6.0 LOWER NIOBRARA RIVER BASIN

6.1 Summary

Based on the analysis of the sufficiency of the long-term surface water supply in the Lower Niobrara River Basin, the Department has reached a preliminary conclusion that the basin is not fully appropriated. The analysis of lag effects of current development for the Lower Niobrara Basin indicates a reduction in streamflows of 10 cfs in twenty-five years. The analysis of the impacts of future development on the Lower Niobrara Basin based on current development trends indicates an additional reduction in streamflows of 101 cfs in twenty-five years. The future number of days available to junior irrigators was not estimated because only minimal surface water administration has occurred on the Niobrara River in the past twenty years. Even though the future number of days available to junior irrigators was not estimated, the current number of days in which surface water was available for diversion far exceeds the number of days necessary to meet the net corn crop irrigation requirement.

6.2 Basin Description

The Lower Niobrara River Basin in Nebraska is defined in this report as the surface areas in Nebraska that drain into the Niobrara River Basin and that have not previously been determined to be fully appropriated. This general basin area extends from the Spencer Hydropower facility in the west downstream to the confluence of the Niobrara River and the Missouri River and includes all aquifers that impact surface water flows in the basin (figure 6-1). The total area of the Lower Niobrara River Basin evaluated in this year's report is approximately 1,200 square miles. The Lower Niobrara and the Upper Elkhorn NRDs are the only NRDs with significant area in the Lower Niobrara River Basin.

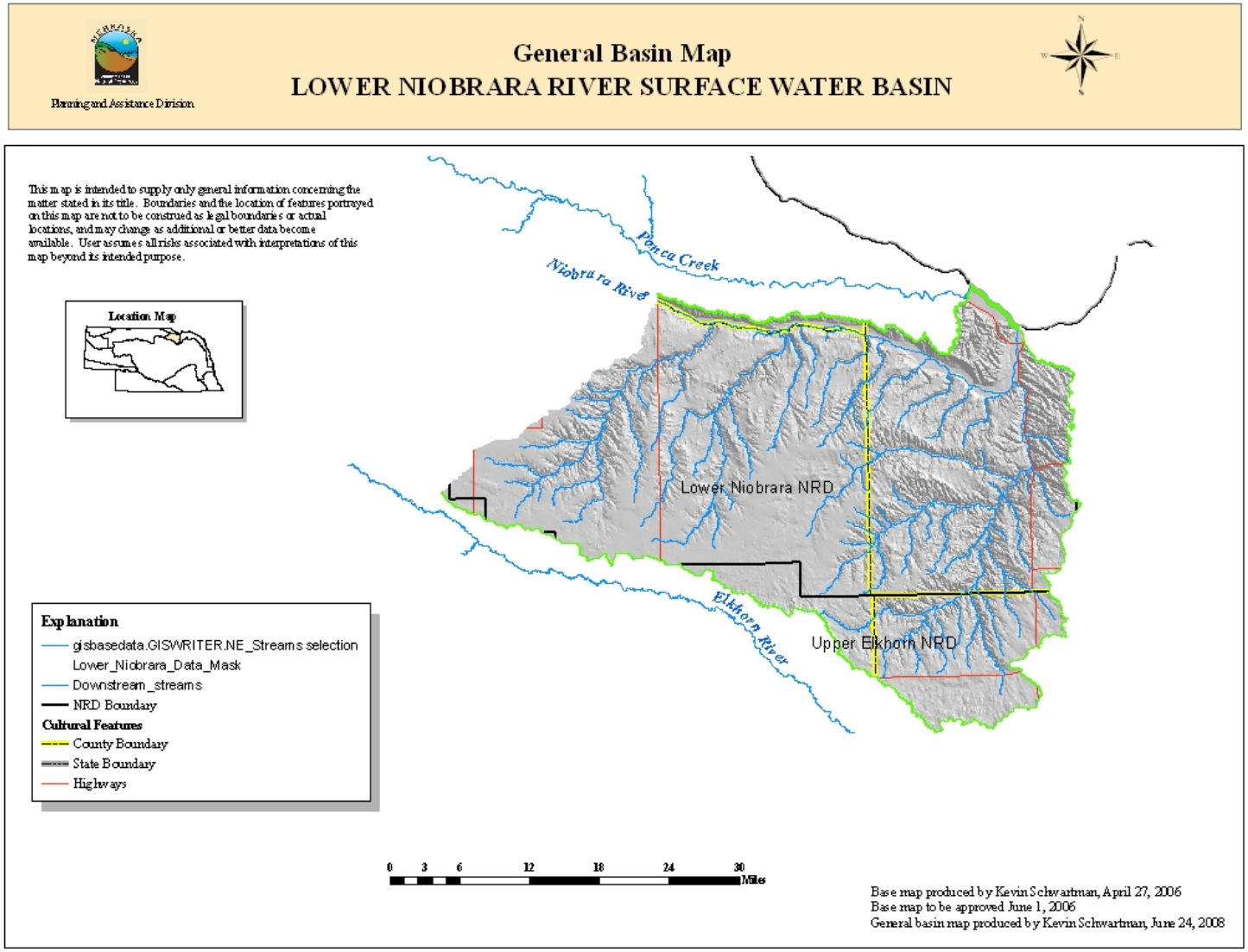

Figure 6-1. General basin map, Lower Niobrara River Basin.

6.3 Nature and Extent of Water Use

6.3.1 Groundwater

Groundwater in the basin is used for a variety of purposes: domestic, industrial, livestock, irrigation, and other uses. A total of 2,382 groundwater wells had been registered within the basin as of December 31, 2008 (Department registered groundwater wells database) (figure 6-2). The locations of all active groundwater wells can be seen in figure 6-3.

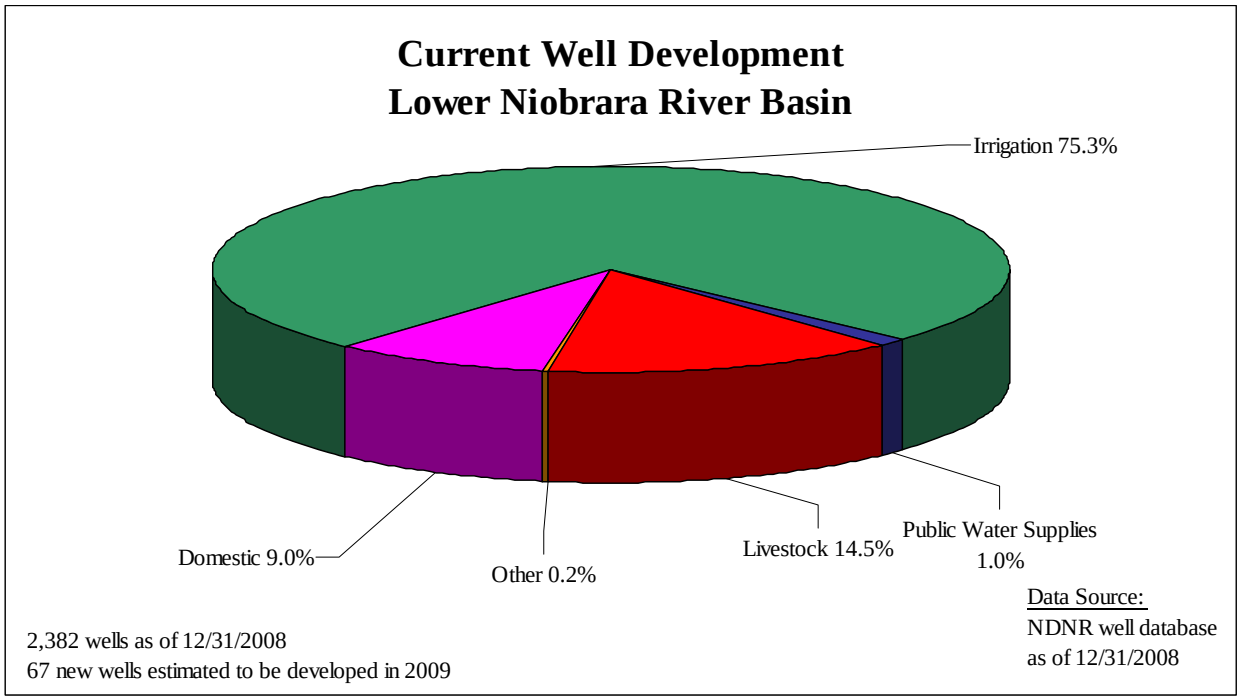

Figure 6-2. Current well development by number of registered wells, Lower Niobrara River Basin.

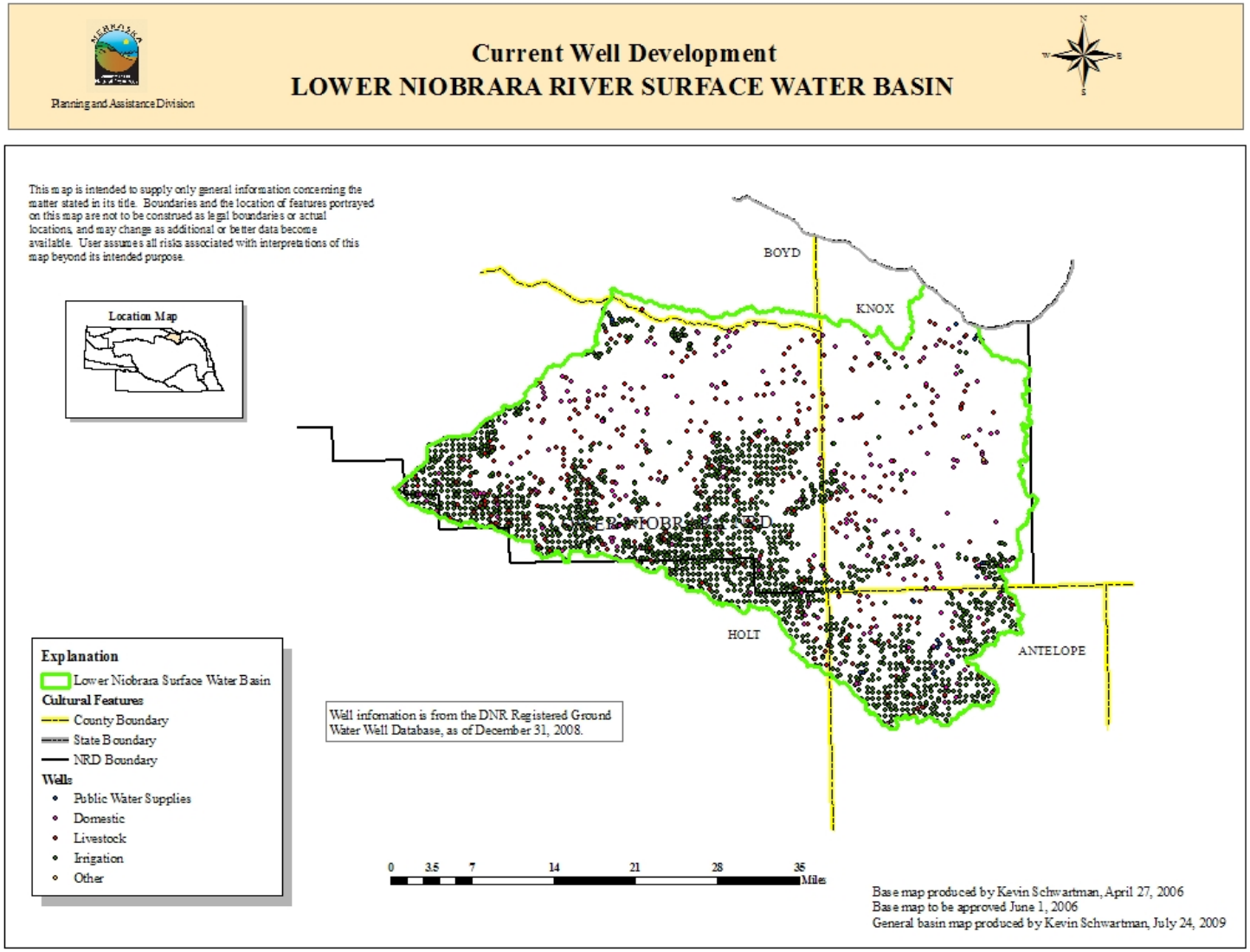

Figure 6-3. Current well locations, Lower Niobrara River Basin.

6.3.2 Surface Water

As of December 31, 2008, 260 active surface water appropriations were held in the basin, issued for a variety of uses (figure 6-4). Most of the surface water appropriations are for irrigation use and storage and tend to be located on the major streams. The first surface water appropriations in the basin were permitted in 1894 and development has continued through the present day. The approximate locations of the surface water diversion points are shown in figure 6-5.

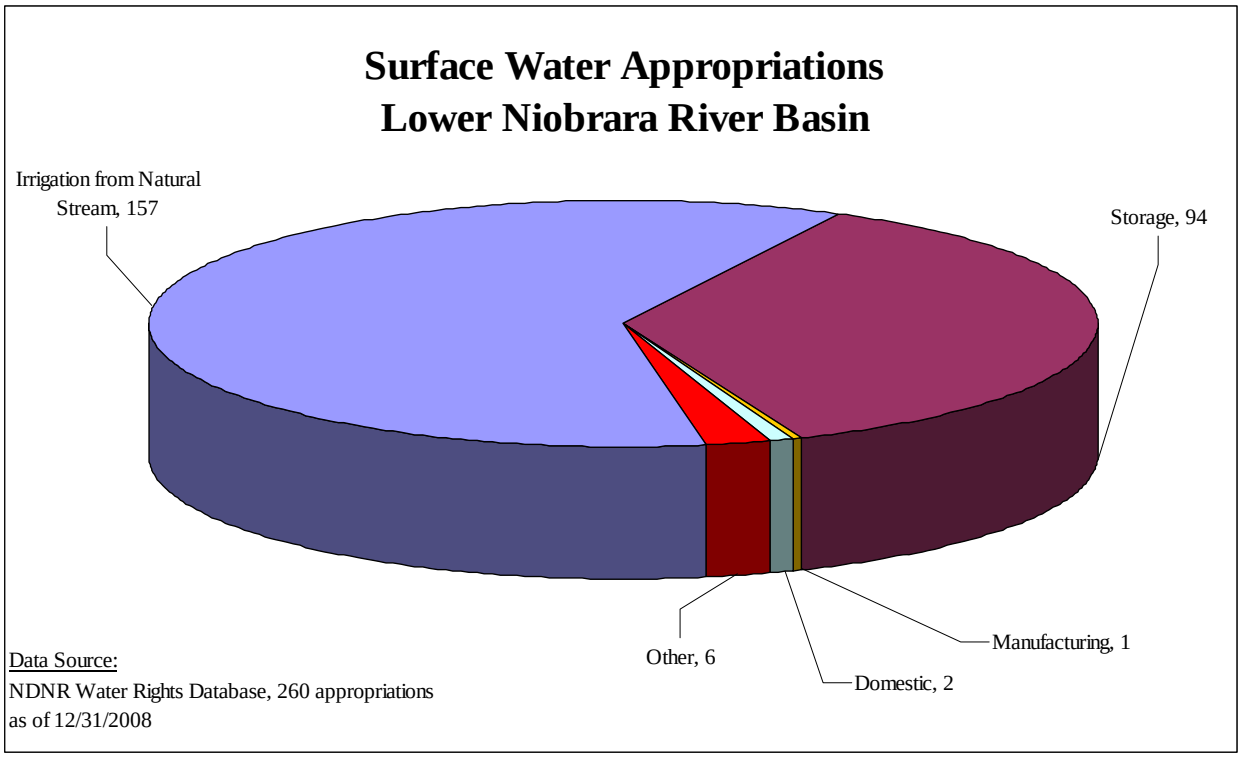

Figure 6-4. Surface water appropriations by number of diversion points, Lower Niobrara River Basin.

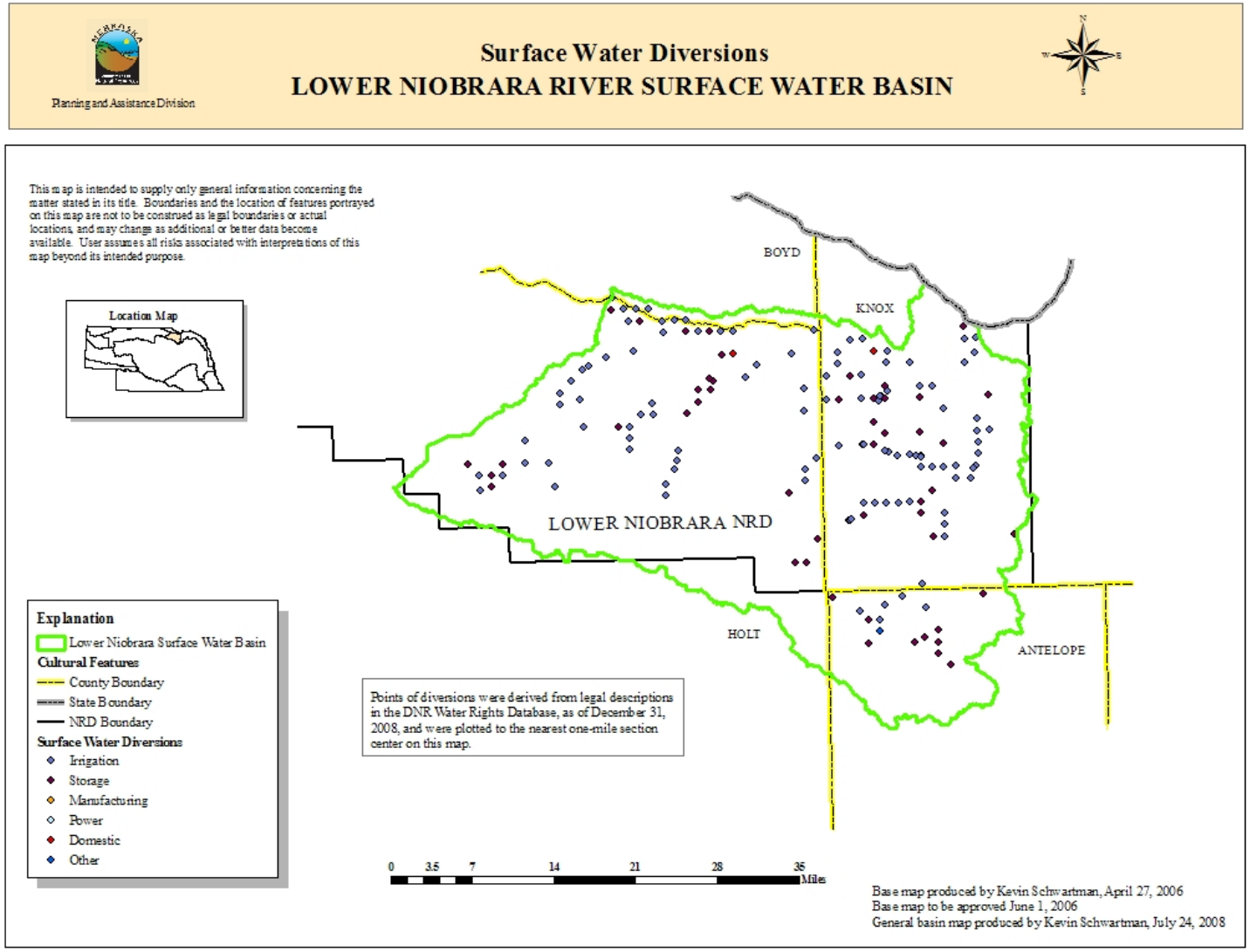

Figure 6-5. Surface water appropriation diversion locations, Lower Niobrara River Basin.

6.4 Hydrologically Connected Area

No sufficient numeric groundwater model is available in the Lower Niobrara River Basin to determine the 10/50 area. Therefore, the 10/50 area was determined using stream depletion factor (SDF) methodology. Figure 6-6 specifies the extent of the 10/50 area. A description of the SDF methodology used appears in the “Methodology” section of this report.

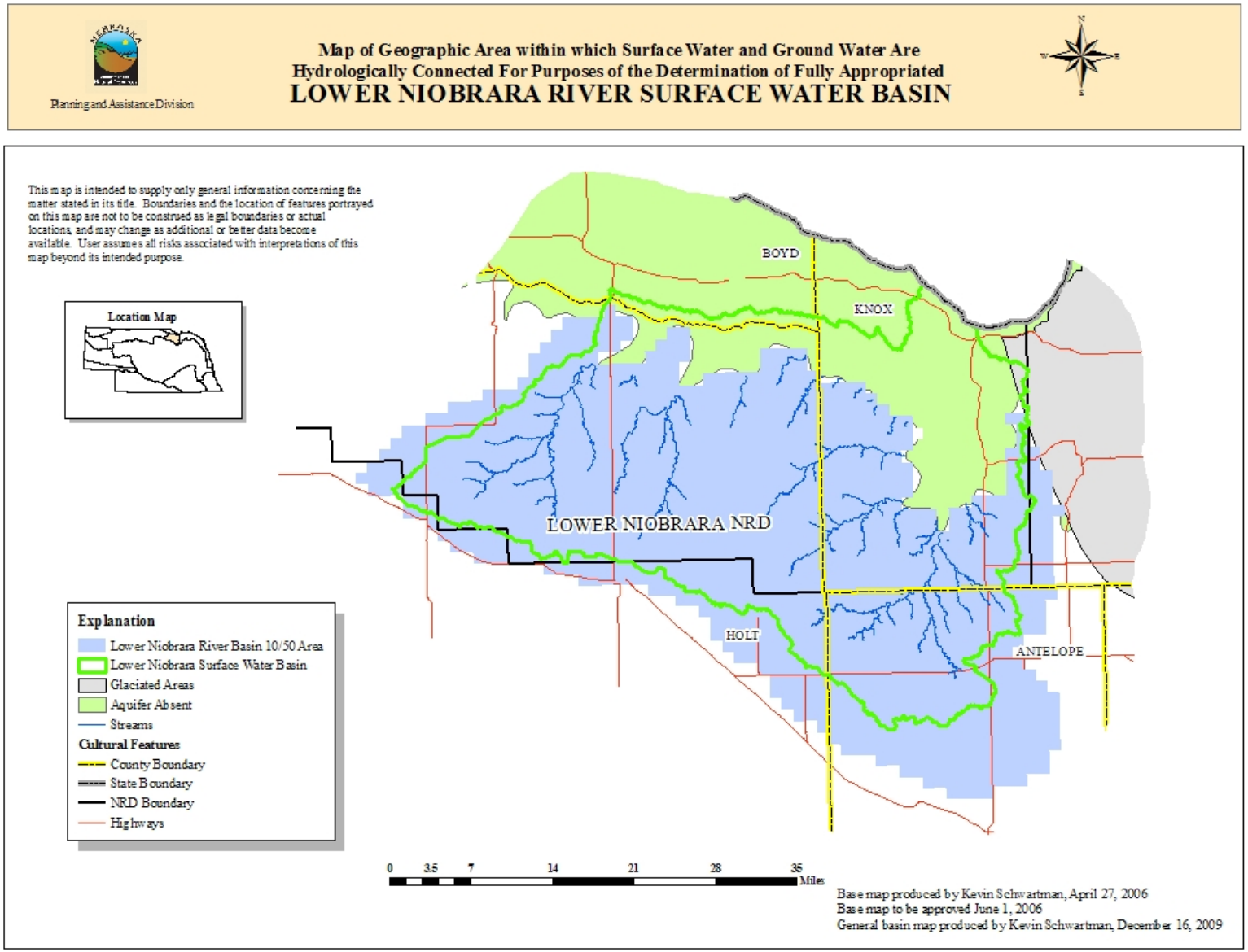

Figure 6-6. 10/50 area, Lower Niobrara River Basin.

6.5 Net Corn Crop Irrigation Requirement

Figure 6-7 is a map of the net corn crop irrigation requirement (NCCIR) for the basin (DNR, 2005). The NCCIR in the basin ranges from 8.9 to 9.6 inches. To assess the number of days required to be available for diversion, a surface water diversion rate equal to 1 cfs per 70 acres, a downtime of ten percent, and an irrigation efficiency of 80% were assumed. Based on these assumptions, a junior surface water appropriation in the Lower Niobrara River Basin will require between 23.6 and 25.5 days annually to divert 65% of the NCCIR and between 30.9 and 33.3 days to divert 85% of the NCCIR.

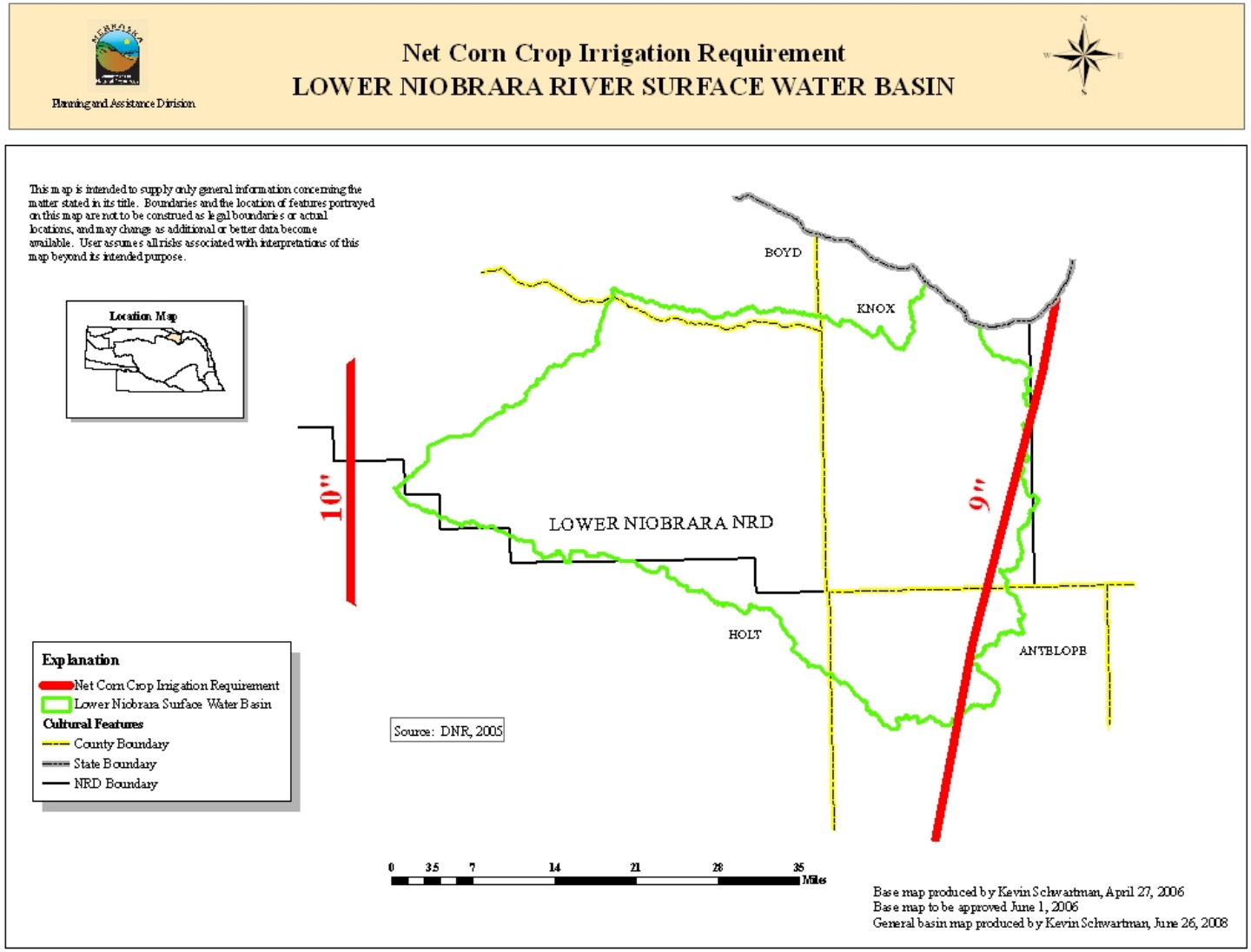

Figure 6-7. Net corn crop irrigation requirement, Lower Niobrara River Basin.

6.6 Surface Water Closing Records

Table 6-1 contains records of all surface water administration that has occurred in the basin between 1989 and 2008.

Table 6-1. Surface water administration in the Lower Niobrara River Basin, 1989-2008.

Year	Water Body	Days	Closing Date	Opening Date
1991	North Branch Verdigre Creek	3	Jul 26	Jul 29

6.7 Evaluation of Current Development

6.7.1 Current Water Supply

The current water supply is estimated by using the previous twenty years (1989-2008) of flows available for junior irrigation rights. The results of the analysis conducted for the Lower Niobrara River Basin are shown in table 6-2. The results indicate that the current surface water supply in the Lower Niobrara River Basin provides an average of 61.9 days available for diversion between July 1 and August 31 and 152.9 days available for diversion between May 1 and September 30 (table 6-3).

Table 6-2. Estimate of the current number of days surface water is available for diversion in the Lower Niobrara River Basin.

Year	July 1 though 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
1989	62	153
1990	62	153
1991	59	150
1992	62	153
1993	62	153
1994	62	153
1995	62	153
1996	62	153
1997	62	153
1998	62	153
1999	62	153
2000	62	153
2001	62	153
2002	62	153
2003	62	153
2004	62	153
2005	62	153
2006	62	153
2007	62	153
2008	62	153
Average	61.9	152.9

Table 6-3. Comparison between the number of days required to meet the net corn crop irrigation requirement and the current number of days surface water is available for diversion in the Lower Niobrara 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)	23.6 to 25.5	61.9 (at least 36.4 days above the requirement)
May 1 – September 30 (85% Requirement)	30.9 to 33.4	152.9 (at least 119.5 days above the requirement)

6.7.2 Long-Term Water Supply

In order to complete the long-term evaluation of surface water supplies, a future twenty-year water supply for the basin must be estimated. The basin's major water sources are precipitation, which runs off as direct streamflow and infiltrates into the ground to discharge as baseflow; groundwater movement into the basin, which discharges as baseflow; and streamflow from the middle Niobrara River. 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 basin was completed. The analysis showed no statistically significant trend in precipitation ($P > 0.95$) over the past fifty years (figure 6-8). Therefore, using the previous twenty years of precipitation and streamflow data as the best estimate of the future surface water supply is a reasonable starting point for applying the lag depletions from groundwater wells.

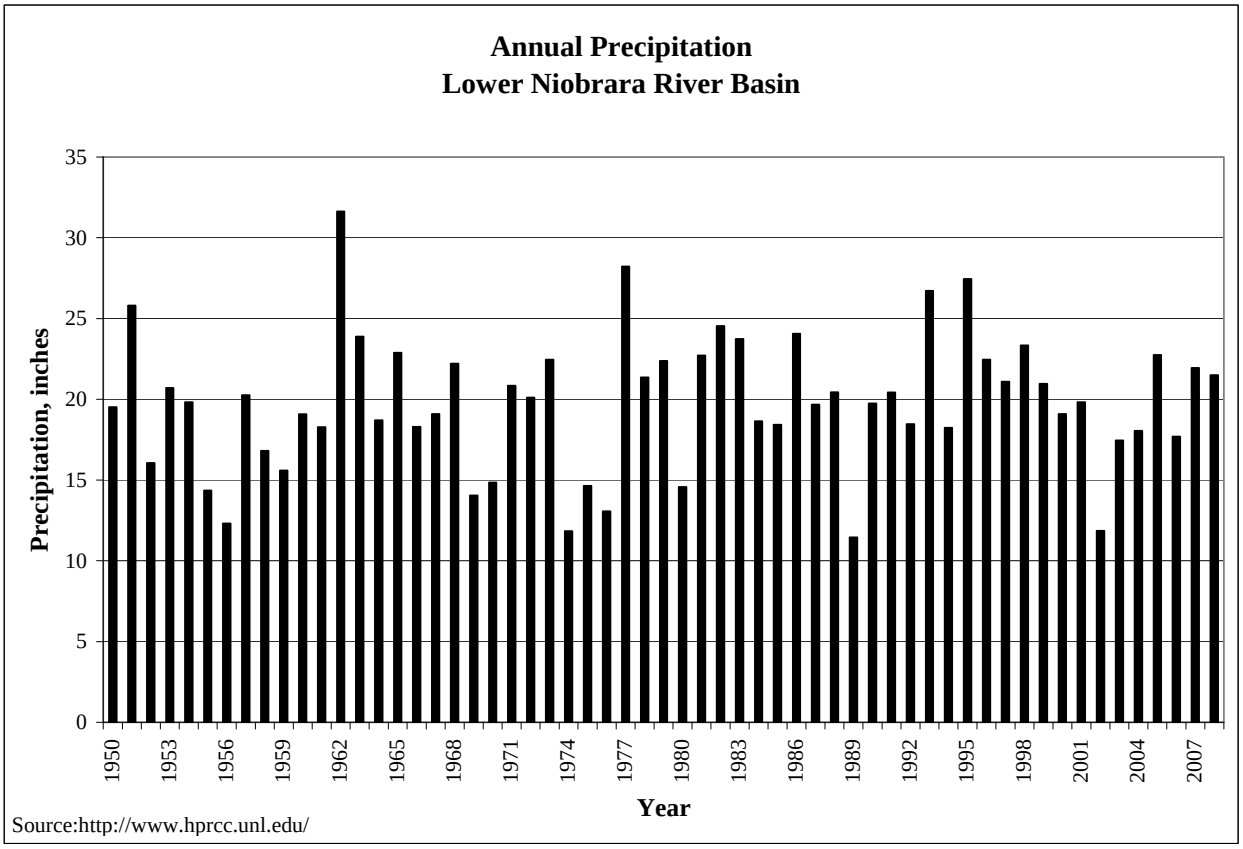

Figure 6-8. Annual precipitation, Lower Niobrara River Basin.

6.7.3 Depletions Analysis

The future depletions due to current well development that could be expected to affect streamflow in the basin were estimated using SDF methodology. The results estimate the future streamflows in the Lower Niobrara River Basin to be depleted by 10 cfs in twenty-five years.

6.7.4 Evaluation of Current Levels of Development against Future Water Supplies

The estimates of the twenty-year average number of days available for diversion were not estimated for the Lower Niobrara Basin because only minimal surface water administration has previously occurred in the basin, and the threshold flows necessary to satisfy senior appropriations could not be estimated. Even though the future water supplies were not estimated, the current number of days in which surface water was available for diversion far exceeds the number of days necessary to meet the 65/85 rule.

6.8 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 twenty-five 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 (figure 6-9). The present-day rate of development is based on the linear trend of the previous ten years of development. Based on the analysis of the past ten years of development, the rate of increase in high capacity wells is estimated to be 68 wells per year in the basin.

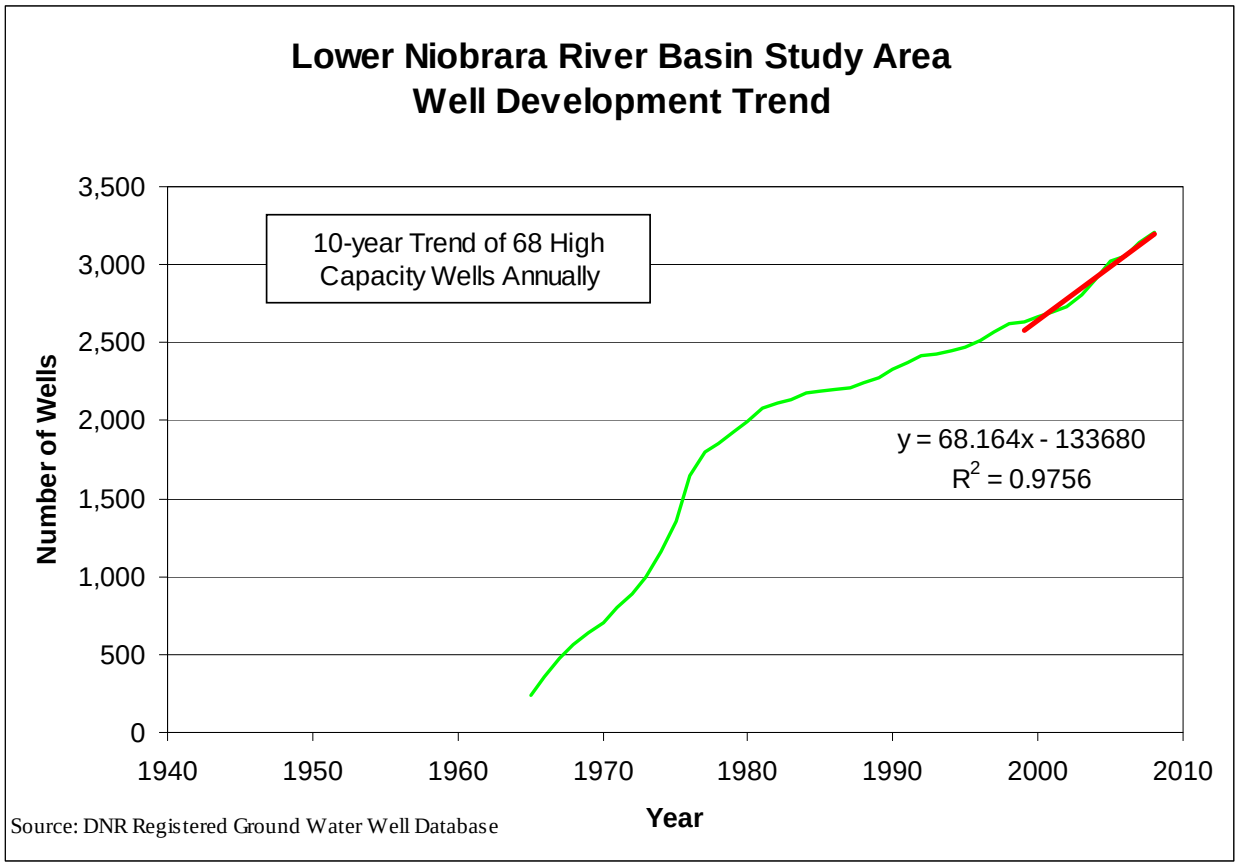

Figure 6-9. High capacity well development, Lower Niobrara River Basin.

The future depletions due to current and future well development that could be expected to affect streamflow in the basin were estimated using SDF methodology. The results estimate the future streamflow to be depleted by an additional 36 cfs in ten years, 58 cfs in fifteen years, 79 cfs in twenty years, and 101 cfs in twenty-five years.

The estimate of the twenty-year average number of days surface water is available for diversion was not calculated because minimal surface water administration has previously occurred and the threshold flows necessary to satisfy senior appropriations could not be estimated. Even though the future water supplies were not estimated, the current number of days in which surface water was available for diversion far exceeds the number of days necessary to meet the 65/85 rule.

6.9 Sufficiency to Avoid Noncompliance

There are no compacts on any portions of the Lower Niobrara River Basin in Nebraska.

6.10 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 G.

6.11 Current Studies being Conducted to Assist with Future Analysis

The Department has initiated a joint study with the University of Nebraska Conservation and Survey Division to complete a hydrogeologic assessment of the entire Niobrara River Basin. This assessment will focus on developing and updating hydrogeologic datasets to reflect the most current data available for the area. Additionally, a substantial portion of the Niobrara River Basin on the south side of the river is included in the Elkhorn-Loup groundwater model study, which is currently being developed to evaluate the groundwater-surface water relationship and the water supply of the Elkhorn and Loup River Basins. Although not developed specifically to evaluate the water supply in the Niobrara River Basin, data developed in support of this study may eventually be adapted to analyze water resources in the Niobrara Basin.

6.12 Relevant Data Provided by Interested Parties

The Department published a request for relevant data for this year's evaluation from interested parties on August 19, 2009 (see Appendix B for affidavit). The Department did not receive any such information.

6.13 Conclusions

Based on the analysis of the sufficiency of the long-term surface water supply in the Lower Niobrara River Basin, the Department has reached a preliminary conclusion that the basin is not fully appropriated. The analysis of lag effects of current development for the Lower Niobrara Basin indicates a reduction in streamflows by 10 cfs in twenty-five years. The analysis of the impacts of future development on the Lower Niobrara Basin based on current development trends indicates an additional reduction in streamflows of 101 cfs in twenty-five years. The future number of days available to junior irrigators was not estimated because only minimal surface water administration has occurred on the Niobrara River in the past twenty years. Even though the future number of days available to junior irrigators was not estimated, the current number of days in which surface water was available for diversion far exceeds the number of days necessary to meet the net corn crop irrigation requirement.

Bibliography of Hydrogeologic References for Lower Niobrara River Basin

Conservation and Survey Division. 2005. *Mapping of Aquifer Properties-Transmissivity and Specific Yield-for Selected River Basins in Central and Eastern Nebraska* Lincoln.

Nebraska Department of Natural Resources. 2005. *2006 Annual Evaluation of Availability of Hydrologically Connected Water Supplies*. Lincoln.

Wen, F.J. and X.H. Chen, 2006. Evaluation of the impact of groundwater irrigation on streamflow depletion in Nebraska.. *Journal of Hydrology* 327: 603-617.