5.0 BLUE RIVER BASINS

5.1 Summary

Based on the analysis of the sufficiency of the long-term surface water supply in the Blue River Basins, the Department has reached a preliminary conclusion that the basins are not fully appropriated. The Department has also determined that, based on current information, if no additional legal constraints are imposed on future development of hydrologically connected surface water and groundwater, and reasonable projections are made about the extent and location of future development, this preliminary conclusion would not change to a conclusion that the basin is fully appropriated.

The analysis of lag effects of current development for areas in the Big Blue River Basin indicates a reduction in streamflows by 23 cfs in 25 years. The analysis of lag effects of current development for areas in the Little Blue River Basin indicates a reduction in streamflows by 27 cfs in 25 years.

The analysis of the impacts of potential future development in the Big Blue River Basin, based on current development trends, indicates an additional reduction in streamflows of 3 cfs in 25 years. The analysis of the impacts of potential future development in the Little Blue River Basin, based on current development trends, indicates an additional reduction in streamflows of 11 cfs in 25 years.

5.2 Basin Descriptions

The Blue River Basins in Nebraska include all surface areas that drain into the Big Blue River and the Little Blue River and all aquifers that impact surface water flows of the basins (Figure 5-1). The total area of the Blue River surface water basins in Nebraska is approximately 7,100 square miles, of which 4,600 square miles are in the Big Blue River Basin and 2,500 square miles are in the Little Blue River Basin. NRDs with significant area in the basins are the Little Blue, the Lower Big Blue, the Upper Big Blue, and the Tri-Basin NRDs. The basins are the subject to an interstate compact between Kansas and Nebraska that sets state line target flows.

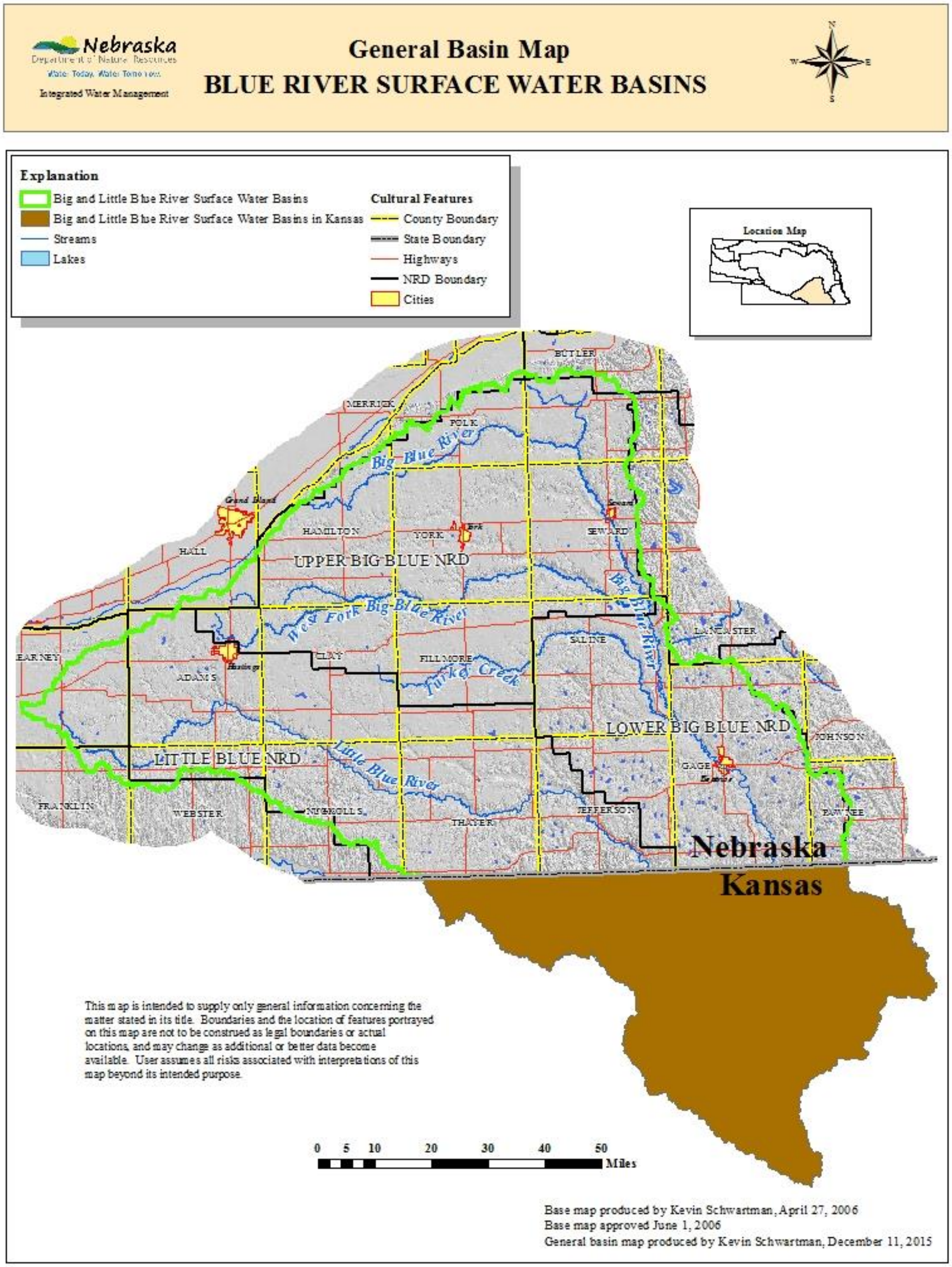

Figure 5-1. General basin map, Blue River Basins.

5.3 Nature and Extent of Water Use

5.3.1 Groundwater

Groundwater in the Blue River Basins is used for a variety of purposes: domestic, industrial, livestock, irrigation, and other uses. A total of 24,900 groundwater wells had been registered within the basins as of December 31, 2014 (Department registered groundwater wells database) (Figure 5-2). The locations of all active groundwater wells are shown in Figure 5-3.

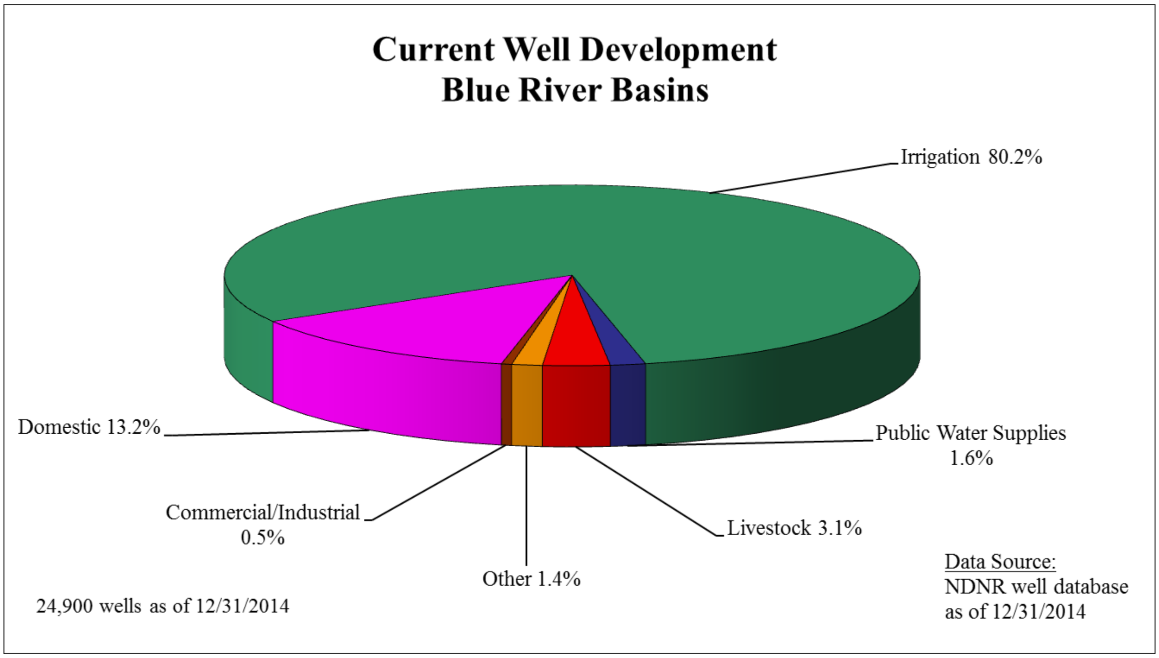

Figure 5-2. Current well development by number of registered wells, Blue River Basins.

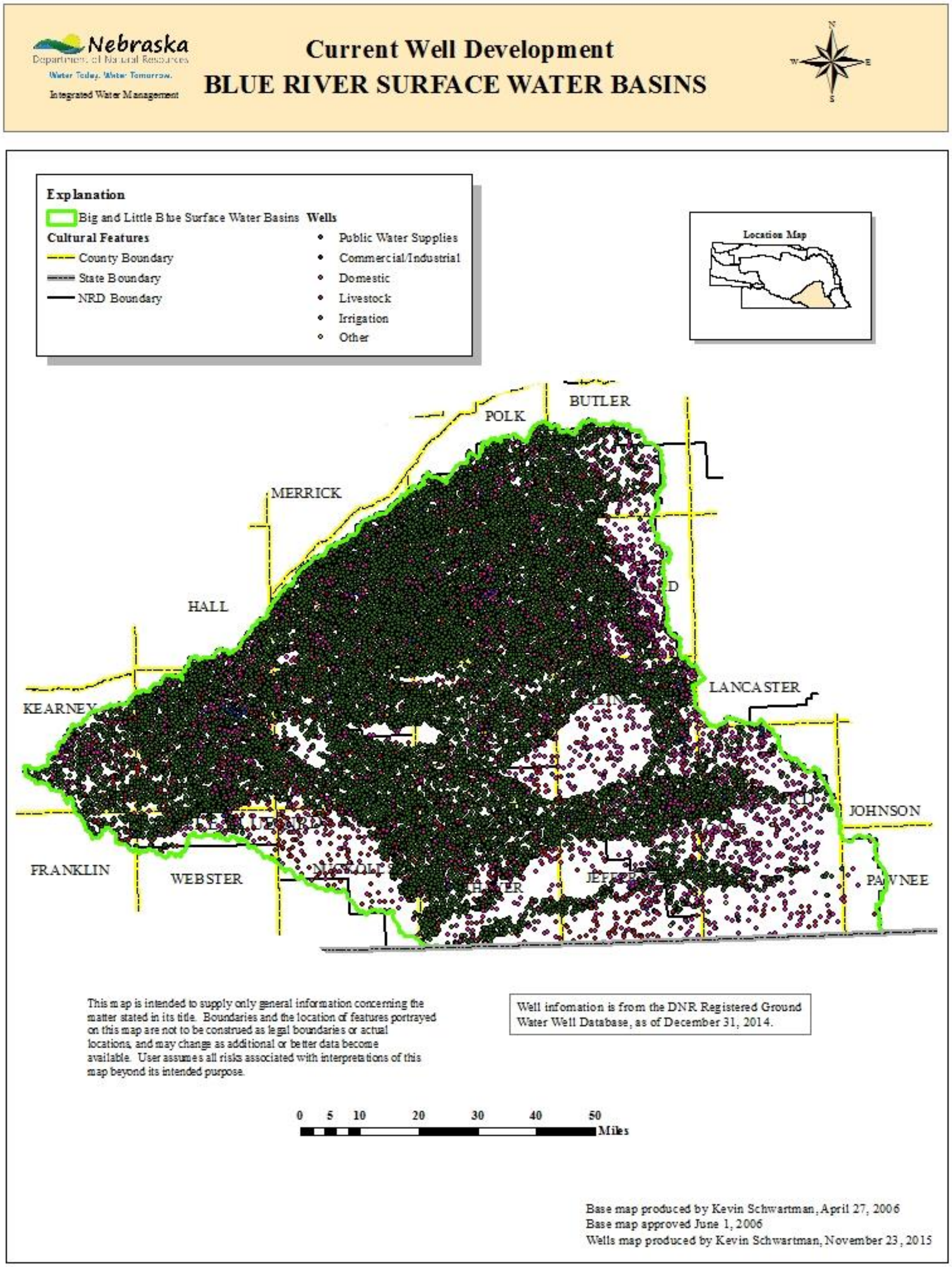

Figure 5-3. Current well locations, Blue River Basins.

5.3.2 Surface Water

As of December 31, 2014, 2,425 active surface water appropriations were held in the Blue River Basins, issued for a variety of uses (Figure 5-4). Most of the surface water appropriations are irrigation and storage uses that tend to be located on the major streams. The first surface water appropriations in the basins were permitted in 1868, and development has continued through the present day. The approximate locations of the surface water diversion points are shown in Figure 5-5.

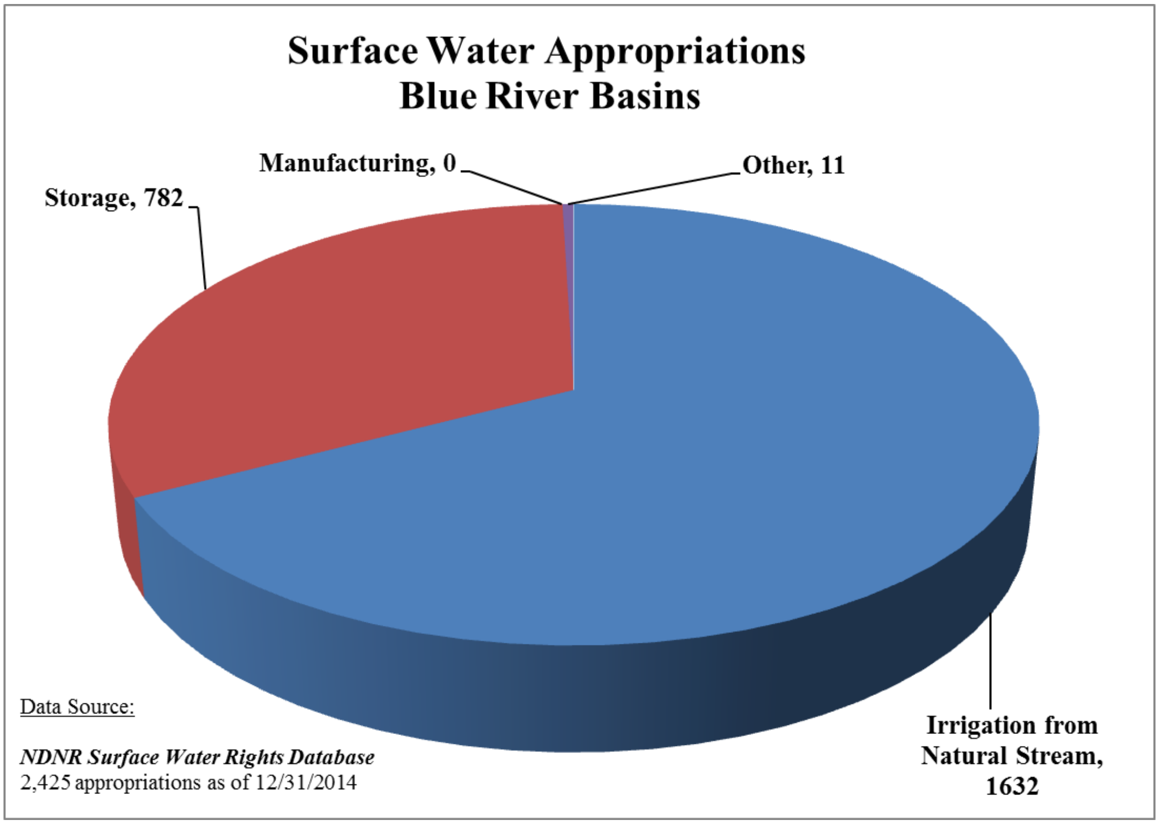

Figure 5-4. Surface water appropriations by number of diversion points, Blue River Basins.

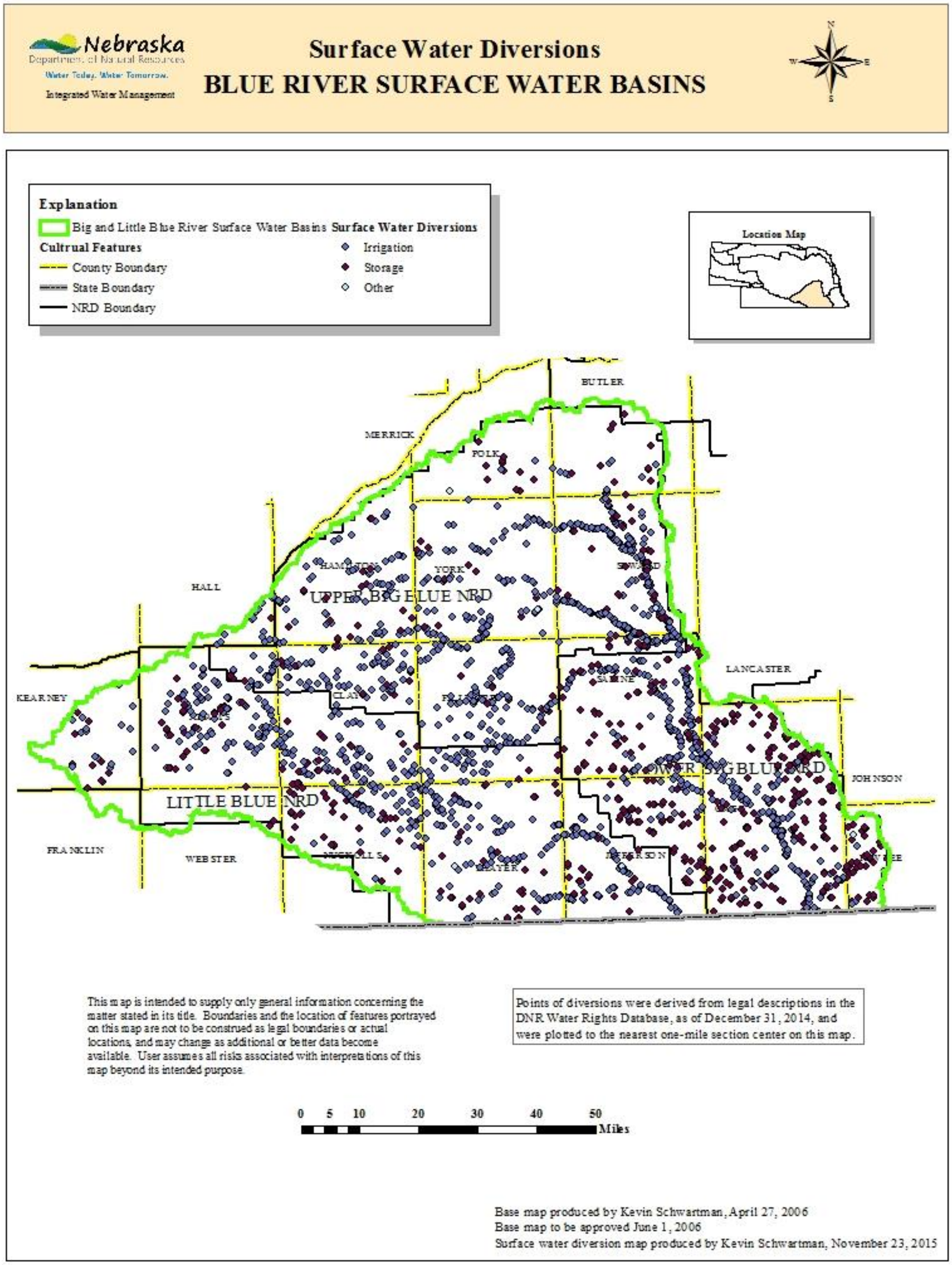

Figure 5-5. Surface water appropriation diversion locations, Blue River Basins.

5.4 Hydrologically Connected Area

The Blue Basin Model was used to determine the extent of the 10/50 area for the Blue River Basins. Figure 5-6 specifies the extent of the 10/50 area for the Little Blue River and Big Blue River basins.

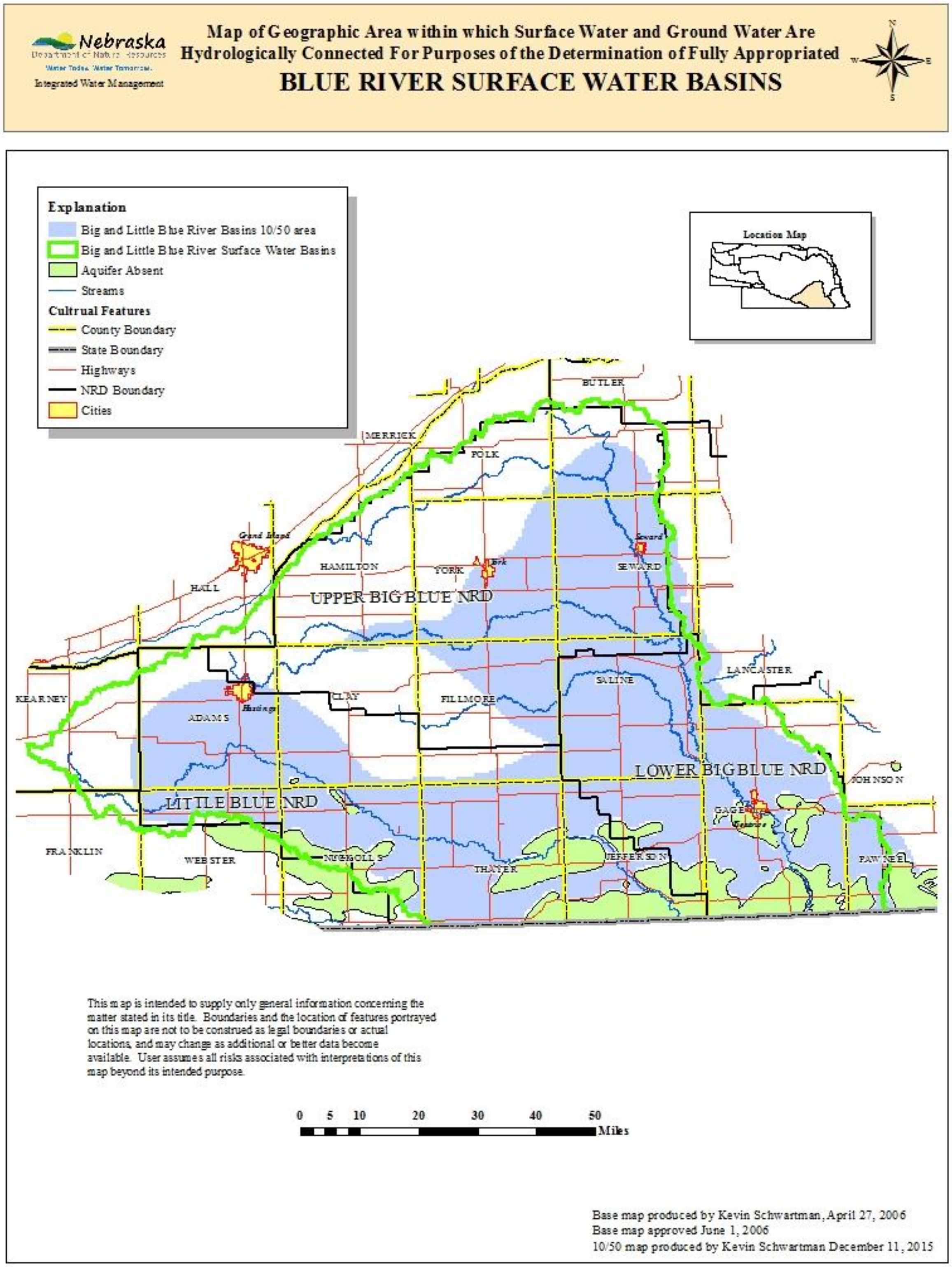

Figure 5-6. 10/50 area for the Blue River Basins.

5.5 Net Corn Crop Irrigation Requirement

Figure 5-7 is a map of the net corn crop irrigation requirement (NCCIR) for the Blue River Basins (DNR, 2005). The greatest NCCIR of a junior surface water appropriation in the Big Blue River Basin is 9.0 inches, and the greatest NCCIR in the Little Blue River Basin is 9.7 inches. To assess the number of days required for diversion, a surface water diversion rate equal to 1 cfs per 70 acres, a downtime of 10 percent, and an irrigation efficiency of 80 percent, were assumed. Based on these assumptions, the junior surface water appropriation in the Big Blue River Basin would need 23.9 days annually to divert 65 percent of the NCCIR and 31.3 days to divert 85 percent of the NCCIR. The junior surface water appropriation in the Little Blue River Basin will need 25.8 days annually to divert 65 percent of the NCCIR and 33.7 days to divert 85 percent of the NCCIR.

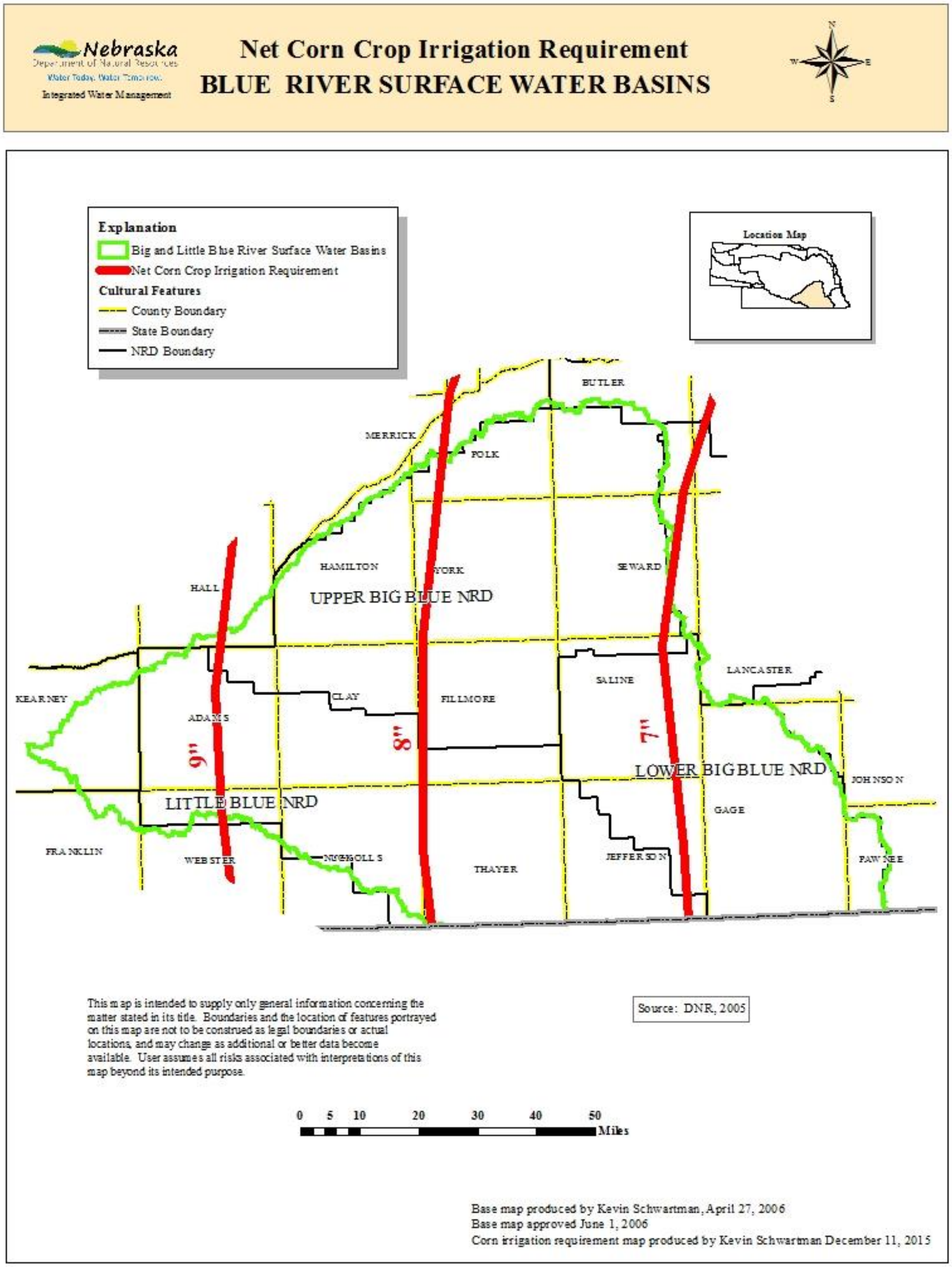

Figure 5-7. Net corn crop irrigation requirement (NCCIR), Blue River Basins.

5.6 Surface Water Closing Records

Tables 5-1 and 5-2 record all surface water administration that has occurred in the basins between 1995 and 2014.

Table 5-1. Surface water administration in the Big Blue River Basin, 1995-2014.

Year	Water Body	Days	Closing Date	Opening Date
2000	Turkey Creek	3	Jun 9	Jun 12
2000	Big Blue River above Lincoln Creek	2	Aug 15	Aug 17
2001	Big Blue River above Lincoln Creek	1	Aug 14	Aug 15
2002	Big Blue River above Lincoln Creek	11	Jul 11	Jul 22
2002	Big Blue River above Lincoln Creek	14	Jul 30	Aug 13
2002	Big Blue River Basin	8	Aug 5	Aug 13
2002	North Fork Big Blue River	1	Aug 14	Aug 15
2003	Big Blue River above Lincoln Creek	49	Jul 16	Sep 3
2003	Big Blue River Basin	11	Jul 17	Jul 28
2003	Big Blue River Basin	8	Aug 11	Aug 19
2004	Big Blue River above Lincoln Creek	16	Aug 3	Aug 19
2005	Big Blue River above Lincoln Creek	14	Jul 12	Jul 26
2005	Big Blue River Basin	13	Jul 13	Jul 26
2005	Big Blue River above West Fork	8	Jul 18	Jul 26
2005	Big Blue River above Lincoln Creek	11	Aug 4	Aug 15
2005	Big Blue River Basin	6	Aug 9	Aug 15
2005	Big Blue River above West Fork	5	Aug 10	Aug 15
2006	Big Blue River above West Fork	13	Jul 1	Jul 14
2006	Big Blue River above West Fork	22	Jul 17	Aug 8
2006	Big Blue River Basin	11	Jul 3	Jul 14
2006	Big Blue River Basin	5	Jul 19	Jul 24
2006	Big Blue River Basin	9	Jul 29	Aug 7
2012	Big Blue River Basin	83	Jul 9	Sep 30
2012	Upstream of A-2440 and A-2816	5	Jul 25	Jul 30
2013	Big Blue River Basin	19	Jul 11	Jul 30
2013	North Fork Big Blue River	23	Aug 21	Sep 13
2013	Big Blue River Basin	18	Aug 26	Sep 13
2014	Big Blue River Basin	14	Jul 29	Aug 11

Table 5-2. Surface water administration in the Little Blue River Basin, 1995-2014.

Year	Water Body	Days	Closing Date	Opening Date
2002	Little Blue River Basin	11	Jul 18	Jul 29
2002	Little Blue River Basin	13	Aug 6	Aug 19
2002	Little Blue River Basin	7	Sep 9	Sep 16
2004	Little Blue River Basin	10	Sep 13	Sep 23
2005	Little Blue River Basin	15	Jul 11	Jul 26
2005	Little Blue River Basin	7	Aug 8	Aug 15
2006	Little Blue River Basin	9	Jul 5	Jul 14
2006	Little Blue River Basin	1	Jul 20	Jul 21
2006	Little Blue River Basin	7	Jul 31	Aug 7
2006	Little Blue River Basin	8	Aug 9	Aug 17
2009	Little Blue River Basin	14	Aug 13	Aug 27
2012	Little Blue River Basin	14	Jul 20	Aug 3
2012	Little Blue River Basin	53	Aug 8	Sep 30
2013	Little Blue River Basin	22	Jul 8	Jul 30
2013	Little Blue River Basin	18	Aug 29	Sep 16
2013	Little Blue River Basin	4	Sep 27	Oct 1
2014	Little Blue River Basin	19	Jul 23	Aug 11

5.7 Evaluation of Current Development

5.7.1 Current Water Supply

The current water supply is estimated by using the most recent 20-year period (1995-2014) of surface water administration. The results of the analyses conducted for the Big Blue River Basin and Little Blue River Basin, respectively, are shown in Tables 5-3 and 5-4. The results indicate that the current surface water supply in the Big Blue River Basin provides an average of at least 49.9 days available for diversion between July 1 and August 31 and 138.6 days available for diversion between May 1 and September 30 (Table 5-5). The current surface water supply in the Little Blue River Basin provides an average of at least 53.7 days available for diversion between July 1 and August 31 and 141.4 days available for diversion between May 1 and September 30 (Table 5-6).

Table 5-3. Estimate of the current number of days surface water is available for diversion in the Big Blue River Basin.

Year	July 1 through August 31 Number of Days Surface Water is Available for Diversion	May 1 through September 30 Number of Days Surface Water is Available for Diversion
1995	62	153
1996	62	153
1997	62	153
1998	62	153
1999	62	153
2000	60	151
2001	61	152
2002	36	127
2003	16	104
2004	46	137
2005	37	128
2006	27	118
2007	62	153
2008	62	153
2009	62	153
2010	62	153
2011	62	153
2012	9	70
2013	37	116
2014	48	139
Average	49.9	138.6

Table 5-4. Estimate of the current number of days surface water is available for diversion in the Little Blue River Basin.

Year	July 1 through August 31 Number of Days Surface Water is Available for Diversion	May 1 through September 30 Number of Days Surface Water is Available for Diversion
1995	62	153
1996	62	153
1997	62	153
1998	62	153
1999	62	153
2000	62	153
2001	62	153
2002	38	122
2003	62	153
2004	62	143
2005	40	131
2006	37	128
2007	62	153
2008	62	153
2009	48	139
2010	62	153
2011	62	153
2012	25	86
2013	37	109
2014	43	134
Average	53.7	141.4

Table 5-5. Comparison between the number of days required to meet the net corn crop irrigation requirement and number of days surface water is currently available for diversion in the Big Blue River Basin.

	Number of Days Necessary to Meet the 65% and 85% of Net Corn Crop Irrigation Requirement	**Average Number of Days Available for Diversion with Current Development**
July 1 – August 31 (65% Requirement)	23.9	49.9 (26.0 days above the requirement)
May 1 – September 30 (85% Requirement)	31.3	138.6 (107.3 days above the requirement)

Table 5-6. Comparison between the number of days required to meet the net corn crop irrigation requirement and number of days surface water is currently available for diversion in the Little Blue River Basin.

	Number of Days Necessary to Meet the 65% and 85% of Net Corn Crop Irrigation Requirement	**Average Number of Days Available for Diversion with Current Development**
July 1 – August 31 (65% Requirement)	25.7	53.7 or greater (28.0 days above the requirement)
May 1 – September 30 (85% Requirement)	33.6	141.4 (107.8 days above the requirement)

5.7.2 Long-Term Water Supply

In order to complete the long-term evaluation of surface water supplies, a future 20-year water supply must be estimated for each basin. The Blue River Basins' water sources are precipitation, which runs off as direct streamflow and infiltrates into the ground to discharge as baseflow; and groundwater movement into the basins, which discharges as baseflow. Using methodology published in the *Journal of Hydrology* (Wen and Chen, 2005), a nonparametric Mann-Kendall trend test of the weighted average precipitation in the basins was completed. The analysis showed no statistically significant trend in precipitation ($P > 0.95$) over the past 60 years (Figure 5-8). Therefore, using the previous 20 years of streamflow data as the best estimate of the future surface water supply is reasonable.

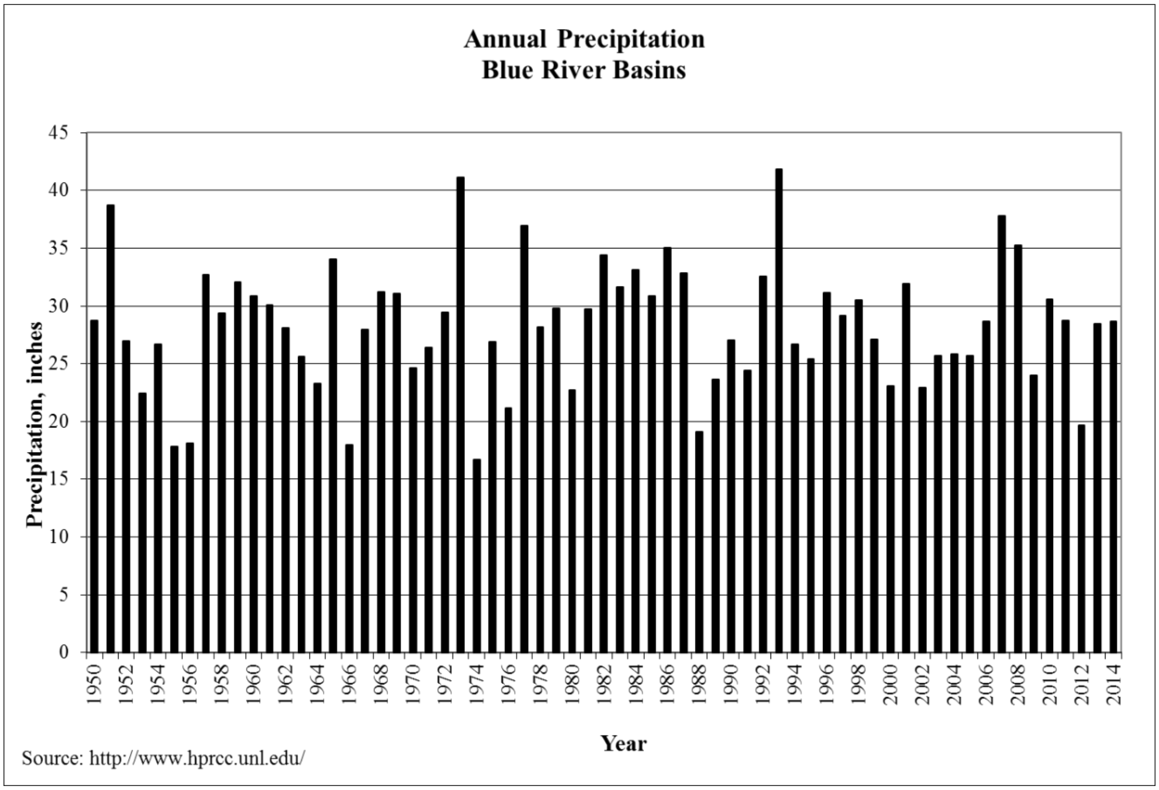

Figure 5-8. Annual precipitation, Blue River Basins.

5.7.3 Depletions Analysis

The future depletions due to current well development that could be expected to affect streamflow were estimated for the Big Blue River and Little Blue River basins using the Blue Basins Model. The results estimate the future streamflow in the Big Blue River Basin to be depleted by an additional 23 cfs in 25 years and flows in the Little Blue River Basin to be depleted by an additional 27 cfs in 25 years.

5.7.4 Evaluation of Current Levels of Development against Future Water Supplies

The estimates of the 20-year average number of days available for diversion are calculated by comparing the depleted future water supply with the flows necessary to satisfy the state line compact target flows. The results of the analyses are shown in Tables 5-7 and 5-8 and are compared to the numbers of days surface water is required to be available to divert 65 percent and 85 percent of the NCCIR in Tables 5-9 and 5-10. In all cases, the estimated long-term surface water supply, given current levels of development, is sufficient to satisfy the 65/85 rule.

Table 5-7. Estimate of days surface water is available for diversion in the Big Blue River Basin with current development and 25-year lag impacts.

Year	July 1 through August 31 Number of Days Surface Water is Available for Diversion	May 1 through September 30 Number of Days Surface Water is Available for Diversion
1	62	153
2	62	153
3	62	153
4	62	153
5	62	153
6	56	147
7	61	152
8	23	114
9	0	88
10	44	135
11	27	118
12	25	116
13	62	153
14	62	153
15	60	151
16	62	153
17	62	153
18	7	64
19	33	108
20	46	137
Average	47.0	135.4

Table 5-8. Estimate of days surface water is available for diversion in the Little Blue River Basin with current development and 25 year lag impacts.

Year	July 1 through August 31 Number of Days Surface Water is Available for Diversion	May 1 through September 30 Number of Days Surface Water is Available for Diversion
1	62	153
2	62	153
3	62	153
4	62	153
5	62	153
6	57	132
7	61	152
8	23	99
9	58	142
10	53	120
11	36	117
12	28	117
13	62	153
14	62	153
15	33	122
16	62	153
17	62	153
18	15	76
19	26	85
20	41	131
Average	49.5	133.5

Table 5-9. Comparison between the number of days required to meet the net corn crop irrigation requirement and number of days surface water is available for diversion in the Big Blue River Basin with current development and lag impacts.

	Number of Days Necessary to Meet the 65% and 85% of Net Corn Crop Irrigation Requirement	Average Number of Days Available for Diversion at Current Development with 25 Years of Lag Impacts
July 1 – August 31 (65% Requirement)	23.9	47.0 (23.1 days above the requirement)
May 1 – September 30 (85% Requirement)	31.3	135.4 (104.1 days above the requirement)

Table 5-10. Comparison between the number of days required to meet the net corn crop irrigation requirement and number of days surface water is available for diversion in the Little Blue River Basin with current development and lag impacts.

	Number of Days Necessary to Meet the 65% and 85% of Net Corn Crop Irrigation Requirement	Average Number of Days Available for Diversion at Current Development with 25 Years of Lag Impacts
July 1 – August 31 (65% Requirement)	25.7	49.5 (23.8 days above the requirement)
May 1 – September 30 (85% Requirement)	33.6	133.5 (99.9 days above the requirement)

5.8 Evaluation of Predicted Future Development

Estimates of the number of high-capacity wells (wells pumping greater than 50 gpm) that would be completed over the next 25 years, if no new legal constraints on the construction of such wells were imposed, were calculated based on extrapolating the present-day rate of increase in well development into the future (Figures 5-9 and 5-10). The present-day rate of development is based on the linear trend of the previous 10 years of development in the basins. Based on the analysis of the past 10 years of development, the rate of increase in high-capacity wells is estimated to be 68 wells per year in the Big Blue River Basin and 86 wells per year in the Little Blue River Basin.

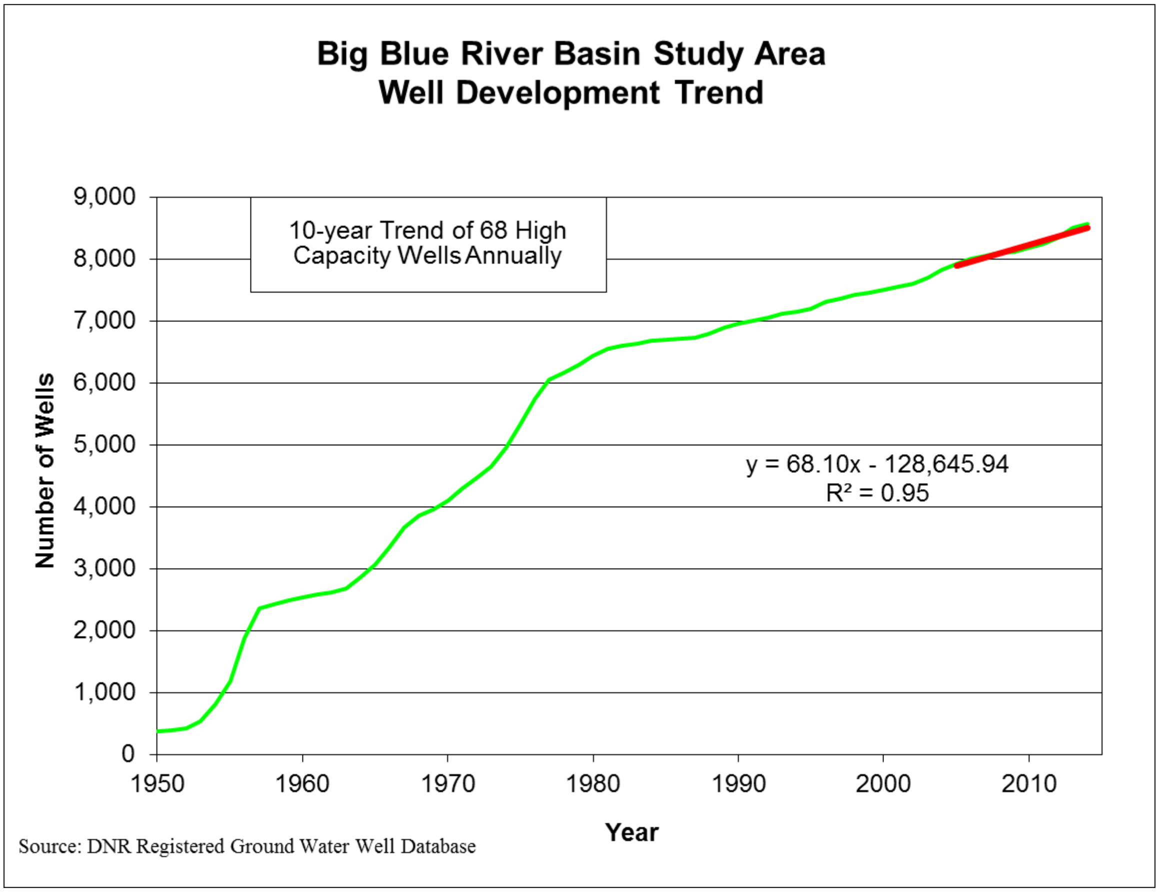

Figure 5-9. High capacity well development, western portion of Big Blue River Basin.

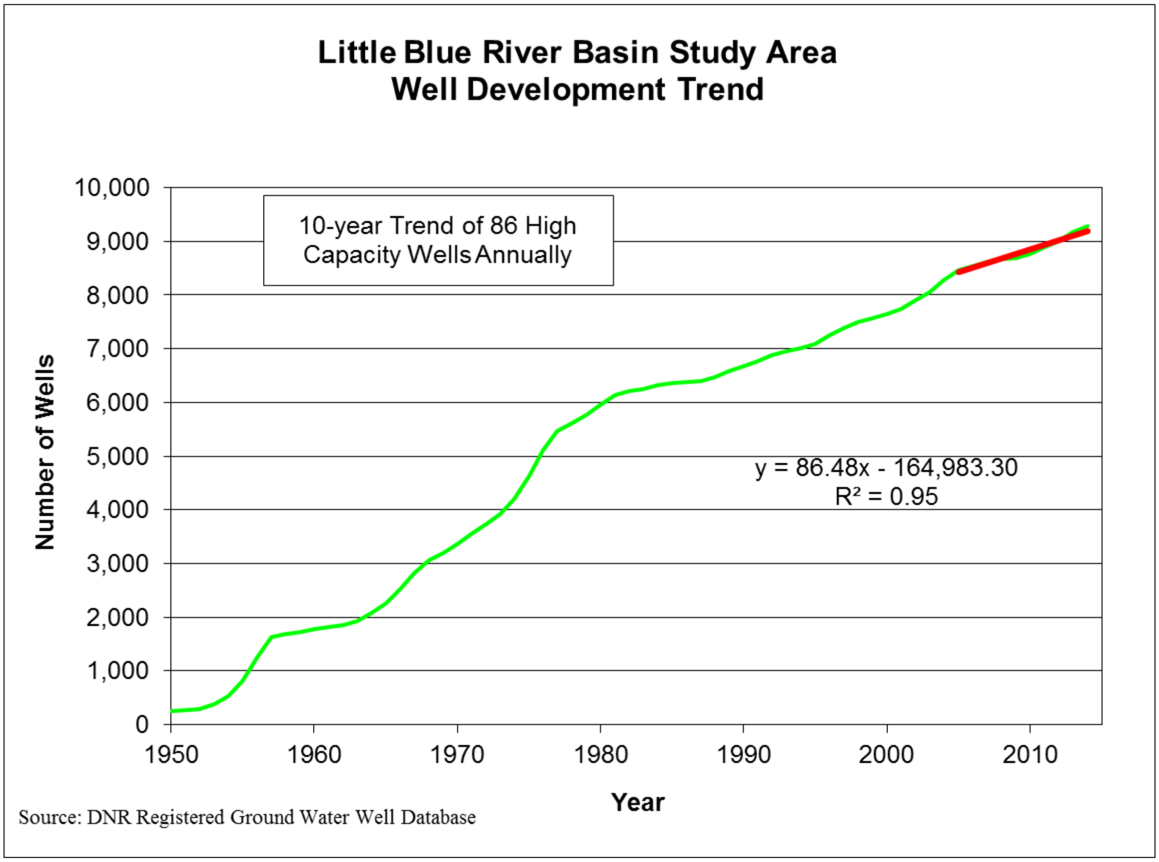

Figure 5-10. High capacity well development, western portion of Little Blue River Basin.

The future depletions due to current and future well development that could be expected to affect streamflow in the basin were estimated using the methodology from Hunt (1999). The results estimate the streamflow in the Big Blue River Basin will be depleted by an additional 3 cfs in 25 years due to potential future development. The results estimate the future streamflow in the Little Blue River Basin will be depleted by an additional 11 cfs in 25 years due to potential future development.

The estimate of the 20-year average number of days surface water is available for diversion with additional future development is calculated by comparing the future lag-adjusted flow with the flows necessary to satisfy the state line compact flow targets. The results of the analyses are shown in Tables 5-11 and 5-12 and are compared to the numbers of days surface water is required to be available to divert 65 percent and 85 percent of the NCCIR in Tables 5-13 and 5-14. The results indicate that, based on current information, the Department's conclusion that the basin is not fully appropriated would not change if no additional constraints are placed on future development of surface water and groundwater in the basin.

Table 5-11. Estimated number of days surface water is available for diversion in the Big Blue River Basin with current and predicted future development.

Year	July 1 through August 31 Number of Days Surface Water is Available for Diversion	May 1 through September 30 Number of Days Surface Water is Available for Diversion
1	62	153
2	62	153
3	62	153
4	62	153
5	62	153
6	56	147
7	61	152
8	22	113
9	0	87
10	43	134
11	26	114
12	24	115
13	61	152
14	62	153
15	59	150
16	62	153
17	62	153
18	6	63
19	32	106
20	46	137
Average	46.6	134.7

Table 5-12. Estimated number of days surface water is available for diversion in the Little Blue River Basin with current and predicted future development.

Year	July 1 through August 31 Number of Days Surface Water is Available for Diversion	May 1 through September 30 Number of Days Surface Water is Available for Diversion
1	62	153
2	62	153
3	62	153
4	62	153
5	62	153
6	53	115
7	59	149
8	22	98
9	55	139
10	51	118
11	33	111
12	26	112
13	59	150
14	62	153
15	27	114
16	61	152
17	62	153
18	13	74
19	23	79
20	41	127
Average	47.9	130.5

Table 5-13. Comparison between the number of days required to meet the net corn crop irrigation requirement and number of days surface water is available for diversion in the Big Blue River Basin with current and predicted future development.

	Number of Days Necessary to Meet the 65% and 85% of Net Corn Crop Irrigation Requirement	**Average Number of Days Available for Diversion with Future Development and 25 Years of Lag Impacts**
July 1 – August 31 (65% Requirement)	23.9	46.6 (22.7 days above the requirement)
May 1 – September 30 (85% Requirement)	31.3	134.7 (103.4 days above the requirement)

Table 5-14. Comparison between the number of days required to meet the net corn crop irrigation requirement and number of days surface water is available for diversion in the Little Blue River Basin with current and predicted future development.

	Number of Days Necessary to Meet the 65% and 85% of Net Corn Crop Irrigation Requirement	**Average Number of Days Available for Diversion with Future Development and 25 Years of Lag Impacts**
July 1 – August 31 (65% Requirement)	25.7	47.9 (22.2 days above the requirement)
May 1 – September 30 (85% Requirement)	33.6	130.5 (96.9 days above the requirement)

5.9 Sufficiency to Avoid Noncompliance

The State of Nebraska is a signatory member of the Kansas–Nebraska Big Blue River Compact (Compact). The purposes of the Compact are to promote interstate comity, to achieve an equitable apportionment of the waters of the Big Blue River Basin, to encourage continuation of the active pollution-abatement programs in each of the two states, and to seek further reduction in pollution of the waters of the Big Blue River Basin.

The Compact sets state line flow targets from May 1 through September 30. The state line targets measured in cubic feet of water per second (cfs) are shown in Table 5-15. If the flow targets are not met, then the State of Nebraska is required to take the following actions:

1. Limit surface water diversions by natural flow appropriators to their decreed appropriations;
2. Close natural flow appropriators with priority dates junior to November 1, 1968, in accordance with the doctrine of priority;
3. Ensure that no illegal surface water diversions are taking place; and
4. Regulate wells installed after November 1, 1968 within the alluvium and valley side terrace deposits downstream of Turkey Creek in the Big Blue River Basin and downstream of Walnut Creek in the Little Blue River Basin, unless the Compact Administration determines that such regulation would not yield any measurable increase in flows at the state line gage.

For the present time, the Compact Administration has found that the regulation of wells within the area described in number four above will not yield measurable increases in flow at the state line.

Table 5-15. State line flow targets for the Blue River Basins.

Month	Big Blue River Target Flow	Little Blue River Target Flow
May	45 cfs	45 cfs
June	45 cfs	45 cfs
July	80 cfs	75 cfs
August	90 cfs	80 cfs
September	65 cfs	60 cfs

As long as Nebraska administers surface and groundwater in compliance with the Compact, decreased streamflow, in and of itself, will not cause Nebraska to be in noncompliance;

therefore, any depletion would not cause Nebraska to be in noncompliance. Decreased streamflows could, however, increase the number of times the state would have to administer water to remain in compliance, thereby reducing the number of days available for junior irrigators to divert.

5.10 Groundwater Recharge Sufficiency

The streamflow is sufficient to sustain over the long-term the beneficial uses from wells constructed in aquifers dependent on recharge from the stream as explained in Appendix F.

5.11 Current Studies Being Conducted to Assist with Future Analysis

The Department has completed a numerical model for the Blue River Basins. The Department plans to continue to work with the local NRDs in these basins to refine pumping estimates that are incorporated into the model for further refinement of the model. Additionally, the Little Blue and Tri-Basin NRDs have initiated efforts to develop a voluntary integrated management plan for the Little Blue River Basin.

5.12 Relevant Data Provided by Interested Parties

The Department published a request for relevant data from interested parties for this year's evaluation on October 21, 2015 (see Appendix B for affidavit). The Department did not receive any such information.

5.13 Conclusions

Based on the analysis of the sufficiency of the long-term surface water supply in the Blue River Basins, the Department has reached a preliminary conclusion that the basins are not fully appropriated. The Department has also determined that, based on current information, if no additional legal constraints are imposed on future development of hydrologically connected surface water and groundwater, and reasonable projections are made about the extent and location of future development, this preliminary conclusion would not change to a conclusion that the basin is fully appropriated.

The analysis of lag effects of current development for areas in the Big Blue River Basin indicates a reduction in streamflows of 23 cfs in 25 years. The analysis of lag effects of current development for areas in the Little Blue River Basin indicates a reduction in streamflows of 27 cfs in 25 years.

The analysis of the impacts of potential future development in the Big Blue River Basin based on current development trends indicates an additional reduction in streamflows of 3 cfs in 25 years. The analysis of the impacts of potential future development in the Little Blue River Basin based on current development trends indicates an additional reduction in streamflows of 11 cfs in 25 years.

Bibliography of Hydrogeologic References for Big and Little Blue River Basins

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