Lynn	84,548	84,331	84,259	83,707	82,597	77,461	99	92	86	80	74	69	1	5	9	13	17	19
Martin	65,070	64,762	62,436	59,984	55,855	51,923	98	90	82	74	67	60	1	9	16	23	29	35
Midland	31,161	30,808	29,877	28,430	27,265	26,247	98	90	82	74	67	60	1	7	13	19	24	30
Motley	1,433	1,433	1,433	1,433	1,433	1,433	100	98	97	95	93	91	0	2	4	5	7	10
Oldham	4,207	3,357	3,141	2,942	2,942	2,551	100	99	98	97	96	95	0	1	1	1	2	2
Parmer	55,443	51,818	49,344	46,776	43,686	41,662	99	91	84	78	72	67	1	4	7	9	12	14
Potter	4,950	2,982	1,980	1,091	764	764	97	84	77	72	69	67	2	9	12	13	14	15
Randall	48,215	47,501	46,411	45,299	42,529	39,803	99	92	85	79	73	68	1	5	9	13	16	19
Swisher	89,148	86,696	82,904	73,435	62,330	55,959	98	90	82	75	68	63	1	8	15	20	24	28
Terry	94,401	93,725	92,233	83,215	68,500	56,852	98	91	83	77	71	68	1	5	9	13	14	14
Yoakum	44,580	34,789	24,947	21,166	16,933	13,933	98	90	85	82	80	79	1	3	3	4	3	3
District																		
Garza County UWCD	15,252	15,252	15,049	15,049	15,049	14,643	99	92	86	79	73	68	1	7	12	18	23	27
Glasscock GCD	16,991	16,818	16,380	16,209	15,314	13,612	98	90	82	74	66	59	2	11	21	30	39	48
High Plains UWCD No. 1	1,088,868	1,034,250	1,002,692	975,472	937,045	894,581	98	91	83	77	70	64	1	7	13	19	25	30
Llano Estacado UWCD	171,815	124,824	97,403	79,349	67,050	56,604	97	83	74	67	61	57	2	11	17	21	25	28
Mesa UWCD	101,143	100,229	99,692	98,149	96,227	92,424	98	91	84	77	71	65	2	9	15	21	28	33
Panhandle GCD	147	147	147	147	147	147	99	98	96	95	94	93	1	1	2	3	4	5
Permian Basin UWCD	88,362	85,863	81,826	77,405	71,492	66,024	98	90	81	74	67	60	1	8	14	20	26	32
Sandy Land UWCD	44,580	34,789	24,947	21,166	16,933	13,933	98	90	85	82	80	79	1	3	3	4	3	3
South Plains UWCD	94,641	93,965	92,472	83,454	68,740	57,091	98	91	84	77	72	68	1	5	9	13	14	14
Management Area																		
Out-of-State	76,367	65,085	55,689	49,005	43,016	39,852	100	98	97	96	95	94	0	1	1	1	1	2
GMA 1	63,440	59,908	57,600	55,398	52,303	49,185	99	93	88	84	79	75	1	4	7	9	12	14
GMA 2	1,735,181	1,609,707	1,524,694	1,444,554	1,354,242	1,269,395	98	90	83	76	70	64	1	7	12	17	22	26
GMA 6	4,516	4,516	4,516	4,516	4,516	4,516	100	98	96	94	92	90	0	2	4	6	8	11
GMA 7	54,508	53,368	51,951	49,949	47,586	44,866	98	90	82	75	67	60	1	7	13	19	25	30

Table A-4. Pumping (reduced by an 8.7 percent correction factor), remaining volume, and average drawdown for the 1.3 pumping scenario (pumping increased to 130 percent of the base pumping shown in Table 1) by decade for each county, groundwater conservation district, and groundwater management area in the model. Pumping is in acre-feet per year. Volume is a percent of the 2008 volume in the model. Drawdown is in feet.

Pumping 130 percent of base scenario	Pumping reduced by 8.7 percent correction ractor						Percent volume remaining						Average drawdown					
	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
County																		
Andrews	79,307	71,566	64,044	56,237	48,374	38,797	97	82	69	57	46	37	1	9	16	23	29	36
Armstrong	6,067	6,067	6,067	6,067	6,067	6,067	99	91	84	76	69	61	1	8	15	22	29	36
Bailey	99,821	67,628	53,518	35,510	23,331	15,293	93	65	44	30	20	14	3	14	25	35	43	52
Borden	6,507	6,507	6,133	5,560	4,975	4,867	97	82	67	52	39	28	2	10	19	28	36	44
Briscoe	44,612	34,464	24,493	20,016	16,671	13,358	96	76	61	50	41	33	2	13	21	28	36	43
Castro	165,654	164,784	162,440	155,573	143,145	121,093	97	83	68	54	41	30	3	16	29	42	54	63
Cochran	80,773	64,682	54,081	40,669	29,774	20,922	94	71	51	36	24	16	2	13	22	31	40	48
Crosby	176,226	175,927	175,927	175,927	175,777	162,952	97	84	70	57	43	30	5	27	50	72	94	115
Dawson	159,716	157,946	153,380	147,201	131,539	116,198	96	81	67	53	40	29	4	18	32	46	58	70
Deaf Smith	167,641	143,365	123,833	93,906	71,463	59,666	96	80	66	54	46	39	2	12	20	26	29	33
Dickens	3,083	3,083	3,083	3,083	3,083	3,083	100	97	95	92	89	85	0	3	6	9	13	17
Ector	12,128	11,345	10,732	10,253	9,516	8,211	97	82	68	55	42	31	1	8	14	20	26	32
Floyd	202,896	194,775	184,880	169,247	156,976	143,024	97	82	69	56	44	34	4	25	45	65	84	103
Gaines	245,370	178,923	137,082	107,885	88,459	73,234	95	74	60	50	41	35	4	18	28	35	42	47
Garza	24,868	24,525	24,354	23,327	20,703	17,158	97	81	66	51	38	27	3	16	29	42	53	63
Glasscock	28,947	28,045	27,151	22,762	17,989	15,145	97	83	69	57	47	39	3	20	36	51	67	82
Hale	169,501	167,652	161,389	147,153	126,763	105,715	97	82	68	54	41	31	2	15	29	41	53	64
Hockley	126,218	120,264	115,170	102,846	84,901	69,030	97	81	65	51	39	29	2	13	23	32	40	47
Howard	40,836	33,789	27,305	23,396	20,184	17,688	96	80	67	56	47	38	2	10	19	27	35	43
Lamb	189,862	169,331	139,486	113,225	90,866	63,251	96	79	64	52	43	37	3	17	28	36	42	42
Lubbock	162,397	153,220	141,912	127,646	106,705	82,912	97	80	65	51	40	31	3	16	29	41	51	57
Lynn	137,485	137,008	132,651	117,960	101,125	80,910	97	80	63	49	36	26	2	13	24	33	41	47
Martin	105,391	103,658	96,702	84,782	76,417	65,490	97	83	69	57	46	36	3	15	27	39	50	61
Midland	51,223	49,372	46,419	42,701	39,778	35,028	97	83	70	58	46	36	2	12	22	32	42	51
Motley	1,433	1,433	1,433	1,433	1,433	1,433	100	98	96	93	90	87	0	2	5	8	11	14
Oldham	4,207	3,357	3,141	2,942	2,942	2,551	100	99	98	97	96	95	0	1	1	2	2	2
Parmer	88,226	75,908	63,282	52,667	41,746	31,879	96	78	62	50	40	33	2	10	17	22	26	28
Potter	4,950	2,982	1,980	1,091	764	764	97	84	77	72	69	67	2	9	12	13	14	15
Randall	48,444	47,501	46,411	45,299	42,365	39,566	99	91	85	78	72	66	1	5	10	14	17	20
Swisher	144,413	138,519	121,630	102,906	85,519	66,972	97	80	65	53	42	33	3	16	28	39	47	54
Terry	151,642	149,542	125,070	91,954	73,302	54,079	96	77	59	45	35	28	2	14	23	30	36	39
Yoakum	85,079	61,618	44,318	33,666	25,752	19,057	94	67	49	35	26	19	2	10	16	21	25	29
District																		
Garza County UWCD	24,868	24,525	24,354	23,327	20,703	17,158	97	81	66	51	38	27	3	16	29	42	53	63
Glasscock GCD	28,947	28,045	27,151	22,762	17,989	15,145	97	83	69	57	47	39	3	20	36	51	67	82
High Plains UWCD No. 1	1,782,086	1,647,898	1,520,850	1,343,579	1,161,446	964,265	97	80	65	52	40	30	3	16	29	42	53	63
Llano Estacado UWCD	245,370	178,923	137,082	107,885	88,459	73,234	95	74	60	50	41	35	4	18	28	35	42	47
Mesa UWCD	159,716	157,946	153,380	147,201	131,539	116,198	96	81	67	53	40	29	4	18	32	46	58	70
Panhandle GCD	147	147	147	147	147	147	99	97	96	94	93	91	1	2	3	4	5	6
Permian Basin UWCD	144,215	135,830	122,812	107,279	96,192	82,770	97	82	69	57	46	37	2	13	25	35	46	56
Sandy Land UWCD	85,079	61,618	44,318	33,666	25,752	19,057	94	67	49	35	26	19	2	10	16	21	25	29
South Plains UWCD	152,873	150,773	126,301	93,184	74,533	55,310	96	77	59	46	36	28	2	13	23	30	35	39
Management Area																		
Out-of-State	76,546	64,864	55,689	48,558	42,882	39,316	100	98	97	95	95	94	0	1	1	1	1	2
GMA 1	63,669	59,908	57,600	55,398	52,139	48,948	99	93	88	83	78	74	1	4	7	10	12	14
GMA 2	2,854,440	2,595,599	2,333,080	2,029,256	1,744,465	1,443,545	96	80	65	52	41	32	3	15	27	37	47	56
GMA 6	4,516	4,516	4,516	4,516	4,516	4,516	100	98	95	92	89	86	0	3	5	9	12	16
GMA 7	92,298	88,761	84,302	75,716	67,282	58,385	97	83	69	57	46	36	2	13	23	33	42	52

Table A-5. Pumping (reduced by an 8.7 percent correction factor), remaining volume, and average drawdown for the 1.6 pumping scenario (pumping increased to 160 percent of the base pumping shown in Table 1) by decade for each county, groundwater conservation district, and groundwater management area in the model. Pumping is in acre-feet per year. Volume is a percent of the 2008 volume in the model. Drawdown is in feet.

Pumping 160 percent of base scenario	Pumping reduced by 8.7 percent correction ractor						Percent volume remaining						Average drawdown					
	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
County																		
Andrews	97,487	86,029	74,222	63,607	48,049	37,358	96	78	62	48	36	28	2	11	20	29	37	45
Armstrong	6,067	6,067	6,067	6,067	6,067	6,067	99	91	83	75	67	59	1	9	16	24	31	38
Bailey	134,280	86,293	47,578	25,393	14,030	7,471	90	51	26	14	7	3	4	22	40	55	68	75
Borden	8,018	7,883	7,021	6,439	5,752	3,650	96	75	56	38	23	12	2	14	26	38	48	59
Briscoe	55,596	42,004	29,638	22,107	16,725	13,435	94	70	52	39	28	21	3	16	27	38	48	58
Castro	203,881	201,287	195,709	175,502	133,263	79,461	96	77	58	41	27	17	3	21	38	54	66	69
Cochran	110,971	87,991	57,157	33,962	19,354	8,815	92	58	32	17	8	4	3	19	33	47	59	68
Crosby	216,870	216,454	216,454	215,830	199,679	108,790	96	79	62	44	27	15	6	35	64	93	121	137
Dawson	194,854	192,645	183,287	164,147	136,509	78,954	95	75	56	39	24	14	5	24	42	60	76	89
Deaf Smith	203,417	169,410	129,147	93,678	72,930	56,150	95	74	57	45	36	29	3	15	26	32	38	41
Dickens	3,083	3,083	3,083	3,083	3,083	3,083	100	97	94	91	87	83	0	3	7	11	15	19
Ector	15,592	14,518	13,440	12,377	10,110	6,795	96	77	59	43	28	17	2	10	18	26	34	41
Floyd	249,552	237,829	218,942	198,227	173,633	150,702	96	78	61	45	32	20	5	32	57	83	108	134
Gaines	286,848	213,533	160,749	126,184	98,650	79,529	93	69	52	39	29	22	5	22	35	46	55	63
Garza	30,638	30,211	29,572	24,547	18,613	13,148	96	74	54	36	22	13	4	22	40	56	71	85
Glasscock	36,120	34,801	30,701	23,025	18,903	13,953	96	79	62	49	38	30	4	25	45	64	83	102
Hale	208,616	203,703	185,187	152,022	112,181	79,807	96	76	57	41	29	20	3	21	38	53	66	76
Hockley	155,464	147,167	136,846	111,032	81,735	55,005	96	74	54	37	23	13	3	17	30	42	53	61
Howard	50,038	39,943	30,630	25,254	20,747	18,034	96	76	60	48	38	29	2	13	23	34	44	53
Lamb	233,761	195,608	152,027	114,580	72,988	49,151	95	72	54	40	31	26	4	22	36	46	48	47
Lubbock	199,954	185,761	163,649	134,590	93,192	58,276	95	74	54	38	26	19	4	22	39	55	64	66
Lynn	169,248	167,505	152,473	123,603	85,553	52,534	95	72	50	32	19	11	3	18	32	44	54	62
Martin	129,695	125,127	111,997	96,676	79,924	66,874	96	78	62	47	35	25	3	19	34	49	63	78
Midland	63,296	60,124	54,929	49,789	42,695	34,110	96	79	63	48	36	25	3	15	28	40	52	63
Motley	1,433	1,433	1,433	1,433	1,433	1,433	100	98	95	92	89	85	0	3	6	9	13	17
Oldham	4,207	3,357	2,942	2,942	2,551	2,551	100	99	97	96	95	95	0	1	1	2	2	2
Parmer	108,155	88,098	66,888	47,794	31,695	20,345	95	70	51	38	29	23	2	13	22	27	30	30
Potter	4,950	2,982	1,980	1,091	764	764	97	84	77	72	69	67	2	9	12	13	14	15
Randall	48,215	47,501	46,411	45,299	42,365	39,341	99	91	84	78	71	66	1	5	10	14	17	20
Swisher	177,886	169,424	139,707	115,769	85,820	65,094	96	75	56	40	28	19	4	21	36	50	60	71
Terry	186,139	181,154	130,553	90,947	62,531	42,809	95	68	46	30	20	12	3	19	31	40	48	55
Yoakum	108,419	74,811	47,211	29,426	17,070	9,705	91	55	32	18	10	5	3	14	23	31	38	43
District																		
Garza County UWCD	30,638	30,211	29,572	24,547	18,613	13,148	96	74	54	36	22	13	4	22	40	56	71	85
Glasscock GCD	36,120	34,801	30,701	23,025	18,903	13,953	96	79	62	49	38	30	4	25	45	64	83	102
High Plains UWCD No. 1	2,188,490	1,981,343	1,716,194	1,420,866	1,086,263	726,008	95	74	55	39	27	18	4	22	39	55	68	75
Llano Estacado UWCD	286,848	213,533	160,749	126,184	98,650	79,529	93	69	52	39	29	22	5	22	35	46	55	63
Mesa UWCD	194,854	192,645	183,287	164,147	136,509	78,954	95	75	56	39	24	14	5	24	42	60	76	89
Panhandle GCD	147	147	147	147	147	147	99	97	96	94	92	90	1	2	3	4	5	6
Permian Basin UWCD	177,369	163,180	141,280	121,421	100,261	84,498	96	78	62	48	36	26	3	17	31	45	58	71
Sandy Land UWCD	108,419	74,811	47,211	29,426	17,070	9,705	91	55	32	18	10	5	3	14	23	31	38	43
South Plains UWCD	187,965	182,980	132,379	92,773	64,356	44,454	95	69	46	31	20	13	3	18	31	40	48	55
Management Area																		
Out-of-State	76,367	64,864	55,689	48,424	42,849	38,911	100	98	96	95	95	94	0	1	1	1	1	2
GMA 1	63,440	59,908	57,400	55,398	51,747	48,723	99	93	88	83	78	73	1	4	7	10	12	15
GMA 2	3,519,787	3,149,870	2,666,644	2,191,316	1,680,623	1,155,097	95	74	55	40	27	19	3	20	35	49	62	70
GMA 6	4,516	4,516	4,516	4,516	4,516	4,516	100	97	94	91	88	84	0	3	6	10	14	18
GMA 7	115,008	109,443	99,070	85,192	71,708	54,858	96	79	62	48	35	26	3	16	29	41	53	65

Table A-6. Pumping (reduced by an 8.7 percent correction factor), remaining volume, and average drawdown for the 1.9 pumping scenario (pumping increased to 190 percent of the base pumping shown in Table 1) by decade for each county, groundwater conservation district, and groundwater management area in the model. Pumping is in acre-feet per year. Volume is a percent of the 2008 volume in the model. Drawdown is in feet.

Pumping 190 percent of base scenario	Pumping reduced by 8.7 percent correction ractor						Percent volume remaining						Average drawdown					
	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060	2010	2020	2030	2040	2050	2060
County																		
Andrews	115,038	100,445	82,492	65,620	45,725	33,431	95	74	55	40	29	21	2	13	24	35	44	54
Armstrong	6,067	6,067	6,067	6,067	6,067	6,067	98	91	82	74	66	58	1	9	17	25	32	40
Bailey	169,107	91,502	40,682	16,149	5,664	840	87	39	16	6	2	1	5	30	54	71	76	56
Borden	9,529	8,995	8,009	7,026	4,042	1,930	95	69	46	25	11	4	3	18	33	47	62	81
Briscoe	65,613	48,948	31,478	22,099	16,547	12,250	93	64	43	29	19	12	4	20	34	47	60	71
Castro	242,120	238,106	221,783	181,619	99,036	58,921	95	72	49	29	16	9	4	26	47	66	74	80
Cochran	140,047	100,314	50,523	23,837	7,787	2,532	89	46	20	7	2	1	4	25	45	62	73	83
Crosby	256,982	256,982	256,715	250,800	147,734	62,218	96	74	53	32	14	6	7	43	78	114	142	163
Dawson	229,991	222,637	206,604	172,574	84,639	40,105	94	69	46	27	13	7	6	29	52	74	90	98
Deaf Smith	239,254	194,120	142,771	101,588	74,518	51,435	94	69	49	35	25	17	3	20	34	44	52	56
Dickens	3,083	3,083	3,083	3,083	3,083	3,083	100	97	93	90	86	82	0	4	8	12	17	21
Ector	19,055	17,763	16,084	13,426	8,451	5,280	95	72	50	31	17	8	2	12	22	32	41	49
Floyd	296,375	277,567	247,256	213,372	179,857	125,049	95	73	53	35	21	9	7	38	70	101	134	166
Gaines	330,947	246,931	182,075	133,700	100,249	64,922	92	64	44	29	19	12	6	26	43	56	68	76
Garza	36,407	35,642	31,740	23,614	14,475	8,523	95	68	43	23	11	4	5	27	49	70	88	110
Glasscock	43,068	41,259	33,253	23,332	17,472	14,334	96	74	55	42	31	23	5	30	53	77	100	122
Hale	247,360	238,110	196,938	139,786	90,943	57,318	95	70	48	31	20	13	4	26	46	62	74	83
Hockley	184,323	172,295	150,742	111,609	63,137	31,717	95	68	44	24	11	4	4	21	38	53	65	77
Howard	59,491	44,831	34,074	26,748	21,668	16,639	95	71	54	41	30	21	3	16	28	40	52	63
Lamb	279,509	225,447	167,671	114,297	60,362	43,467	94	65	43	28	19	14	5	28	46	59	62	67
Lubbock	237,129	212,367	176,793	124,746	65,302	31,821	94	67	44	26	17	13	5	27	49	66	71	59
Lynn	201,010	196,768	161,530	109,321	51,979	28,097	94	65	38	19	9	4	4	23	40	55	66	79
Martin	153,666	144,672	126,488	104,679	80,997	57,808	96	74	55	39	26	16	4	23	41	59	76	93
Midland	75,370	70,343	62,728	54,588	41,789	31,528	96	75	56	40	26	16	3	18	33	48	61	73
Motley	1,433	1,433	1,433	1,433	1,433	1,433	100	97	94	91	87	83	0	3	6	10	14	18
Oldham	4,207	3,357	2,942	2,942	2,551	2,551	100	98	97	96	95	94	0	1	1	2	2	3
Parmer	126,361	95,582	67,251	38,285	22,436	13,537	93	64	42	29	22	19	3	16	26	31	31	30
Potter	4,950	2,982	1,980	1,091	764	764	97	84	77	72	69	67	2	9	12	13	14	15
Randall	48,215	47,501	46,411	45,299	42,365	39,341	99	91	84	77	71	65	1	6	10	14	18	21
Swisher	211,044	197,217	159,180	120,371	80,659	49,618	95	69	47	29	17	9	4	26	44	61	74	88
Terry	220,484	206,837	133,153	79,551	44,135	22,259	93	60	34	18	9	4	4	23	38	50	60	66
Yoakum	131,083	81,993	40,798	19,060	7,691	2,249	89	44	19	8	3	1	3	18	31	42	48	42
District																		
Garza County UWCD	36,407	35,642	31,740	23,614	14,475	8,523	95	68	43	23	11	4	5	27	49	70	88	110
Glasscock GCD	43,068	41,259	33,253	23,332	17,472	14,334	96	74	55	42	31	23	5	30	53	77	100	122
High Plains UWCD No. 1	2,583,209	2,266,062	1,850,958	1,401,358	855,313	500,712	94	68	46	29	18	11	5	27	48	67	79	83
Llano Estacado UWCD	330,947	246,931	182,075	133,700	100,249	64,922	92	64	44	29	19	12	6	26	43	56	68	76
Mesa UWCD	229,991	222,637	206,604	172,574	84,639	40,105	94	69	46	27	13	7	6	29	52	74	90	98
Panhandle GCD	147	147	147	147	147	147	99	97	95	93	91	89	1	2	3	4	5	7
Permian Basin UWCD	210,353	187,493	159,342	130,819	102,176	73,957	95	74	55	39	27	17	3	20	37	54	69	84
Sandy Land UWCD	131,083	81,993	40,798	19,060	7,691	2,249	89	44	19	8	3	1	3	18	31	42	48	42
South Plains UWCD	222,905	209,257	135,573	81,971	46,343	23,816	93	60	35	19	9	4	4	23	38	50	60	67
Management Area																		
Out-of-State	76,367	64,235	55,689	48,508	42,782	38,911	100	98	96	95	95	94	0	1	1	1	1	2
GMA 1	63,440	59,908	57,400	55,398	51,747	48,723	99	93	87	82	77	73	1	4	7	10	13	15
GMA 2	4,182,869	3,638,312	2,916,746	2,200,452	1,369,585	816,688	94	68	46	29	17	10	4	25	44	62	74	82
GMA 6	4,516	4,516	4,516	4,516	4,516	4,516	100	97	94	90	86	83	0	3	7	11	15	20
GMA 7	137,493	129,365	112,064	91,346	67,712	51,142	96	74	55	39	27	18	3	19	35	49	64	78

Appendix B

Water budgets for each stress period of the predictive groundwater availability model run

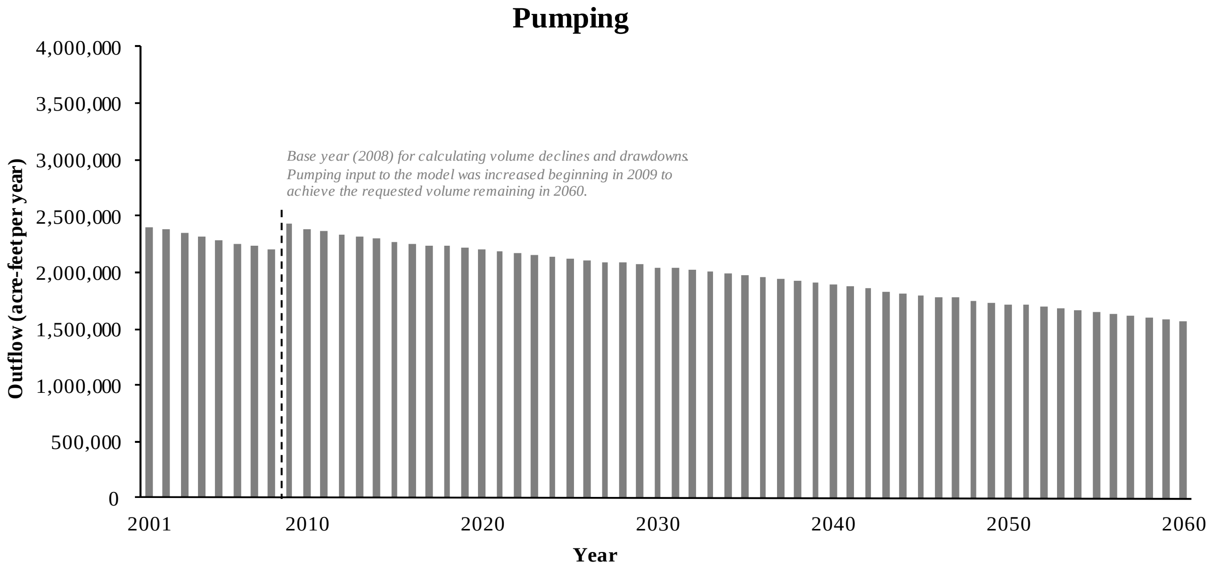


Figure B-1. Pumping output from the Ogallala Aquifer by year in the groundwater availability model for Groundwater Management Area 2. Note that these pumping values have not been adjusted using the 8.7 percent correction factor.

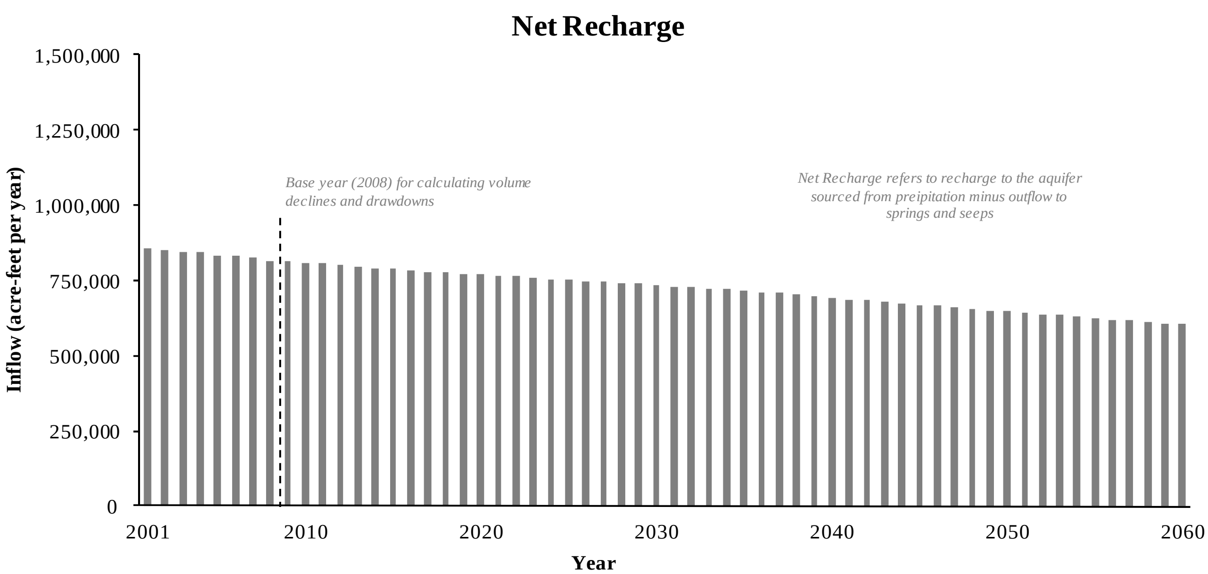


Figure B-2. Net recharge to the Ogallala Aquifer by year in the groundwater availability model for Groundwater Management Area 2. Note that net recharge refers to recharge to the aquifer sourced from precipitation minus outflow to springs and seeps.

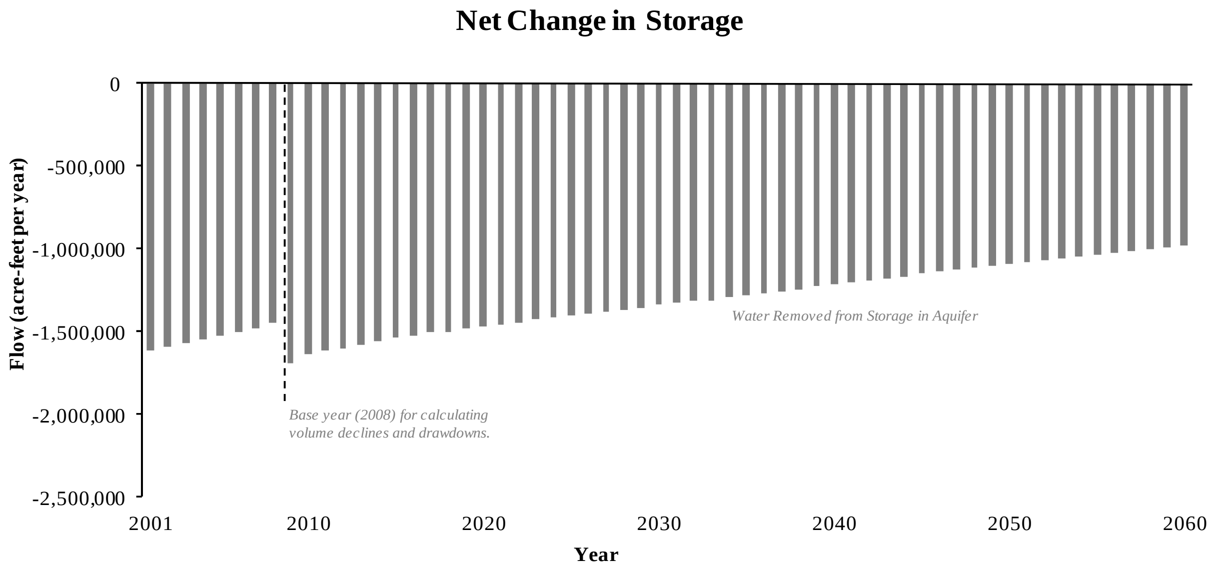


Figure B-3. Net change in storage (the volume of water stored in the aquifer) by year in the Ogallala Aquifer for Groundwater Management Area 2.

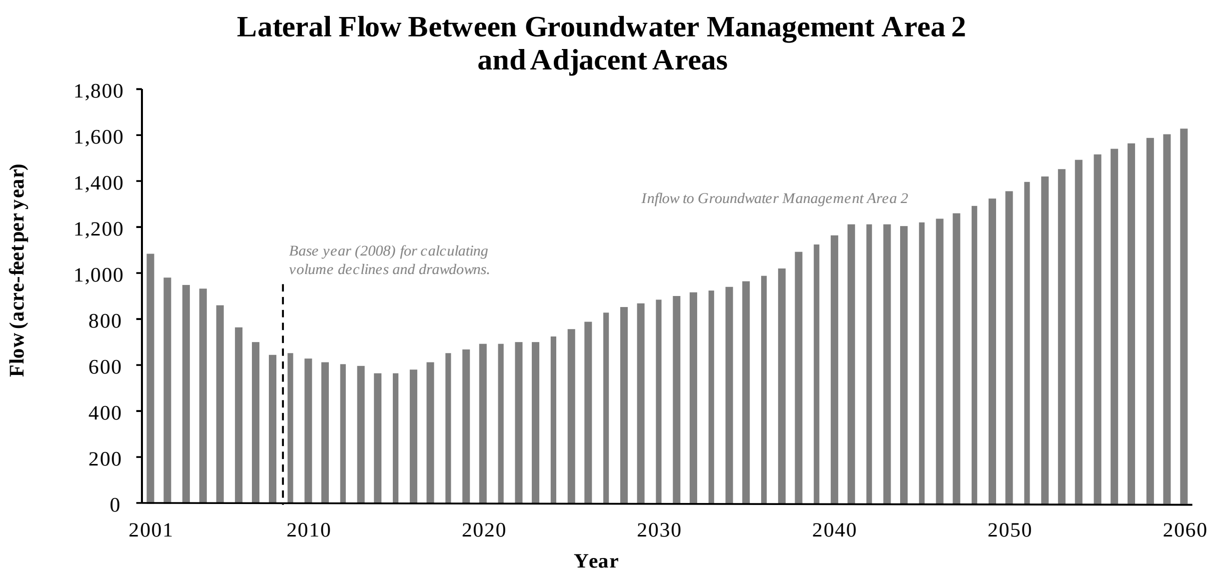


Figure B-4. Net lateral flow each year between Groundwater Management Area 2 and adjacent areas.

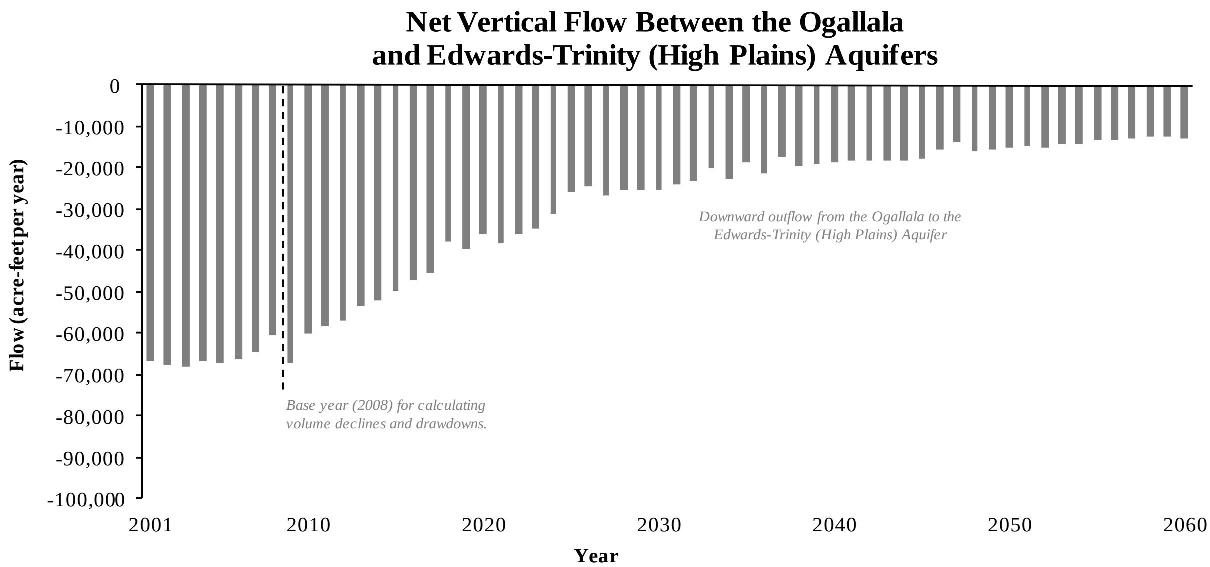


Figure B-5. Net vertical flow by year between the Ogallala and the underlying Edwards-Trinity (High Plains) aquifers for Groundwater Management Area 2.

Appendix C

Water budget tables by county, groundwater conservation district, and groundwater management area for the 2009-2060 predictive model run

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

	Andrews	Armstrong	Bailey	Borden	Briscoe	Castro	Cochran	Crosby	Dawson	Deaf Smith	Dickens	Ector	Floyd	Gaines	Garza	Glasscock
Inflow																
Constant Head	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wells	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Recharge	1,971	2,883	10,268	1,926	2,509	52,911	8,358	39,714	53,675	26,434	1,035	243	30,171	33,981	8,171	706
Multi-Node Wells	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vertical Leakage Lower	0	0	159	162	0	0	224	3	2,308	0	0	0	2,535	1,789	621	0
Lateral Flow	2,071	554	738	500	840	736	1,089	3,563	5,601	1,724	703	182	5,875	2,246	1,498	803
Total Inflow	*4,042*	*3,437*	*11,165*	*2,588*	*3,349*	*53,647*	*9,671*	*43,280*	*61,584*	*28,158*	*1,738*	*425*	*38,581*	*38,016*	*10,290*	*1,509*
Outflow																
Constant Head	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wells	40,016	6,646	23,471	4,505	13,076	129,246	27,837	148,301	109,059	72,984	3,377	7,368	136,799	52,650	18,651	16,284
Drains	143	753	0	648	1,473	0	0	1,929	1,217	50	1,492	0	1,387	972	593	206
Multi-Node Wells	0	0	0	0	0	0	0	0	5,164	0	0	0	0	12,973	0	0
Vertical Leakage Lower	0	0	442	53	0	0	454	3	4,128	0	0	0	1,163	11,207	75	0
Lateral Flow	2,012	74	435	114	751	3,711	859	552	3,490	686	244	417	2,394	6,075	0	146
Total Outflow	42,171	7,473	24,348	5,320	15,300	132,957	29,150	150,785	123,058	73,720	5,113	7,785	141,743	83,877	19,319	16,636
Inflow - Outflow	**-38,129**	**-4,036**	**-13,183**	**-2,732**	**-11,951**	**-79,310**	**-19,479**	**-107,505**	**-61,474**	**-45,562**	**-3,375**	**-7,360**	**-103,162**	**-45,861**	**-9,029**	**-15,127**
Storage Change	**-38,175**	**-4,038**	**-13,203**	**-2,733**	**-11,959**	**-79,320**	**-19,501**	**-107,507**	**-61,482**	**-45,563**	**-3,376**	**-7,367**	**-103,172**	**-45,870**	**-9,029**	**-15,128**
Model Error	**46**	**2**	**20**	**1**	**8**	**10**	**22**	**2**	**8**	**1**	**1**	**7**	**10**	**9**	**0**	**1**
Model Error (percent)	**0.11%**	**0.03%**	**0.08%**	**0.02%**	**0.05%**	**0.01%**	**0.08%**	**0.00%**	**0.01%**	**0.00%**	**0.02%**	**0.09%**	**0.01%**	**0.01%**	**0%**	**0.01%**

Table C-1 cont.

	Hale	Hockley	Howard	Lamb	Lubbock	Lynn	Martin	Midland	Motley	Oldham	Parmer	Potter	Randall	Swisher	Terry	Yoakum
Inflow																
Constant Head	0	0	0	0	0	0	0	0	0	0	0	52	1,195	0	0	0
Wells	0	0	0	0	11,459	0	0	0	0	0	0	0	0	0	0	0
Recharge	58,349	31,566	2,047	45,044	36,339	55,548	5,897	3,619	431	2,695	25,397	192	18,966	19,127	40,970	14,174
Multi-Node Wells	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vertical Leakage Lower	1,776	318	0	531	3,974	991	0	0	0	0	0	0	0	0	330	61
Lateral Flow	842	1,503	605	1,909	2,635	1,250	4,538	504	498	10	352	141	795	2,532	1,694	415
Total Inflow	*60,967*	*33,387*	*2,652*	*47,484*	*54,407*	*57,789*	*10,435*	*4,123*	*929*	*2,705*	*25,749*	*385*	*20,956*	*21,659*	*42,994*	*14,650*
Outflow																
Constant Head	0	0	0	0	0	0	0	0	0	0	0	2	94	0	0	0
Wells	122,947	73,895	17,864	93,301	99,431	93,433	66,472	34,310	1,569	2,794	44,892	837	43,336	70,437	65,070	22,860
Drains	0	1	158	524	1,293	88	536	0	1,759	455	0	0	702	81	226	0
Multi-Node Wells	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,494	314
Vertical Leakage Lower	3,238	393	0	679	2,983	1,647	0	0	0	0	0	0	0	0	1,623	414
Lateral Flow	7,101	2,120	318	1,752	1,614	3,175	458	516	256	1,017	585	77	280	1,749	2,052	1,121
Total Outflow	133,286	76,409	18,340	96,256	105,321	98,343	67,466	34,826	3,584	4,266	45,477	916	44,412	72,267	70,465	24,709
Inflow - Outflow	**-72,319**	**-43,022**	**-15,688**	**-48,772**	**-50,914**	**-40,554**	**-57,031**	**-30,703**	**-2,655**	**-1,561**	**-19,728**	**-531**	**-23,456**	**-50,608**	**-27,471**	**-10,059**
Storage Change	**-72,306**	**-43,048**	**-15,689**	**-48,782**	**-50,929**	**-40,554**	**-57,042**	**-30,715**	**-2,657**	**-1,565**	**-19,729**	**-532**	**-23,467**	**-50,616**	**-27,485**	**-10,063**
Model Error	**-13**	**26**	**1**	**10**	**15**	**0**	**11**	**12**	**2**	**4**	**1**	**1**	**11**	**8**	**14**	**4**
Model Error (percent)	**0.01%**	**0.03%**	**0.01%**	**0.01%**	**0.01%**	**0%**	**0.02%**	**0.03%**	**0.06%**	**0.09%**	**0.00%**	**0.11%**	**0.02%**	**0.01%**	**0.02%**	**0.02%**

Table C-2. Water budgets by groundwater conservation district for the last stress period of the groundwater availability model run (2060). All values are reported in acre-feet per year.

	Garza County UWCD	Glasscock GCD	High Plains UWCD No. 1	Llano Estacado UWCD	Mesa UWCD	Panhandle GCD	Permian Basin UWCD	Sandy Land UWCD	South Plains UWCD
Inflow									
Constant Head	0	0	1,174	0	0	52	0	0	0
Wells	0	0	11,459	0	0	0	0	0	0
Recharge	8,171	706	428,758	33,981	53,675	58	7,935	14,174	41,215
Multi-Node Wells	0	0	0	0	0	0	0	0	0
Vertical Leakage Lower	621	0	10,506	1,789	2,308	0	0	61	330
Lateral Flow	1,498	803	12,413	2,246	5,601	93	4,784	415	1,575
Total Inflow	*10,290*	*1,509*	*464,310*	*38,016*	*61,584*	*203*	*12,719*	*14,650*	*43,120*
Outflow									
Constant Head	0	0	0	0	0	2	0	0	0
Wells	18,651	16,284	1,086,495	52,650	109,059	161	83,734	22,860	65,767
Drains	593	206	3,567	972	1,217	74	650	0	226
Multi-Node Wells	0	0	0	12,973	5,164	0	0	314	1,494
Vertical Leakage Lower	75	0	10,791	11,207	4,128	0	0	414	1,639
Lateral Flow	0	146	11,337	6,075	3,490	45	716	1,121	2,234
Total Outflow	19,319	16,636	1,112,190	83,877	123,058	282	85,100	24,709	71,360
Inflow - Outflow	**-9,029**	**-15,127**	**-647,880**	**-45,861**	**-61,474**	**-79**	**-72,381**	**-10,059**	**-28,240**
Storage Change	**-9,029**	**-15,128**	**-647,981**	**-45,870**	**-61,482**	**-79**	**-72,393**	**-10,063**	**-28,253**
Model Error	**0**	**1**	**101**	**9**	**8**	**0**	**12**	**4**	**13**
Model Error (percent)	**0.00%**	**0.01%**	**0.01%**	**0.01%**	**0.01%**	**0.00%**	**0.01%**	**0.02%**	**0.02%**

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

	GMA 1	GMA 2	GMA 6	GMA 7
Inflow				
Constant Head	1,247	0	0	0
Wells	0	11,459	0	0
Recharge	24,736	604,546	1,466	4,568
Multi-Node Wells	0	0	0	0
Vertical Leakage Lower	0	15,782	0	0
Lateral Flow	1,113	4,601	1,039	597
Total Inflow	*27,096*	*636,388*	*2,505*	*5,165*
Outflow				
Constant Head	97	0	0	0
Wells	53,613	1,547,196	4,946	57,962
Drains	1,911	11,318	3,251	206
Multi-Node Wells	0	19,945	0	0
Vertical Leakage Lower	0	28,502	0	0
Lateral Flow	1,061	2,969	338	186
Total Outflow	56,682	1,609,930	8,535	58,354
Inflow - Outflow	**-29,586**	**-973,542**	**-6,030**	**-53,189**
Storage Change	**-29,602**	**-973,756**	**-6,034**	**-53,211**
Model Error	**16**	**214**	**4**	**22**
Model Error (percent)	**0.03%**	**0.01%**	**0.05%**	**0.04%**