GAM run 08-85

by Richard Smith, P.G.
Eric Aschenbach,
And Shirley Wade, Ph.D., P.G.
Texas Water Development Board
Groundwater Availability Modeling Section
(512) 936-0877
April 23, 2009

REQUESTOR:

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

EXECUTIVE SUMMARY:

We ran the groundwater availability model for the southern part of the Ogallala Aquifer for two fifty year scenarios: (1) pumping in each county based on measured ten year average water level declines and (2) pumping in each county based on 1-foot average 10-year water level declines. We produced maps of saturated thickness for each scenario on a decadal basis and tables of the groundwater pumped for each year in each of the seven groundwater conservation districts and for each county in Groundwater Management Area 2. The number of inactive cells is directly proportional to the volume of pumping and the length of time.

DESCRIPTION OF REQUEST:

Mr. Jason Coleman, with the South Plains Underground Water Conservation District, requested a determination of the volume that could be pumped each year in each groundwater conservation district in Groundwater Management Area 2 over fifty years that achieves the ten-year average drawdowns from information provided by the groundwater conservation districts for each of the twenty-two counties located within Groundwater Management Area 2. As a separate scenario, he also requested the pumping volume required to achieve a one foot drawdown based on weighting of the ten year averages from information provided by Groundwater Management Area 2 in each county as shown in Table 1.

METHODS:

To address the request, we completed the following steps:

- We used ArcGIS© version 9.1 to calculate the volume pumped from each cell in the southern part of the Ogallala Aquifer groundwater availability model which corresponds to the measured ten year average drawdown for each of the counties in Table 1. For those counties with shorter records, the five year average was

- The overall ten-year average drawdown was determined to be -0.675 feet for the twenty-two counties. To achieve the requested overall average drawdown of -1.0 feet for the second requested scenario, the average drawdown in each county was multiplied by a factor of 1.481 for the calculations below;
- We extracted the average recharge from each cell in the model using Groundwater Vistas;
- We multiplied the area of each cell (one square mile) by the amount of annual drawdown and the specific yield. We then added the average recharge per cell to determine the amount of pumping required in each cell to achieve the requested drawdowns for each scenario;
- We created two well files to reflect the respective pumping scenarios of a weighted average drawdown of -0.675 feet per year and a weighted average drawdown of one foot per year;
- We ran the model for a fifty year period for each scenario with average recharge and exported the water levels to ArcGIS© version 9.1 to create maps showing, on a decade by decade basis, the changes in saturated thickness; and
- We exported the water budgets for each groundwater conservation district and each county to create tables showing the pumpage for each year for the two scenarios.

In an effort to determine a starting stress period in the predictive, we compared the total volume of groundwater as computed by the U.S. Geological Survey for 2006 (the latest year) with volumes computed for several stress periods in the initial phase of the predictive cycle of the groundwater availability model run. The volumes computed are for the entire model area and therefore are only approximate. Stress period two has a difference of less than one percent from the U.S. Geological Survey volume. Therefore, stress period two was used as the baseline year and stress period three the first year of the new simulation representing 2009.

Figure 1 shows the location of each of the seven groundwater conservation districts in the analysis.

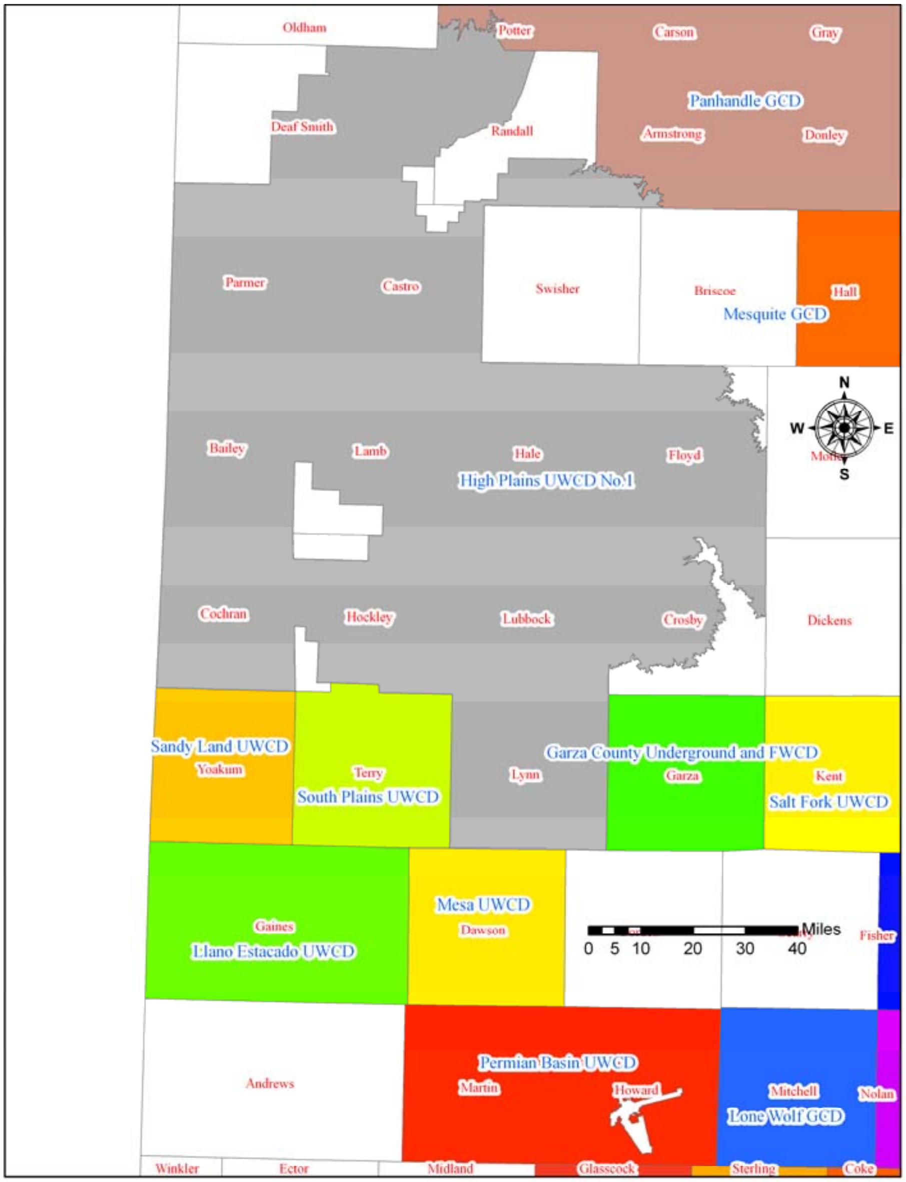


Figure 1: Location of the High Plains, Sandy Land, South Plains, Garza County, Llano Estacado, Mesa, and Permian Basin groundwater conservation districts (TWDB, 2009).

PARAMETERS AND ASSUMPTIONS:

- We used version 1.01 of the groundwater availability model for the southern part of the Ogallala Aquifer (Blandford and others, 2003).
- See Blandford and others (2003) for assumptions and limitations of the groundwater availability model for the southern part of the Ogallala Aquifer. The root mean squared error (a measure of the difference between simulated and measured water levels during model calibration) for this model is 47 feet.
- We used Groundwater Vistas Version 5 (Environmental Simulations, Inc. 2007) as the interface to process model output results for the groundwater availability model for the southern part of the Ogallala Aquifer
- Average recharge used in the groundwater availability model was based on a percentage of precipitation for the 1950 through 1990 period of record. Since this includes the 1950s drought of record, the average recharge used for this analysis is considered a conservative estimate.
- All values in the tables are in acre-feet per year.

RESULTS:

Table 1 includes data provided by Mr. Jason Coleman, general manager of the South Plains Underground Water Conservation District, and shows the measured annual drawdown, ten year average drawdown, and five year average drawdown for each of the twenty-two counties comprising Groundwater Management Area 2. The districts composed of these counties include:

- Garza County Underground and Fresh Water Conservation District,
- High Plains Underground Water Conservation District No 1,
- Llano Estacado Underground Water Conservation District,
- Mesa Underground Water Conservation District,
- Permian Basin Underground Water Conservation District,
- Sandy Land Underground Water Conservation District, and
- South Plains Underground Water Conservation District.

Figures 2 and 3 are the baseline saturated thickness used for each scenario (modeled as the end of 2008). Figures 4 and 5 are the modeled saturated thickness for the one-foot average drawdown scenario after one year. Table 2 provides the pumping volumes for each year in each district for the specified ten-year average drawdown by county scenario. Table 3 lists the pumping volumes for each year in each county for the ten-year average drawdown scenario. Figures 6 through 15 indicate the saturated thickness across the aquifer with the ten year average drawdown per year. Table 4 provides the pumping volumes for each year in each district using the ten-year weighted one-foot average drawdown scenario. Table 5 lists the pumping volumes for each year in each county for the ten-year weighted one-foot drawdown scenario. Figures 16 through 25 indicate the saturated thickness across the aquifer for the weighted average scenario that achieves the overall average drawdown of -1.0 feet.

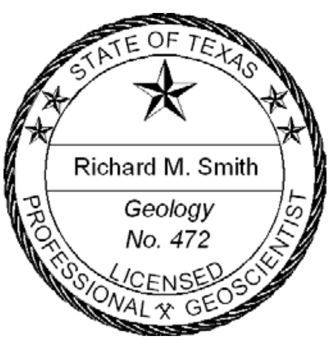
Based on an examination of the figures, the southern part of the Ogallala Aquifer is least impacted with the county average of -0.675 feet of drawdown. For the scenario with a weighted average of -1.0 feet of drawdown, large swaths of the more heavily pumped counties become "dry" (the water level in the model falls below the bottom of the aquifer in the model cell), indicating that the aquifer may not be able to sustain pumping over the this time period in this area. These cells are subsequently inactivated and no longer are in the model. This affects the value for groundwater pumpage since, as the cells become inactive, they can no longer contribute pumping to the model. Differences in model run results for the one-foot drawdown scenario in GAM Run 07-44 versus this run (GAM Run 08-85) are attributable to weighting the drawdown by county in GAM Run 08-85 versus calculating the drawdown on a regional scale in GAM Run 07-44.

REFERENCES:

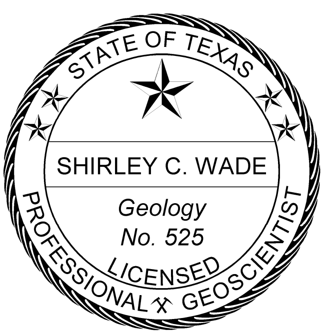
Blandford, T.N., Blazer, D.J., Calhoun, K.C., Dutton, A.R., Naing, T., Reedy, R.C., and Scanlon, B.R., 2003, Groundwater availability of the southern Ogallala Aquifer in Texas and New Mexico—Numerical simulations through 2050: Final Report prepared for the Texas Water Development Board by Daniel B. Stephens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

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

Texas Water Development Board, 2009 http://www.twdb.state.tx.us/mapping/maps/jpg/GCDwithGMA.jpg.



The seal appearing on this document was authorized by Richard M. Smith, P.G. on April 23, 2009



The seal appearing on this document was authorized by Shirley C. Wade, P.G. on April 23, 2009

Table 1: Measured annual drawdowns, ten year average drawdowns, and five year average drawdowns for twenty-two counties located on the Southern Ogallala Aquifer. Values in this table were supplied by Mr. Jason Coleman, General Manager of the South Plains UWCD. All values are reported in feet. Negative values indicate an average decrease in water levels and positive values indicate an average rise in water levels.

Year / County	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	10 Year Average	5 Year Average
Armstrong	0.42	0.46	0.55	0.49	0.55	0.54	0.72	0.69	0.67	0.55	0.56	0.63
Bailey	-0.53	-0.62	-0.44	-0.43	-0.33	-0.27	-0.25	0.26	-0.15	-0.12	-0.29	-0.11
Castro	-1.76	-1.92	-1.67	-1.79	-1.67	-1.61	-1.33	-1.13	-1.40	-1.21	-1.55	-1.34
Cochran	-0.74	-0.80	-0.72	-0.74	-0.62	-0.62	-0.68	-0.33	-0.64	-0.39	-0.63	-0.53
Crosby	-0.50	-0.56	-0.37	-0.14	-0.08	-0.16	0.07	0.09	-0.54	-0.75	-0.29	-0.26
Dawson	-0.45	-3.50	-2.17	-0.76	-2.43	-1.92	-2.41	0.93	-1.35	-1.22	-1.53	-1.19
Deaf Smith	-0.40	-0.36	-0.26	-0.30	-0.32	-0.42	-0.25	-0.02	-0.24	-0.21	-0.28	-0.23
Floyd	-0.63	-0.78	-0.62	-0.53	-0.39	-0.41	-0.45	-0.15	-0.79	-1.02	-0.58	-0.56
Gaines	-1.50	-3.80	0.20	-1.30	-2.50	-1.20	-3.30	1.00	-0.90	-1.20	-1.45	-1.12
Garza						-2.40	-2.40	2.20	0.20	-1.61	na	-0.80
Hale	-1.56	-1.67	-1.46	-1.43	-1.30	-1.31	-0.94	-0.54	-1.39	-1.51	-1.31	-1.14
Hockley	-0.50	-0.55	-0.41	-0.50	-0.42	-0.46	-0.47	-0.26	-0.61	-0.83	-0.50	-0.53
Howard						0.92	0.54	2.18	0.24	-0.46	na	0.69
Lamb	-1.37	-1.39	-1.24	-1.23	-1.24	-1.20	-1.02	-0.64	-0.93	-0.75	-1.10	-0.91
Lubbock	-0.50	-0.61	-0.50	-0.44	-0.42	-0.35	-0.28	-0.18	-0.71	-1.30	-0.53	-0.56
Lynn	-0.36	-0.52	-0.22	-0.23	-0.06	0.10	0.35	0.99	-0.36	-1.03	-0.13	0.01
Martin						1.32	1.17	1.24	-1.57	0.04	na	0.44
Parmer	-1.64	-1.60	-1.43	-1.45	-1.40	-1.31	-1.12	-0.65	-1.27	-1.14	-1.30	-1.10
Potter	-0.03	-0.01	-0.04	0.29	0.50	-0.04	0.31	0.11	-0.09	-0.12	0.09	0.03
Randall	0.07	0.04	0.02	0.08	-0.04	-0.07	-0.03	0.08	-0.05	-0.18	-0.01	-0.05
Terry	-0.95	-3.13	-1.79	-1.65	-1.38	-1.45	-1.46	1.09	0.33	-1.06	-1.15	-0.51
Yoakum	-0.01	-2.40	-0.90	-1.90	-1.10	-1.40	-1.10	-0.50	-0.90	-0.80	-1.10	-0.94
Yearly Average	*-0.68*	*-1.25*	*-0.71*	*-0.73*	*-0.77*	*-0.62*	*-0.65*	0.29	-0.57	*-0.74*		

Table 2: Pumping volumes for each year in each district for the specified ten-year average drawdown by county scenario. Decreases in the volume pumped indicate increases in “dry” (inactive) cells within the model. FWCD is the abbreviation for Fresh Water Conservation District and UWCD is the abbreviation for Underground Water Conservation District.

Year	Garza County Underground and FWCD pumping (acre-feet per year)	High Plains UWCD No 1 pumping (acre-feet per year)	Llano Estacado UWCD pumping (acre-feet per year)	Mesa UWCD pumping (acre-feet per year)	Permian Basin UWCD pumping (acre-feet per year)	Sandy Land UWCD pumping (acre-feet per year)	South Plains UWCD pumping (acre-feet per year)
2009	19,065	1,356,984	309,262	189,129	13,220	127,783	176,184
2010	19,065	1,354,321	308,270	189,129	13,220	127,314	176,184
2011	19,065	1,351,846	306,714	189,129	13,220	126,625	176,072
2012	19,065	1,349,365	305,321	189,129	13,220	126,087	176,072
2013	19,065	1,346,682	304,741	189,129	13,220	125,721	176,072
2014	19,065	1,343,791	303,941	188,951	13,220	124,995	175,961
2015	19,065	1,340,623	301,893	188,951	13,220	124,565	175,961
2016	19,065	1,336,992	301,047	188,951	13,220	123,641	175,961
2017	19,065	1,334,237	299,416	188,951	13,220	122,832	175,961
2018	19,065	1,331,176	297,792	188,720	13,220	121,084	175,695
2019	19,065	1,329,132	296,955	188,495	13,220	119,409	175,695
2020	19,065	1,325,447	295,443	188,264	13,220	117,769	175,208
2021	19,065	1,321,332	293,625	188,264	13,220	116,041	175,097
2022	19,065	1,317,008	292,823	188,023	13,220	114,178	174,854
2023	19,065	1,311,245	291,854	188,023	13,220	112,602	174,610
2024	19,065	1,306,695	291,074	188,023	13,220	111,292	174,344
2025	19,065	1,300,165	289,862	187,782	13,220	108,971	173,456
2026	19,065	1,297,052	287,444	187,782	13,220	105,802	172,135
2027	19,065	1,291,686	285,787	187,212	13,220	103,051	171,563
2028	19,065	1,286,399	284,028	186,741	13,220	98,357	170,811
2029	18,967	1,280,539	283,117	186,355	13,215	96,040	170,004
2030	18,967	1,276,233	280,719	184,966	13,203	92,602	168,500
2031	18,967	1,269,497	277,965	183,782	13,203	88,329	166,216
2032	18,967	1,264,425	275,361	182,314	13,203	84,782	164,622
2033	18,967	1,258,513	272,997	180,698	13,203	80,761	161,746

Table 2 (Continued).

Year	Garza County Underground and FWCD pumping (acre-feet per year)	High Plains UWCD No 1 pumping (acre-feet per year)	Llano Estacado UWCD pumping (acre-feet per year)	Mesa UWCD pumping (acre-feet per year)	Permian Basin UWCD pumping (acre-feet per year)	Sandy Land UWCD pumping (acre-feet per year)	South Plains UWCD pumping (acre-feet per year)
2034	18,967	1,251,807	272,010	178,957	13,203	78,318	158,934
2035	18,967	1,243,454	269,552	176,351	13,203	73,059	156,590
2036	18,872	1,239,255	267,845	173,761	13,203	69,866	152,261
2037	18,758	1,232,523	266,164	171,896	13,203	66,550	147,797
2038	18,758	1,227,995	264,432	169,826	13,192	62,390	145,342
2039	18,758	1,221,978	262,156	167,843	13,181	59,200	142,074
2040	18,758	1,215,394	259,979	165,657	13,181	55,102	137,374
2041	18,658	1,207,828	257,666	164,404	13,181	52,444	132,280
2042	18,658	1,201,813	256,653	162,337	13,181	49,644	128,853
2043	18,519	1,196,487	254,336	159,763	13,181	45,509	124,530
2044	18,519	1,190,264	250,522	159,086	13,181	41,984	120,201
2045	18,519	1,182,117	246,962	156,913	13,181	38,786	115,625
2046	18,519	1,175,497	244,389	155,916	13,181	36,447	111,086
2047	18,519	1,171,919	243,767	154,681	13,175	35,600	108,961
2048	18,519	1,163,964	241,363	152,614	13,175	32,931	105,612
2049	18,519	1,156,844	238,496	149,885	13,161	30,082	102,968
2050	18,519	1,151,660	235,375	148,077	13,134	28,329	99,607
2051	18,519	1,145,160	233,742	146,347	13,134	26,035	94,700
2052	18,519	1,138,865	231,034	144,237	13,134	22,652	91,681
2053	18,519	1,131,020	228,245	142,801	13,134	20,698	88,645
2054	18,519	1,124,239	225,024	140,872	13,132	19,347	87,084
2055	18,519	1,118,065	222,260	138,138	13,126	17,302	84,344
2056	18,519	1,110,533	219,904	134,727	13,126	16,117	81,430

Table 3: Pumping volumes for each year in each county for the specified ten-year average drawdown by county scenario. Decreases in the volume pumped indicate increases in “dry” (inactive) cells within the model. All pumping values are in acre-feet.

Year	Armstrong	Bailey	Castro	Cochran	Crosby	Dawson	Deaf Smith	Floyd	Gaines	Garza	Hale
2009	3,135	43,134	211,226	72,313	61,748	189,129	93,752	95,711	309,262	19,065	205,117
2010	3,135	43,093	211,226	72,313	61,748	189,129	93,371	95,642	308,270	19,065	204,839
2011	3,135	43,093	211,226	72,313	61,748	189,129	93,067	95,436	306,714	19,065	204,237
2012	3,135	43,093	211,226	72,313	61,748	189,129	92,916	95,436	305,321	19,065	203,959
2013	3,135	42,979	211,226	72,160	61,748	189,129	92,843	95,352	304,741	19,065	203,551
2014	3,135	42,875	211,226	72,160	61,748	188,951	92,611	95,192	303,941	19,065	203,551
2015	3,135	42,875	210,748	72,160	61,748	188,951	92,189	95,066	301,893	19,065	203,387
2016	3,135	42,704	210,748	72,160	61,748	188,951	91,897	95,066	301,047	19,065	203,222
2017	3,135	42,704	210,265	72,160	61,748	188,951	91,723	94,620	299,416	19,065	202,483
2018	3,135	42,591	209,288	72,160	61,748	188,720	91,334	94,551	297,792	19,065	202,066
2019	3,135	42,451	208,773	71,965	61,748	188,495	91,170	94,218	296,955	19,065	202,066
2020	3,135	42,391	207,533	71,965	61,748	188,264	91,012	94,145	295,443	19,065	201,928
2021	3,135	42,271	206,322	71,589	61,748	188,264	90,874	94,145	293,625	19,065	201,319
2022	3,135	42,271	204,117	71,463	61,748	188,023	90,874	94,145	292,823	19,065	201,319
2023	3,135	42,242	202,492	71,110	61,748	188,023	90,535	93,939	291,854	19,065	200,911
2024	3,135	42,138	200,923	71,110	61,748	188,023	90,237	93,780	291,074	19,065	200,336
2025	3,135	41,876	199,826	71,110	61,748	187,782	90,123	93,639	289,862	19,065	200,336
2026	3,135	41,498	199,180	70,917	61,748	187,782	89,860	93,639	287,444	19,065	199,811
2027	3,135	41,397	197,969	70,058	61,748	187,212	89,778	93,325	285,787	19,065	199,134
2028	3,135	41,348	196,320	69,432	61,748	186,741	89,588	93,165	284,028	19,065	198,856
2029	3,135	41,250	193,425	69,146	61,748	186,355	89,402	92,950	283,117	18,967	198,036
2030	3,135	41,144	192,188	68,926	61,748	184,966	89,003	92,950	280,719	18,967	197,744
2031	3,135	41,096	189,510	68,246	61,748	183,782	88,924	92,950	277,965	18,967	197,090
2032	3,135	40,945	188,952	68,132	61,748	182,314	88,761	92,881	275,361	18,967	196,768
2033	3,135	40,794	186,769	67,768	61,748	180,698	88,432	92,812	272,997	18,967	195,897

Table 3 (Continued).

Year	Armstrong	Bailey	Castro	Cochran	Crosby	Dawson	Deaf Smith	Floyd	Gaines	Garza	Hale
2034	3,135	40,688	185,792	67,085	61,748	178,957	87,959	92,812	272,010	18,967	195,678
2035	3,135	40,544	184,398	66,215	61,748	176,351	87,886	92,812	269,552	18,967	195,516
2036	3,135	40,484	183,464	65,803	61,748	173,761	87,589	92,738	267,845	18,872	195,378
2037	3,135	40,353	182,430	64,353	61,748	171,896	87,343	92,295	266,164	18,758	195,171
2038	3,135	40,242	180,918	64,045	61,748	169,826	87,158	92,295	264,432	18,758	194,893
2039	3,135	39,883	180,105	63,730	61,748	167,843	86,866	92,226	262,156	18,758	193,678
2040	3,135	39,735	177,972	63,242	61,748	165,657	86,719	92,226	259,979	18,758	193,257
2041	3,135	39,472	176,272	62,521	61,748	164,404	86,265	92,066	257,666	18,658	192,803
2042	3,135	39,435	175,140	62,059	61,748	162,337	86,117	92,066	256,653	18,658	192,060
2043	3,135	39,230	174,417	61,384	61,748	159,763	86,117	91,997	254,336	18,519	191,867
2044	3,135	38,935	173,273	61,073	61,748	159,086	86,017	91,997	250,522	18,519	191,080
2045	3,135	38,777	172,376	60,475	61,748	156,913	85,831	91,997	246,962	18,519	190,371
2046	3,135	38,518	170,968	60,228	61,748	155,916	85,728	91,997	244,389	18,519	189,765
2047	3,135	38,420	170,036	59,678	61,748	154,681	85,704	91,997	243,767	18,519	189,213
2048	3,135	38,334	169,208	58,963	61,748	152,614	85,487	91,833	241,363	18,519	187,569
2049	3,135	38,239	168,141	58,132	61,748	149,885	85,307	91,825	238,496	18,519	186,855
2050	3,135	38,052	167,306	57,175	61,748	148,077	85,096	91,738	235,375	18,519	186,108
2051	3,135	37,757	166,616	56,136	61,748	146,347	84,845	91,629	233,742	18,519	185,679
2052	3,135	37,553	165,768	55,324	61,748	144,237	84,461	91,501	231,034	18,519	185,138
2053	3,135	37,331	163,953	53,987	61,748	142,801	84,278	91,300	228,245	18,519	184,572
2054	3,135	37,245	162,528	53,259	61,748	140,872	84,211	91,146	225,024	18,519	183,575
2055	3,135	37,182	161,149	52,194	61,748	138,138	84,042	91,123	222,260	18,519	182,847
2056	3,135	37,068	159,760	50,752	61,748	134,727	83,833	90,994	219,904	18,519	182,269

Table 3 (Continued).

Year	Hockley	Howard	Lamb	Lubbock	Lynn	Martin	Parmer	Potter	Randall	Terry	Yoakum
2009	90,779	4,887	184,455	99,998	80,471	8,423	144,379	581	24,482	175,022	127,783
2010	90,779	4,887	184,014	99,998	80,471	8,423	142,743	581	24,482	175,022	127,314
2011	90,641	4,887	183,884	99,939	80,471	8,423	141,357	581	24,482	174,909	126,625
2012	90,641	4,887	183,412	99,939	80,471	8,423	139,698	581	24,482	174,909	126,087
2013	90,641	4,887	183,191	99,849	80,471	8,423	138,119	581	24,482	174,909	125,721
2014	90,641	4,887	183,075	99,849	80,471	8,423	135,570	581	24,482	174,799	124,995
2015	90,641	4,887	182,413	99,849	80,471	8,423	133,661	581	24,482	174,799	124,565
2016	90,505	4,887	182,187	99,849	80,471	8,423	130,836	581	24,482	174,799	123,641
2017	90,505	4,887	182,187	99,849	80,471	8,423	129,372	581	24,482	174,799	122,832
2018	90,456	4,887	182,187	99,526	80,471	8,423	127,974	581	24,482	174,533	121,084
2019	90,456	4,887	182,187	99,526	80,471	8,423	126,789	581	24,482	174,533	119,409
2020	90,456	4,887	181,961	99,526	80,471	8,423	124,563	581	24,482	174,046	117,769
2021	90,456	4,887	181,647	99,215	80,471	8,423	122,980	581	24,482	173,935	116,041
2022	90,456	4,887	181,201	99,044	80,471	8,423	120,810	581	24,482	173,691	114,178
2023	90,456	4,887	180,954	99,044	80,471	8,423	117,719	581	24,482	173,447	112,602
2024	90,456	4,887	180,387	99,044	80,471	8,423	115,858	581	24,482	173,181	111,292
2025	90,456	4,887	179,709	99,044	80,471	8,423	111,380	581	24,482	172,294	108,971
2026	90,456	4,887	178,529	99,044	80,471	8,423	111,051	581	24,482	170,972	105,802
2027	90,329	4,887	178,128	99,044	80,471	8,423	108,798	581	24,482	170,400	103,051
2028	90,171	4,887	177,876	99,044	80,471	8,423	106,343	581	24,482	169,649	98,357
2029	90,171	4,882	177,188	98,952	80,471	8,423	105,173	581	24,482	168,842	96,040
2030	90,098	4,882	176,948	98,834	80,471	8,411	103,287	581	24,477	167,338	92,602
2031	89,930	4,882	176,463	98,834	80,471	8,411	101,044	581	24,477	165,054	88,329
2032	89,930	4,882	174,967	98,725	80,471	8,411	98,717	581	24,474	163,460	84,782
2033	89,930	4,882	174,204	98,725	80,471	8,411	97,189	581	24,474	160,584	80,761

Table 3 (Continued).

Year	Hockley	Howard	Lamb	Lubbock	Lynn	Martin	Parmer	Potter	Randall	Terry	Yoakum
2034	89,791	4,882	171,954	98,725	80,471	8,411	94,782	581	24,474	157,771	78,318
2035	89,791	4,882	169,722	98,725	80,471	8,411	90,876	581	24,474	155,427	73,059
2036	89,791	4,882	169,483	98,725	80,471	8,411	88,701	581	24,469	151,098	69,866
2037	89,609	4,882	168,488	98,656	80,471	8,411	86,521	581	24,469	146,635	66,550
2038	89,609	4,882	167,209	98,392	80,471	8,400	85,438	581	24,469	144,180	62,390
2039	89,609	4,882	166,019	98,255	80,471	8,389	83,492	581	24,469	140,911	59,200
2040	89,609	4,882	165,068	98,255	80,471	8,389	80,838	581	24,469	136,212	55,102
2041	89,609	4,882	163,157	98,255	80,471	8,389	78,254	581	24,469	131,118	52,444
2042	89,609	4,882	161,282	98,255	80,471	8,389	76,474	581	24,463	127,691	49,644
2043	89,609	4,882	159,486	98,255	80,471	8,389	74,547	581	24,463	123,368	45,509
2044	89,544	4,882	158,132	98,054	80,471	8,389	72,191	581	24,463	119,038	41,984
2045	89,544	4,882	155,651	98,054	80,471	8,389	68,691	581	24,463	114,463	38,786
2046	89,544	4,882	153,943	97,906	80,471	8,389	66,253	581	24,463	109,923	36,447
2047	89,544	4,876	153,353	97,854	80,471	8,389	65,327	581	24,463	107,798	35,600
2048	89,544	4,876	151,449	97,739	80,471	8,389	62,585	581	24,463	104,450	32,931
2049	89,544	4,865	149,696	97,365	80,471	8,387	59,935	581	24,463	101,805	30,082
2050	89,532	4,863	148,488	97,093	80,471	8,361	58,589	581	24,463	98,445	28,329
2051	89,469	4,863	145,783	96,969	80,471	8,361	57,103	581	24,463	93,537	26,035
2052	89,391	4,863	143,578	96,781	80,471	8,361	55,267	581	24,463	90,519	22,652
2053	89,334	4,863	141,175	96,483	80,471	8,361	53,901	581	24,463	87,482	20,698
2054	89,334	4,861	140,115	96,429	80,471	8,361	51,286	581	24,463	85,922	19,347
2055	89,334	4,856	138,884	96,377	80,471	8,361	49,432	581	24,463	83,181	17,302
2056	89,184	4,856	136,954	96,314	80,471	8,361	47,413	581	24,463	80,268	16,117

Table 4: Pumping volumes for each year in each district using the ten-year weighted one-foot average drawdown scenario. Decreases in the volume pumped indicate increases in "dry" (inactive) cells within the model. FWCD is the abbreviation for Fresh Water Conservation District and UWCD I is the abbreviation for Underground Water Conservation District.

Year	Garza County Underground and FWCD pumping (acre-feet per year)	High Plains UWCD No 1 pumping (acre-feet per year)	Llano Estacado UWCD pumping (acre-feet per year)	Mesa UWCD pumping (acre-feet per year)	Permian Basin UWCD pumping (acre-feet per year)	Sandy Land UWCD pumping (acre-feet per year)	South Plains UWCD pumping (acre-feet per year)
2009	24,012	1,710,528	414,636	250,202	13,856	170,192	226,608
2010	24,012	1,705,100	412,056	250,202	13,856	168,719	226,442
2011	24,012	1,699,973	409,507	250,202	13,856	167,551	226,442
2012	24,012	1,694,487	408,126	249,939	13,856	166,503	226,278
2013	24,012	1,687,704	405,883	249,939	13,856	165,709	226,278
2014	24,012	1,682,163	401,564	249,939	13,856	163,623	226,278
2015	24,012	1,677,310	399,540	249,342	13,856	160,171	225,949
2016	24,012	1,669,199	396,907	249,026	13,856	156,882	225,488
2017	24,012	1,661,648	394,552	249,026	13,856	154,361	225,139
2018	24,012	1,651,457	392,512	248,701	13,856	150,162	224,545
2019	24,012	1,641,303	388,929	248,389	13,856	146,218	223,887
2020	24,012	1,630,634	385,587	248,126	13,856	141,174	221,871
2021	24,012	1,622,699	382,399	246,875	13,856	134,826	220,627
2022	23,877	1,611,555	380,700	245,467	13,856	128,339	218,329
2023	23,877	1,600,220	375,337	243,517	13,856	121,448	215,762
2024	23,877	1,591,299	371,254	241,651	13,850	114,071	212,435
2025	23,877	1,578,334	367,885	238,220	13,850	105,886	207,155
2026	23,877	1,564,050	363,860	234,690	13,850	99,463	201,271
2027	23,745	1,549,137	360,857	229,676	13,850	91,185	195,615
2028	23,594	1,538,501	357,094	225,300	13,838	85,109	189,009
2029	23,594	1,530,398	352,936	221,835	13,838	78,365	181,679
2030	23,594	1,518,049	349,357	217,133	13,838	70,994	174,064
2031	23,457	1,506,165	346,325	214,782	13,838	63,862	166,431
2032	23,281	1,492,559	343,348	209,894	13,838	57,841	158,018
2033	23,281	1,479,844	335,556	206,327	13,838	50,896	149,673

Table 4 (Continued)

Year	Garza County Underground and FWCD pumping (acre-feet per year)	High Plains UWCD No 1 pumping (acre-feet per year)	Llano Estacado UWCD pumping (acre-feet per year)	Mesa UWCD pumping (acre-feet per year)	Permian Basin UWCD pumping (acre-feet per year)	Sandy Land UWCD pumping (acre-feet per year)	South Plains UWCD pumping (acre-feet per year)
2034	23,281	1,463,682	330,025	203,863	13,826	45,484	141,463
2035	23,281	1,451,712	323,382	200,644	13,815	40,214	135,930
2036	23,281	1,436,404	317,814	196,306	13,815	36,794	128,815
2037	23,281	1,426,392	312,644	191,293	13,815	33,483	119,412
2038	23,281	1,412,257	305,888	188,520	13,815	27,118	114,608
2039	23,281	1,396,431	302,336	184,592	13,808	22,917	112,068
2040	23,281	1,380,501	296,867	180,310	13,808	21,008	106,869
2041	23,073	1,365,583	288,853	174,468	13,808	18,941	99,664
2042	23,073	1,352,348	281,597	168,985	13,808	16,500	94,777
2043	23,073	1,336,744	274,261	162,766	13,765	13,212	90,208
2044	22,866	1,324,206	265,521	156,367	13,765	11,983	86,782
2045	22,866	1,310,455	254,625	147,350	13,757	11,531	83,673
2046	22,676	1,293,679	245,842	138,607	13,757	9,295	78,429
2047	22,572	1,285,877	239,492	134,858	13,757	8,178	74,785
2048	22,468	1,269,318	227,830	127,094	13,757	6,202	70,135
2049	22,347	1,253,880	218,961	119,433	13,757	5,779	65,239
2050	22,261	1,241,326	207,754	113,833	13,757	5,266	60,547
2051	21,662	1,225,526	197,347	106,250	13,757	4,315	56,689
2052	21,404	1,207,530	185,486	100,356	13,750	3,522	53,440
2053	21,311	1,190,794	173,953	94,957	13,747	3,354	49,075
2054	21,311	1,173,919	162,069	88,723	13,747	2,786	45,109
2055	21,223	1,158,897	148,890	81,353	13,747	2,635	41,828
2056	21,073	1,140,109	139,288	75,769	13,747	2,030	35,492

Table 5: Pumping volumes for each year in each county using the ten-year weighted one-foot average drawdown scenario. Decreases in the volume pumped indicate increases in "dry" (inactive) cells within the model. All pumping volumes are in acre-feet.

Year	Armstrong	Bailey	Castro	Cochran	Crosby	Dawson	Deaf Smith	Floyd	Gaines	Garza	Hale
2009	3,165	52,898	283,601	95,901	71,084	250,202	111,796	121,657	414,636	24,012	269,194
2010	3,165	52,898	283,601	95,901	71,084	250,202	111,235	121,370	412,056	24,012	268,012
2011	3,165	52,771	283,601	95,901	71,084	250,202	110,983	121,260	409,507	24,012	267,297
2012	3,165	52,653	283,601	95,714	71,084	249,939	110,687	121,064	408,126	24,012	267,060
2013	3,165	52,653	282,908	95,480	71,084	249,939	110,005	120,906	405,883	24,012	266,823
2014	3,165	52,393	282,442	95,480	71,084	249,939	109,567	120,524	401,564	24,012	266,391
2015	3,165	52,327	280,333	95,480	71,084	249,342	108,898	120,243	399,540	24,012	265,067
2016	3,165	51,991	278,339	94,885	71,084	249,026	108,472	119,819	396,907	24,012	264,869
2017	3,165	51,763	276,034	94,571	71,084	249,026	108,374	119,719	394,552	24,012	264,433
2018	3,165	51,721	271,895	93,903	71,084	248,701	108,216	119,528	392,512	24,012	263,689
2019	3,165	51,661	268,925	93,520	71,084	248,389	107,607	118,876	388,929	24,012	263,255
2020	3,165	50,915	266,738	92,862	71,084	248,126	107,162	118,684	385,587	24,012	262,311
2021	3,165	50,783	265,040	91,907	71,084	246,875	106,684	118,588	382,399	24,012	261,877
2022	3,165	50,718	260,250	90,883	71,084	245,467	106,484	118,297	380,700	23,877	261,038
2023	3,165	50,643	256,198	90,056	71,084	243,517	105,888	118,011	375,337	23,877	259,419
2024	3,165	50,379	253,423	89,534	71,084	241,651	105,629	118,011	371,254	23,877	258,533
2025	3,165	50,318	250,372	88,505	71,084	238,220	105,234	117,819	367,885	23,877	257,318
2026	3,165	49,811	247,253	87,024	71,084	234,690	104,555	117,448	363,860	23,877	256,405
2027	3,165	49,588	243,712	85,709	71,084	229,676	103,965	117,255	360,857	23,745	255,576
2028	3,165	49,467	241,498	84,867	71,084	225,300	103,585	117,155	357,094	23,594	254,114
2029	3,165	49,318	240,099	84,052	71,084	221,835	103,158	117,059	352,936	23,594	253,915
2030	3,165	48,904	236,683	83,413	71,084	217,133	102,801	116,965	349,357	23,594	252,924
2031	3,165	48,376	233,425	82,557	71,084	214,782	102,357	116,766	346,325	23,457	252,416
2032	3,165	47,668	231,542	81,820	71,084	209,894	102,115	116,574	343,348	23,281	250,871
2033	3,165	47,387	230,004	80,405	71,084	206,327	101,625	116,371	335,556	23,281	249,965

Table 5 (Continued).

Year	Armstrong	Bailey	Castro	Cochran	Crosby	Dawson	Deaf Smith	Floyd	Gaines	Garza	Hale
2034	3,165	46,665	226,717	79,703	71,084	203,863	101,149	116,371	330,025	23,281	248,773
2035	3,165	46,449	224,166	78,230	71,084	200,644	101,096	116,371	323,382	23,281	247,180
2036	3,165	46,382	221,951	76,495	71,084	196,306	100,535	116,371	317,814	23,281	244,544
2037	3,165	46,382	220,696	74,834	71,084	191,293	99,995	116,165	312,644	23,281	242,800
2038	3,165	46,105	217,189	72,923	71,084	188,520	99,617	115,973	305,888	23,281	240,743
2039	3,165	45,550	214,207	71,066	71,084	184,592	99,209	115,781	302,336	23,281	238,437
2040	3,165	45,288	212,148	69,211	71,084	180,310	98,814	115,686	296,867	23,281	234,988
2041	3,165	45,168	208,620	66,488	71,084	174,468	98,470	115,590	288,853	23,073	233,611
2042	3,165	44,882	206,863	64,703	71,084	168,985	98,317	115,495	281,597	23,073	232,051
2043	3,165	44,641	203,564	62,129	71,084	162,766	98,022	115,278	274,261	23,073	229,255
2044	3,165	44,300	200,975	59,636	71,084	156,367	97,809	115,087	265,521	22,866	228,265
2045	3,165	43,215	197,761	57,509	71,084	147,350	97,471	115,087	254,625	22,866	226,080
2046	3,165	43,012	194,609	54,985	71,084	138,607	97,266	114,895	245,842	22,676	222,820
2047	3,165	42,845	193,584	54,103	71,084	134,858	97,124	114,700	239,492	22,572	220,818
2048	3,165	42,684	189,590	51,858	71,084	127,094	96,856	114,275	227,830	22,468	218,331
2049	3,165	42,521	185,382	50,017	71,084	119,433	96,357	114,179	218,961	22,347	214,892
2050	3,165	42,190	182,544	48,697	71,084	113,833	96,048	114,055	207,754	22,261	211,657
2051	3,165	41,958	179,187	47,322	71,084	106,250	95,639	113,645	197,347	21,662	206,918
2052	3,165	41,616	174,664	45,520	71,084	100,356	95,395	113,240	185,486	21,404	201,541
2053	3,165	41,118	170,358	43,896	71,084	94,957	94,858	113,035	173,953	21,311	197,631
2054	3,165	40,706	166,821	42,527	71,084	88,723	94,651	112,823	162,069	21,311	192,537
2055	3,165	40,364	163,797	41,616	71,084	81,353	94,309	112,683	148,890	21,223	186,796
2056	3,165	39,745	157,955	40,514	71,084	75,769	93,858	112,283	139,288	21,073	182,604

Table 5 (Continued).

Year	Hockley	Howard	Lamb	Lubbock	Lynn	Martin	Parmer	Potter	Randall	Terry	Yoakum
2009	112,371	5,127	236,840	123,382	85,824	8,831	190,474	601	24,814	225,012	170,192
2010	112,206	5,127	236,378	123,299	85,824	8,831	187,157	601	24,814	224,846	168,719
2011	112,206	5,127	235,513	123,185	85,824	8,831	184,061	601	24,814	224,846	167,551
2012	112,206	5,127	235,063	123,185	85,824	8,831	179,688	601	24,814	224,682	166,503
2013	112,043	5,127	234,214	123,003	85,824	8,831	175,203	601	24,814	224,682	165,709
2014	111,970	5,127	234,214	122,808	85,824	8,831	171,029	601	24,814	224,682	163,623
2015	111,970	5,127	234,214	122,808	85,824	8,831	168,922	601	24,814	224,353	160,171
2016	111,970	5,127	233,412	122,613	85,824	8,831	165,007	601	24,814	223,892	156,882
2017	111,970	5,127	232,348	122,417	85,824	8,831	160,775	601	24,814	223,543	154,361
2018	111,970	5,127	232,100	122,248	85,824	8,831	156,133	601	24,814	222,949	150,162
2019	111,970	5,127	231,389	122,248	85,824	8,831	150,612	601	24,814	222,291	146,218
2020	111,970	5,127	229,561	122,248	85,824	8,831	146,148	601	24,814	220,275	141,174
2021	111,785	5,127	228,724	122,248	85,824	8,831	141,607	601	24,814	219,030	134,826
2022	111,434	5,127	227,492	122,248	85,824	8,831	138,263	601	24,814	216,733	128,339
2023	111,434	5,127	227,309	122,248	85,824	8,831	133,925	601	24,814	214,166	121,448
2024	111,338	5,122	225,675	121,984	85,824	8,831	131,332	601	24,805	210,838	114,071
2025	111,338	5,122	222,573	121,984	85,824	8,831	126,749	601	24,805	205,559	105,886
2026	111,172	5,122	219,418	121,694	85,824	8,831	121,888	601	24,805	199,675	99,463
2027	111,172	5,122	216,862	121,694	85,824	8,831	115,804	601	24,805	194,019	91,185
2028	111,172	5,122	214,186	121,694	85,824	8,818	112,590	601	24,805	187,413	85,109
2029	110,939	5,122	211,691	121,415	85,824	8,818	109,199	601	24,800	180,083	78,365
2030	110,939	5,122	208,938	121,415	85,824	8,818	104,867	601	24,800	172,468	70,994
2031	110,939	5,122	205,852	121,224	85,824	8,818	101,313	601	24,800	164,835	63,862
2032	110,939	5,122	203,457	120,878	85,824	8,818	95,181	601	24,800	156,422	57,841
2033	110,939	5,122	199,002	120,878	85,824	8,818	90,958	601	24,800	148,077	50,896

Table 5 (Continued).

Year	Hockley	Howard	Lamb	Lubbock	Lynn	Martin	Parmer	Potter	Randall	Terry	Yoakum
2034	110,851	5,122	195,520	120,787	85,824	8,806	84,286	601	24,800	139,867	45,484
2035	110,851	5,122	192,676	120,424	85,824	8,795	80,618	601	24,800	134,334	40,214
2036	110,851	5,122	188,214	119,962	85,824	8,795	76,288	601	24,800	127,219	36,794
2037	110,851	5,122	185,615	119,806	85,824	8,795	73,173	601	24,793	117,816	33,483
2038	110,659	5,122	181,933	119,538	85,824	8,795	69,809	601	24,793	113,012	27,118
2039	110,562	5,115	177,680	118,848	85,824	8,795	66,314	601	24,793	110,472	22,917
2040	110,176	5,115	174,813	118,591	85,824	8,795	61,087	601	24,793	105,272	21,008
2041	110,085	5,115	171,869	117,679	85,824	8,795	57,602	601	24,793	98,067	18,941
2042	109,964	5,115	170,159	116,943	85,824	8,795	52,021	601	24,793	93,181	16,500
2043	109,738	5,102	167,152	116,805	85,824	8,766	47,793	601	24,793	88,612	13,212
2044	109,322	5,102	164,760	116,522	85,824	8,766	44,890	601	24,793	85,186	11,983
2045	109,179	5,094	160,788	115,812	85,824	8,766	44,018	601	24,793	82,077	11,531
2046	108,973	5,094	157,257	115,733	85,824	8,766	39,838	601	24,793	76,833	9,295
2047	108,892	5,094	155,665	115,199	85,824	8,766	38,336	601	24,793	73,189	8,178
2048	108,386	5,094	152,563	114,219	85,824	8,766	35,135	601	24,793	68,539	6,202
2049	108,316	5,094	150,345	113,441	85,824	8,766	32,555	601	24,793	63,643	5,779
2050	108,218	5,094	148,916	112,408	85,824	8,766	30,503	601	24,793	58,951	5,266
2051	107,765	5,094	146,629	111,683	85,824	8,766	27,999	601	24,793	55,093	4,315
2052	107,428	5,086	142,930	111,011	85,824	8,766	27,162	601	24,793	51,844	3,522
2053	107,372	5,083	138,295	110,682	85,824	8,766	25,872	601	24,793	47,479	3,354
2054	107,082	5,083	133,976	109,730	85,824	8,766	24,661	601	24,793	43,513	2,786
2055	106,720	5,083	131,166	109,219	85,824	8,766	23,631	601	24,793	40,232	2,635
2056	106,169	5,083	127,784	108,304	85,824	8,766	22,077	601	24,793	33,896	2,030

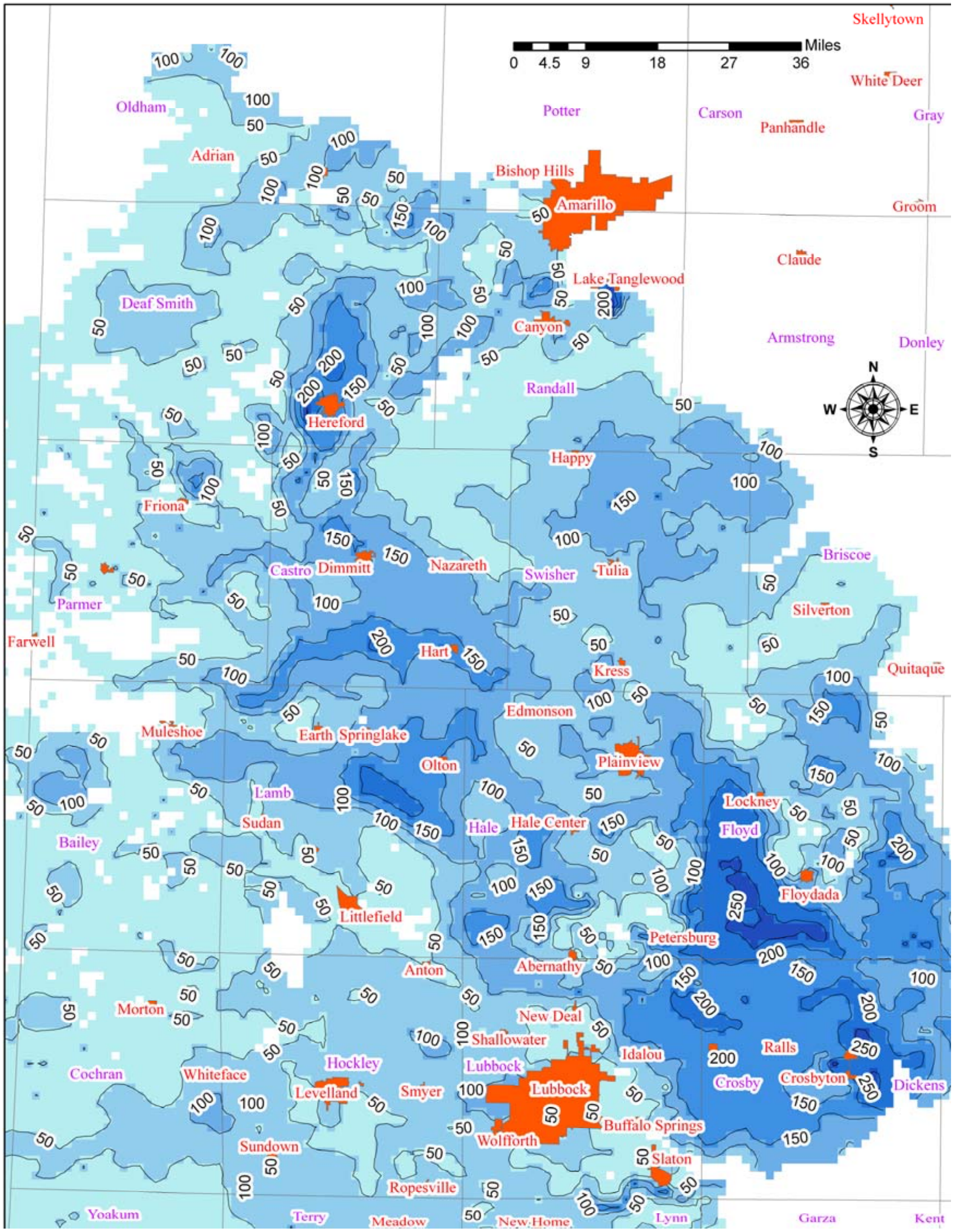


Figure 2: Baseline saturated thickness for the northern half of the southern portion of the Ogallala Aquifer. White areas are inactive cells or outside the model boundary. Contour interval is 50 feet.

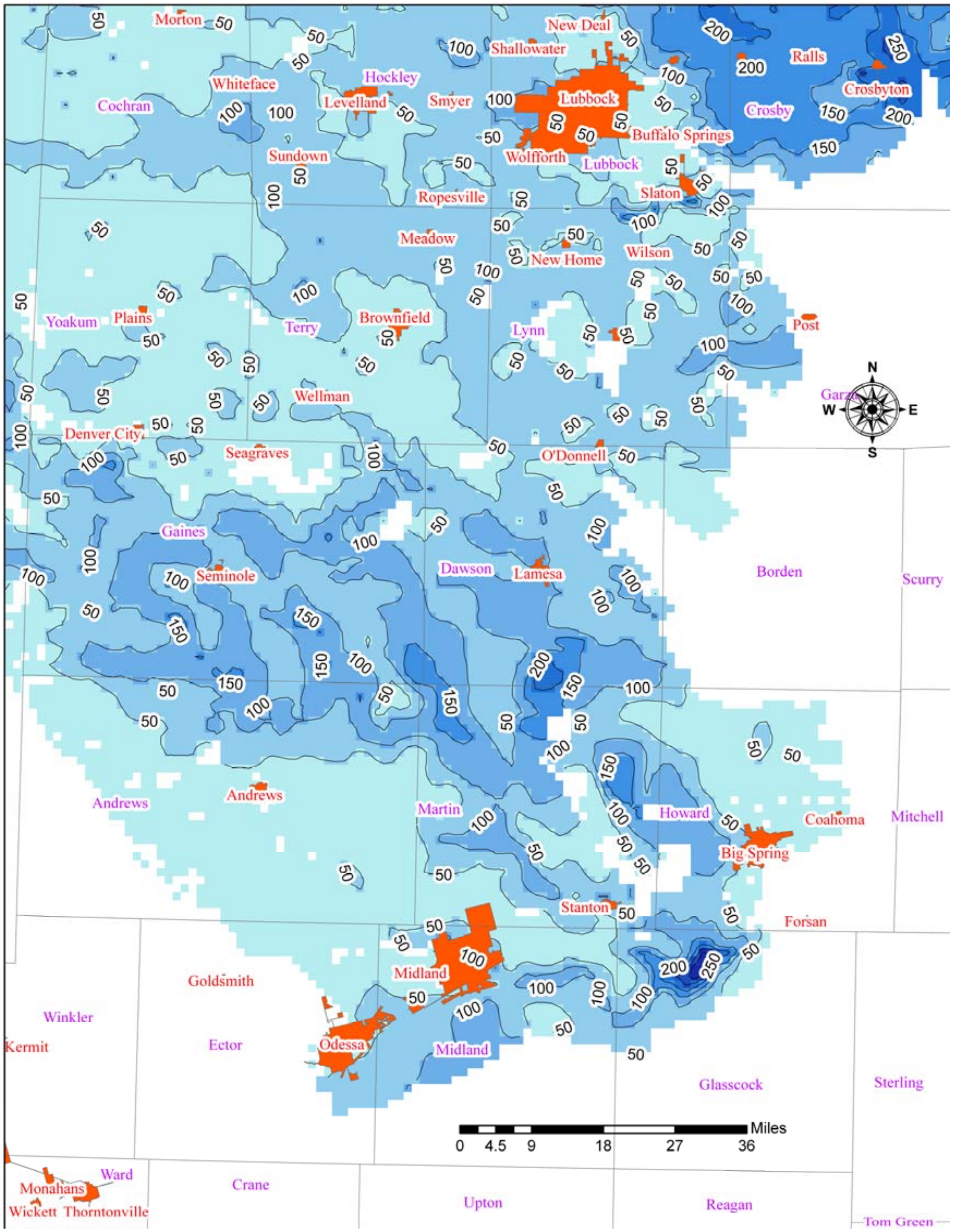


Figure 3: Baseline saturated thickness for the southern half of the southern part of the Ogallala Aquifer. White areas are inactive cells or outside the model boundary. Contour interval is 50 feet.

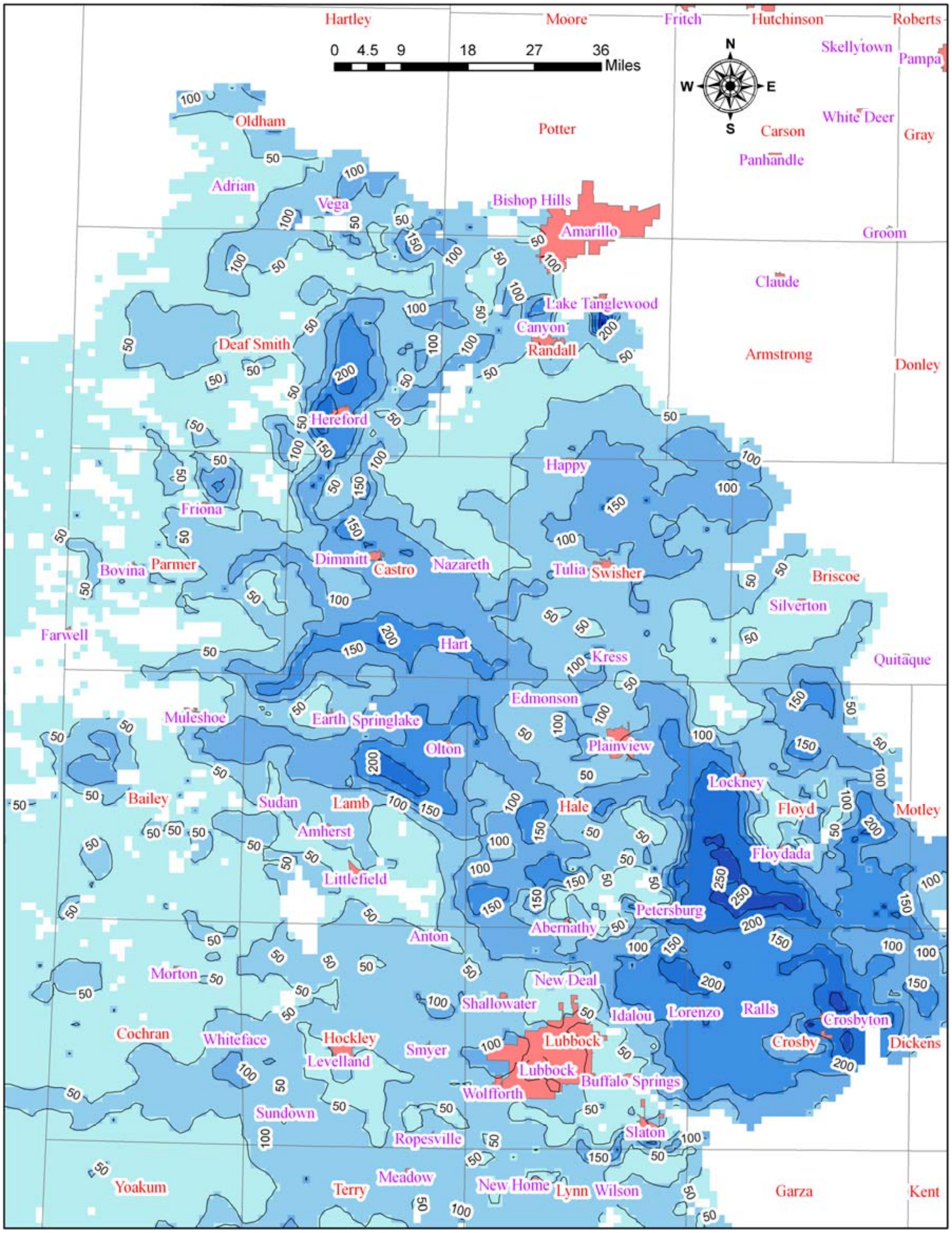


Figure 4: Saturated thickness of the northern half of the southern part of the Ogallala Aquifer in the first stress period (assume year 2009) for the one-foot weighted average drawdown scenario (see Table 1). White areas are inactive cells or outside the model boundary. Major cities are labeled and highlighted in red. Contour interval is 50 feet.

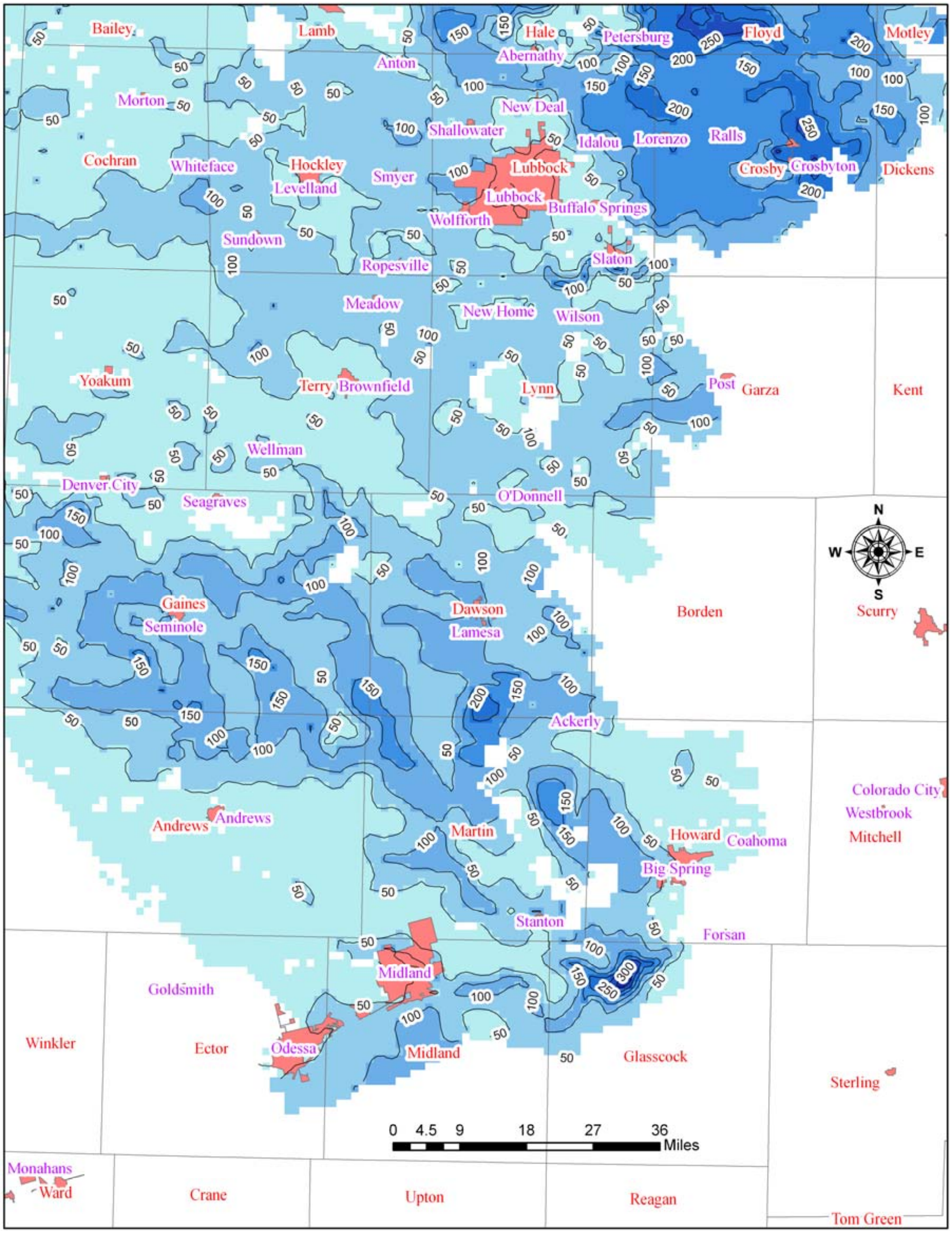


Figure 5: Saturated thickness of the southern half of the southern part of the Ogallala Aquifer in the first stress period (assume year 2009) for the one-foot weighted average drawdown scenario (see Table 1). White areas are inactive cells or outside the model boundary. Major cities are labeled and highlighted in red. Contour interval is 50 feet.

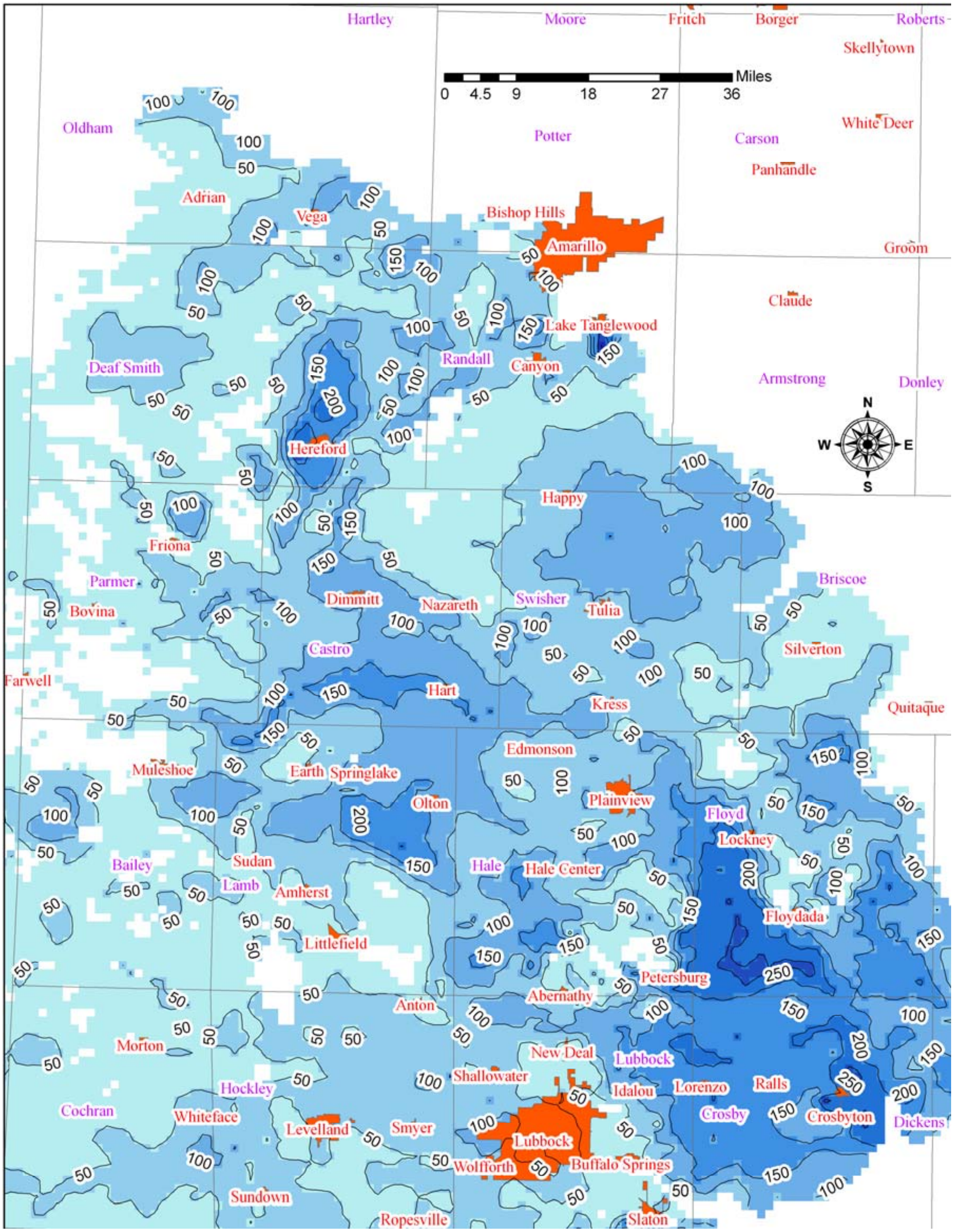


Figure 6: The northern part of the Southern Ogallala Aquifer in 2020 using ten year average drawdowns for each county based on Table 1. White areas are inactive cells or outside the model boundary. Major cities are labeled and highlighted in red. Contour interval is 50 feet.

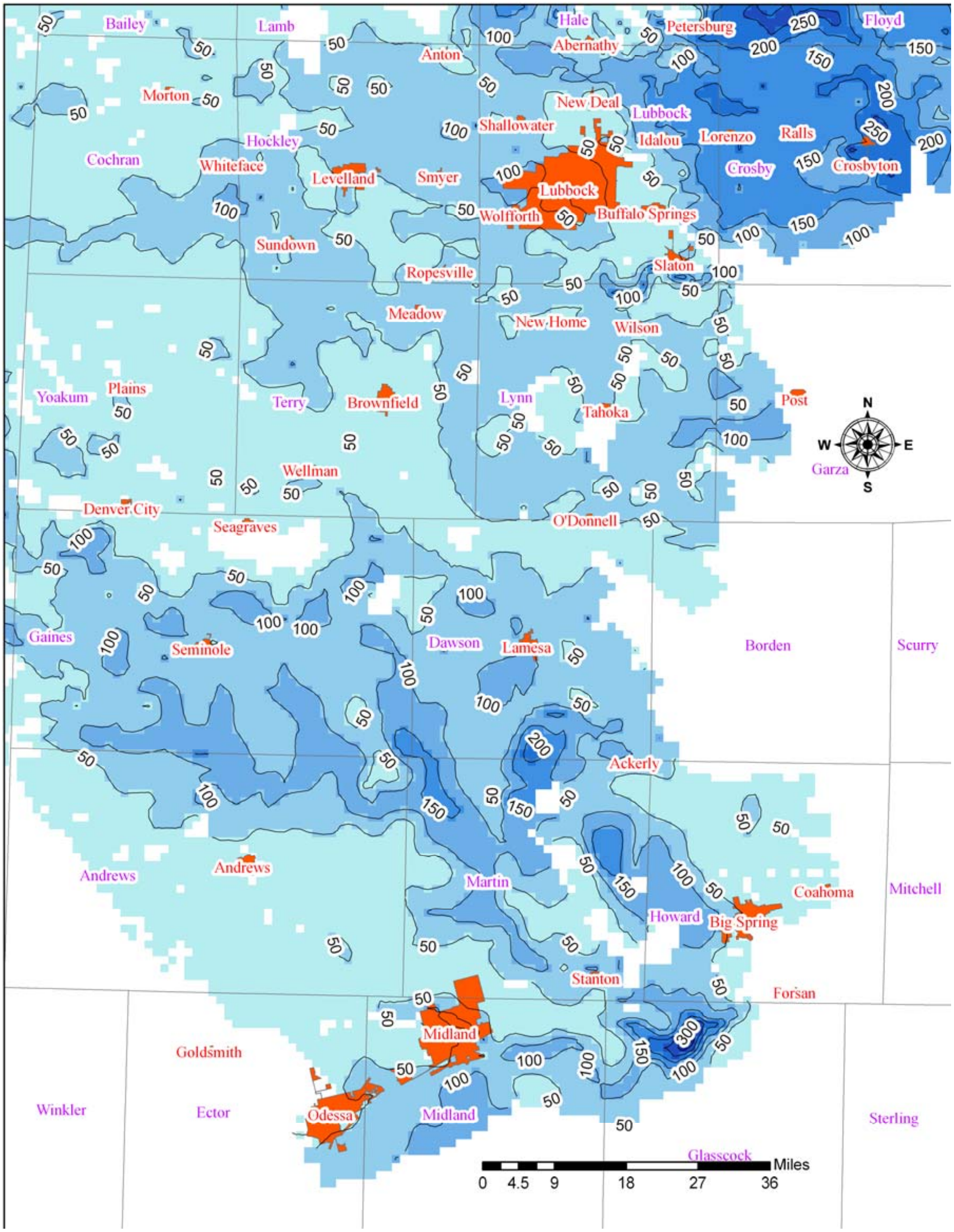


Figure 7: The southern part of the Southern Ogallala Aquifer in 2020 using ten year average drawdowns for each county based on Table 1. White areas are inactive cells or outside the model boundary. Major cities are labeled and highlighted in red. Contour interval is 50 feet.

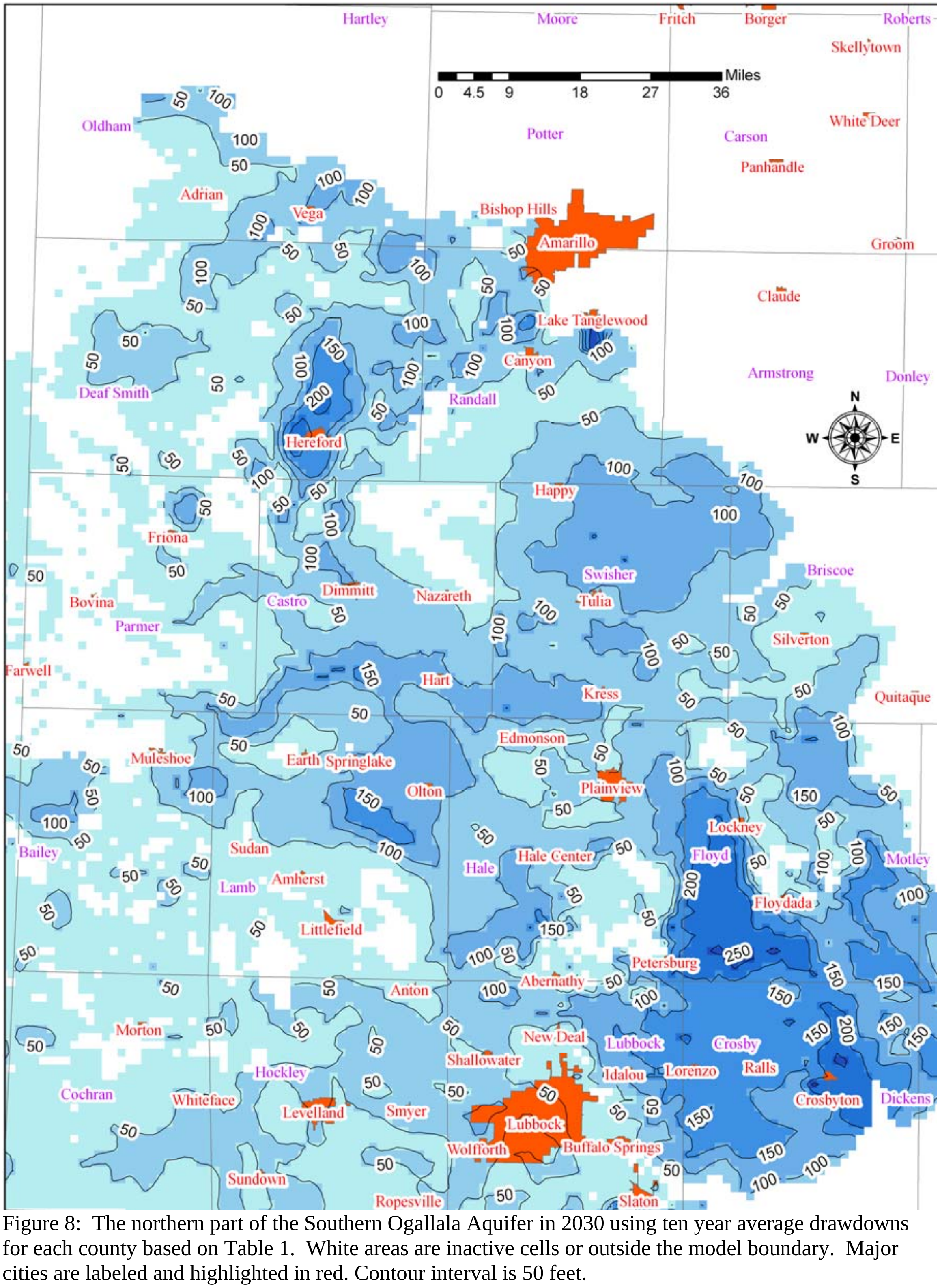


Figure 8: The northern part of the Southern Ogallala Aquifer in 2030 using ten year average drawdowns for each county based on Table 1. White areas are inactive cells or outside the model boundary. Major cities are labeled and highlighted in red. Contour interval is 50 feet.

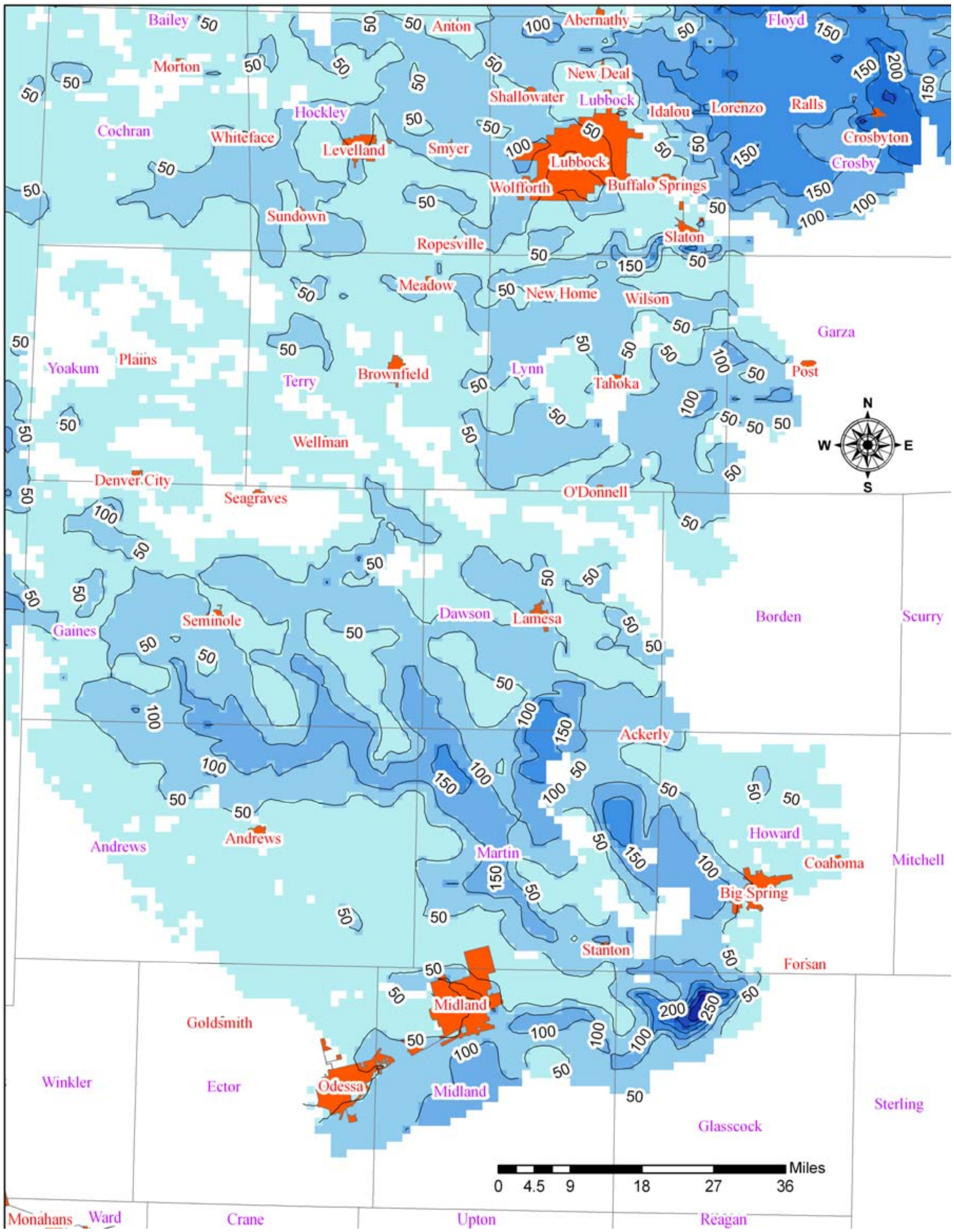


Figure 9: The southern part of the Southern Ogallala Aquifer in 2030 using ten year average drawdowns for each county based on Table 1. White areas are inactive cells or outside the model boundary. Major cities are labeled and highlighted in red. Contour interval is 50 feet.

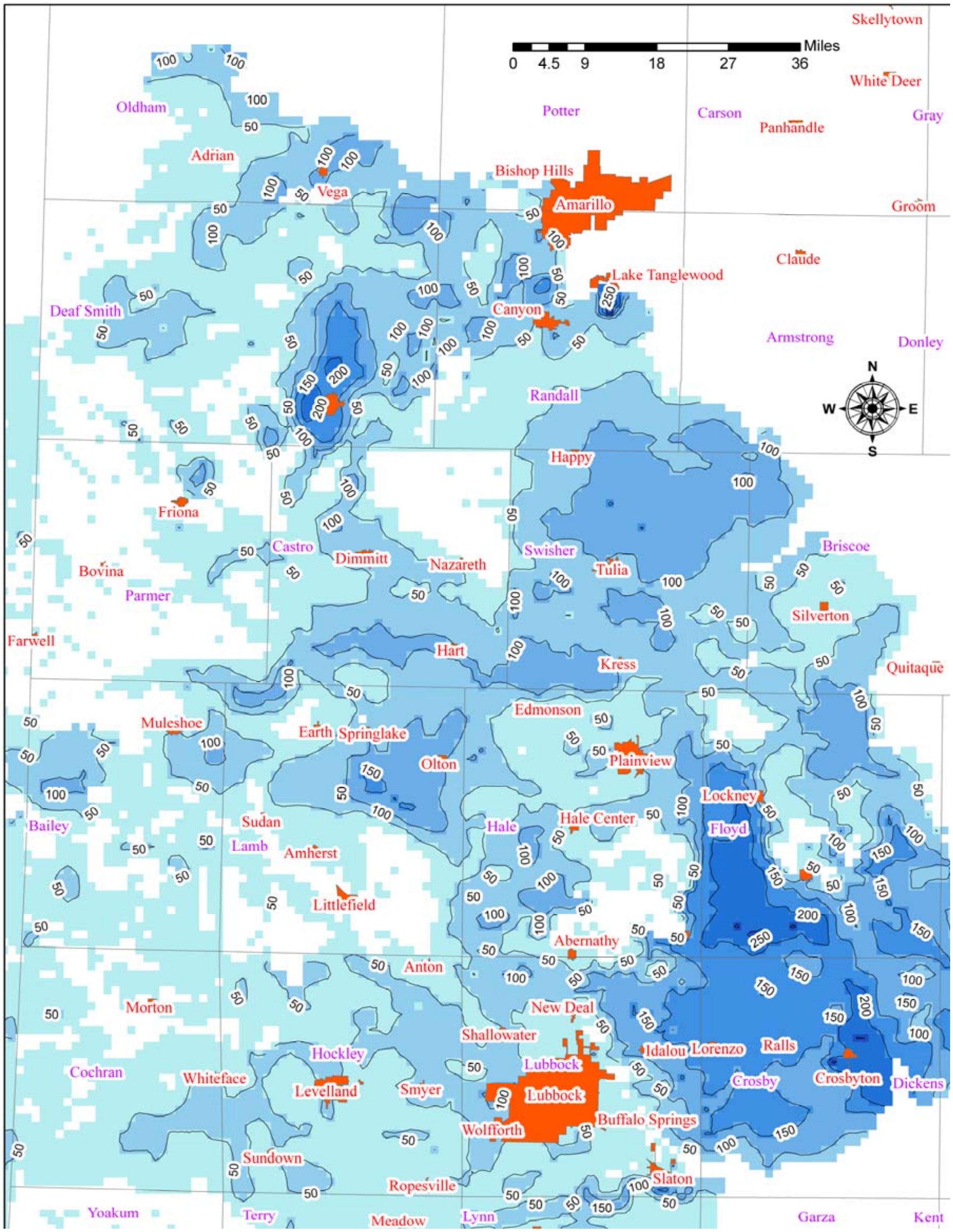


Figure 10: The northern part of the Southern Ogallala Aquifer in 2040 using ten year average drawdowns for each county based on Table 1. White areas are inactive cells or outside the model boundary. Major cities are labeled and highlighted in red. Contour interval is 50 feet.

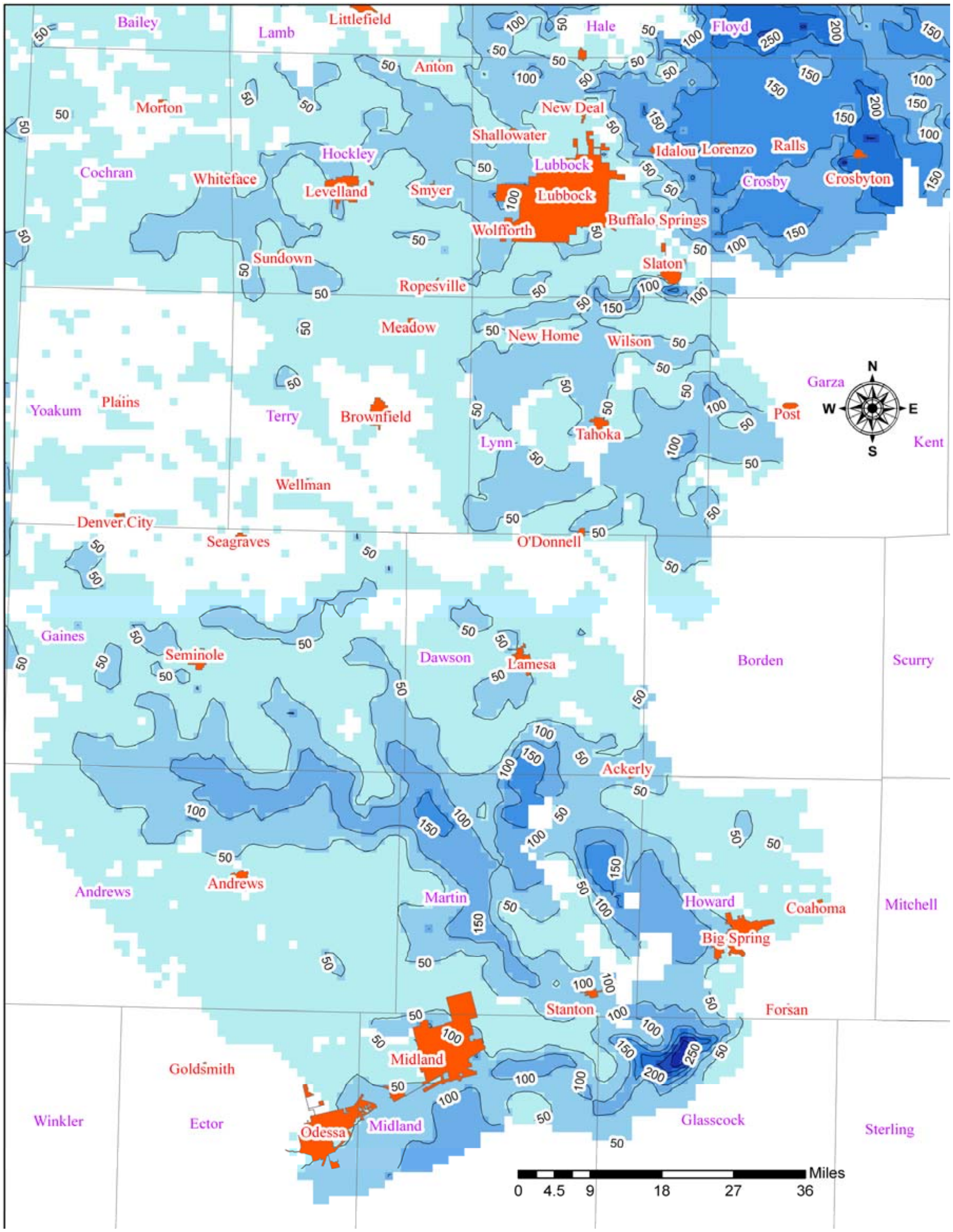


Figure 11: The southern part of the Southern Ogallala Aquifer in 2040 using ten year average drawdowns for each county based on Table 1. White areas are inactive cells or outside the model boundary. Major cities are labeled and highlighted in red. Contour interval is 50 feet.

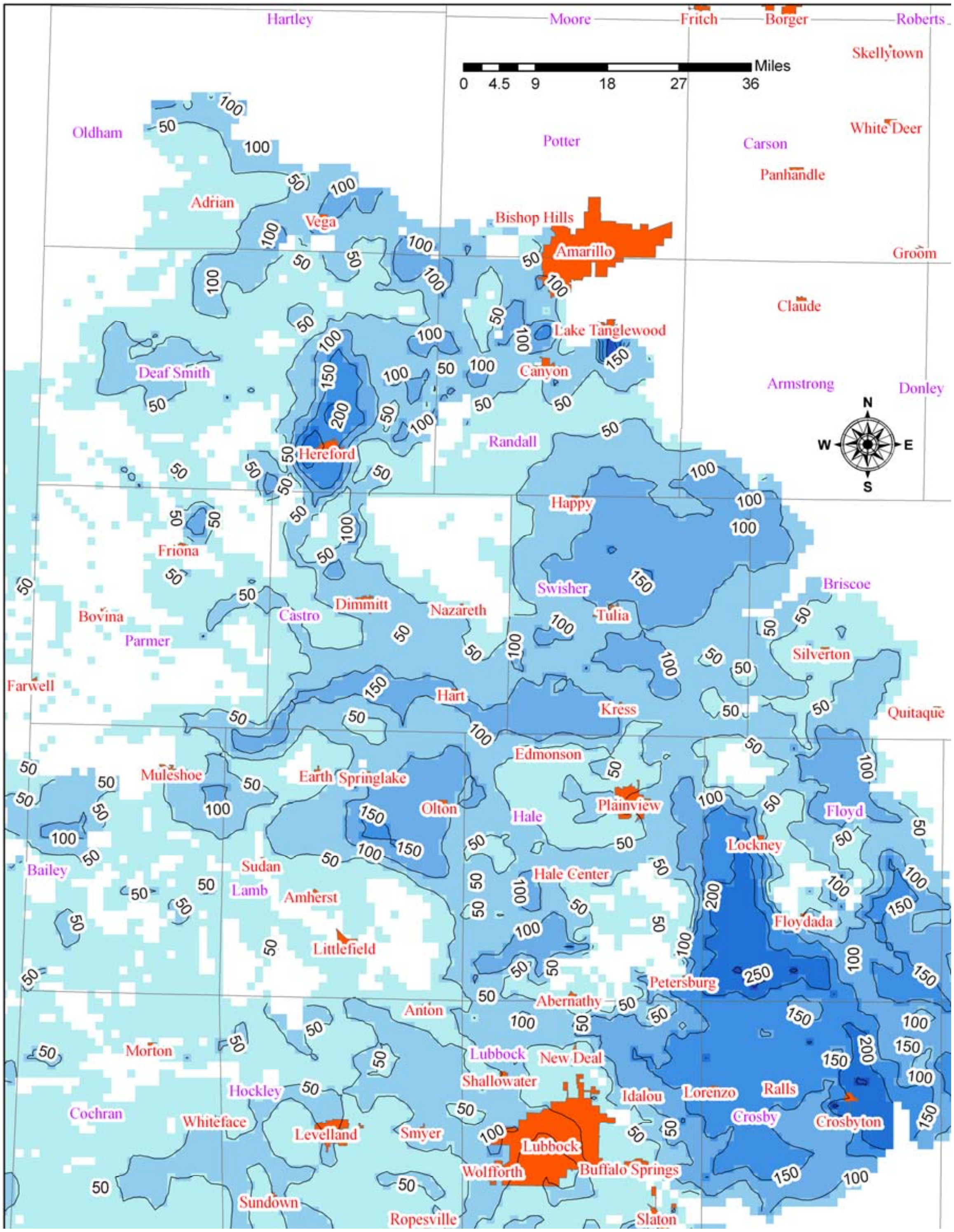


Figure 12: The northern part of the Southern Ogallala Aquifer in 2050 using ten year average drawdowns for each county based on Table 1. White areas are inactive cells or outside the model boundary. Major cities are labeled and highlighted in red. Contour interval is 50 feet.

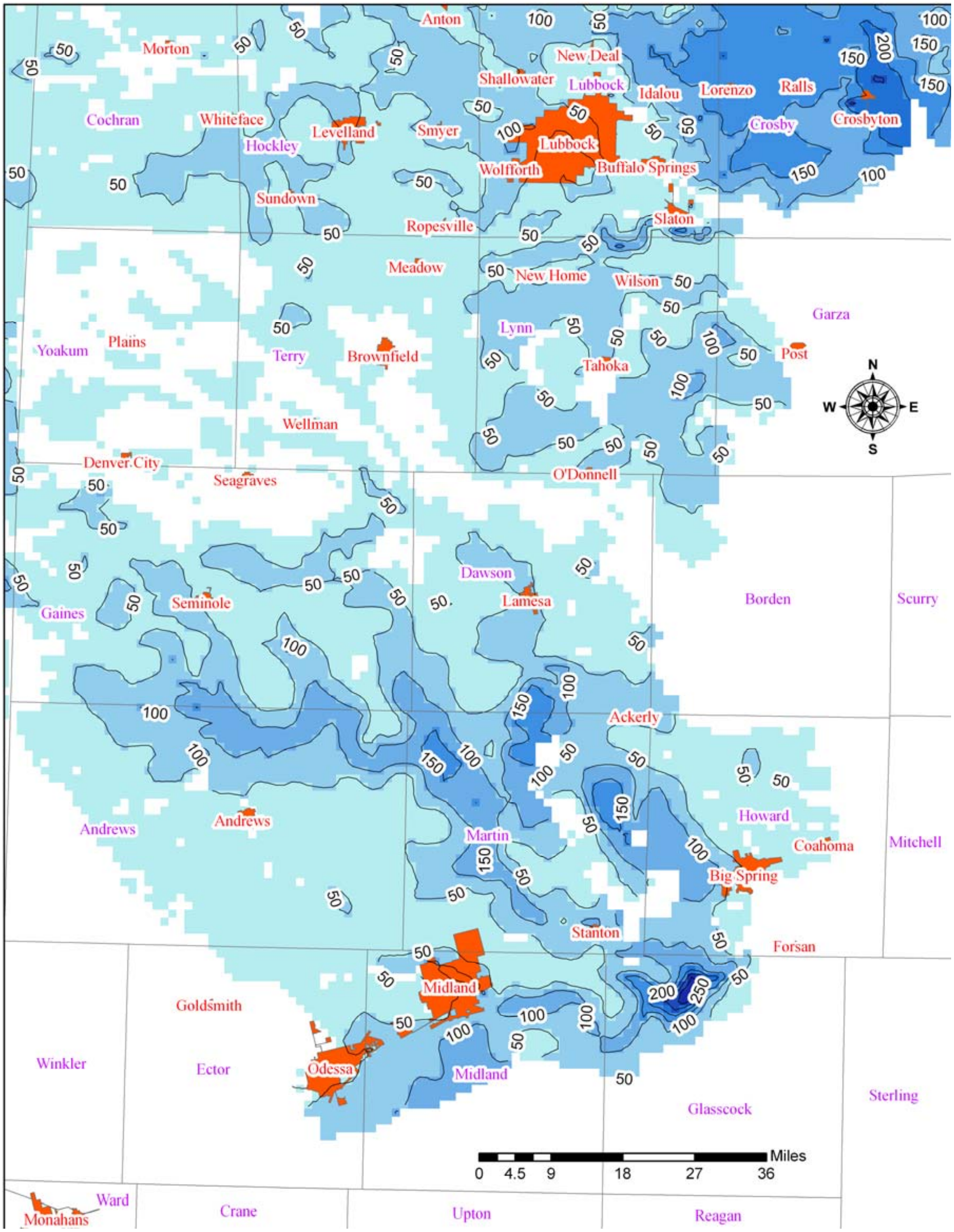


Figure 13: The southern part of the Southern Ogallala Aquifer in 2050 using ten year average drawdowns for each county based on Table 1. White areas are inactive cells or outside the model boundary. Major cities are labeled and highlighted in red. Contour interval is 50 feet.

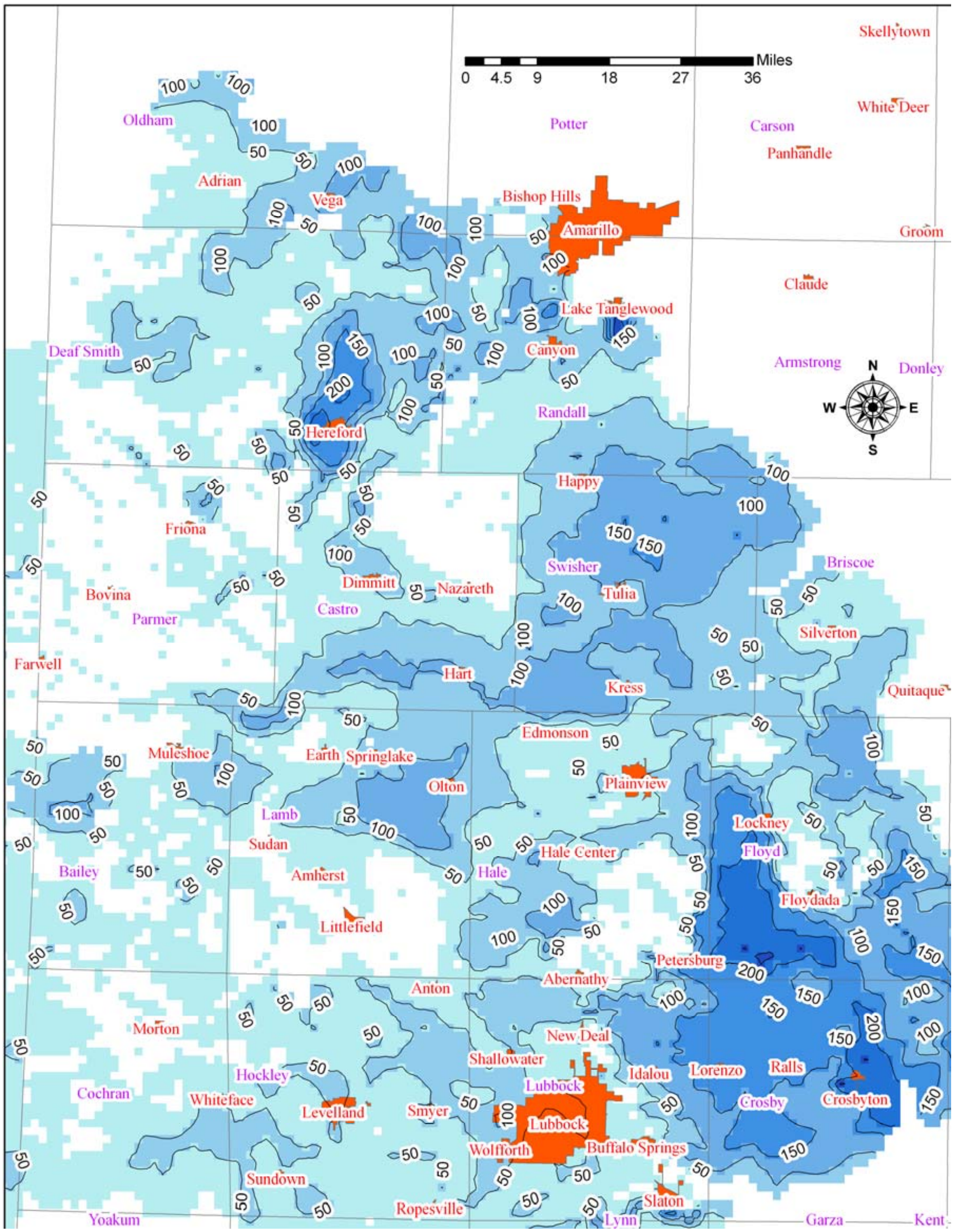


Figure 14: The northern part of the Southern Ogallala Aquifer in 2060 using ten year average drawdowns for each county based on Table 1. White areas are inactive cells or outside the model boundary. Major cities are labeled and highlighted in red. Contour interval is 50 feet.

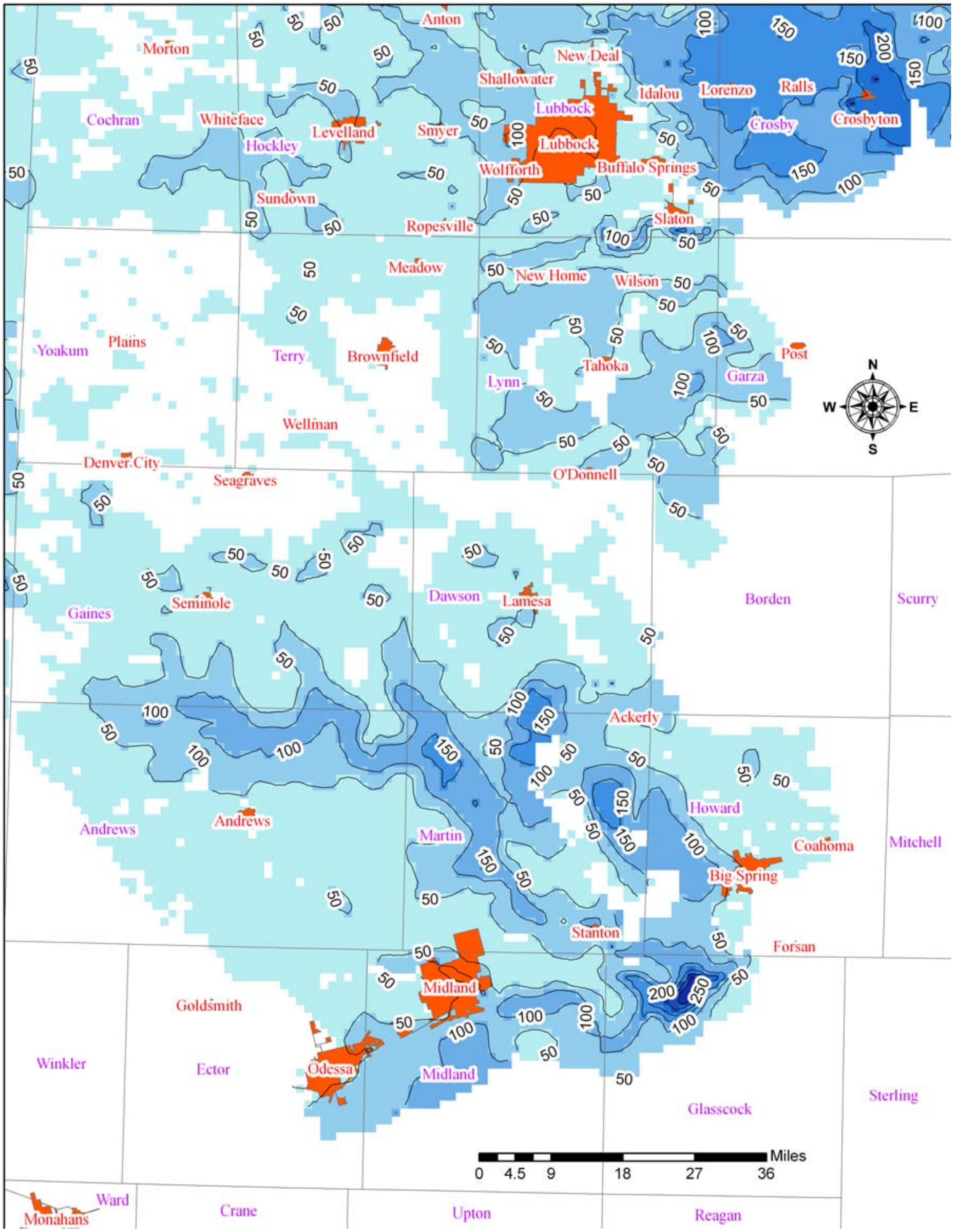


Figure 15: The southern part of the Southern Ogallala Aquifer in 2060 using ten year average drawdowns for each county based on Table 1. White areas are inactive cells or outside the model boundary. Major cities are labeled and highlighted in red. Contour interval is 50 feet.

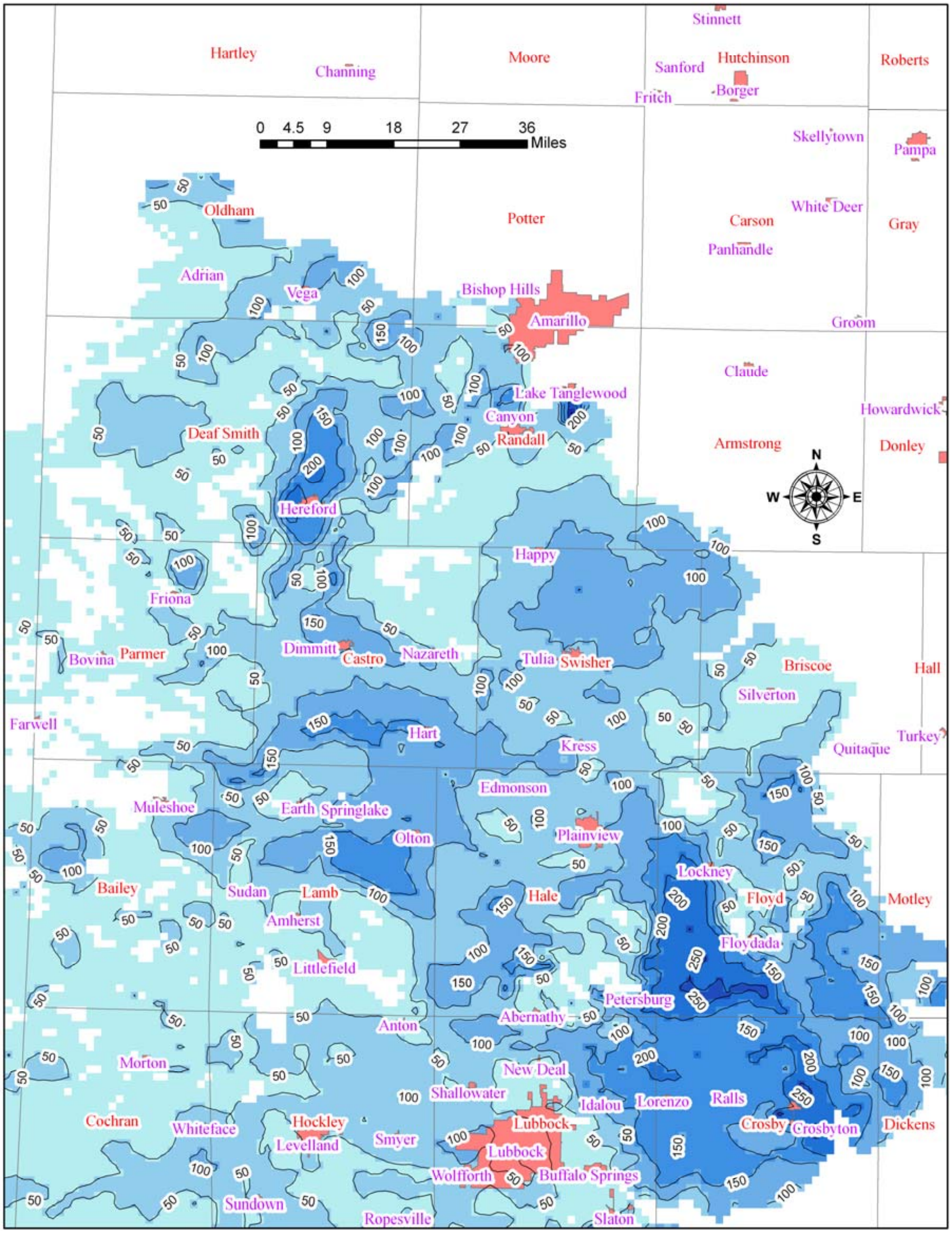


Figure 16: The northern part of the Southern Ogallala Aquifer in 2020 using weighted ten year average drawdowns for each county to achieve one foot of drawdown over the entire aquifer based on Table 1. White areas are inactive cells or outside the model boundary. Major cities are labeled and highlighted in red. Contour interval is 50 feet.

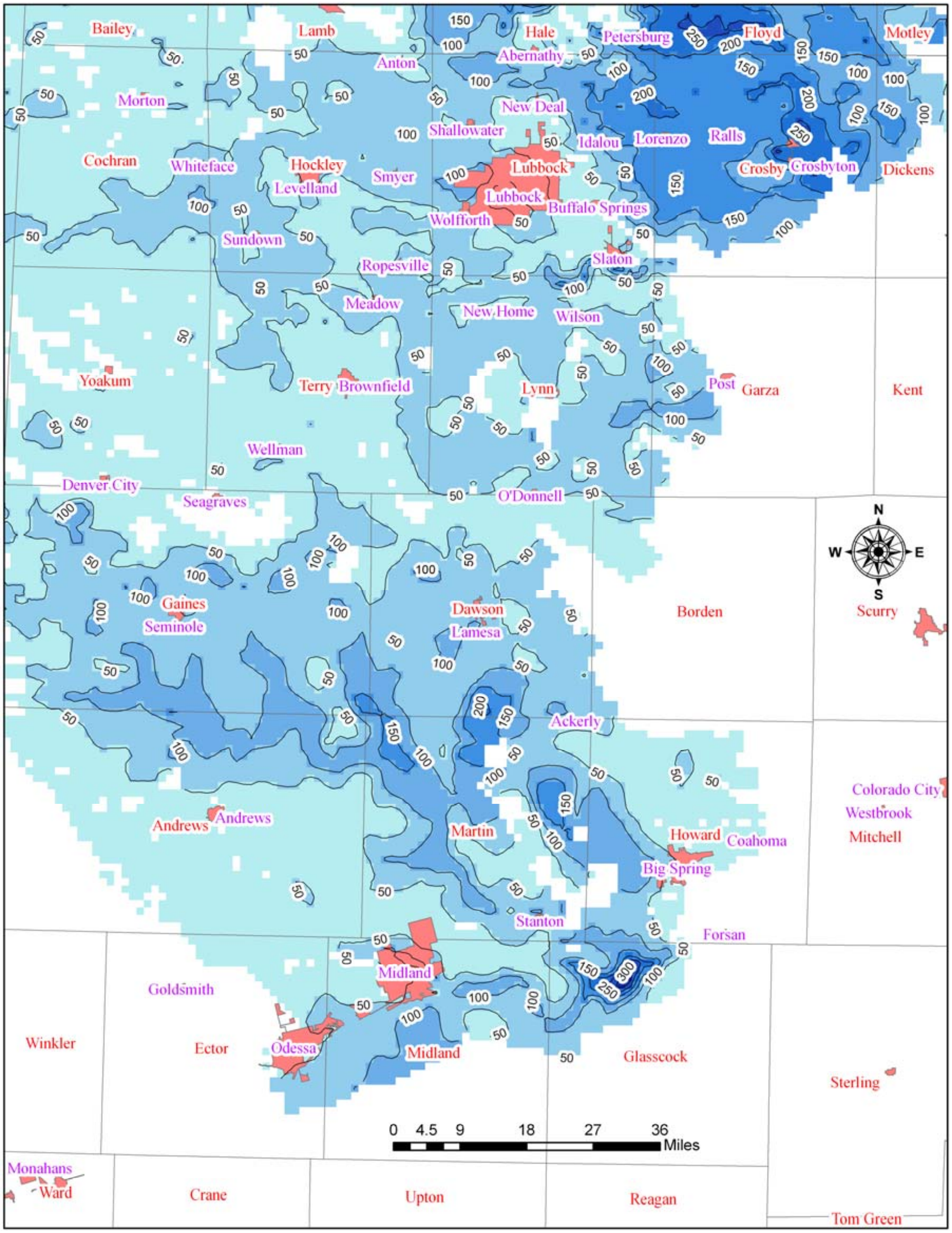


Figure 17: The southern part of the Southern Ogallala Aquifer in 2020 using weighted ten year average drawdowns for each county to achieve one foot of drawdown over the entire aquifer based on Table 1. White areas are inactive cells or outside the model boundary. Major cities are labeled and highlighted in red. Contour interval is 50 feet.

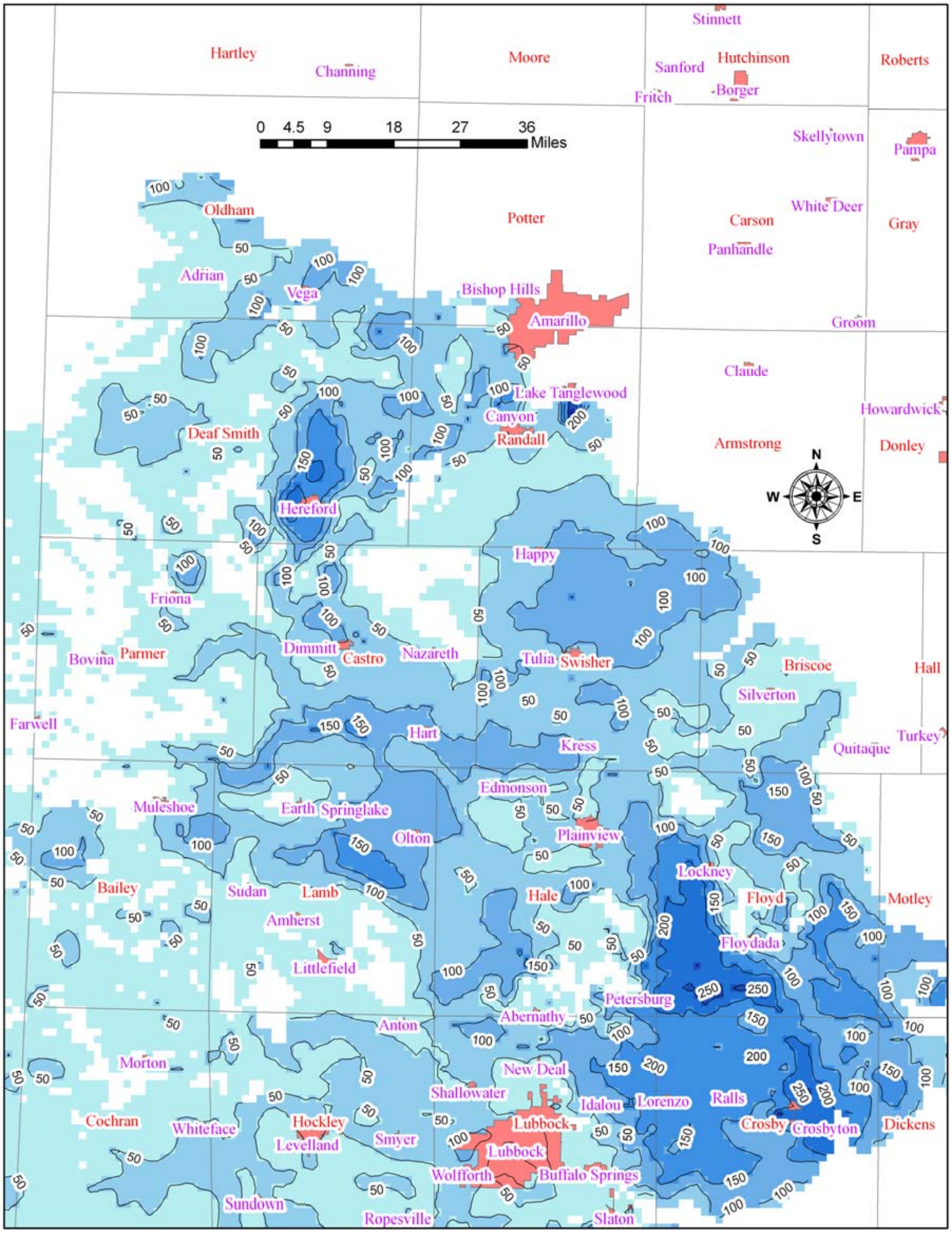


Figure 18: The northern part of the Southern Ogallala Aquifer in 2030 using weighted ten year average drawdowns for each county to achieve one foot of drawdown over the entire aquifer based on Table 1. White areas are inactive cells or outside the model boundary. Major cities are labeled and highlighted in red. Contour interval is 50 feet.

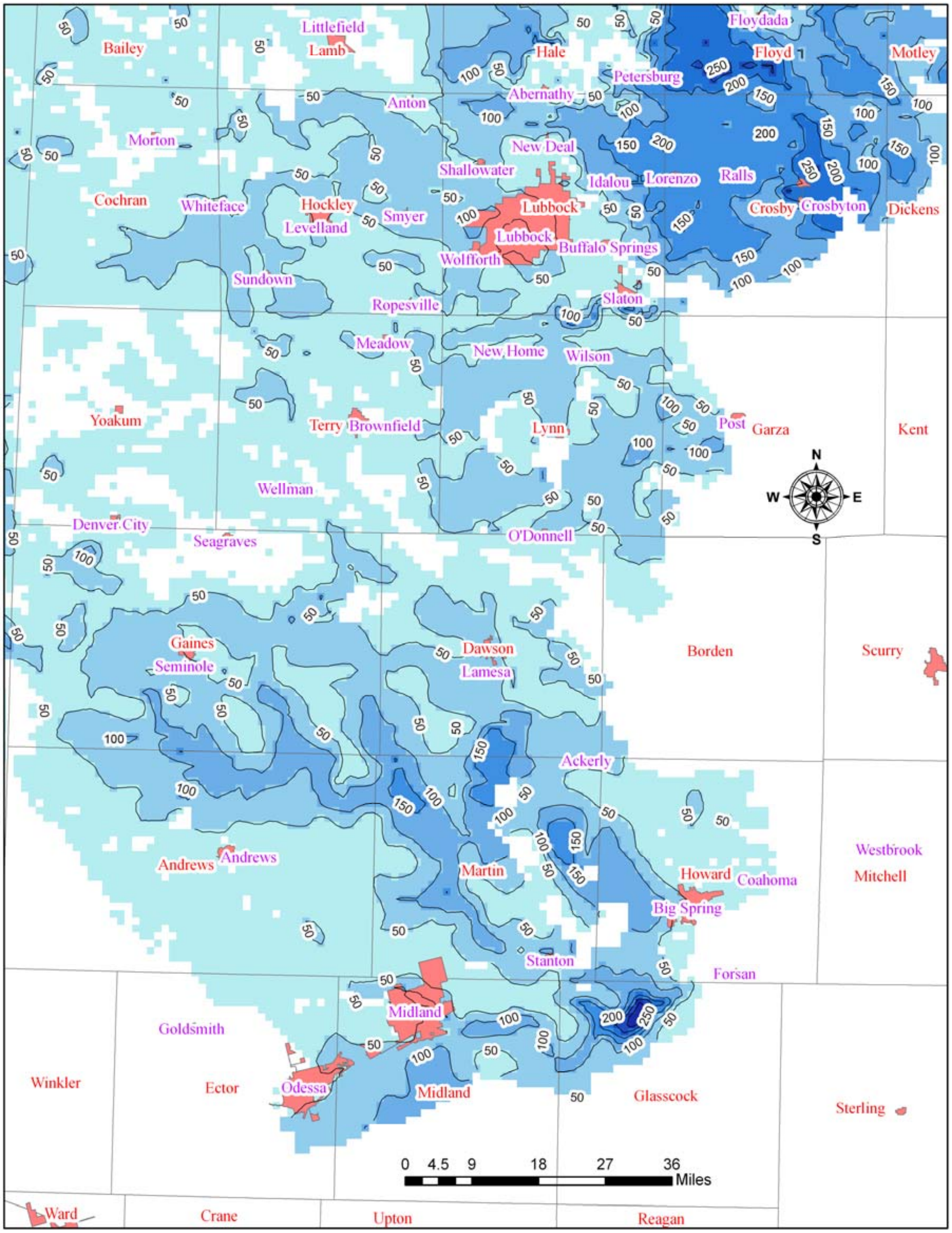


Figure 19: The southern part of the Southern Ogallala Aquifer in 2030 using weighted ten year average drawdowns for each county to achieve one foot of drawdown over the entire aquifer based on Table 1. White areas are inactive cells or outside the model boundary. Major cities are labeled and highlighted in red. Contour interval is 50 feet.

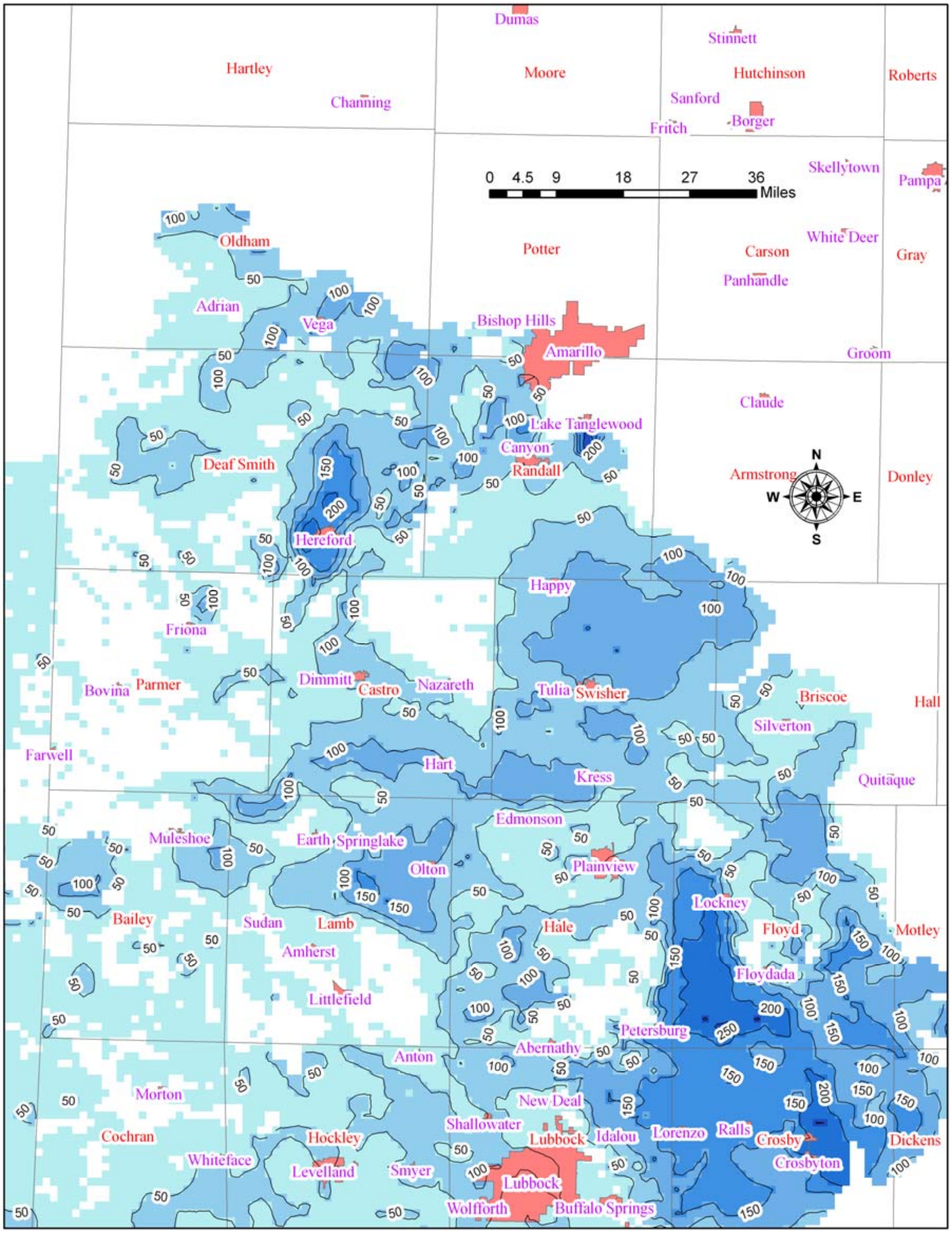


Figure 20: The northern part of the Southern Ogallala Aquifer in 2040 using weighted ten year average drawdowns for each county to achieve one foot of drawdown over the entire aquifer based on Table 1. White areas are inactive cells or outside the model boundary. Major cities are labeled and highlighted in red. Contour interval is 50 feet.

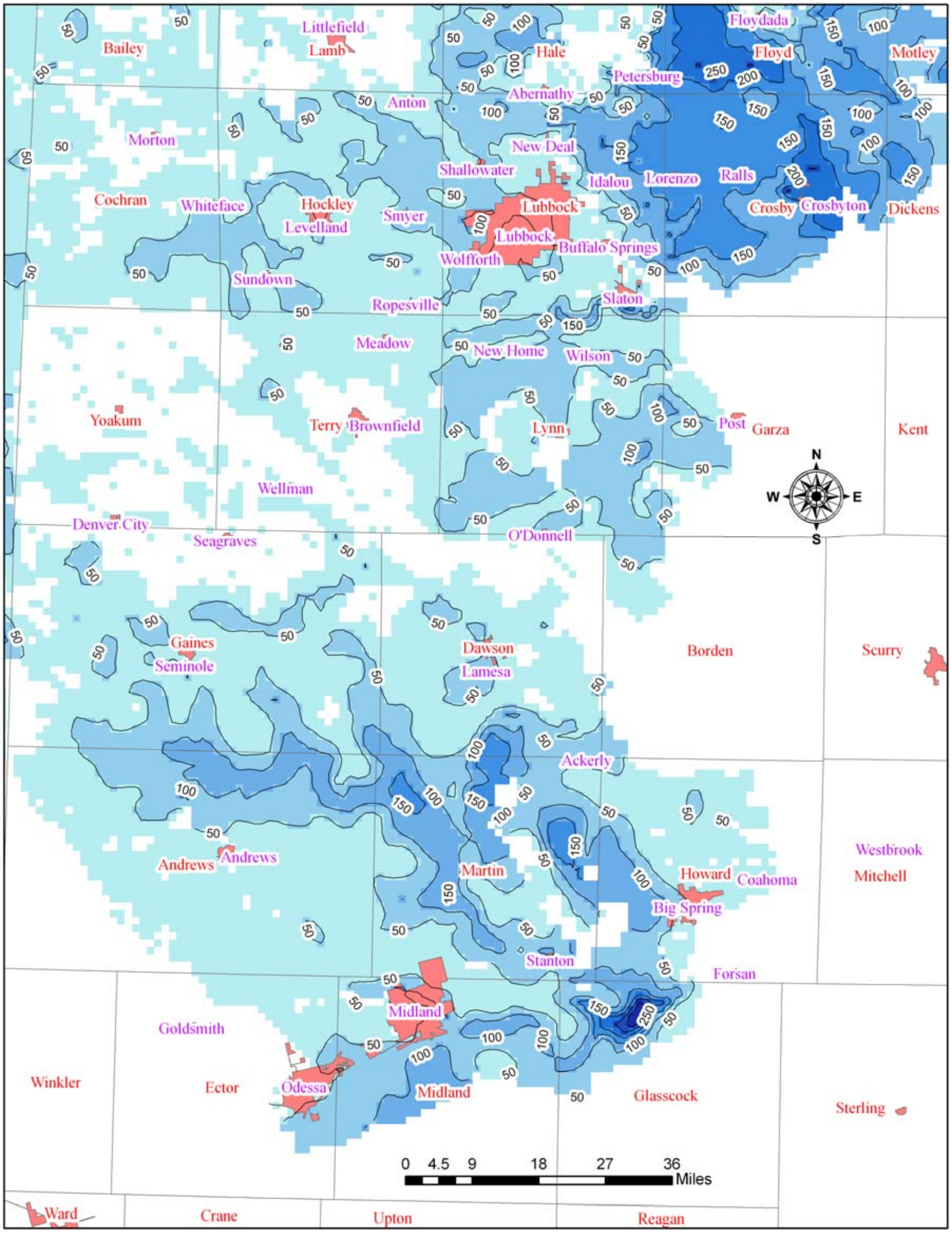


Figure 21: The southern part of the Southern Ogallala Aquifer in 2040 using weighted ten year average drawdowns for each county to achieve one foot of drawdown over the entire aquifer based on Table 1. White areas are inactive cells or outside the model boundary. Major cities are labeled and highlighted in red. Contour interval is 50 feet.

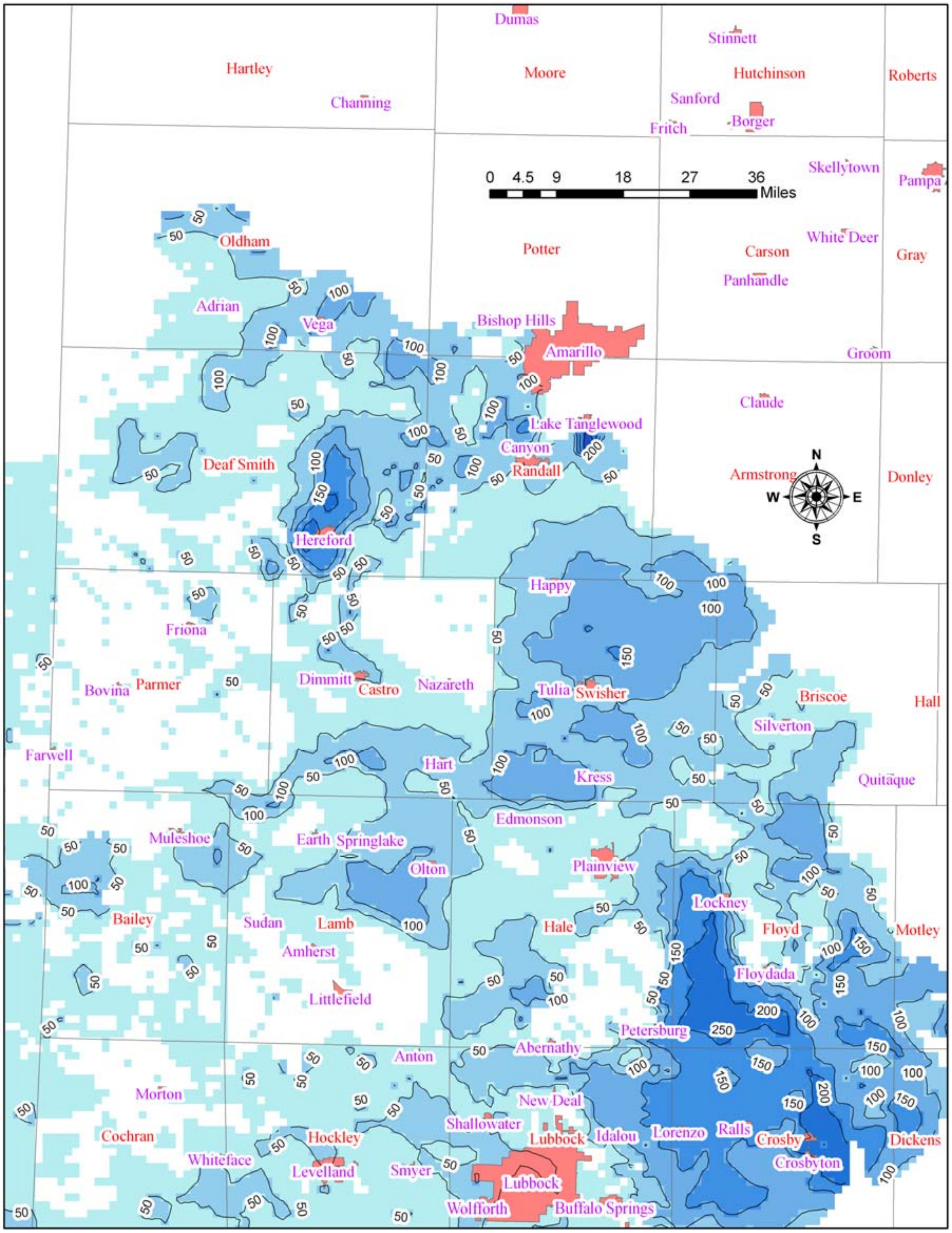


Figure 22: The northern part of the Southern Ogallala Aquifer in 2050 using weighted ten year average drawdowns for each county to achieve one foot of drawdown over the entire aquifer based on Table 1. White areas are inactive cells or outside the model boundary. Major cities are labeled and highlighted in red. Contour interval is 50 feet.

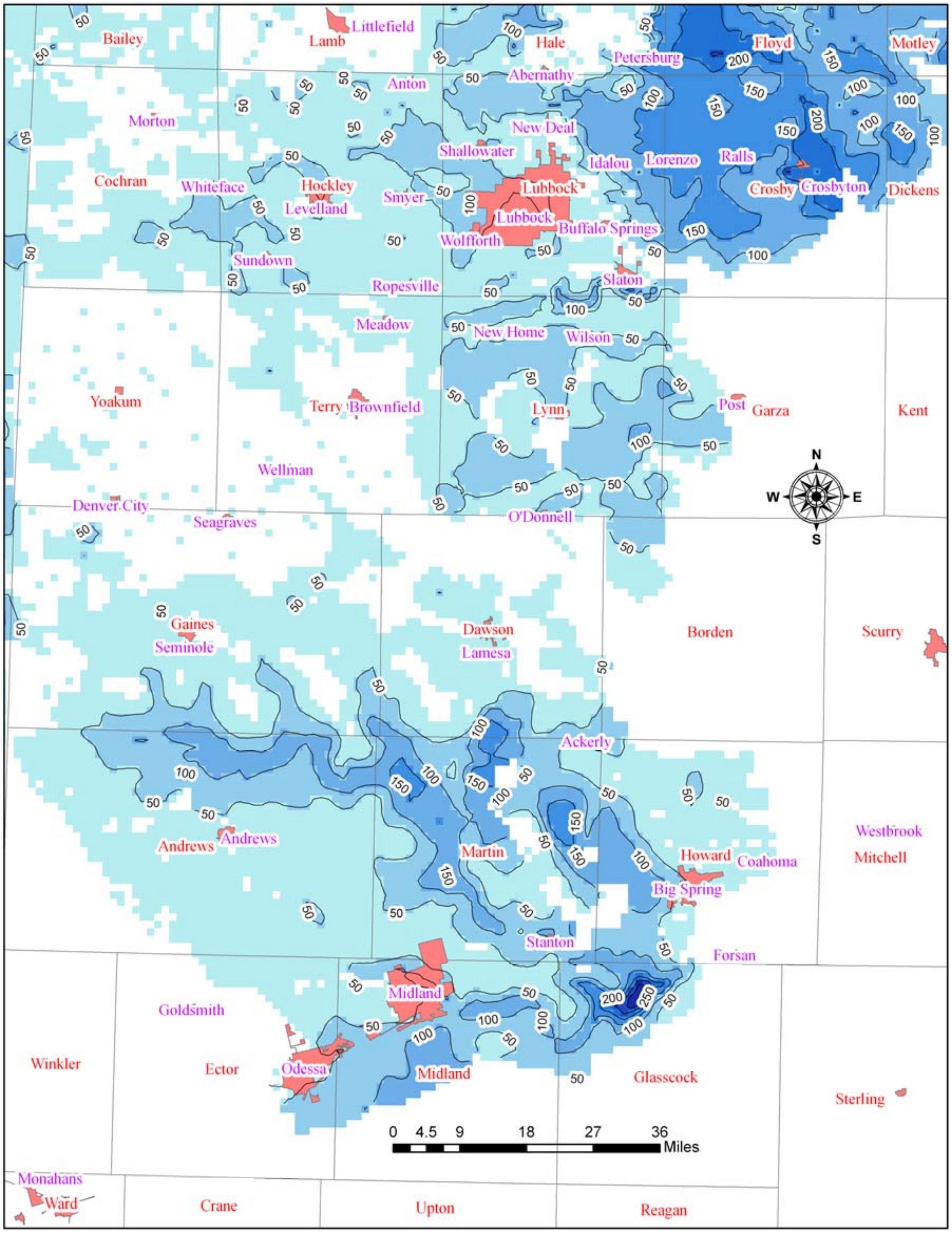


Figure 23: The southern part of the Southern Ogallala Aquifer in 2050 using weighted ten year average drawdowns for each county to achieve one foot of drawdown over the entire aquifer based on Table 1. White areas are inactive cells or outside the model boundary. Major cities are labeled and highlighted in red. Contour interval is 50 feet.

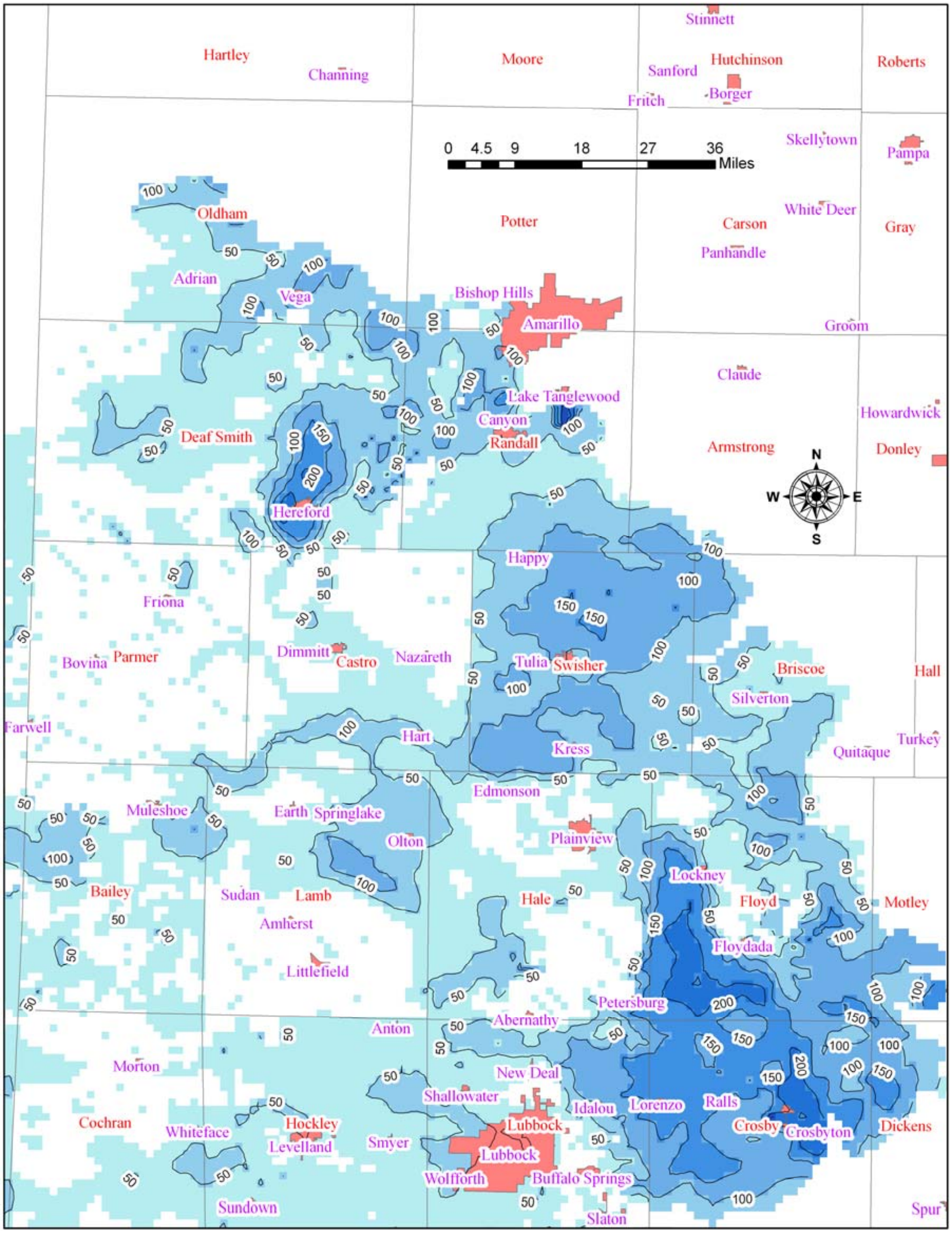


Figure 24: The northern part of the Southern Ogallala Aquifer in 2060 using weighted ten year average drawdowns for each county to achieve one foot of drawdown over the entire aquifer based on Table 1. White areas are inactive cells or outside the model boundary. Major cities are labeled and highlighted in red. Contour interval is 50 feet.

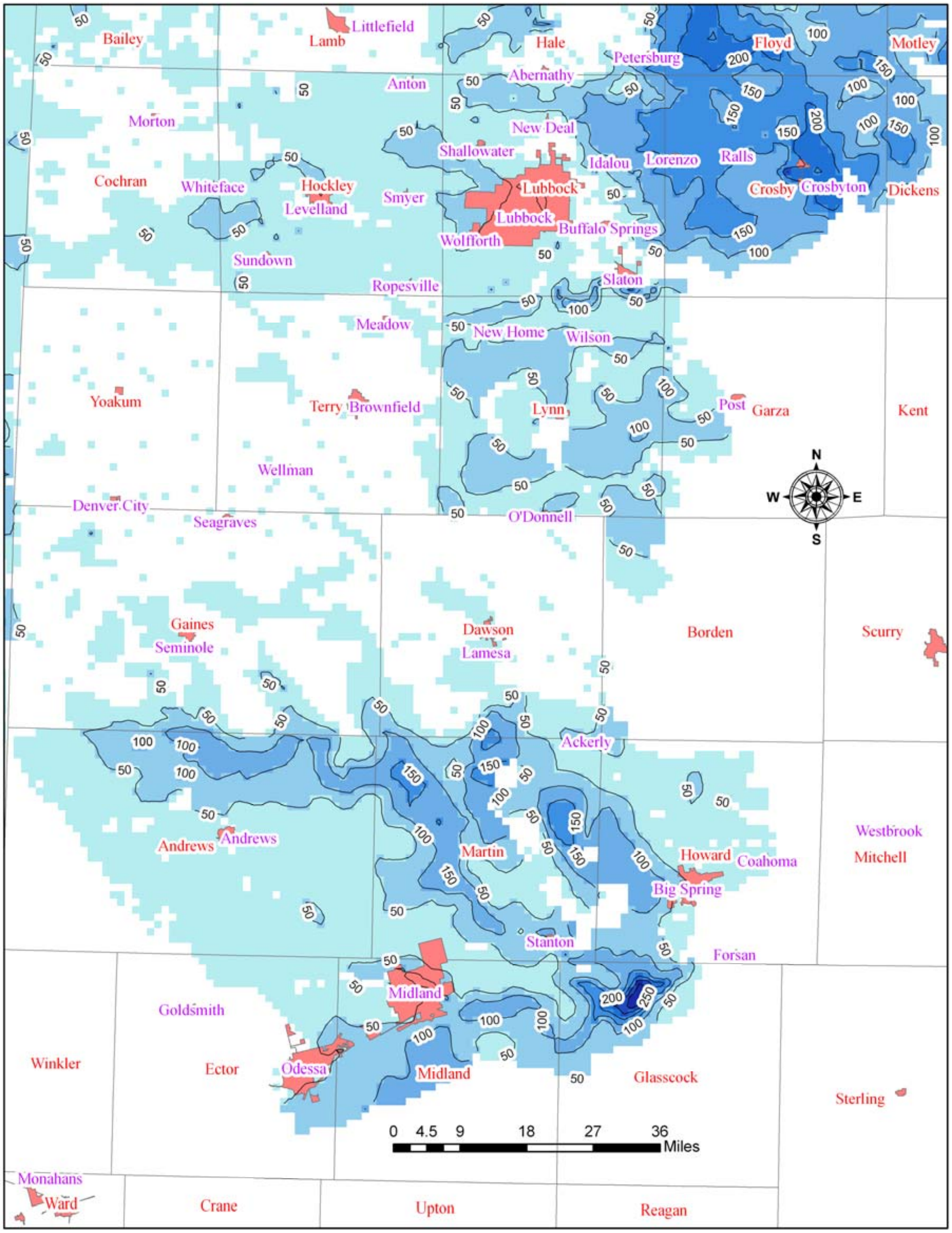


Figure 25: The southern part of the Southern Ogallala Aquifer in 2060 using weighted ten year average drawdowns for each county to achieve one foot of drawdown over the entire aquifer based on Table 1. White areas are inactive cells or outside the model boundary. Major cities are labeled and highlighted in red. Contour interval is 50 feet.