APPENDIX C

Statement
of
Kansas Chief Engineer David W. Barfield

COMES NOW, David W. Barfield, pursuant to 28 U.S.C. § 1746, and states as follows:

1. I am Chief Engineer of the Division of Water Resources, Kansas Department of Agriculture (Kansas Chief Engineer).

2. I am a licensed professional engineer, and, as Kansas Chief Engineer, I have principal responsibility for the administration of water in Kansas, including representing Kansas on the interstate water compact administrations to which it is a party.

3. I have worked on Republican River Compact matters since 1992. From 1992 until 2007, I led technical efforts related to Kansas' interstate water issues regarding the Republican River ("Republican"). I was Kansas' representative to the Republican River Compact Administration ("RRCA") Engineering Committee from 1994 until 2007. I was the lead technical representative in the mediated negotiations between Kansas and Nebraska of 1995-1997 and was Kansas' technical representative in settlement discussions from 2001-2002. I co-authored the Accounting Procedures that became Appendix C of the Final Settlement Stipulation ("FSS"), and was a member of the Groundwater Modeling Committee established by the FSS. FSS, § IV.C. As Kansas' RRCA Engineering Committee representative following the entry of the

Supreme Court Decree of May 19, 2003 ("Decree") approving the FSS, I participated in its work to conduct a comprehensive review of the Accounting Procedures, the development of an accounting spreadsheet, and other matters related to implementation of the Decree. Since 2007, as Kansas Chief Engineer, I have represented Kansas as compact commissioner.

4. I have read the Petition to which this statement is attached as Appendix C, and the facts stated in the Petition are true and correct to the best of my knowledge, information and belief.

5. As is demonstrated herein, excessive groundwater pumping for irrigation in Nebraska is the principal cause of Nebraska's violations of the Republican River Compact and the Decree enforcing the Compact.

6. The depletion of stream flows caused by groundwater pumping is a physical process that has been well understood for many decades, and is now quantified and applied to the Republican River Basin ("Basin") using the methods agreed upon by the States, prescribed in the FSS, and approved in the Decree. The quantitative details of determining the physical impact of groundwater pumping on Republican streamflows are specified in the RRCA Groundwater Model incorporated into the Decree in this case.

7. A short explanation of the physical relationship between groundwater pumping and Republican streamflows follows:

8. The Ogallala aquifer and the alluvial aquifers associated with the Republican River and its tributaries are, in a sense, like huge underground reservoirs of sands and gravels containing water, replenished by rainfall that percolates through the overlying soils. When the reservoir is full, the overflow creates streamflow. Figure 1 (A) (from U.S. Geological Survey, Circular 1139, *Ground Water and Surface Water: A Single Resource*). When ground-water pumping begins, groundwater levels decline in the immediate vicinity of the pumping. As pumping continues, groundwater levels continue to decline and the area over which the decline occurs expands. Where the aquifer materials are uniform, the geometric shape of the water level declines resembles an inverted cone, with the apex at the well location, and is often referred to as a "cone of depression." Groundwater is induced to flow toward each pumping well location. As the cone of depression increases in size, the pumped water is derived from "stored" groundwater. Figure 1 (B). There are over 10,000 wells in the Republican Basin in Nebraska, each creating its own cone of depression and interacting with the other cones.

9. As pumping continues and the cone of depression expands laterally away from the location of pumping, it can intersect a stream, such as the Republican River or one of its tributaries. When this occurs, flow in the stream diminishes because less groundwater discharges to the stream, and/or more

water is induced to seep from the stream into the aquifer. Figure 1 (C).

10. If pumping ceases, the impact on stream flow does not immediately stop; rather, water that would have otherwise been in the stream instead refills the cone of depression, and groundwater levels slowly begin to rise toward the levels that existed before the pumping began. Consequently, streamflow does not fully recover until the groundwater levels have returned to their original level. In the Basin, depending on the location of the pumping, this recovery process would take years, decades or even longer.

11. Groundwater levels are routinely monitored at numerous locations throughout the Basin in Nebraska, and provide a direct and objective measure of groundwater conditions, trends, and the potential for future stream depletions in the basin. Groundwater levels document how much water is in the underground reservoir, and whether the amount of water in the reservoir is increasing, decreasing, or staying the same. When groundwater levels are decreasing, less water is being added to the reservoir than is being removed, thus depleting the amount of water in the reservoir. As the water in the reservoir is depleted, stream flows are also depleted due to the processes described above.

12. By assembling the data available for wells within an area, a composite characterization of groundwater level changes from year to year over the

past several decades can be developed. For example, the Upper Republican Natural Resources District ("URNRD") encompasses Perkins, Chase and Dundy counties in southwestern Nebraska (see map in Appendix 1 to the Brief).

13. Attached to this Statement is Figure 2, which depicts the average decline since 1980 in groundwater levels at 200 or so monitoring locations in the URNRD for each year, relative to average groundwater levels that existed in 1980. Figure 2 shows that, on average, groundwater levels in this district have been steadily declining at a rate of almost 1 foot per year for the better part of 30 years. Apart from some slowing of the rate of decline during the significantly wetter climatic periods of the middle 1990s and 2007-2009, the decline has been persistent and unrelenting. This is true even since accounting under the Decree began at the beginning of 2003.

14. The trend of groundwater level declines in the URNRD guarantees continuing and increasing stream flow depletions unless Nebraska takes dramatic remedial measures to reverse the declines. For example, streamflows in the upper reaches of Frenchman Creek, a major tributary to the Republican River that flows through this district, have all but vanished. Streamflows at this location are principally comprised of baseflows – discharges from the groundwater system. The annual streamflow of Frenchman Creek at the gage near Imperial, Nebraska is shown on Figure 3. This figure shows the total streamflow passing the gage for each year from

1960 through 2009. Annual streamflows prior to the late 1960s were generally in the range of 50,000 to 60,000 acre-feet. Since that time, as groundwater pumping has increased, groundwater levels have declined, and streamflows have steadily decreased, such that by 2009 the flow was less than 4,000 acre-feet, (except for major runoff that occurred in 2007). This streamflow depletion is not surprising, given the steady decline in groundwater levels and groundwater storage shown by the groundwater level data shown in Figure 2.

15. The impacts of groundwater pumping on groundwater levels and streamflows extend downstream in the basin, and accumulate in Harlan County Lake. The inflows to Harlan County Lake form a significant part of Kansas' water supply. United States Geological Survey stream gaging data on the Republican at Orleans, Nebraska illustrates the impacts of stream flow depletion from groundwater pumping on these inflows. This gage is located near the upper boundary of the lake's flood pool. It provides the best available data on inflows to Harlan County Lake from the mainstem of the Republican. Figure 4 displays the total annual stream flow at this gage from 1960 through 2009. The figure evidences the steady decline in the inflows to Harlan County Lake. Also shown in Figure 4 is the annual precipitation at Harlan County Lake. As is true at other precipitation gages in the Basin, precipitation does not decrease over time. For the most part, the overall decline in inflows shown in Figure 4 reflects the

continuing depletion of groundwater storage and groundwater discharge to the streams in the Basin above Harlan County Lake and the increasing depletion by Nebraska of water supplies relied upon by Kansas.

16. The fact that groundwater storage continues to be depleted, as is illustrated in Figure 2, indicates that stream flow depletions will continue to increase. This increasing deficit in groundwater storage means that even if groundwater pumping were to stop tomorrow, streamflow depletions will continue long into the future. In essence, groundwater storage depletions are simply streamflow depletions waiting to happen.

17. Figure 5 shows the expansion, from 1960 to 2008, of acreage within Nebraska and Kansas that is irrigated by groundwater. This data was developed by the States for the Republican River Compact Administration Groundwater Model. The expansion in groundwater-irrigated acreage since 1980 in Nebraska contrasts sharply with the lack of increase in Kansas. Much of this expansion occurred after Kansas began raising its concerns in the mid-1980s about Nebraska's overdevelopment. Even since the Decree was entered, Nebraska has allowed significant expansion in acreage irrigated by groundwater.

18. Similarly, Figure 6 shows the growth in Nebraska's groundwater pumping within the Republican River Basin over time. This data is summarized from data provided by the State of Nebraska for the

RRCA Groundwater Model. While there is significant variation year to year due to the natural variation in precipitation and other climatic factors, the increasing trend is clearly related to the expansion of irrigated acreage. While Nebraska pumping declined over the last several years, these reductions correspond to a period of unusually high precipitation, which temporarily reduced the need for irrigation water supply.

19. That Nebraska failed the first test of compliance under the FSS is not in dispute. Under the FSS, the first compliance year for the Water-Short Year test was 2006. FSS, App. B at B1. In Water-Short Year 2006, Nebraska was subject to the two-year compliance test set out in the FSS. Under this test, Nebraska was required to limit its beneficial consumptive use above Guide Rock for the years 2005 and 2006 to its allocation above Guide Rock less its imported Water Supply Credit.

Table 1 shows Nebraska's overuse for this first compliance test under the Decree, according to the methods agreed to by the States and ordered by the Court. The States agreed that Nebraska's overuse of water above Guide Rock in 2005 was at least 42,390 acre-feet. While the States agreed to all the accounting inputs and the final groundwater model run for 2006, the States disagreed over the amount of Nebraska's overuse due principally to the inability to agree on how to allocate Harlan County Lake evaporation between Kansas and Nebraska for 2006. As shown in Table 1, Kansas calculated Nebraska's overuse of its allocation for 2006 to be 36,100 acre-feet. By comparison, in the 2009 arbitration trial, Nebraska calculated its overuse for 2006 to be 28,615 acre-feet. Under Kansas' calculations, Nebraska's average overuse is 39,480 acre-feet per year; under Nebraska's calculations, Nebraska's average overuse is 35,505 acre-feet per year.

Table 1 also shows the annual Nebraska statewide overuse for years 2003 to 2006 for Nebraska's statewide test of compliance. This compliance test is done for a 5-year average, the first of which was for 2003-2007. The States have not agreed to the 2007 accounting. However, this tabulation shows Nebraska's pattern of overuse of its statewide allocations during four of five years of the accounting period.

20. Nebraska's depletions to streamflow from groundwater pumping, as determined from the official RRCA Groundwater Model, averaged 201,960 acre-feet above Guide Rock, Nebraska, for 2005 and 2006. In those same years, Nebraska overused its allocation by an average of 39,480 acre-feet per year above Guide Rock, by Kansas' calculations. By Nebraska's calculations, Nebraska's overuse averaged 35,505 acre-feet per year. Nebraska's overuse represents a yearly consumptive water use for more than 500,000 people, assuming 125 gallons per capita per day and 50% consumptive use. Kansas Department of Agriculture Division of Water Resources, 2007 Municipal Water Use Report, Table 20, City of Salina; FSS, App. C, at C31.

To achieve compliance in the inevitable dry periods and water-short years to come, Nebraska must significantly reduce its groundwater pumping, which Nebraska has thus far failed to do. Based on the amount of its overuse in 2005 and 2006, Nebraska needs to reduce its groundwater pumping depletions to at least as low as 170,000 acre-feet or implement a hydrologically equivalent alternative. A similar result is obtained when Nebraska's overuse of its statewide allocations are considered for the last five-year period (2002 to 2006) for which the amount of consumptive use is available from agreed RRCA accounting.

21. As is described above, groundwater pumping impacts to streamflow cannot be turned on and off or even significantly reduced in the short term. Figure 7 shows how Nebraska depletions to streamflows from groundwater pumping have grown over time, and can be expected to continue to increase unless very significant actions are taken. Figure 7 shows the historic depletions through 2008, as estimated by the States using the jointly developed RRCA Ground-water Model. Figure 7 also shows a future projection that was made using the RRCA Groundwater Model to illustrate the general potential trend in depletions going forward. This projection was made by assuming long-term average conditions with average ground-water pumping per acre from the period 2003 to 2008 applied to recent irrigated acreage (2007). This 2003 to 2008 period was wetter than average in Nebraska, and so this projection represents a future condition

with less irrigation pumping per acre than has occurred historically.

22. Figure 7 demonstrates that, even assuming reduced groundwater pumping, Nebraska's impacts will extend and exacerbate the tendency to violate the Decree during dry periods. This is because Nebraska's future depletions are far above the threshold to prevent overuse during dry periods. Until Nebraska recognizes this fact and embraces the monumental changes that are needed to attain and maintain compliance with the Compact, its depletions will continue to grow, making future compliance progressively more difficult. Kansas has estimated that Nebraska must reduce its pumping by approximately 40% in order to reduce groundwater depletions sufficiently to achieve future Compact compliance or implement a hydrologically equivalent alternative. While in recent years Nebraska has preferred purchasing surface water for delivery to Kansas rather than making the necessary groundwater pumping reductions, its past purchases have been insufficient to obtain compliance. Moreover, the data presented here suggests that there will be significantly less available surface water supplies in future dry periods because of streamflow depletions caused by Nebraska's pumping. See Figs. 3, 6. Thus, Nebraska has little choice but to sharply reduce its groundwater pumping, or take some hydrologically equivalent action.

23. Nebraska's recent reduction in groundwater pumping is largely due to above average precipitation, particularly 2007 to 2009 for Nebraska's part of the Basin, which temporarily decreased the demand for irrigation water supply.

Figure 8 shows the relationship between precipitation in the Republican River basin in Nebraska and Nebraska's groundwater irrigation pumping. As precipitation increases, irrigation pumping per acre is reduced. The sum of precipitation and irrigation depth has remained relatively constant over the period.

24. As shown by the forgoing, Nebraska has violated the Decree and must take significant action immediately in order to prevent future violations of the Decree.

I state under penalty of perjury that the foregoing is true and correct.

Executed on April 26, 2010.

/s/ David W. Barfield
David W. Barfield

Attachments

Figure 1

Illustration of the Effect of Groundwater Pumping on Streamflow

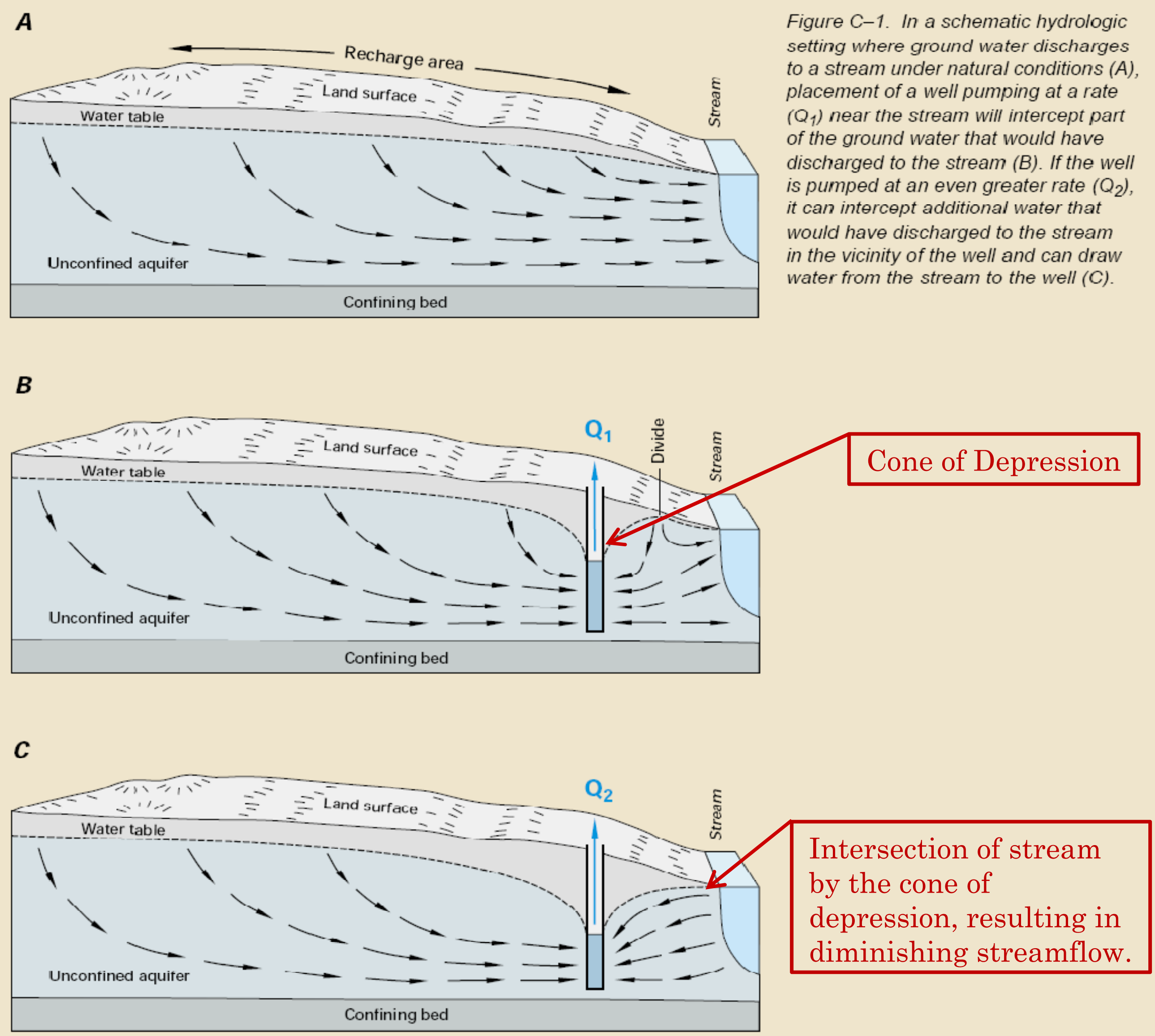


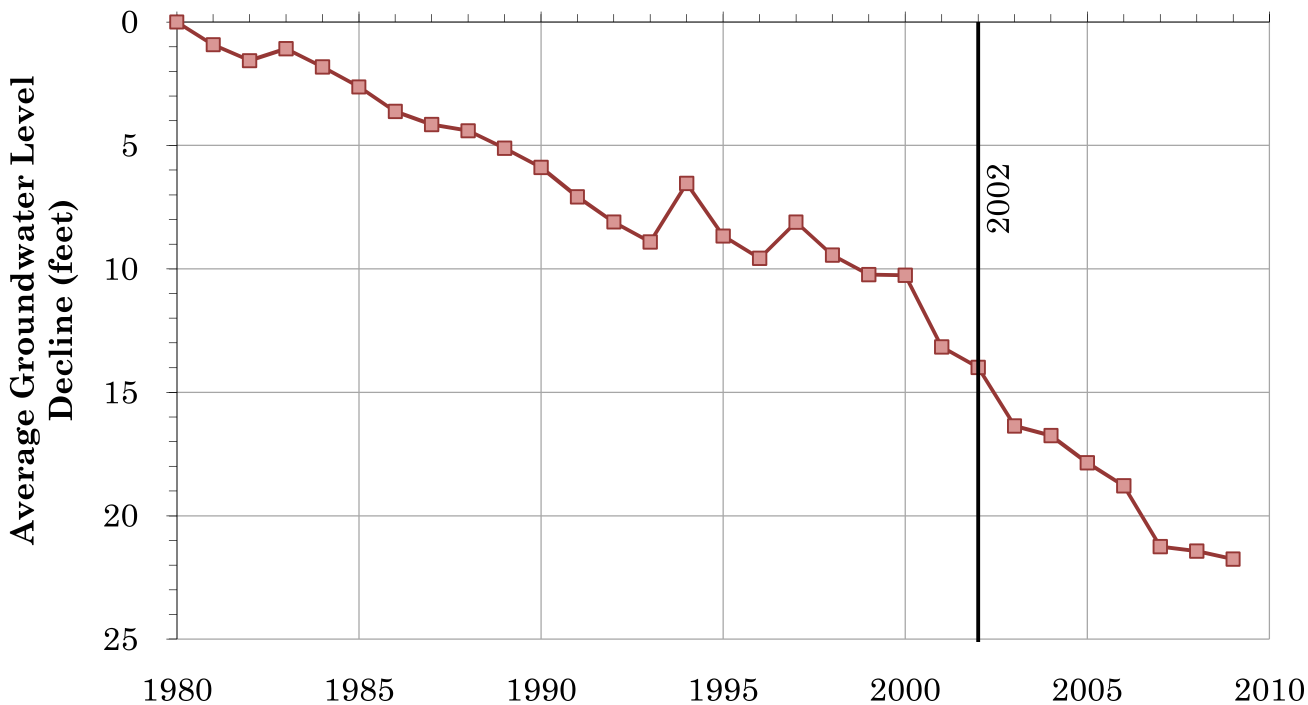
Figure C–1. In a schematic hydrologic setting where ground water discharges to a stream under natural conditions (A), placement of a well pumping at a rate (Q_1) near the stream will intercept part of the ground water that would have discharged to the stream (B). If the well is pumped at an even greater rate (Q_2), it can intercept additional water that would have discharged to the stream in the vicinity of the well and can draw water from the stream to the well (C).

C14

Source: United States Geological Survey, Circular 1139, *Ground Water and Surface Water: A Single Resource* (1998), Figure C-1, p. 15 (Figure title and boxed annotations in red added).

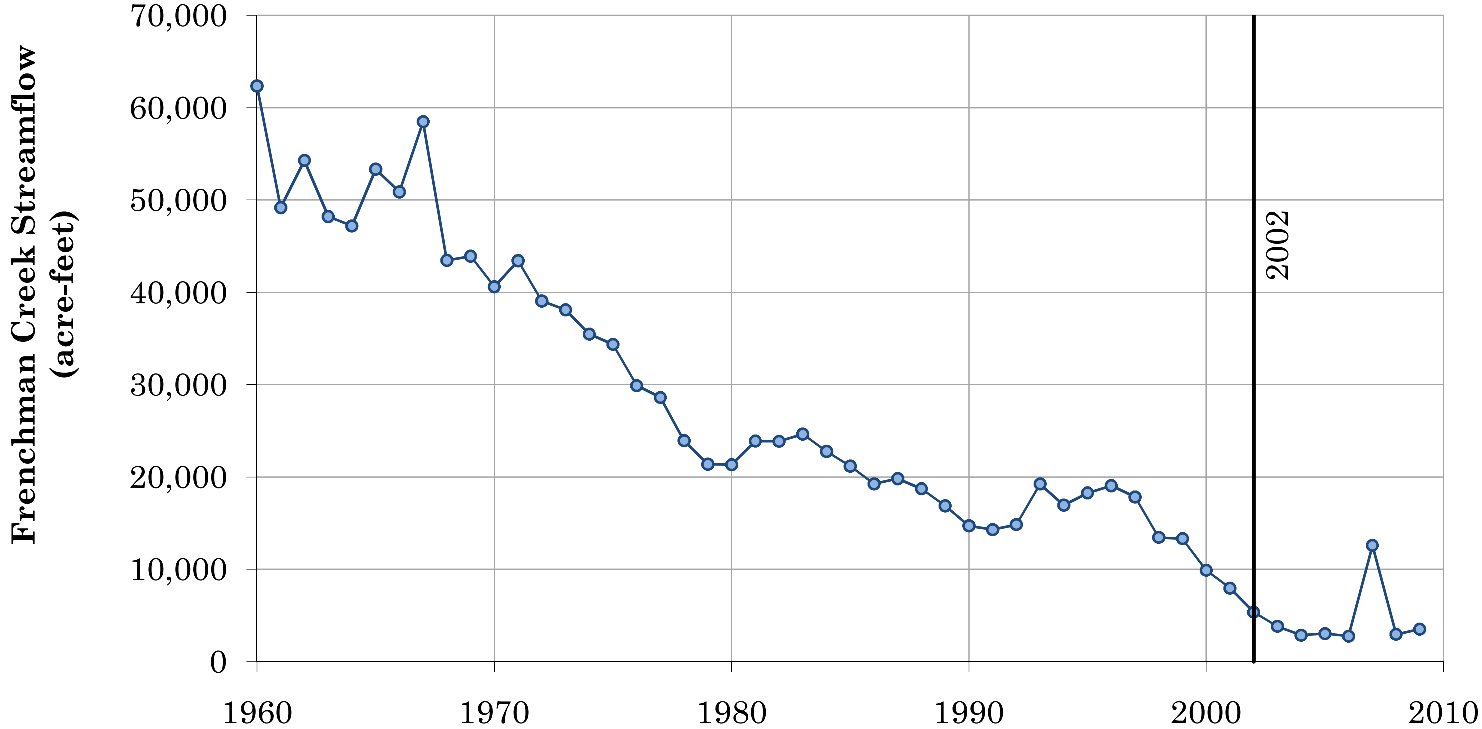
C15

Figure 2
Average Groundwater Level Decline
Upper Republican Natural Resources District, Nebraska



Source: United States Geological Survey National Water Information System
Note: Each data point represents the average for wells with data in 1980 and each corresponding year. Number of observations included in each average value varies from 190 to 238.

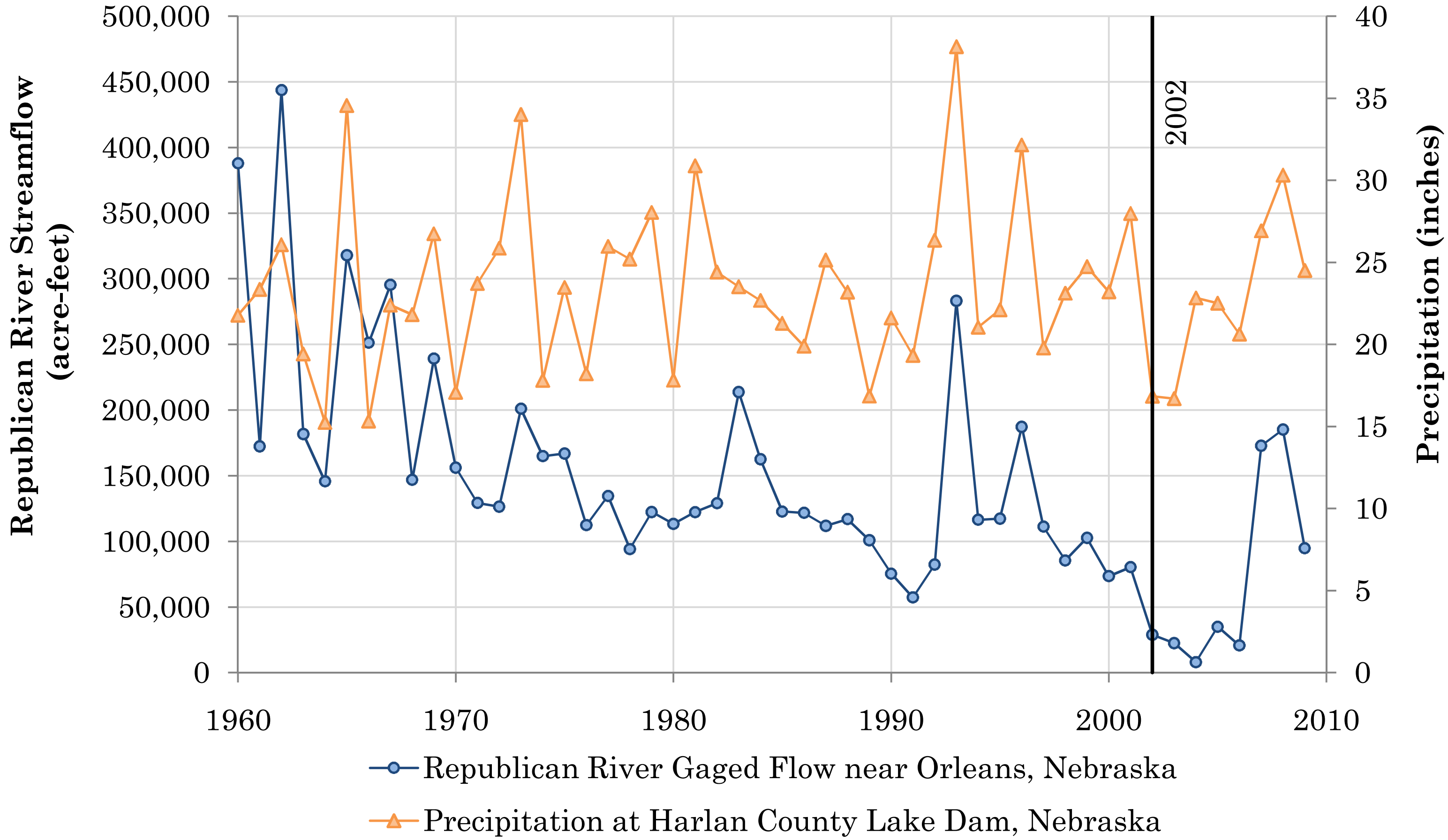
Figure 3
Frenchman Creek Annual Streamflow
Upper Republican Natural Resources District, Nebraska



Source: United States Geological Survey (1960 - September, 1994) and Nebraska Department of Natural Resources (October, 1994 - 2009), Gage 06831500 Frenchman Creek near Imperial, Nebraska

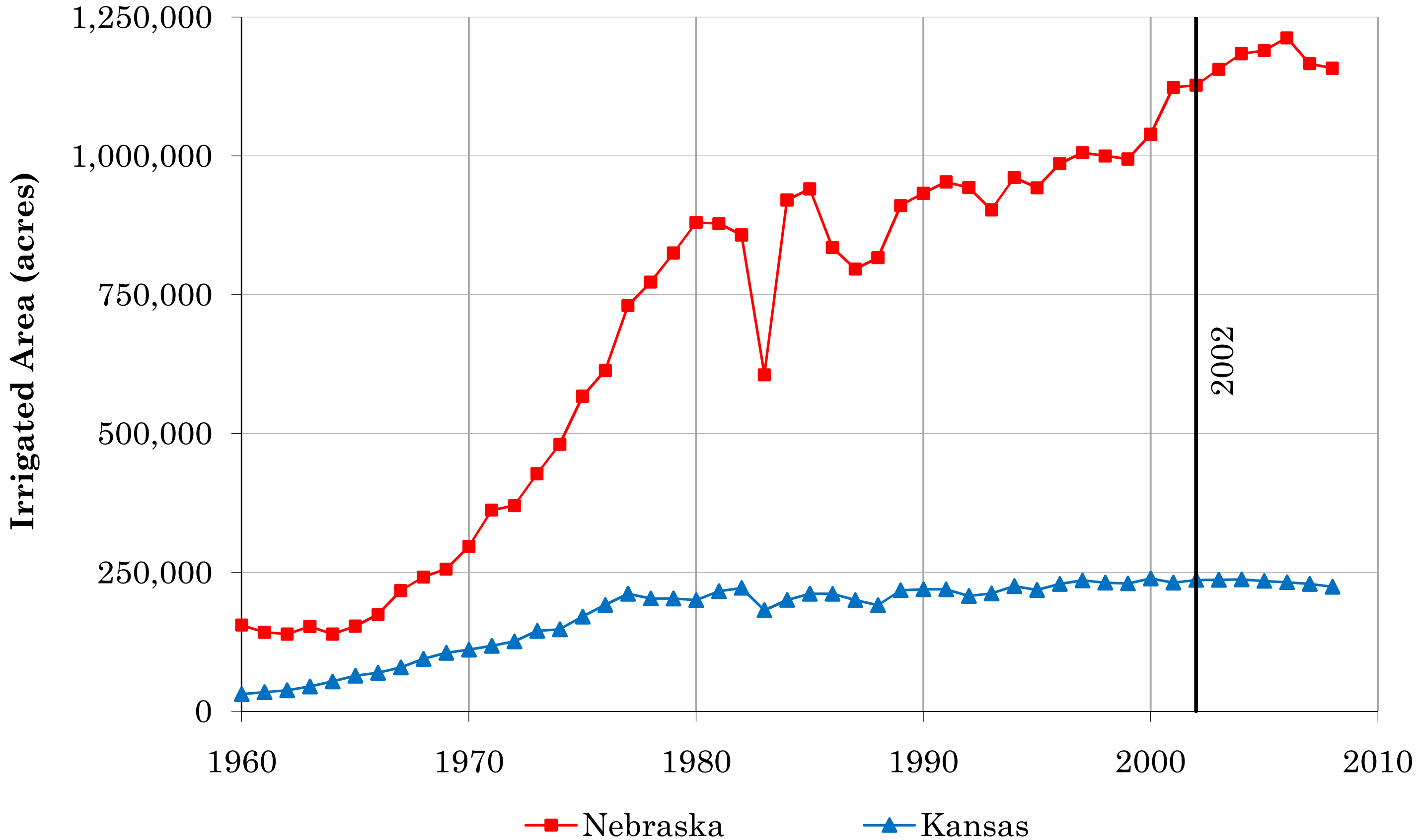
Figure 4

Annual Republican River Streamflow [1] and Local Precipitation [2]
Harlan County Lake, Nebraska



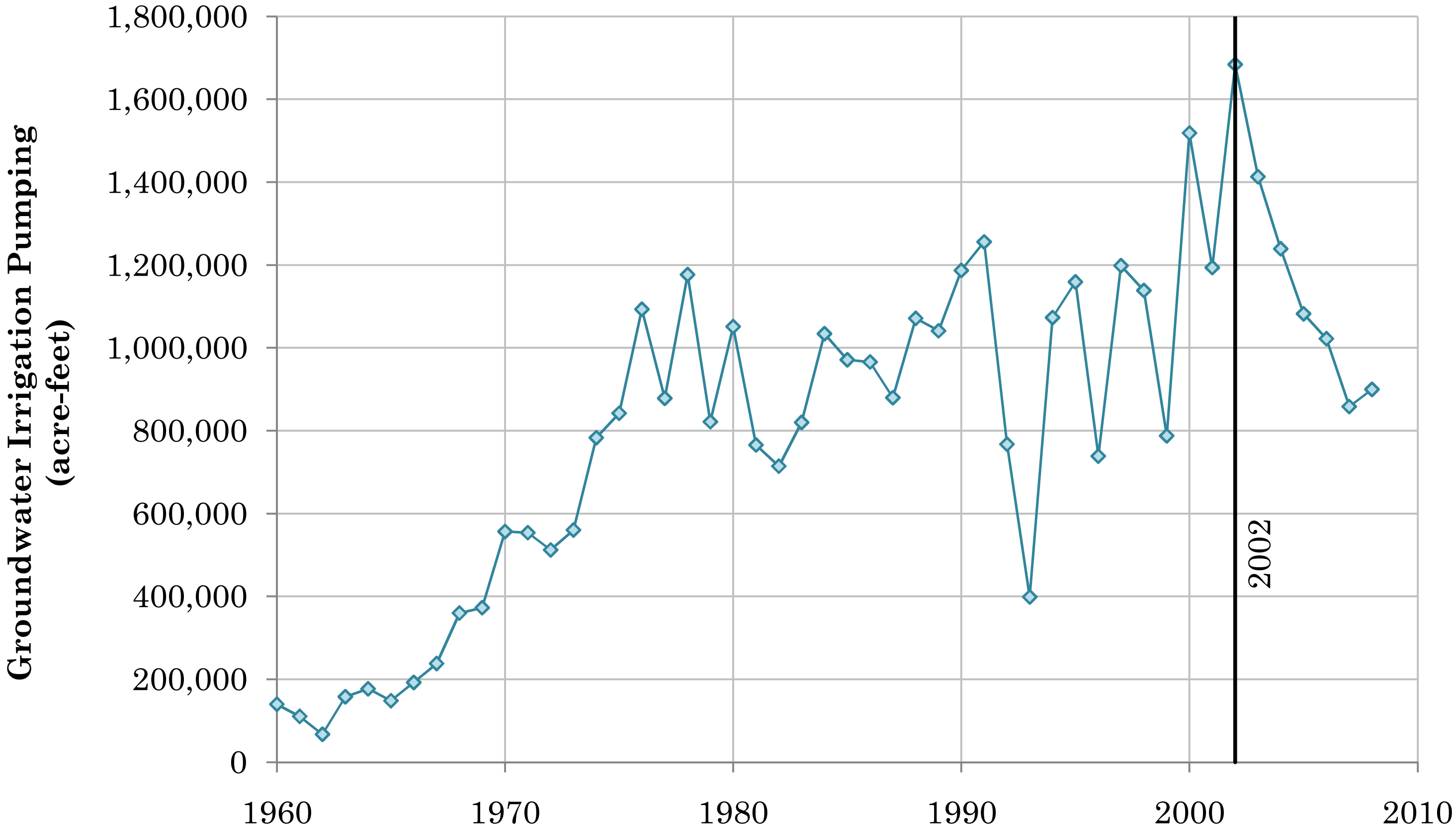
Source:
(1) United States Geological Survey Gage 06844500 Republican River near Orleans, Nebraska
(2) United States Bureau of Reclamation precipitation at Harlan County Lake Dam

Figure 5
Groundwater Irrigated Area
Republican River Basin, Nebraska and Kansas



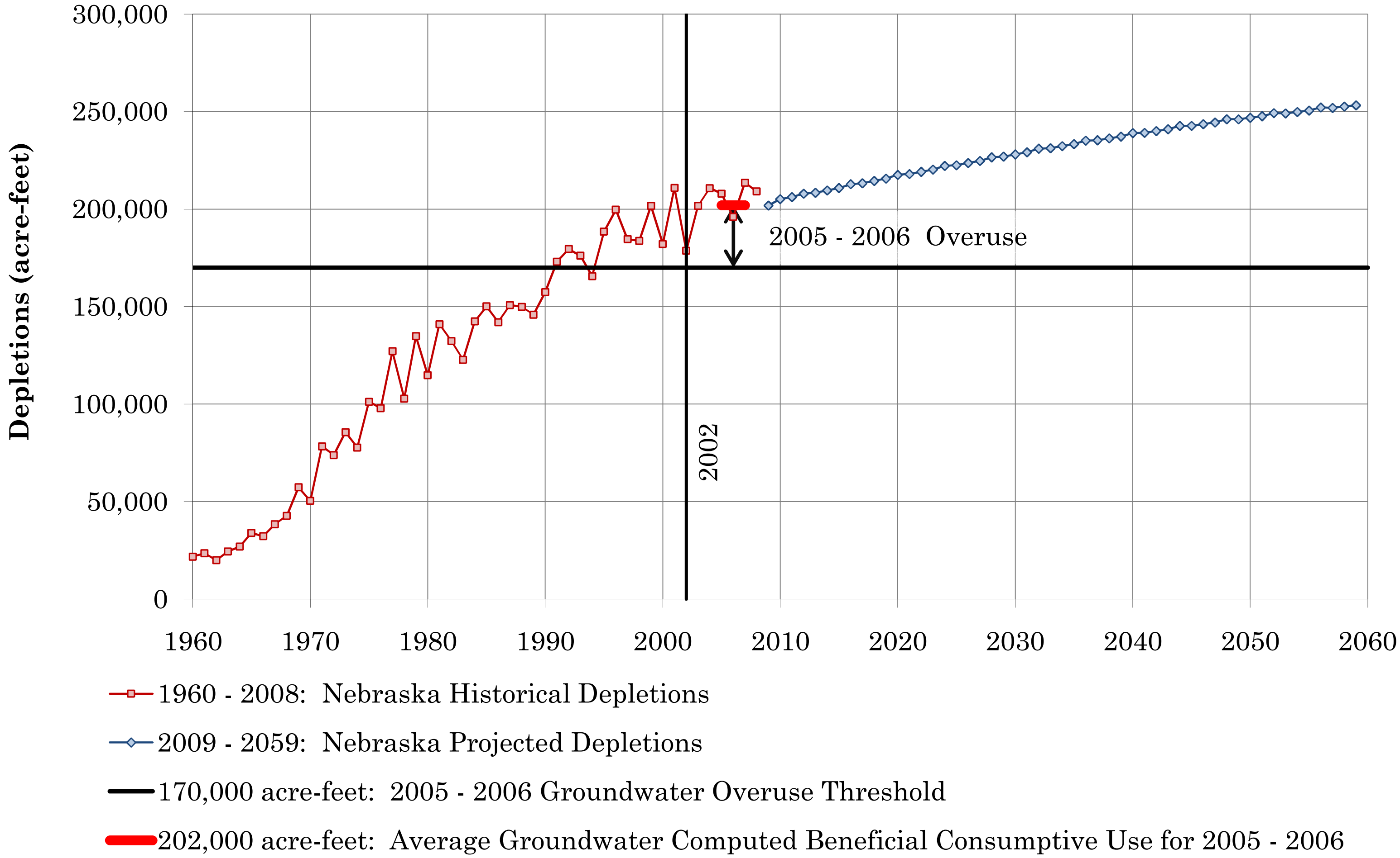
Source: Republican River Compact Administration Groundwater Model data.

Figure 6
Groundwater Irrigation Pumping by Nebraska
Republican River Basin, Nebraska



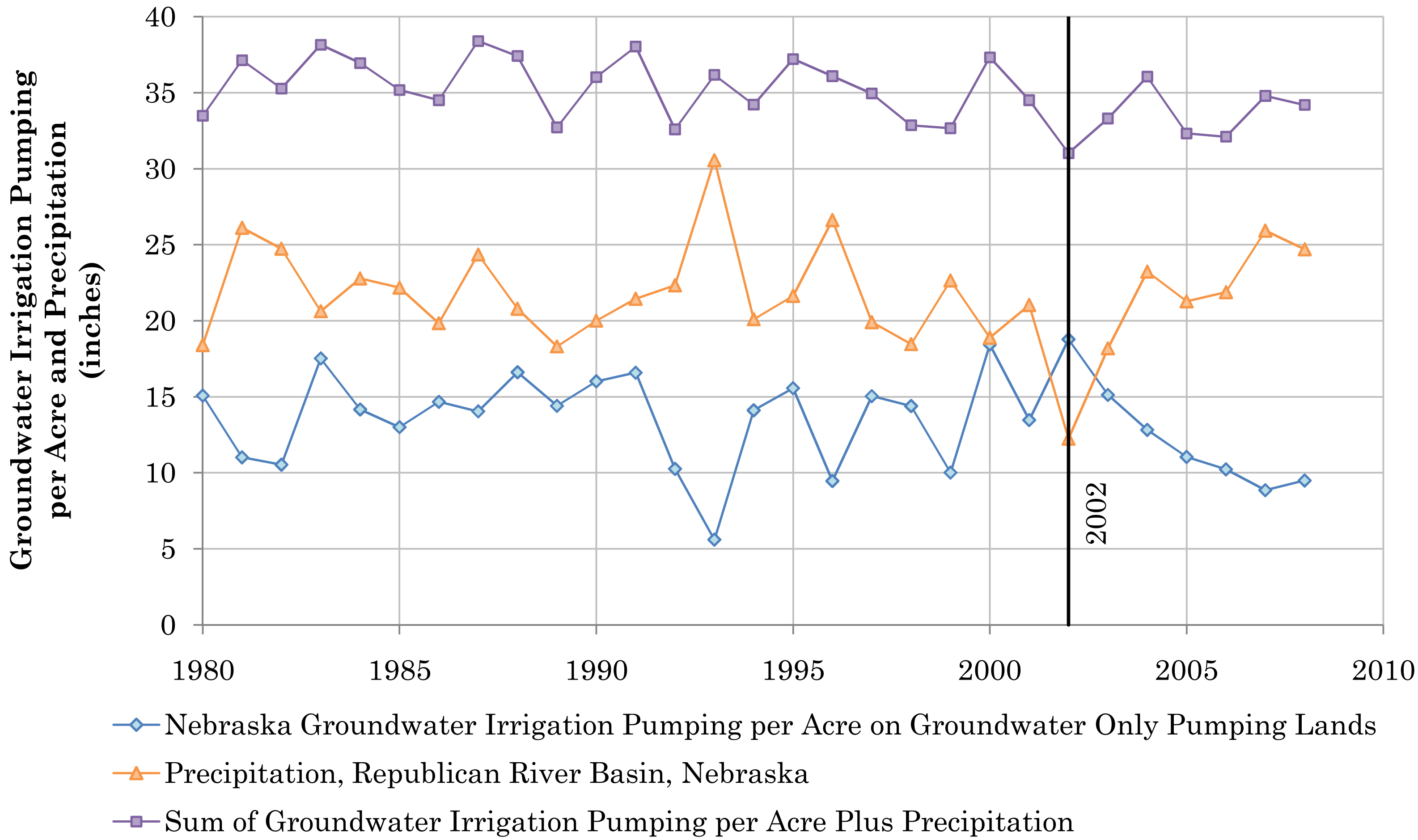
Source: Republican River Compact Administration Groundwater Model data.

Figure 7
Depletions of Republican River Streamflow Above Guide Rock, Nebraska
By Nebraska Groundwater Pumping
Historical and Projected



Source:
(1) Historical Depletions - Republican River Compact Administration Groundwater Model results.
(2) Projected Depletions - Republican River Compact Administration Groundwater Model results generally based on average conditions for years 1959 - 2008 and 2003 - 2008 average groundwater pumping per acre.

Figure 8
Nebraska Groundwater Irrigation and Precipitation
Republican River Basin, Nebraska



Source: Republican River Compact Administration Groundwater Model data.

Table 1
Nebraska Overuse
2003-2006

1	2	3	4	5
Year	Water-Short Year Test Above Guide Rock		Statewide Test Above Hardy	
	per Kansas (acre-feet)	per Nebraska (acre-feet)	per Kansas (acre-feet)	per Nebraska (acre-feet)
2003			25,420	25,420
2004			36,640	36,640
2005	42,860	42,390	42,325	41,785
2006	36,100	28,615	36,880	N/A
Average	39,480	35,505	35,315	N/A
Total	78,960	71,005	141,265	N/A

C22

Notes:

a. Columns 2 and 3 show Nebraska overuse above Guide Rock (subject to Water-Short Year accounting for 2005 and 2006).

b. Columns 4 and 5 show Nebraska statewide overuse above Hardy (subject to five-year accounting for all years, starting in 2003).

c. All values in column 2 and the 2006 value in column 4 are as determined by Kansas as shown in Kan. Exh. 1, Attachments 1 and 2 (1/20/2009) in Nonbinding Arbitration before Karl J. Dreher.

d. All values in column 3 are as determined by Nebraska as shown in the RRCA Compact Accounting spreadsheet for 2005 without non-federal reservoir evaporation below Harlan County Lake and the value determined by Nebraska for 2006 as shown in Neb. Exh. 8, Table 1, at 5 (2/17/2009) in Nonbinding Arbitration before Karl J. Dreher.

e. 2003-2005 values in column 4 are as shown in RRCA, 45th Annual Report, Eng'g Comm. Rep., Table 3C: Compact Accounting with non-federal reservoir evaporation below Harlan County.

f. Values in Column 5 are as shown in RRCA, 45th Annual Report, Eng'g Comm. Rep., Table 3C: Compact Accounting without non-federal reservoir evaporation below Harlan County.

g. N/A = not available.