

No. 126, Original

In the
SUPREME COURT OF THE UNITED STATES

STATE OF KANSAS,
Plaintiff

v.

STATE OF NEBRASKA and
STATE OF COLORADO,
Defendants.

Before Special Master William J. Kayatta, Jr.

Ensuring Compliance by Nebraska

Expert Report of David W. Barfield, P.E.

Chief Engineer, Division of Water Resources
Kansas Department of Agriculture

November 18, 2011

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Table 1: Record of Nebraska Compact Allocation and Use of the Republican River, 1959-2007

Attachment 1: *Statement of Kansas Chief Engineer David W. Barfield, Appendix C to Kansas Motion for Leave to File Petition, Petition, and Brief in Support, Kansas v. Nebraska & Colorado, No. 126 Original. (April 26, 2010)*

I. Introduction

This report provides my analysis of the State of Nebraska's noncompliance with the Republican River Compact ("Compact"), the inadequacies of Nebraska's current plan to comply with the Compact, and the remedies required to overcome those inadequacies and ensure Nebraska's compliance. I base this expert analysis on my professional expertise in three interrelated areas. First, as Kansas Chief Engineer since 2007, I am statutorily responsible for the proper administration of all surface water and groundwater rights in Kansas, and to ensure that Kansas fulfills its obligations under its four interstate water compacts. Second, I serve as the Kansas representative to the Republican River Compact Administration ("RRCA"), service that has made me familiar with the structural reasons for Nebraska's long noncompliance with the Compact. Finally, from 1992 through 2007, I served as the Interstate Water Issues Specialist for Kansas. In that capacity, I assisted Kansas' efforts to resolve its concerns with Nebraska's noncompliance through the RRCA, between 1992 and 1998; and between 1998 and 2003, I served on the technical team that negotiated and implemented the Final Settlement Stipulation ("FSS"), its Accounting Procedures, and the RRCA groundwater model ("Model").

Nebraska has a documented and increasing inability to comply with the Compact when the Compact matters most—during critical dry periods, such as those years between 1989-1992 and 2002-2007. Nebraska now claims that it has put in place a plan to ensure future compliance. Yet as I will demonstrate below, Nebraska's current plan remains insufficient to ensure Compact compliance during critical dry periods and over the long term. That plan is insufficient because it fails to address the cause of Nebraska's noncompliance—excessive groundwater pumping, which is permanently depleting the baseflows within the river's hydrological system. Indeed, without a substantially different plan than its current one, Nebraska's future groundwater computed beneficial consumptive use ("CBCU") will grow and eventually exceed Nebraska's total Compact allocation in dry periods. This systemic overdraft will cause surface water supplies to become increasingly scarce during dry periods, further undermining the purposes of the federal water projects within the river basin that are so crucial to the Compact and to Kansas. As groundwater over-pumping further diminishes these surface supplies, Nebraska will not be able to depend upon them for compliance purposes. Most importantly from my perspective, Nebraska's plan will produce further violations of the Compact and further harm to Kansas.

Nebraska's excessive over-pumping of groundwater has injured the hydrological system of the river basin, and that injury is getting worse. Its compliance plan does not treat that injury. Instead, Nebraska's plan merely addresses the symptoms of that injury, through a variety of strained and convoluted short-term mechanisms. As I will show in this report, Nebraska's current plan is insufficient to achieve Compact compliance for three principal reasons.

- As with past plans, Nebraska's current compliance plan lacks an essential element: a realistic plan to permanently address the continuing increases in groundwater depletions that inevitably result from excessive groundwater pumping.

- The principal effect of the current iteration of Nebraska's Integrated Management Plans ("IMP's") is to delay the substantial action that is immediately required to ensure future Compact compliance over the long term.
- Many essential details of Nebraska's compliance plan are untested, uncertain, and indefinite. Therefore, that plan is unreliable.

These reasons fundamentally undermine the trustworthiness of Nebraska's compliance plan. After suffering for Nebraska's noncompliance during the dry periods of 1989-1992 and 2002-2006, Kansas should no longer be required to trust Nebraska and its various and iterative plans for Compact compliance. The Court should do what Nebraska has long known to be necessary, but what it cannot or will not achieve. First, to overcome the hydrological inadequacies of the Nebraska plan, it should order substantial and definite cuts in groundwater pumping that are sufficient to enable Compact compliance over the long term. Second, to overcome the plan's administrative inadequacies, the Court should appoint a River Master who will supervise and enforce an effective compliance plan. Without these much-needed remedies, Kansas will be required to return to the Court when Nebraska's plan eventually fails, as it inevitably will. Kansas can no longer be expected to rely upon Nebraska's purported commitment to a Supreme Court decree.

Attached as Attachment 1 to this report is my Statement attached to the Kansas Petition ("Statement"), which is made a part of this report, and to which I regularly refer. This report also refers to other Kansas expert reports, which I have listed in the References section.

a. Prior Proceedings in this Action

Following the Court's approval of the Decree of May 19, 2003, 538 U.S. 720, the States worked to implement the methods and procedures set forth in the FSS. The States, acting through the RRCA, jointly developed the accountings that would quantify the allocations for each State, sub-basin by sub-basin. The FSS provides for a phase-in period, which delayed the first water-short year test until 2006, but included the years 2005 and 2006. The results of this test were determined in 2007. For normal years, the first test began in 2007, for years 2003 through 2007. The results of this test were determined in 2008.

The first annual accountings under the FSS revealed that Nebraska was overusing its allocations. During the phase-in years, Kansas repeatedly called for action by Nebraska. Nebraska's actions did not sufficiently reduce its overuse, and so it failed its first tests of compliance.

As a result of Nebraska's failure to meet these tests, I wrote Dr. Ann Bleed, then Director of Nebraska's Department of Natural Resources, in December 2007. In that letter, I formally recognized Nebraska's noncompliance with the FSS, and suggested remedies that would enable Nebraska to comply. Despite consideration of the matter by the RRCA pursuant

to Section VII.A of the FSS, Nebraska did not respond with any significant changes in its approach to Compact compliance.

On October 21, 2008, the States initiated non-binding arbitration on the matter according to the dispute resolution provisions set forth in Section VII of the FSS. The States selected Mr. Karl Dreher, a former chief water engineer for the State of Idaho, as the Arbitrator. While six issues were considered during this arbitration, the two most important for my purposes concerned Nebraska's noncompliance with the Compact and the FSS, and the proper remedies to ensure Nebraska's compliance in the future. Hearings and limited discovery proceeded during the fall and winter of 2008-2009, concluding with ten days of trial in Denver in March and April of 2009. On June 30, 2009, Mr. Dreher issued his final decision (corrected July 13, 2009). In that decision, Mr. Dreher stated, "[t]he fact is Nebraska has not been in compliance with the FSS since it was executed on December 15, 2002, until the 5-year normal administration period ending in 2008, following the wet year of 2007 with wet-year conditions continuing through 2008" Final Arbitration Decision of June 30, 2009 (Corrected July 13, 2009), Finding 151, pp. 57-58 (internal citations omitted). Mr. Dreher also found that "Kansas had adequately demonstrated that its proposed remedy would result in Nebraska's compliance with the FSS, even during dry-year conditions" *Id.*, Finding 135, pp. 49-50. Yet Mr. Dreher also found that Kansas had not shown that its remedy was the minimum remedy necessary for compliance, and that Kansas experts had possibly overestimated the reductions in groundwater irrigated acreage necessary for Nebraska's compliance. *Id.*, p. 50. Conversely, Nebraska "has underestimated the amounts by which it is likely to exceed its allocations during dry-year conditions," by as much as 30,000 acre-feet per year. *Id.*, Finding 150, p. 57. Most importantly, Mr. Dreher was consistently skeptical of Nebraska's ability to ensure future compliance with the Compact and the FSS. See *id.*, Findings 136-151, pp. 50-58.

In May, 2010, Kansas filed a Motion for Leave to File Petition, Petition, and Brief in Support with the Supreme Court of the United States, pursuant to *Kansas v. Nebraska & Colorado*, No. 126 Orig. In April, 2011, the Court granted Kansas' Motion and appointed Mr. William J. Kayatta, Jr. as Special Master. This expert report is submitted as part of the Kansas case.

II. The History of Nebraska's noncompliance with the Compact

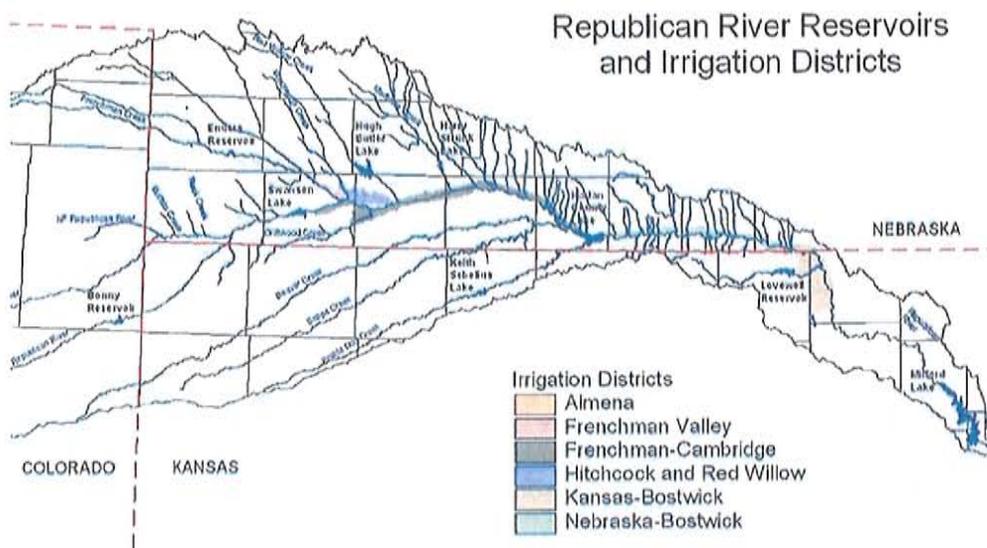
a. The Compact and the Republican River Basin, 1943-1970

The Compact equitably divides all of the waters of the Republican River Basin ("Basin") among Colorado, Kansas, and Nebraska. When any state's use (what is called "computed beneficial consumptive use" or "CBCU" in the Accounting Procedures) exceeds its allocation, it deprives the downstream state of its share; water allocation compacts are a zero-sum game. The United States Supreme Court has made it clear that the apportionment of water pursuant to an interstate water compact binds the citizens of each state and all water claimants within that state. *Hinderlider v. La Plata River & Cherry Creek Ditch Co.*, 304 U.S. 92, 102 (1938). This

obligation was well known at the time of the Compact negotiations; indeed, M.C. Hinderlider himself represented the State of Colorado at those negotiations.

After the ratification of the Compact by the States and Federal government in 1943, a federal system of reservoirs and irrigation districts was developed, consistent with the plan that motivated the Compact's development. (see Figure 1 below) (see, e.g., Flood Control Act of December 22, 1944, P.L. 534 (now codified at 43 U.S.C. 390b), Approving the Comprehensive Plan of Senate Doc. 191 & No. 475, as revised by Doc. 247, 78th Cong., 2d Session). The need to protect the federal government's investments in water-supply infrastructure was a principal reason behind the Compact. See Statement of Mr. Robert D. Kutz, Project Manager for the Bureau of Reclamation ("Bureau"), 29th Annual Report of the RRCA, p. 14 (1989). Indeed, the Compact explicitly provides that federal surface water development in each State be charged to that state's respective allocation. Compact, Art. XI (a).

Figure 1:
Republican River Reservoirs and Irrigation Districts



Even in this early period, the states made it clear, and the Court ultimately agreed in adopting the FSS, that groundwater is part of the "Virgin Water Supply" of the Basin, insofar as it contributes to streamflows. FSS, Section II, *Kansas v. Nebraska and Colorado*, No. 126 Orig., FINAL SETTLEMENT STIPULATION 1.9 (December 15, 2002). The Compact clearly placed the burden on each State to limit its consumptive use to its Compact allocation, regardless of whether the consumptive use derived from surface waters or from groundwater that contributes to surface water flows.

As the surface water use and groundwater use and depletions increased, each state's individual use also increased. This was not surprising and, to the extent consistent with

Compact allocations, such development was appropriate and enabled by the provisions of the Compact.

b. Nebraska's over-development of groundwater resources, 1970-2002

Subsequent to the ratification of the Compact, all three states allowed substantial groundwater development in the Ogallala aquifer and alluvial valley of the Republican River and its tributaries. The effects of this groundwater pumping became evident in the Basin during the 1970's in declining groundwater levels and, in many cases, declining streamflows derived from groundwater outflows. Colorado and Kansas responded to this problem; with the exception of three counties of the Upper Republican Natural Resource District, Nebraska did not.

By the late 1970's, Colorado effectively closed its portion of the Basin to new groundwater development. Kansas began significant restrictions during the same period, and closed its upper basin in northwest Kansas to all new water development in 1984. Thus by the late 1970's, both Colorado and Kansas had stopped increasing groundwater development in their respective portions of the Republican River Model Domain, by limiting the number of active groundwater wells to approximately 4,000 wells in each state.

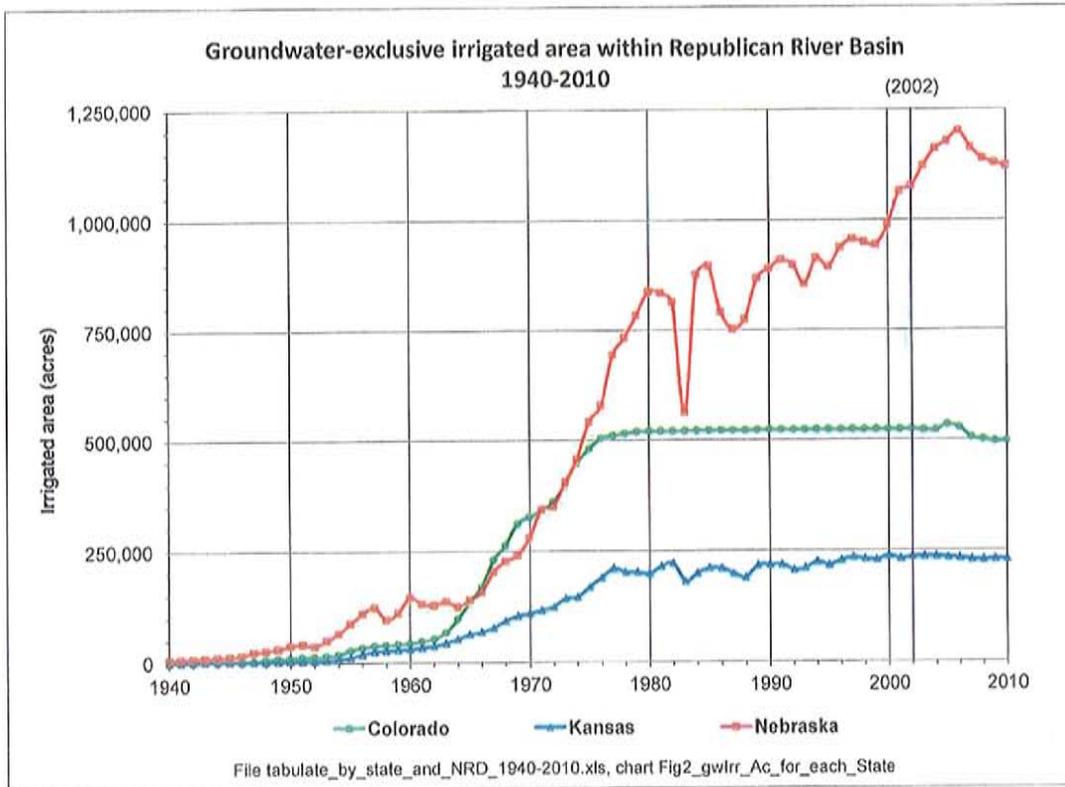
Despite the fact that Nebraska overused its statewide allocation by 1968 and seriously overused it in 1976 and 1978, Nebraska nonetheless continued to allow groundwater development to increase. From 1976 to 2000, the cumulative number of active wells in the Model Domain in Nebraska increased by about 50 percent, from approximately 12,000 active wells in 1976 to over 18,000 wells in 2000. *Kansas v. Nebraska and Colorado*, No. 126 Orig., FINAL REPORT OF THE SPECIAL MASTER WITH CERTIFICATE OF ADOPTION OF RRCA GROUNDWATER MODEL, p. 18 (September 17, 2003).

In Nebraska, groundwater development and pumping are controlled by its Natural Resource Districts ("NRD's"), which are separate from and independent of the Nebraska Department of Natural Resources ("DNR"). Prior to the adoption of the FSS, only the Upper Republican NRD had significant limits on new groundwater development: it implemented a Groundwater Management Area in 1978. The Middle and Lower Republican River NRD's failed to restrict any groundwater development until the end of 2002, when the FSS required that restriction. Yet the NRD's allowed substantial increases in irrigated acreage after 2002.

These facts are reflected in Figure 2, which shows the expansion, from 1940 to 2010, of acreage within the Basin that is irrigated by groundwater. This data was developed by the States for the Model. From the late 1970's to the present, Kansas has maintained a limit of just under 250,000 acres, and Colorado has maintained a limit of approximately 500,000 acres. Yet over the same period, the amount of groundwater-exclusive acreage in Nebraska's portion of the Basin has increased by nearly sixty percent, from 750,000 acres to approximately 1.2 million acres. (The aberrant and large but temporary decline in irrigated acres in 1983 was most likely due to the federal Payment in Kind program of that year.) This growth in Nebraska continued substantially, even after the NRDs instituted moratoria on new wells pursuant to the FSS in

2002. Both the State of Nebraska and its NRD's have allowed this expansion of groundwater development in the Basin, despite clear violations of the Compact and complaints by Kansas.

Figure 2:
Groundwater-exclusive irrigated area within the Republican River basin, 1940-2010



c. Nebraska's over-development leads to Compact violations

Nebraska's serious over-development of groundwater supplies eventually led to a clear pattern of increasing non-compliance with its allocations, both in frequency and magnitude, during critical periods of reduced supply. In general, these sequences are related to Basin precipitation in Nebraska. In years of above-average precipitation, water supply and allocations increase, while water use for irrigation decreases, because irrigation is less necessary. Since 2007, Nebraska's portion of the Basin has enjoyed ample precipitation, and Nebraska has been in compliance. See Attachment 1, Figure 8 to my Statement (Kansas Petition, p. C17); see also Figure 3. In dry years, water supply and allocations are lower, and non-compliance by Nebraska has been the regular result. The record shows that during dry periods, when water is most needed, Nebraska has repeatedly failed to stay within its allocation. And even when Nebraska has been in compliance during wet periods, its depletions of groundwater baseflow have continued to grow, compounding the problem of all future dry periods.

Table 1 is a compilation of summaries of the RRCA record with respect to Nebraska's compliance and noncompliance. According to the records of the RRCA, Nebraska's first statewide overuse was 1968. Its first multi-year violation occurred in the middle and late 1970's. In 1976 and 1978, Nebraska's statewide overuse was reported to be 97,000 acre-feet and 61,000 acre-feet, respectively. Had the current compliance standards been in effect then, Nebraska would have failed water-short year tests in 1977 and 1978, and the five-year tests in 1978, 1979, and 1980.

d. Kansas calls for Action

Nebraska's continuing over-development of groundwater resources and its officially-reported overuse led Kansas to raise its concerns to the RRCA starting in the late 1970's. As Nebraska's violations grew more serious, Kansas began diligent efforts to address these concerns through the RRCA, starting in 1983. Chief Engineer David Pope consistently made his concerns about Nebraska's noncompliance known to the RRCA at its annual and special meetings. RRCA, 32nd Annual Report, for Compact Year 1991, pp. 8-9 (1992).

- At the Special Meeting of the RRCA on February 7, 1986, Chief Engineer Pope expressed his concern that over-pumping would allow "over development of a basin that could result in a reduction of streamflow in dry years." RRCA, 26th Annual report, for Compact Year 1985, p. 11 (1986).
- The following year, Chief Engineer Pope repeated his concerns "about long term depletions that are occurring in the Republican River Basin . . . and, how to deal with the present situation of consumptive uses exceeding adjusted allocations . . ." RRCA, 28th Annual Report, for Compact Year 1987, p. 12 (1988).
- In 1989, In 1989 Kansas proposed a specific solution to the problem of groundwater over-development, which failed by a vote of 2 to 1, with Nebraska voting no. RRCA, 33rd Annual Report, for Compact Year 1992, p. 20 (1993).
- By 1990, Chief Engineer Pope noted that both Kansas and Colorado had "taken definite action" to limit groundwater development, but that Nebraska "had not done so, noting few restrictions on well development in over-allocated areas." RRCA, 30th Annual Report, for Compact Year 1989, p. 12 (1990).

By 1991, Chief Engineer Pope had begun to notify Nebraska of its noncompliance, noncompliance caused by "Nebraska's combined surface and ground water consumptive uses being above their adjusted allocations." This led Chief Engineer Pope to officially request Nebraska "to take the appropriate administrative actions necessary" to limit its use within its Compact allocations. RRCA, 32nd Annual Report, for Compact Year 1991, pp. 10, 9 (1992). Consequently, Chief Engineer Pope

made a motion that the compact administration ask each of the states to take whatever measures are necessary to stay within their annual adjusted allocations of beneficial consumptive use of the water of the Republican River. Pope stated that "the intent was to show the administration was in agreement and to provide additional emphasis for dealing with the issue." Kansas voted yes, Nebraska voted no, Colorado voted yes; the motion failed.

Id. at 10. In 1992, Chief Engineer Pope stated,

the Compact records show that the amount of over-use in Nebraska translates roughly into the amount of shortage being experienced by the Kansas-Bostwick irrigation project in the years, 1989, 1990, and 1991. These depletions upstream directly translate into water that is not available to Kansas."

RRCA, 33rd Annual Report, for Compact Year 1992, p. 21 (1993). By the mid-1990's, Kansas was reporting significant shortages within the lower part of the Basin, shortages "aggravated by Nebraska's over-use of her allocations . . ." RRCA, 35th Annual Report, for Compact Year 1994, p. 19 (1995).

1989-92 witnessed a second sequence of years where Nebraska failed to keep its use within its allocation for multiple years to the detriment of Kansas. Nebraska's statewide overuse was 37,400 acre-feet for 1989, 32,700 acre-feet for 1990, and 52,260 acre-feet for 1991. *See* Table 1. Had the current compliance standards been in effect then, Nebraska would have failed water-short year tests in 1990, 1991, and 1992, and would have also failed the five-year tests in 1991 and 1992. Were it not for the flood year of 1993, such a failure could have continued for much longer.

e. Impacts to Kansas prior to the litigation, 1988-1993

Because it depends upon inflows into Harlan County Lake, the Kansas Bostwick Irrigation District ("KBID") has been significantly harmed by upstream over-pumping of groundwater that would otherwise flow to the river. These impacts did not start with the most recent drought, but were also significant during 1990-93, another period when Nebraska's use exceeded its adjusted allocations as computed by the RRCA under its methods of that time. *See* Table 1.

For example, in the KBID Annual Report for 2007, there is a table entitled "Information From Crop Census" that provides for annual values of classified acres, irrigated acres, acre-feet of water delivered, and inches/acre for years 1958 to 2000. The table also indicates the years of short supply and which years began with restrictions in deliveries. It shows that every year from 1989 to 1993 was either short of supply or started with restrictions and significant reductions in acres served, or with reductions in water deliveries, especially in 1991 and 1992.

f. Litigation leads to the Final Settlement Stipulation

Since the 1980's, Kansas had been diligent in asking Nebraska to limit its groundwater development and use, so that Kansas could receive its allocation; but Nebraska failed to do so. Kansas worked with the RRCA to study the matter, and offered resolutions to address the issue. After reaching an impasse in 1995, Kansas and Nebraska entered into a final attempt to avoid litigation, through intense, facilitated negotiations. The two states reached a preliminary settlement, but Nebraska ultimately rejected it, ending negotiations in 1997. *Kansas v. Nebraska and Colorado*, No. 126 Orig., formally began in 1998.

Throughout the 1990's, Nebraska continued to allow groundwater development to increase. After Special Master McCusick issued preliminary rulings that required the effects of groundwater pumping to be included in determining the States' allocations under the Compact, the States began settlement discussions. Those discussions culminated with the execution of the FSS on December 15, 2002, with the federal government's concurrence. *Kansas v. Nebraska and Colorado*, No. 126 Orig., FINAL SETTLEMENT STIPULATION, 42 (December 15, 2002).

These negotiations, begun in October, 2001, were led by chief engineers of great experience: Hal Simpson of Colorado, David Pope of Kansas, and Roger Patterson of Nebraska. They, along with their staff, attorneys, data experts and groundwater modelers, worked diligently to develop the FSS, the Accounting Procedures, and the Model. The federal government, including its own technical staff and legal counsel, also participated throughout the process. After seven months of intense negotiations, a framework for the settlement was developed and agreed to by the states in April 2002. The states then took an additional eight months to add the detail found in the FSS and its appendices. Between their years of working together through the RRCA and the extensive information produced during the lawsuit's discovery period, the States had extensive data to draw upon, as well as the assistance of the federal government.

The FSS, which includes the Accounting Procedures and the Reporting Requirements, is a carefully produced, thoroughly examined, and flexible document. It provides clear and agreed-upon standards and methods for determining Compact compliance in a manner that seeks to maximize the benefit and flexibility for each State. The FSS performs this dual function through a series of carefully crafted balances. It provides extensive but limited sub-basin flexibility. Rather than requiring strict annual compliance, it balances five-year compliance periods during all periods with additional two-year compliance periods during critical water short years. The tests for water-short years ensure that downstream states have access to their allocation during the most crucial water-short periods. The Accounting Procedures work with the Model to quantify both groundwater depletions and credits to Nebraska for the imported water supply from the Platte River Basin. Finally, the FSS allows each state to develop its own data, while simultaneously allowing for the States to exchange underlying data.

Like the FSS, the Model is the product of long-term cooperation among experienced engineers, some of the finest groundwater modelers in the nation, as well as experts in data

analysis. The Technical Groundwater Modeling Committee was formed in the Spring of 2002. Its membership included modelers Dr. Willem Schreuder, Michael McDonald, Dan Morrissey, Chuck Spalding and Steve Larson, state officials Ken Knox, Dr. Bleed, and me, as well as Alan Burns and Mark Phillips for the United States. As its starting point, this committee reviewed and adopted the model grid and data sets from the United States Geological Survey's multi-year, \$1 million effort to model the entire Basin. The modeling committee then worked extensively through December 2002 to further develop the groundwater model and to provide estimates of groundwater depletions for purposes of the broader negotiations. A model report was attached to the FSS agreement in December 2002, in which the States agreed on calibration targets and model fundamentals. The committee continued its work over the following six months to improve the model's functions and calibration. The final model was completed on June 30, 2003, with the agreement of all the states. Even since the Model's initial adoption by the RRCA, minor errors have been corrected, and its implementation improved through action of the RRCA.

The FSS, the Model, and the Accounting Procedures received widespread praise. Special Master McKusick praised the FSS as a document that was fully compatible with the Compact.

I am fully satisfied that in framing the Final Settlement Stipulation the party States have stayed within the boundaries of the Compact and that their settlement is in all respects compatible with the controlling provisions and purposes of the Compact.

SECOND REPORT OF THE SPECIAL MASTER, pp. 2-3. McKusick's approval was shared by Mr. David Cookson, Counsel of Record for Nebraska. Cookson praised both the settlement process and the FSS in his statements before the Special Master.

[T]he added benefit [of the settlement process]...is we have added on significant parts to this settlement that weren't part of our initial controversy but will allow this process to work in the manner that was envisioned in 1943...[W]e have created an interwoven product that...not only is consistent with the terms of the Compact but provides a meaningful way for us to get along in the future and administer the Compact in a way that's beneficial to all three States.

Id., p. 30, n. 51. Cookson's statement before the Special Master provides a clear picture of how Nebraska understood the FSS—as an agreed-upon compromise which was fully consistent with the Compact, and which dealt with the States' obligations in a clear and flexible manner. Cookson added,

In terms of an annual or even an averaged annual Compact allocation from Kansas's perspective, they're really interested in water being available when they [need] it.

What we tried to address here was a practical solution within the general principles of the Compact, without being inconsistent with its terms, such that we could address their practical concerns in a way that didn't, in the other States' view, unduly burden us with non-Compact [obligations].

So it was a compromise...in the spirit of Article IX, which allows the Compact Administration to adopt rules and regulations that...are consistent with the terms of the Compact.

So we tried to address the dispute over Guide Rock and what that meant in a way that addressed the needs of Kansas in a practical way and addressed the concerns of up-stream States...such that we aren't burdened with what we would consider to be non-Compact obligations.

Id., p. 56, n. 121.

III. Nebraska knowingly disregarded its obligations under the FSS between 2003 and 2007

The FSS was hailed as a victory for all States. Yet its compliance tests and its methods of how groundwater depletions would be computed, when combined with Nebraska's past overuse, made it clear that Nebraska would have to significantly reduce groundwater pumping, particularly to meet the tests of critical dry periods. The challenge facing Nebraska is illustrated by Figure 7 to my Statement, which shows the historic growth in Nebraska's groundwater depletions and their projected growth to 2060. See Statement, Attachment 1 (Kansas Petition, p. C20).

In negotiating the FSS, Kansas granted major concessions. It allowed significant flexibility in evaluating Compact compliance, rather than insisting upon compliance on an annual basis. Furthermore, it waived claims for past damages. Because that settlement was endorsed by all of the States and approved by the Supreme Court, Kansas fully expected Nebraska to respond decisively to its over-development of groundwater, eliminate the excessive depletions shown in Figure 7 to my Statement, and return itself to compliance, especially during critical periods. As the record shows, it did not.

a. The first accounting results showed noncompliance by Nebraska

Following the ratification of the FSS, the states worked diligently to implement it. At its 2003 annual meeting, the RRCA adopted the Accounting Procedures the Model as its methods for determining water supply, allocations, each State's use, and compliance pursuant to the FSS.

The accounting for the 2003 year, the first official year of Compact accounting pursuant to the new methods, was formally adopted at a special meeting of the RRCA in January 2005. RRCA, 44th Annual Report, for Compact Year 2004, p. 2 (2005). It showed that Nebraska's 2003

use exceeded its 2003 allocation by 25,420 acre-feet. *Id.*, p. 11. In 2004, Nebraska exceeded its allocation by 36,640 acre-feet. See Table 1.

These findings were significant, because it was becoming more and more evident that a sequence of dry years was returning to the Basin. 2002, the year the FSS negotiations were completed, was the driest year on record, and was followed by a second dry year. These findings should have reinforced the need for prompt action by Nebraska, but that action did not come. In each of these years, Kansas communicated to Nebraska that its CBCU had exceeded its annual Compact allocation, and called on Nebraska to take additional action. See Table 1. Following 2002, Nebraska substantially overused its annual allocations, in 2003, 2004, 2005, and 2006 as well. The States fully agreed upon the accountings for 2003 and 2004. The RRCA agreed upon the 2005 accounting, except for the issue of evaporation from non-federal reservoirs below Harlan County Lake. The engineering committee and the RRCA accepted all of the 2006 accounting data and model runs, but the final accounting was not developed for similar reasons as in 2005-- continued disputes over allocating evaporation from non-federal reservoirs and Harlan County Lake. See *id.*

b. Nebraska's ineffective implementation of the FSS

In the years that immediately followed the signing of the FSS, Nebraska's principal compliance activities consisted of seeking reductions in irrigated acres through incentive-based land retirement programs, metering, and developing pumping allocations in the three Republican River NRD's.

Nonetheless, Nebraska continued to allow a substantial number of new wells in most of the Basin through the end of 2002, even as the States were negotiating the FSS. In the FSS, Nebraska agreed to implement a moratorium on most new wells. This it did. Subsequently, Nebraska also utilized the federal Conservation Reserve and Enhancement Program ("CREP") to provide federal monies in exchange for retiring farmland from irrigation. Approximately 50,000 acres were thus retired. However, even as Nebraska was claiming to reduce groundwater irrigation through CREP, in fact, Nebraska's Republican River NRD's as well as DNR allowed significant expansion of irrigated acres after the Court's approval of the FSS. See Letter from Roger Patterson to the Lower Republican NRD Board, April 9, 2003.

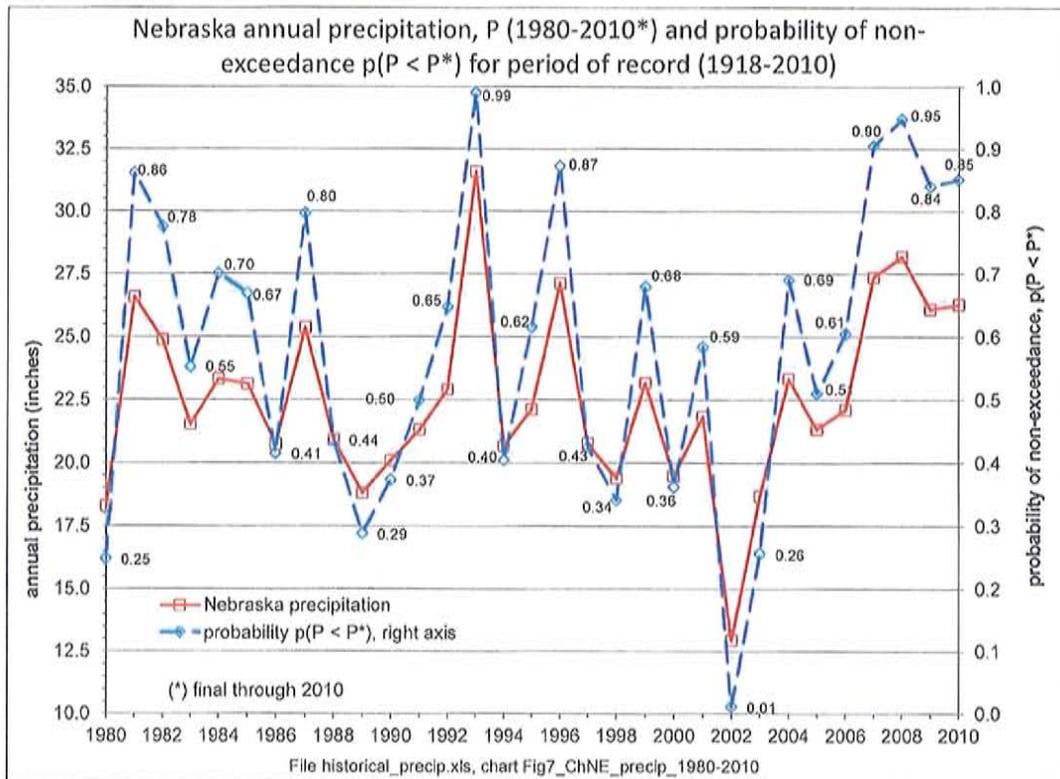
c. Nebraska's first IMP's (2005-2007)

Although the Upper Republican NRD imposed allocation limits as far back as 1978, the state of Nebraska did not address the growing streamflow depletions caused by its over-development of groundwater supplies. The problem of this over-development is expressed in both groundwater declines and streamflow depletions, as shown in figures 3 and 4 of my Statement. See Attachment 1 (Kansas Petition, p. C16-C17).

In an attempt to coordinate Nebraska's separate surface water and groundwater regulation, IMP's were authorized in 2004, and the NRD's adopted their first IMP's in 2005.

Despite the need to be much more aggressive in light of a growing record of overuse, the IMP's contained only token limits on groundwater pumping. Indeed, each of these IMP's, which set allocations for the period 2005-2007, had a goal of reducing the average annual pumping by only five percent, based on the average annual pumping during the period 1998-2002, a period of above average pumping due to below average precipitation, including 2002, the driest year on record. See Figure 3 below. These were the allocations in effect during 2005 and 2006, the period that is the subject of this dispute.

**Figure 3:
Nebraska annual precipitation and Probability of Non-exceedance, 1918-2010**



Moreover, these IMP's allowed the Upper NRD to carry over unlimited quantities of unused allocations to the succeeding allocation period. The Middle and Lower NRD's allowed carryover of twelve inches and nine inches of allocation respectively. Unused carryover at the time was almost 3,000,000 acre-feet. Besides these significant carryovers, which allowed for expanded use during critical dry periods, each of the IMP's also contained provisions allowing their respective NRD boards to grant variances from the allocations, pooling among landowners, and transfers over significant distances of unused allocations. Thus, these IMP's did little to provide a mechanism to reduce, much less stop, the longer term impacts from past groundwater pumping. Those lag effects will continue many generations into the future.

d. DNR's own modeling results promoted a call to action by the Director of DNR, but Nebraska rejected that call to action

The political leadership in Nebraska was well aware of the reductions and limitations that compliance with the FSS required. After the FSS was signed, Dr. Ann Bleed, first Deputy Director, then Interim Director, and finally Director of DNR, completed computer model runs to determine NRD allocations that would be necessary for Nebraska to achieve Compact compliance. Dr. Bleed's runs revealed that the allocations necessary for Compact compliance were substantially lower than the NRD's allocations. It appears Dr. Bleed knew that if Nebraska were to comply with the FSS, the NRD's would have to substantially reduce their use of groundwater. A brief overview of this modeling work, upon which Dr. Bleed relied, is reviewed in the Dr. Samuel P. Perkins, Ph.D. and Steven P. Larson, *Reducing Future Impacts of Pumping on Groundwater Consumptive Use* (November 18, 2011) ("Perkins/Larson Report"). DNR developed forty year future projections to determine the actions needed to comply with Nebraska's allocation over that time horizon. DNR found that, to achieve long-term compliance, Nebraska's pumping would have to be reduced by approximately 50%.

On December 15, 2006, at the invitation of Dan Smith, the director of the Middle Republican NRD, Nebraska Governor Dave Heineman and Dr. Bleed attended a water conference in McCook, Nebraska, in which they clearly conveyed the need to curtail groundwater use in the Basin. Governor Heineman told the conference that the "real key" to Nebraska's compliance was "to reduce consumptive use and achieve a balance between competing interests for water." *Irrigation Cuts of 15, 50 percent needed for Republican River Compliance?*, MCCOOK DAILY GAZETTE, December 15, 2006, available at <http://www.mccookgazette.com/story/1181591.html> (last accessed November 16, 2011). Dr. Bleed, then acting director for Nebraska NRD, went on to detail DNR's proposal for what would be necessary to achieve compliance with the Compact and the FSS within the Basin: a fifty-percent reduction in withdrawals from the quick response wells, and a fifteen percent reduction in the "upland" areas. Dr. Bleed reported that in the Upper Republican NRD, that meant limits of 2.8 to 5.7 inches per year on quick response wells, and restrictions of 11.38 inches per year on the upland wells. In the Middle Republican NRD, the DNR proposal envisioned limits of 2.7 to 5.3 inches per year on quick response wells, and restrictions of 9.0 inches per year on the upland wells. And in the Lower Republican NRD, the DNR plan called for limits of 2.4 to 4.8 inches per year on quick response wells, and restrictions of 9.6 inches per year on the upland wells. Governor Heineman and Dr. Bleed recognized the need for substantial and immediate action; Bleed noted that "there will be lots of sacrifices." Yet they fully acknowledged the need to comply with the FSS. As Governor Heineman stated, "It will be painful . . . but we must reduce consumptive use to meet compliance with the Compact." *Id.*

Mr. Smith followed up the December conference in McCook with an open letter on behalf of the Middle Republican NRD. In this letter, Smith acknowledged that he had organized the December conference "to discuss the dire situation Nebraska must address regarding water issues." Smith confirmed Ms. Bleed's call for fifty-percent reductions in pumping from quick-

response wells and fifteen-percent reductions in upland wells. "An Open Letter to All Concerned About Nebraska Water Issues," January 4, 2007, *available at* http://www.nrdnet.org/news_events/news_pdfs/MRNRD_010207.pdf (last accessed November 16, 2011). However, Mr. Smith acknowledged that even the DNR plan was not aggressive enough for the state to achieve compliance: "This plan proposed compliance within five years; however, compliance must be achieved by the end of 2007." *Id.* at p. 3. Even with that five year span, Smith clearly understood DNR's proposal: "our existing allocations, which DNR both established and agreed upon, need to be drastically reduced in order to achieve compliance." *Id.*

Rather than heeding this collective call to action from the Governor, the Director of DNR and a prominent NRD leader, it eventually became apparent that Nebraska would take much different direction. Eventually, in March 2008, Dr. Bleed suddenly departed her post. Nebraska has since discontinued considering significant reductions in groundwater pumping that can lead to permanent solutions to Compact compliance, adopting instead a short-term plan aimed at protecting current levels of groundwater pumping. Indeed, Dr. Bleed has recently lamented the failure of the new Nebraska approach to compliance: "[i]f we don't amend the Integrated Management Plans, Nebraska's assertion that it has taken steps to ensure Compact compliance will be called into question by the Supreme Court." *Not to [sic] late to face Republican River reality*, MCCOOK DAILY GAZETTE, September 22, 2010, *available at* <http://www.mccookgazette.com/story/1666700.html> (last accessed November 16, 2011).

e. Nebraska's second-generation IMP's (planned for 2008-2012, but replaced in 2011)

During 2007, the IMP's were amended into their second generation, and new allocations were set for the next allocation period, from 2008 through 2012. Yet these allocations, like their predecessors, were inadequate, aiming to reduce the pumping by twenty percent from the 1998-2002 average annual pumping. For instance, the Middle NRD's goal was to reduce pumping volume twenty percent "under average precipitation conditions." These modest reductions were far less than what Nebraska knew was needed, and did not even become effective until 2008, the sixth year following the signing of the FSS in 2002, and in the wake of four years of demonstrated non-compliance with the FSS. The IMP's also make it clear that allocations cannot be further reduced without a public hearing and approval of the NRD boards.

Chief Engineer David Pope wrote Dr. Bleed on January 24, 2007, to express his concerns that the Nebraska NRD's did not recognize what she had made so clear at the McCook conference a month before: namely, "the need for immediate and significant actions to reduce consumptive water use to come into compliance." Letter of Chief Engineer David Pope to Dr. Ann Bleed, January 24, 2007, p. 1.

During the RRCA dispute resolution process early in 2008, the states reviewed this set of IMP's, which became a focus of the 2009 Arbitration. Kansas found that such an untargeted,

nominal reduction was vastly below the significant and targeted action that Nebraska, and Dr. Bleed, clearly knew to be required. As summarized above at page 5, Arbitrator Karl Dreher agreed with Kansas that this second generation of IMP's was insufficient to protect Kansas from Nebraska's noncompliance during critical dry periods.

f. The impacts of Nebraska's noncompliance with the FSS

As had occurred in the early 1990's, once again in 2003 and following, water users in KBID and other water users in the lower Republican basin in Kansas did not receive the water to which Kansas was entitled under the Compact. Kansas had the capacity and need to use that water, and those users were damaged by Nebraska's failure to comply with the Compact during this time. See the expert reports for Kansas by Dale Book, P.E., and Angela Schenk, and by Dr. Joel Hamilton and Dr. M. Henry Robison for information relevant to these impacts in 2005 and 2006. It is important to note that Kansas experienced water shortages outside of these two years.

IV. Nebraska's dysfunctional system of water rights administration is a structural obstacle to Compact compliance

The State of Nebraska is directly responsible for compliance with the FSS, but it has delegated the authority to reduce CBCU to entities that it does not directly control.

In Nebraska, surface water is governed by one set of laws and is administered by DNR. See Neb. Rev. Stat. § 61-206(1) (2009) ("The Department of Natural Resources is given jurisdiction over all matters pertaining to water rights for irrigation, power, or other useful purposes except as such jurisdiction is specifically limited by statute.") Groundwater is governed by a different set of laws and administered by NRD's. See Neb. Rev. Stat. § 46-702 (2011) ("The Legislature also finds that natural resources districts have the legal authority to regulate certain activities and, except as otherwise specifically provided by statute, as local entities are the preferred regulators of activities which may contribute to ground water depletion."). An NRD is a political subdivision of the state of Nebraska. Neb. Rev. Stat. § 2-3213(1) (2007). Each NRD has its own taxing authority, its board members are popularly elected, and its authority is limited to a discrete geographic area. (See generally Neb. Rev. Stat. §§ 2-3201 *et seq.*)

In 2004, the Nebraska legislature modified the management of groundwater and surface water by enacting LB 962. This bill introduced the mandatory adoption and implementation of IMP's in over-appropriated and fully appropriated basins such as the Basin. Neb. Rev. Stat. § 46-715(1) (2011). The IMP concept, however, was not developed specifically for FSS compliance in the Basin. Senator Ed Schrock, the chairman of the Natural Resources Committee who introduced LB 962 and served on the forty-nine member commission specifically tasked by the Governor to develop a state wide interrelated water management plan, stated that: "I would say that LB 962 really does not impact the Republican River Basin much because the Republican

Basin must live within the terms that we agreed to settle our lawsuit with the state of Kansas.” (Nebraska Unicameral Legislature, Floor Debate, LB 962, March 2, 2004, Transcript pg. 10428).

In fully appropriated areas, the NRD’s adopt IMP’s with the concurrence of DNR. Neb. Rev. Stat. § 46-715(1) (2011). Because, the NRD’s “jointly develop” the IMP with DNR, the NRD’s have veto control over what goes into the IMP’s. *Id.* The ground water controls called for in these plans must then be implemented by the NRD through separate rules and regulations. As Dan Smith, manager of the Middle Republican NRD stated, “[a]n NRD implements an integrated management plan by adopting rules and regulations for a groundwater management area.” Deposition of Dan Smith, 59:21-23, October 28, 2011. Indeed, as of the drafting of this report, all of the groundwater allocations adopted by the three Republican River NRD’s for the *second-generation* IMP’s are still in effect.

The state of Nebraska, acting through DNR, has no direct supervisory authority over the NRD’s concerning groundwater administration. In the event that DNR and an NRD cannot agree on the content of an IMP, then the Governor of Nebraska convenes and appoints the members of a third entity, known as the Interrelated Water Review Board, to resolve the dispute. *See* Neb. Rev. Stat. § 46-719(2)(a) (2011). DNR and the NRD present their proposals, and the board then selects a solution, conducts public hearings, and, eventually, adopts an IMP on behalf of DNR and the NRD. *Id.* § 46-719(2)(b)-(d). Even then, the ground water controls adopted by the board still have to be “implemented and enforced by the affected natural resources districts.” *Id.* § 46-719(2)(e). This same dispute resolution process applies whenever DNR and an NRD cannot agree on modifications to an IMP or on enforcement and implementation of the regulatory controls for ground water in an IMP. *Id.* § 46-719(3)-(4). To date, DNR has never requested that the board be convened to exercise its potential authority over NRD’s, despite Nebraska’s continuing overdevelopment of groundwater, and despite Nebraska’s clear obligations under the Compact and the FSS.

a. Nebraska has unreasonably rejected long-term water supply planning

The states have adopted the Model to compute depletions to streamflows from groundwater pumping and imported water supply credits from the Platte Basin. The model is used by all the states to project future groundwater depletions and IWS credits under various assumed pumping and hydrologic conditions to evaluate future compliance.

As discussed above, DNR ran long-term projections (forty years or greater) to determine the future of its groundwater depletions and its implications to compliance for a variety of alternatives, and reported its findings to the NRD’s and others in the Basin. The results demonstrated that substantial cuts (approximately 50%) to groundwater pumping are necessary to stop the increase in Nebraska’s groundwater CUCU that is the root of its compliance problem.

These conclusions have been rejected repeatedly in the IMP process, and Nebraska has adopted increasingly shorter “long-term” planning and projection processes. The latest, third-

generation IMP defines its “long-term” planning horizon as between five and twenty years distant. Upper Republican NRD IMP, Section IX.B.e. Further, Nebraska’s experts now deem long-term projections and planning to be as short as five years. Deposition of Dr. James Schneider, Ph.D., October 24, 2011, p. 22.

This position is neither reasonable nor defensible, given Nebraska’s history of non-compliance in critical periods and its knowledge of its growing groundwater depletions, knowledge obtained through the work of Dr. Bleed. There is a present and future condition of significant groundwater depletion in the Basin, and that condition must be confronted. Delay will only make that reckoning more difficult and future noncompliance by Nebraska more likely.

The output from the Model shows the history of the steady increase in Nebraska groundwater depletions over time. The steepness of that increase, from 50,000 acre-feet in 1970 to 200,000 acre-feet in 2000, is the result of both increasing groundwater pumping over the period, and from the increasing effects of pumping farther away from a stream—an effect that takes time to become manifest. Even without increasing groundwater pumping, Nebraska’s groundwater depletions continue to grow due these “legacy effects.” While we cannot predict the sequence of wet and dry years ahead, the historic records demonstrate that the Basin will be subject to such cycles in the future.

b. Nebraska has rejected significant reductions in groundwater pumping

After Arbitrator Dreher found Nebraska’s compliance plan insufficient for critical periods, DNR and the NRDs initiated work on a replacement plan.

In October 2009, DNR provided the NRD’s with a briefing entitled “Compliance Options During Dry Years for Integrated Management Planning in the Republican River Basin.” The briefing provided three options to consider. The options included:

- A reduction in basin-wide pumping sufficient to allow the NRD’s to remain within their share of allowable depletions in all years. This option allows Nebraska to treat all groundwater users equally and only curtailed surface water use. Nebraska’s supporting projections indicated that reductions of approximately 60% reduction would be required.
- To comply in most years Nebraska DNR proposed no additional reductions in the IMP pumping limits, but sought compliance in water-short periods by curtailing surface water use and reducing pumping in a “10% / 5-year” Rapid Response Region.
- To comply in most years, Nebraska DNR proposed no additional reductions in the IMP pumping limits, but aspired to compliance in water-short periods by curtailing surface water use and by reducing groundwater pumping in a “10% / 2 year” Rapid Response Region, combined with additional pumping restrictions of approximately 1% per year.

The NRD's took the option that took the least amount of current action—the last one described above-- and DNR conceded. My evaluation of the effect of this decision is discussed below. The NRD's decided to take the minimum action required at present, and thereby postpone necessary action.

V. Nebraska's current compliance plan is inadequate

Nebraska is required by the Compact and the FSS to be in compliance with every Compact compliance period: this includes five-year compliance during all years, and two-year compliance during critical water short-years. (Nebraska has not so far sought the option of alternative water-short year administration.) Compliance over a five-year period neither excuses nor mitigates failure to comply over a two-year water short period. As has been shown, Nebraska's response to the problem of its overuse has been inadequate.

Nebraska has presented its IMP's as the solution to groundwater over-development and its past non-compliance. As is shown below and in the Perkins/Larson Report, our analysis of the most definitive restrictions in the IMP's shows they require significantly less than what Nebraska must do to achieve compliance in the future. Nebraska's groundwater CBCU will continue to grow into the future without substantial, enforceable reductions and controls on its groundwater depletions.

a. An overview of Nebraska's third-generation IMP's and their likely effects

Rather than take significant, additional cuts to groundwater pumping-- the dominant cause of Nebraska's past non-compliance and a known and growing problem threatening its future compliance—Nebraska's third-generation IMP's take a different approach: modest cuts in long-term groundwater pumping and the adoption of a set of projection methods, standards, and potential actions to deal with critical dry periods. Below is a summary of the most significant provisions of the current IMP's; the citations are to the Upper Republican NRD IMP.

- Maintain the expectation that "long-term" pumping would be less than 80% of the 1998-2002 baseline. (Section VI.A.3.a).
- Have as a goal to reduce groundwater pumping by another 5% over the coming five years, principally through voluntary programs or "other means" determined by the NRD. The necessity of continuing this requirement is to be re-evaluated in 2015. (Section VI.A.3.b).
- A requirement that the NRD's groundwater depletions be below its share of the "allowable ground water depletions" over the five-year average periods. (Section VI.A.3.b).
- A projection method by which at the end of each year, DNR examines the status of its compliance through year's end and makes an estimate of the upcoming year's expected allocations and CBCU, based on a dry-year forecast. In doing so, it establishes each

NRD's share of the Nebraska's "allowable groundwater depletions" and an estimate of each NRD's expected CBCU. (Section XII).

- The NRDs are given a broad array of alternatives for addressing any projected overuse of its share of Nebraska's groundwater depletions, including "surface water leasing, ground water leasing, augmentation, etc." (Section VI.B).
- A method to determine whether the coming year is a "Compact Call Year" in which extraordinary water administration is required. (Section XI.B.b).
- In addition to surface water controls prescribed by the FSS, in Compact Call Years DNR commits to regulate surface water users to ensure Compact compliance including closing notices on all natural flow and storage permits until the call is no longer needed. (Section VII generally and esp. VII.F).
- In the annual evaluation, if a Compact Call Year is indicated, an NRD's expected CBCU for the coming year must be less than its share of the allowable. If it is projected to be greater than its share, the NRD must develop a plan, which it submits to DNR for evaluation. This can include consideration of potential yields from various alternatives to pumping reductions. If agreement on an acceptable plan is not reached, the NRD is supposed to require the curtailment of pumping in the Rapid Response Region. (Section IX.B.2.c, Section VI.B.1).
- Methods to determine when a Compact Call Year can be discontinued. (Section IX.B.d).
- A provision for an annual meeting between DNR and the NRD's "to review expected long-term (5-20 year) increases in depletions to streamflow and discuss potential mitigation measures that may be necessary." (Section IX. B. e).

The IMP's prescribe only limited explicit reductions to groundwater pumping, and provide a broad array of alternatives to avoid significant pumping reductions, and to avoid the threat of the suspension of groundwater pumping in the Rapid Response Region.

b. The third-generation IMP's are hydrologically inadequate.

i. Kansas' and Nebraska's long-term modeling results show that the third-generation IMP's are inadequate.

The Perkins/Larson Report has developed sixty-year future projections of groundwater conditions in the Basin. It also reviews Nebraska's own results from its forty-year future projections, performed by Nebraska when it was focused on long-term solutions to the problem of its noncompliance.

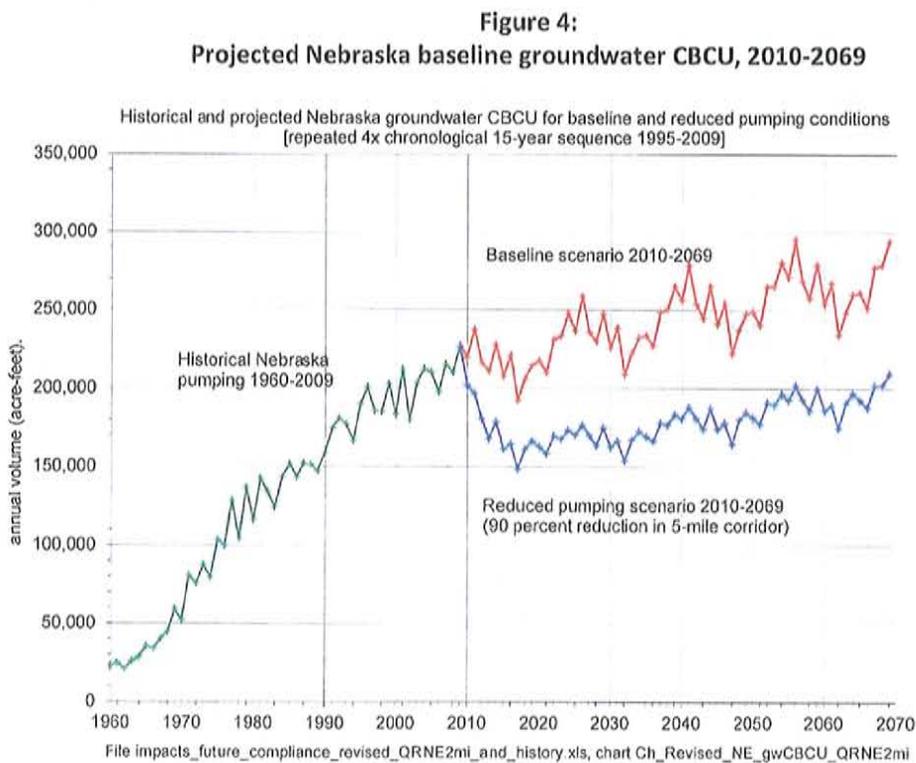
Kansas' modelers have developed a reasonable future projection method to compute and evaluate the future Nebraska groundwater CBCU values of various potential Nebraska management outcomes according to these third-generation IMP's.

The details of the assumptions Kansas has made are provided in the Perkins/Larson Report, including what years to repeat (1995-2009), the level of groundwater pumping, and a means to provide for a reasonable degree of annual variability in those futures. While other assumptions can be made and the future will certainly not be the exact sequence that Kansas experts projected, the effect of groundwater depletions with certain levels of groundwater pumping cannot be denied.

Determining reasonable assumptions for Nebraska’s future pumping in light of the current generation of IMP’s was more difficult, because of the lack of certainty provided relative to that future pumping. While this uncertainty of action (and the consequent delay of needed groundwater cuts) is a central flaw of the IMP’s, the following assumptions were made to create the baseline future:

- Adherence to NRD limits of 80% of 1998-2002 baseline groundwater pumping.
- Adherence to NRD allocations to individual users, ignoring carryovers of unpumped groundwater amounts.

Figure 4 shows the resulting future Nebraska groundwater CBCU from these baseline conditions.



As is summarized in the Perkins/Larson Report, this baseline will produce a 700 acre-feet per year, per year increase in Nebraska's groundwater CBCU. This is because of a fundamental hydrological relationship: the more Nebraska's groundwater pumping exceeds basin recharge, the larger will be the growth in groundwater depletions to streamflow.

ii. The additional groundwater reductions provided for under the third-generation IMP's are also inadequate

The above analysis does not include the curtailment of the Rapid Response Regions pursuant to the IMP's. Based on our review of the IMP's and the options available to the Republican River NRD's, we believe that these NRD's, with the acquiescence of DNR, will avoid significant pumping cuts for years, if not decades, as long as there is some surface water remaining in critical dry periods. However, while this short-term compliance occurs, Nebraska's groundwater depletions will continue on their upward projection, creating a bigger and even more chronic problem in the future.

Despite significant reservations about the implementability of this alternative, to evaluate the potential effects of the suspension (curtailment) of the Rapid Response Regions, Kansas modeled the suspension of groundwater pumping in the Rapid Response Regions, both (1) intermittently to show the benefit during the years of curtailment, in terms of slowing the upward progression of groundwater CBCU; and (2) permanently suspending groundwater pumping in these regions to see the upper boundary of the benefit of Rapid Response Region curtailment.

1. Intermittent suspension results

For the intermittent suspension, for illustrative purposes, we assumed a suspension of all years corresponding to 2002-2007 in the four 1995-2009 periods modeled. More details on the methodology and results are shown in the Perkins/Larson report. Figure 5 contrasts the groundwater CBCU of the baseline alternative versus the intermittent suspension of the Rapid Response region.

Figure 5:
Projected Nebraska groundwater CBCU under baseline conditions vs. intermittent suspension in Rapid Response Region in years corresponding to 2002-2007.

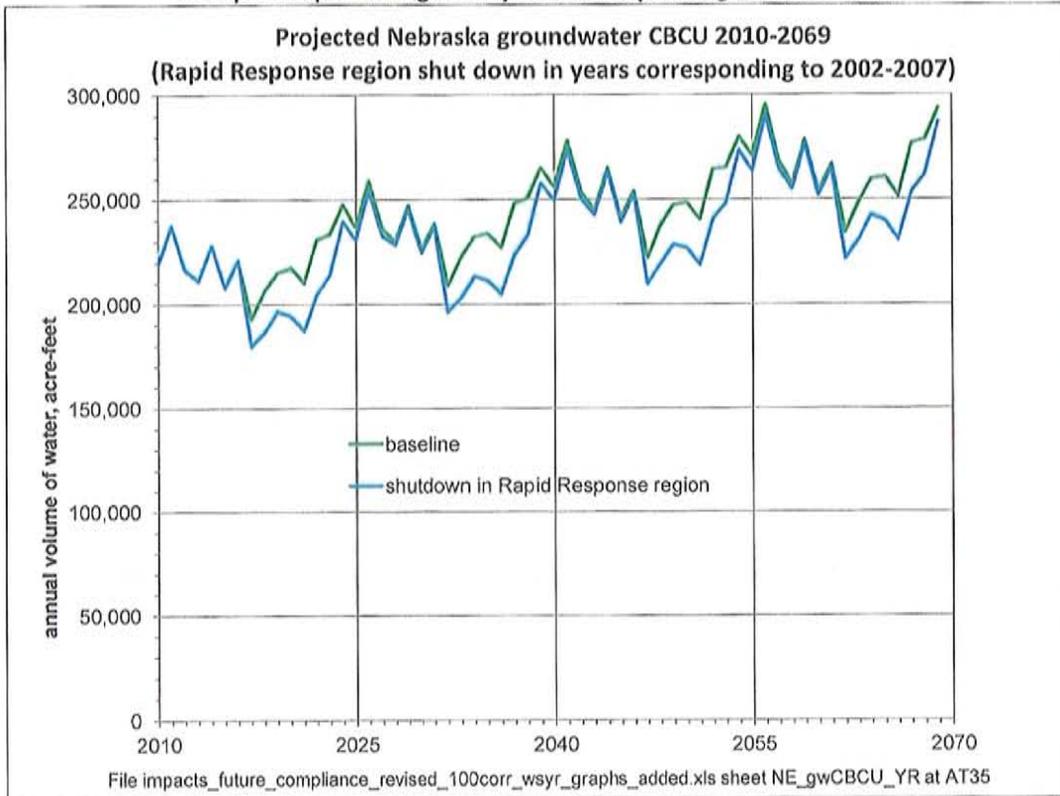
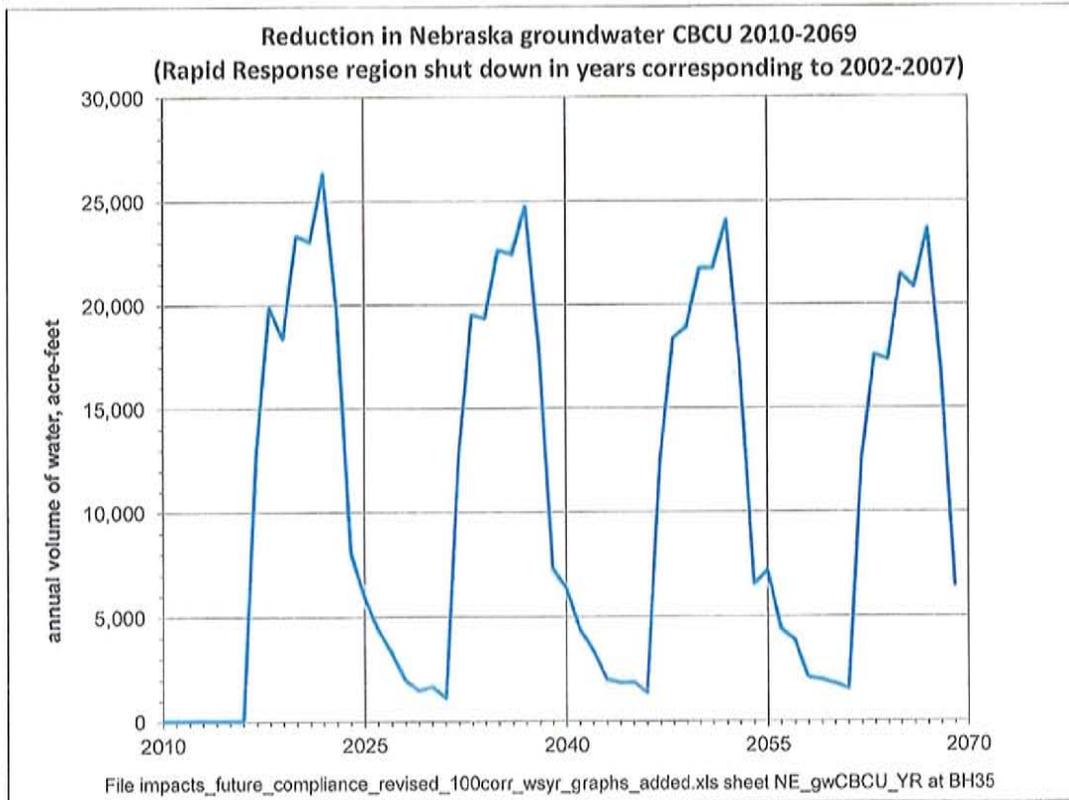


Figure 6 shows the differences in the base run future and this intermittent suspension of the Rapid Response Region.

Figure 6:
Reduction in Nebraska groundwater CBCU due to shutdown in Rapid Response region in years corresponding to 2002-2007.



The results from the modeling of an intermittent suspension show a reduction in groundwater depletions of approximately 12,000 to 13,000 acre-feet of reduction in CBCU in the first year of suspension, and 18,000 to 20,000 acre-feet in the second year of the suspension. This slowly rises to a peak of 24,000 to 26,000 acre-feet of benefit by the sixth year of suspension. After the suspension ends, depletions rebound to their pre-suspension levels. This analysis shows little reduction in the overall rate of levels of depletion, only the limited benefit during the years of suspension. So, even assuming suspension in six years of every fifteen years in the Rapid Response Region, the long-term growth rate of Nebraska groundwater CBCU continues unabated at approximately 700 acre-feet per year, per year.

2. Permanent suspension results

Kansas also ran a future scenario with a permanent suspension of the Nebraska Rapid Response Region. Figure 7 contrasts the groundwater CBCU of the baseline alternative versus the permanent suspension of groundwater pumping in the Rapid Response Region.

Figure 7:
Projected Nebraska groundwater CBCU under baseline conditions vs. permanent suspension of groundwater pumping in Rapid Response Region.

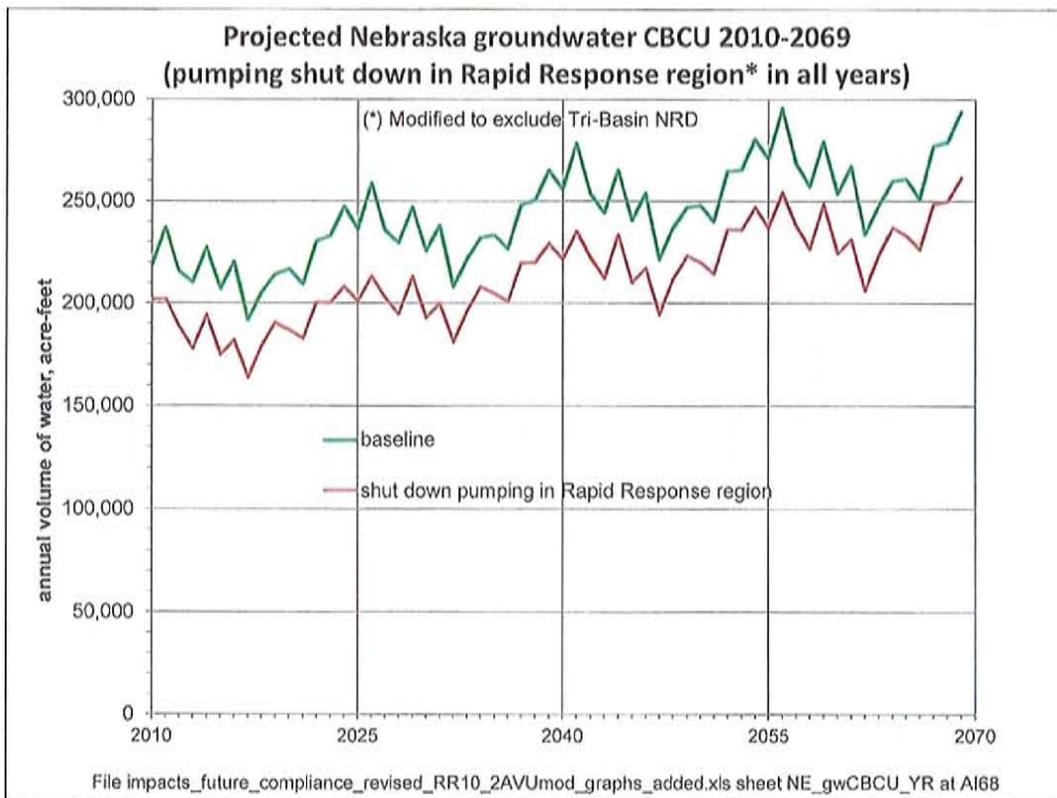
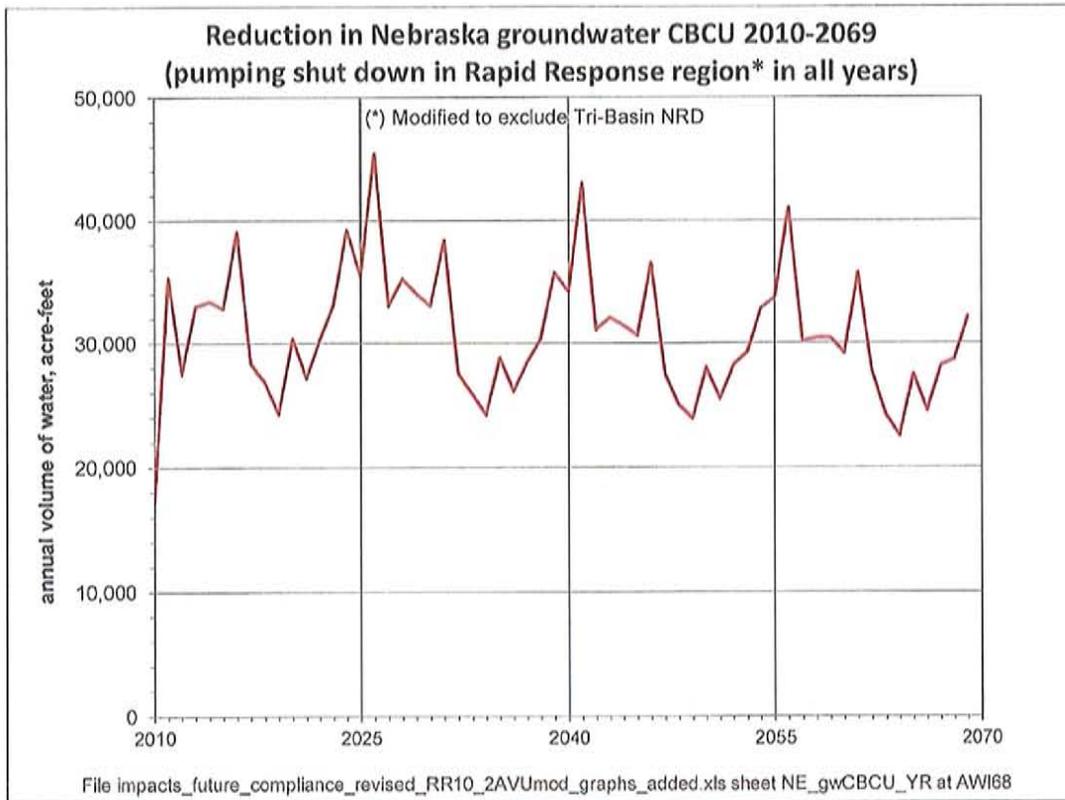


Figure 8 below shows the difference in groundwater CBCU between the base run and the permanent suspension of the Rapid Response Region.

Figure 8:
Reduction in Nebraska groundwater CBCU due to permanent suspension in Rapid Response Region.



Here there is an immediate and long benefit from the permanent suspension of the area, and yet, after the initial drop in groundwater CBCU, the benefits level off and even diminish a bit with time. The benefit during dry periods is on the order of 25,000 to 30,000 acre-feet per year in dry periods of the future that Kansas experts modeled. But over time, the upward trend in groundwater CBCU and downward trend in the benefits of curtailment in the Rapid Response Region become clear: the long-term problem has been delayed but not addressed.

3. 25% reduction results

The IMP's suggest that the NRDs will be required to reduce pumping to a 25% reduction from the base pumping (1998-2002 average) rather than just 20%. Our modelers ran this future scenario to determine the benefit of this versus the base case of a 20% reduction from the baseline pumping.

Figure 9 contrasts the future groundwater CBCU between pumping that corresponds to the 80% limitation and the 75% limitation of base line pumping.

Figure 9:
Comparison of Nebraska groundwater CBCU for cases with 80 percent (baseline) and 75 percent of average 1998-2002 pumping.

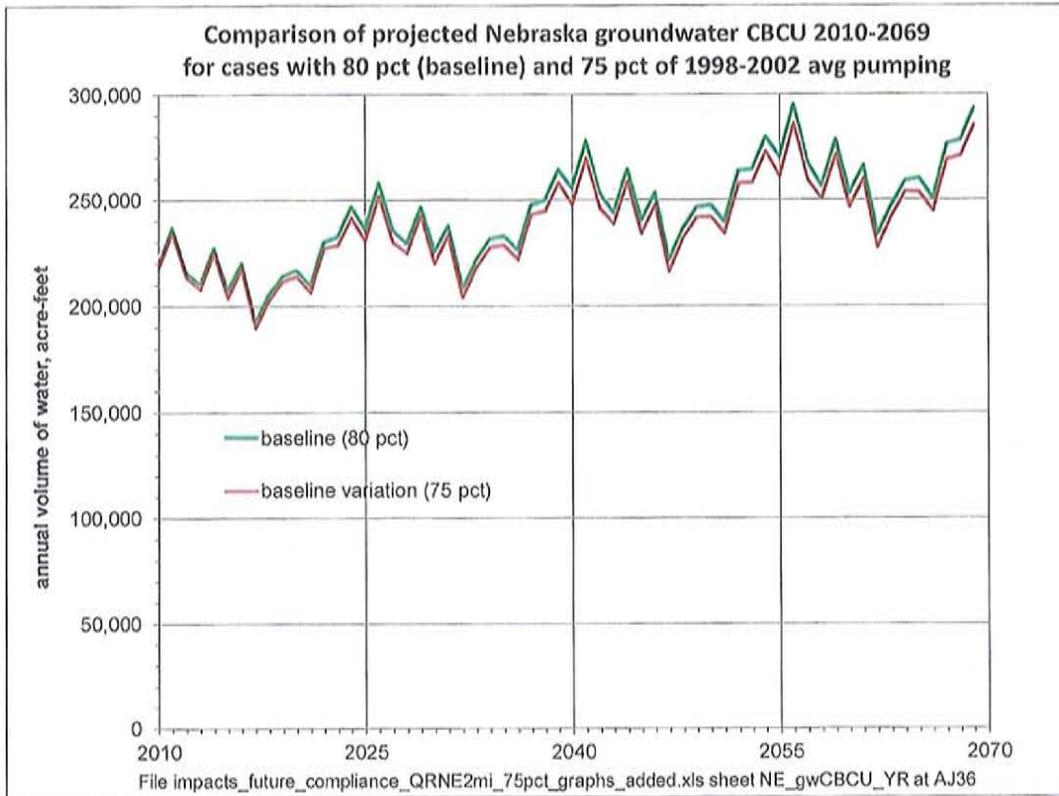
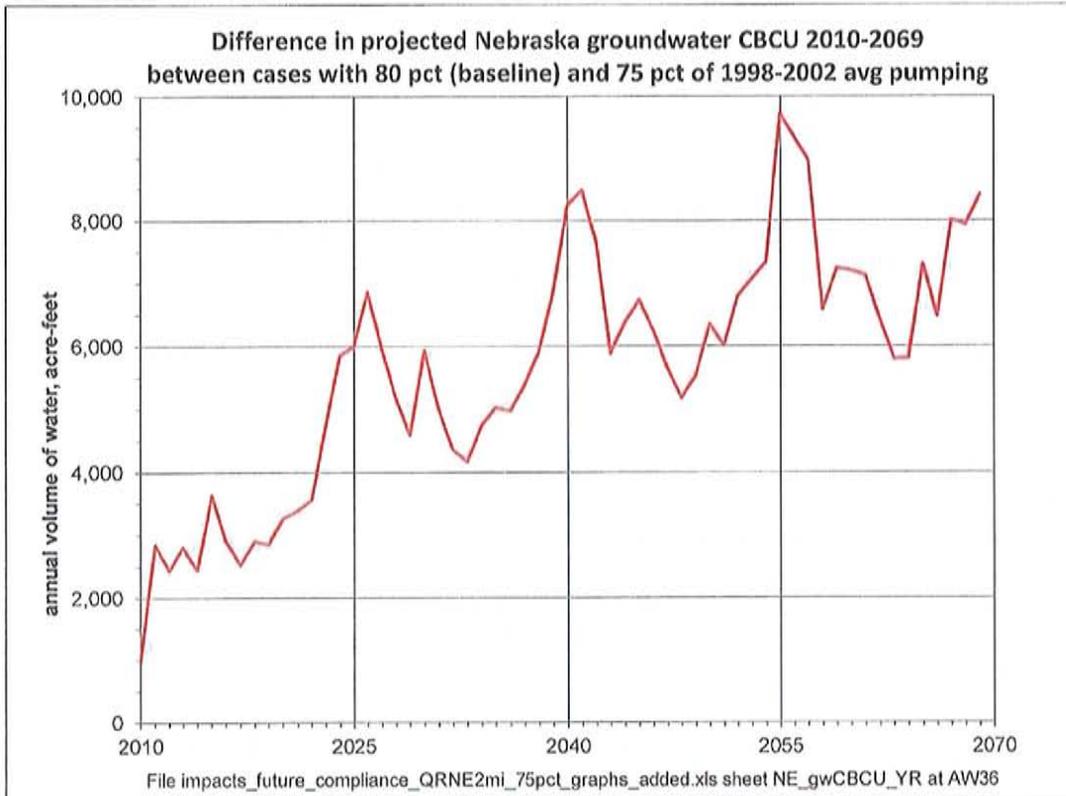


Figure 10 shows the reduction in Nebraska groundwater CBCU due to the additional pumping reduction.

Figure 10:
Difference in Nebraska groundwater CBCU between cases with 80 percent (baseline) and 75 percent of average 1998-2002 pumping.



As expected, reductions in CBCU grow over time, from the limited but long-term reduction in groundwater pumping. The benefit in the dry period of the third cycle is approximately 6,000 acre-feet per year. The reduced pumping slows the long-term rate of growth in depletions as shown in Figure 9 above.

4. Summary of results

While some of these alternatives can provide a reduction in the rate of growth of future depletions or a source of water to address dry-year compliance in the nearer term, all of these alternative cases are inadequate to stem the growth in Nebraska's groundwater depletions. These computations demonstrate the inadequacy of the IMP's, even if their provisions can be implemented and enforced.

It is clear that until there are much more substantial reductions in groundwater use, depletions will grow. As the Perkins/Larson Report demonstrates, both Kansas model runs and similar runs done by Nebraska indicate future growth in groundwater depletions of between 700 and 1000 acre-feet per year, starting from a base level of approximately 200,000 acre-feet per year during dry periods at current pumping levels.

On the other hand, there is no evidence to show that Nebraska's dry period allocations will change significantly. As explained more fully in Dale Book, P.E., *Requirements for Nebraska's Compliance with the Republican River Compact* (November 18, 2011), Nebraska's dry year allocation can be expected to be around 211,000 acre-feet per year.

While I cannot predict the year when Nebraska's groundwater depletions will outstrip its dry-year allocations, it appears that, without significant changes in management, it can be expected to do so in the future. Under the wrong set of conditions, it could be in the nearer term.

c. Nebraska's compliance plan remains administratively inadequate

As the downstream state, Kansas must rely on the actions of the upstream state to obtain its fair share of the water supply. As Kansas chief engineer and Compact commissioner, it is my duty to determine if Nebraska's plan for compliance will provide Kansas with that supply. As I evaluate this question, these third-generation IMP's raise many concerns about their administrative adequacy and their implementability. Many of their provisions are uncertain, ambiguous, and untested. I see the following potential barriers to their timely implementation:

- The Resolution of disputes between DNR and the NRD's on the sufficiency of their plans to offset their depletions in lieu of cuts in groundwater pumping.
- Whether the state can require curtailment in the Rapid Response Regions if it judges the NRD's plan to be insufficient.
- Whether curtailment of groundwater users in the Rapid Response Regions will bring any legal challenge, and what the results of such challenges may be.
- Whether Nebraska can regulate surface water uses in general pursuant to an IMP, and particularly those that are tied to Bureau projects, while allowing groundwater pumping to continue. As I understand it, Bureau project water must remain connected to the lands within that particular project.
- At this writing, the NRD's have not approved regulations implementing the third-generation IMP's, and they lack experience in enforcing them. Deposition of Michael Clements, 50:19-21, October 26, 2011.
- What will be the implications of an NRD failing to fulfill its obligations under an IMP?

The development of water-management plans and their implementation and enforcement are two clearly different things. This is especially the case with new and potentially restrictive water management plans such as these IMP's, because of their array of "options" and untested mechanisms. These can be delayed and even overcome through legal challenges and legislative backlash. On the Arkansas River, Colorado attempted in the 1960's to regulate groundwater pumping, and these attempts were overcome and/or reversed by the Colorado Supreme Court. It took Kansas' lawsuit against Colorado, *Kansas v. Colorado*, No. 105 Original, to force Colorado to require either curtailment of post-compact groundwater development or replace depletions caused by over-pumping. *Kansas v. Colorado*, No. 105 Orig., FIRST REPORT OF THE SPECIAL MASTER, July, 1994, pp. 118-119.

The IMP's are also full of incompletely specified and ambiguous mechanisms, which include, among others:

- Section III, Definitions, "Net depletions" - How will the DNR and NRD compute the yields from the various statewide and/or NRD activities in the alternative to groundwater pumping – in Section VIII for statewide activities, or under Section IX.B.2.c for individual NRD's?
- Where is the surety on the part of the State of Nebraska that, through its agencies of courts, it will exercise authority over the NRD's to cause them to take actions to come into compliance? This is missing in the IMP's.
- Once DNR approves the NRD's plans, how will the execution of those plans be monitored and evaluated?
- Section VII.F – when a Compact call is issued, how will it affect Harlan County Reservoir? If waters are passed through, might the interests and rights of the state of Kansas be compromised?
- How will the surface water curtailment benefits of Section IV.B.d be computed and credited against NRD obligations?
- What is the method of determining the end of a compact call under section IX.d?
- Will the early warning system under checklist C provide sufficient early action to maintain compact compliance?
- What is the meaning of Section IX.B.f ? Does Nebraska have some plan in motion for operating Harlan County Reservoir in a way contrary to the consensus plan between the Bureau and the Corps? If so, what is the plan, and how will it affect the obligations of the NRD's under the IMP and the rights of Kansas under the Compact and FSS?
- Will all of this add up to the required actions that the IMP implies are necessary to accomplish Compact compliance?

While some portions of the plan are fairly specific, such as the forecasting methodology, other parts, as noted above, have little specificity and lack transparency in their processes. This is in contrast to the clear and jointly developed FSS, Accounting Procedures, and Model.

Based on this review of the third-generation IMP's, it seems to me that the most likely outcome, if the Court does not intervene, will be to further delay the substantial cuts in groundwater pumping that are needed for Nebraska's compliance with the Compact.

d. Concerns with alternatives to reductions in groundwater pumping

The solutions to Nebraska's problem are limited. In the shorter term, depending on the weather, Nebraska may be able to rely on surface water purchases. But as baseflows continue towards extinction in Nebraska's portion of the Basin, surface water will be in shorter and shorter supply. One of Nebraska's experts has concluded as much. See Dr. Jim Schneider, Ph.D., "Potential Benefits from the Purchase of Surface Water Rights in the Republican River Basin," (March, 2007).

If implementable, Nebraska's plan to suspend groundwater pumping in its Rapid Response Regions could also be used to provide a reduction of CBCU of approximately 12,000 acre-feet during the first year, and approximately 20,000 to 25,000 acre-feet in subsequent years of maintained suspensions.

The IMP's also mention using augmentation as a possible alternative to pumping reductions. Augmentation is the replacement of stream depletion by water from an external source. Augmentation may be a useful short-term option, but when done within the same Basin, it is simply borrowing from the hydrological future.

The FSS requires that augmentation plans, their accounting, and their modeling be approved prior to implementation, in a manner that is acceptable to the other Compact States. FSS, III.B.1.k. This ensures that the interests of the States are protected, and that the augmentation is properly represented in the Model and the accounting. A basic tenet of water-supply augmentation is that augmentation should occur with the same timing and at the same location as the depletions it replaces.

Since 2007 I have been hearing discussions of the possibility of Nebraska's developing augmentation plans. At the 2007 annual meeting, I reminded Nebraska of this and requested its Commissioner to coordinate with Kansas at the earliest possible date concerning these plans, since Kansas would want to ensure that they are implemented in a manner consistent with the Compact, the FSS, and the Accounting Procedures. *Id.* Nebraska has failed to do so.

The Upper Republican NRD has purchased water rights in the Rock Creek sub-basin for the purposes of augmentation. Recent media reports that augmentation plans are being discussed within Nebraska. See Russ Pankonin, *Design on NRD augmentation project taking shape*, GRAND TRIBUNE SENTINEL, available at http://www.grantribune.com/index.php?option=com_content&view=article&id=5281:design-on-nrd-augmentation-project-taking-shape&catid=35:ag-news&Itemid=55, (last accessed Nov. 18, 2011). This sub-basin is in western Nebraska, above both Swanson and Harlan County Reservoirs. Kansas will have significant concerns with the operation, modeling, and accounting of this augmentation project.

Its operation will result in the postponement of needed pumping reductions for some time, without necessarily achieving the same benefits. Despite news reports of the purchase of the water rights and the on-going design for a pipeline for delivery of the water, Nebraska has not submitted an augmentation plan to the RRCA.

There are also regular reports in the news media that the other NRDs are also exploring plans for the use of augmentation. In the case of the Lower Republican NRD, there is some discussion of augmenting the water below Harlan County dam and possibly below Guide Rock. Kansas will have concerns with its operation, modeling, and accounting; but nothing has been submitted to the RRCA.

VI. The Bureau of Reclamation's criticisms of IMP's are justified.

a. The Bureau's Concerns with Nebraska's groundwater over-pumping

The Bureau is a pivotal partner in the administration of the water supplies of the Basin. From at least the mid-1980's onward, Bureau personnel within the Basin have expressed their concerns about Nebraska's excessive groundwater development. Mr. Robert D. Kutz, area manager for the Bureau's Nebraska-Kansas Area Projects Office, consistently warned the RRCA about the harmful effects of excessive groundwater pumping in Nebraska. He stressed that "the Compact was initiated at the Bureau's insistence to protect its investments . . ." 29th Annual Report of the RRCA, p. 14 (1989). Independently of Kansas, the Bureau had become concerned with the effects of Nebraska's pumping on Bureau reservoirs. In 1983, Mr. Kutz reported to the RRCA that "the Middle NRD has completed ground water model studies of the Republican Basin. The studies indicate that base flows will be depleted in some streams by the year 2000 unless the continuation of ground water development in Red Willow and Medicine Creek basins is stopped." 24th Annual Report of the RRCA, p. 5 (1984). Five years later, Mr. Kutz "agreed a good faith effort to curtail allocations on over-appropriated basins was necessary." 29th Annual Report of the RRCA, p. 14 (1989).

Nonetheless, groundwater development continued in Nebraska. In 1990, Mr. Kutz reported Bureau findings on the decreased inflows into Harlan County Lake.

A graph showing the Harlan County Reservoir inflows on a 10 year running average basis was shown to the Commissioners. The Bureau attributed early initial declines in inflow to development of upstream federal projects in the basin. Later period declines were attributed to an increase in groundwater development. Water conservation practices were not believed to be a major contributor to the declines . . .

31st Annual Report of the RRCA, p.6 (1991). Two years later, Mr. Kutz distributed to the RRCA a handout showing ten-year moving averages of the inflow to all the Bureau reservoirs in the Republican Basin; these averages showed a significant decrease in average inflow. 33rd Annual Report of the RRCA, p. 12 (1993). Based on this pattern of declines, Mr. Kutz concluded that

"decreased precipitation is not the overriding significant factor in determining loss of streamflow, although there may be significant changes or trends in true precipitation at a specific gaging station." 34th Annual Report of the RRCA, p. 17 (1994). "[P]recipitation may have a small effect upon the decline in streamflow, but that it does not explain the 66% decline in streamflow." *Id.*, p. 18 (1994).

Long before Kansas filed suit, the Bureau had clearly articulated the two principal ways in which Nebraska threatened the water supply of the Basin: Nebraska was not limiting groundwater development, and it lacked the laws to do so. Consequently, streamflows throughout the Basin were declining, threatening the viability of Bureau reservoirs. "According to a recent report filed by the Bureau . . . 'due to extensive groundwater pumping above the reservoir [Enders], the inflow (2003) was only 10 percent of the average preconstruction flow of the Enders Dam site.'" *Low Streamflows threaten Rock Creek Hatchery*, MCCOOK DAILY GAZETTE, February 25, 2005, available at <http://www.mccookgazette.com/story/1089652.html> (last accessed November 16, 2011). Indeed, Darrol Eichner, a Nebraska Game and Parks Fisheries Supervisor, warned that low streamflows and ensuing fish kills were "likely to continue as a result of groundwater depletion." *Id.*

Figure 4 to my Statement illustrates an extended set of the type of data which Mr. Kutz was showing to the RRCA during the 1980's and 1990's. See Statement, Attachment 1, (Kansas Petition, p. C17). This figure represents the inflows to Harlan County Lake, which is the major source of supply for the Nebraska Bostwick Irrigation District ("NBID") as well as KBID, between 1940 and 2007, together with precipitation levels in the Nebraska portion of the Republican River model domain over the same period.

While land use practices have been a part of this decline, groundwater pumping impacts have been a major contributor through reducing baseflow, and are especially significant during critical dry periods when baseflows are the dominant part of the water supply.

More recently, the Bureau has clearly and consistently communicated its concerns with the third-generation IMP's, concerns related to both their impact on Bureau projects their ability to achieve long-term compliance for Nebraska. See Aaron M. Thompson, Statement of the Bureau of Reclamation Regarding Proposed Integrated Management Plan for the Upper Republican Natural Resources District, June 10, 2010; see also Letter of Aaron M. Thompson, Area Manager, Bureau of Reclamation, to Brian Dunnigan, Dan Smith, and Jasper Fanning, re: Questions and Concerns Related to the Proposed Republican River Basin Integrated Management Plans (IMPs), July 27, 2010. DNR has responded to these concerns. See Letter of Brian P. Dunnigan to Aaron Thompson, August 23, 2010. However, the Bureau has not been satisfied with DNR's response, and it continues "to be concerned that the IMPs do not adequately address the need for long-term sustainability To meet Compact compliance on a long-term basis, it is essential that the IMPs be designed to provide sustainability." Letter of Aaron M. Thompson to Brian P. Dunnigan, September 30, 2010, p. 3. Despite numerous communications and several in-person meetings, two things seem clear: first, the Bureau clearly remains unconvinced that the third-generation IMP's will enable Nebraska to comply

with the Compact over the long term; second, the Bureau remains concerned that the shortcomings of these IMP's will have negative effects on Bureau projects.

b. Surface water purchases are not a long-term solution and require supervision by federal authority

One of the means listed in the IMP's to avoid curtailment of the Rapid Response Regions during Compact Call Years is through the purchase or lease of existing surface water rights. Yet primarily because of well pumping, surface water supplies have decreased and will continue to do so as long as groundwater depletions increase.

Nebraska's history of surface water purchases for Compact compliance raises concerns for Kansas. Nebraska did not purchase surface water from 2003 to 2005. In 2006 and again in 2007, Nebraska purchased rights to water in Bureau and non-Bureau projects, to reduce Nebraska's CBCU and to make water available for Kansas' use, due to Nebraska's on-going overuse of its allocations. This increased Kansas' allocation, since water left in storage does not contribute to the computed water supply and allocations. In 2006, Nebraska purchased the very limited supply of surface water available from NBID. Nebraska did not, however, restrict the use of groundwater wells whose water was applied to the same NBID lands, thus increasing the problem of depleted releases from Harlan County Lake for KBID. Late notice of these supplies hampered Kansas irrigators' ability to make the most optimum use of this limited water. Most of their cropping decisions had been made by the time the NBID water-purchase agreement was finalized.

In 2007 Nebraska again purchased water, and again gave Kansas very late notice that the water would be made available to Kansas. Once again, irrigators (primarily in KBID) had made planting decisions which limited their ability to benefit from the additional water supply. Moreover, such late notice harmed Nebraska as well, since Kansas irrigators would have to use the purchased water in order for Nebraska to receive allocation credit for the transfer of water to Kansas. (Water left in storage does not contribute to the computed water supply and allocations; water released does.) Kansas was not invited to provide input into the terms of the contract between Nebraska and the Bureau. Yet, under the terms of the contract, Kansas was forced to use the purchased water *prior* to using its normal allocation. Pursuant to the terms of KBID's contract with the Bureau, most of Kansas' normal allocation of water from Harlan County Lake was then redivided with NBID. Once again, NBID users were allowed to use their wells to make up for the undelivered surface water, further increasing groundwater impacts on the River in the Basin.

While the State of Nebraska and the NRD's claimed credit for these purchases, but the benefits to Kansas and to Nebraska's compliance were limited. This illustrates the need for Nebraska's use of means of compliance other than cuts in groundwater pumping to be supervised by an impartial River Master. Surface water may be available in the near-term future, but its use, its utility for compliance, and its crediting must be carefully considered. Because Nebraska's over-pumping of groundwater has reduced surface water supplies in the

Basin, reliance on those supplies for compliance purposes is not dependable over the long term, and should not be used as a means to delay action.

VII. The Kansas Remedy acknowledges the hydrological fact that Nebraska must significantly reduce its groundwater pumping to achieve Compact compliance over the long term

a. The Kansas remedy is the minimum remedy necessary for Compact compliance

Kansas' proposed remedy was constructed to establish the needed suspension in groundwater pumping to reduce Nebraska's groundwater depletions to a level consistent with allocations during the critical five-year periods, namely 181,000 acre-feet per year. In addition, Nebraska would be required to take additional action, including ad hoc surface water purchases, to achieve and maintain compliance during the more severe water-short year tests. See Dale E. Book, P.E., *Requirements for Nebraska's Compliance with the Republican River Compact*, (November 18, 2011), p. 9.

As indicated from a review of the Nebraska modeling work, a general reduction to all groundwater users to achieve this reduction in CBCU would be on the order of 50%. However, this would accomplish a lasting solution: the upward trend in Nebraska groundwater CBCU would be maintained at a level consistent with its allocation. One down side of this alternative is that it may take many years to see the full reduction in CBCU. See the Perkins/Larson Report, Figure 4, p. 9.

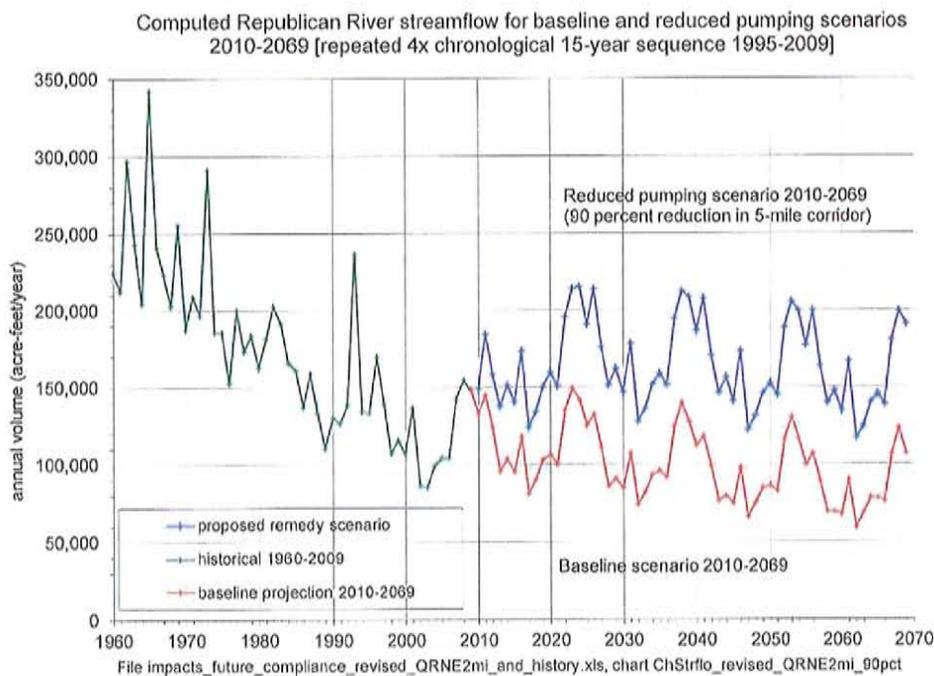
An alternative to this general reduction approach is to permanently curtail targeted areas near the Basin's streams that provide significant short-term as well as long-term compliance benefits in reducing stream depletions. This solution affects fewer water users, but it is also a less enduring solution. In evaluating a targeted alternative, Kansas experts first evaluated the permanent curtailment of all pumping from Nebraska's Rapid Response Region, but found it to be inadequate to prevent future non-compliance.

Given that conclusion, Dr. Perkins and Mr. Larson determined the level of pumping reduction necessary to reduce Nebraska's groundwater depletions to this level and sustain it over the next 40-50 years. Figure 1 of the Perkins/Larson Report shows the area of curtailment Kansas used to accomplish this objective. It is comprised of a nominal five-mile corridor around the Basin's major streams. It was found that a 90% reduction in pumping was required in the zone to accomplish the criteria set out in Mr. Book's report, *Requirements for Nebraska's Compliance with the Republican River Compact*.

Figure 4 above (at page 23) contrasts the resulting Nebraska groundwater CBCU under this reduced pumping condition and the baseline conditions. As is shown in Figure 4, while groundwater CBCU declines to acceptable levels for the coming thirty to forty years of the projection, there remains a definite upward trend in groundwater CBCU over the long term. This demonstrates that this plan is insufficient over the longer term.

In addition to estimating CBCU, the Model estimates baseflows. Figure 11 below shows the States' jointly developed historic estimated baseflows from the RRCA Groundwater Model in green as well as Kansas estimates of future projected baseflows under baseline conditions and under our reduced pumping scenario. As Figure 11 shows, without additional pumping constraints, the Basin's baseflows will continue to decline, making less surface water available in dry periods. Under Kansas' reduced pumping alternative, baseflows recover to a degree needed for Compact compliance at least over the coming few decades. Again, the baseflow projection graph shows that over the longer term, baseflows will again decline.

Figure 11:
Computed Republican River streamflow for base case and proposed remedy scenarios



Thus, Kansas proposes that Nebraska reduce its groundwater-irrigated acreage in the Basin by approximately 302,000 acres, out of its total of approximately 1.2 million acres irrigated, or some hydrologic equivalent. Dale Book, P.E., *Requirements for Nebraska's Compliance with the Republican River Compact*, (November 18, 2011), p.9. This is the minimum reduction necessary.

Although this proposed reduction is substantial, it must be appreciated within the context of Nebraska's unsustainable overdevelopment of its groundwater resources over the last thirty years. The size of the required reduction is a reflection of the degree of overdevelopment allowed by the State of Nebraska and its NRD's. (This over-development includes

the post-Settlement “completion” of additional wells evidenced by the rise in reported irrigation acreage in Figure 2.) Had Nebraska put adequate groundwater controls in place when Colorado and Kansas put theirs in place, or in response to Kansas’ concerns in the 1980’s, the action required by Nebraska at this time would be much less significant, or perhaps even unnecessary.

As is shown in Figure 4 above, Nebraska groundwater depletions have been continually increasing over the decade and are currently on the order of 200,000 acre-feet per year and will continue to steadily increase in the future, until more substantial reductions are accomplished. This level of groundwater depletion, even with ad hoc surface water purchases by Nebraska, resulted in the significant overuse of its allocation in the last decade. Nebraska cannot turn its groundwater depletions on and off at will. With increasing future groundwater depletions, surface water supplies available for purchase in the future will be smaller and less reliable.

b. Nebraska’s long noncompliance, together with the inadequacy of the IMP’s, require supervision by a River Master

Kansas has requested that the Court appoint a River Master to supervise Nebraska’s water-management related activities within the Basin, to ensure Nebraska’s compliance with the FSS and any order of the Court. The scope of duties of the River Master will be a function of the specificity and certainty of the solution. A prescribed and enduring remedy of substantial groundwater reductions as Kansas has required will have less long-term supervision needs than one that provides more flexibility to Nebraska.

First, a River Master could supervise Court-required reductions to groundwater CBCU, ensuring that the State of Nebraska requires the NRD’s to make such reductions. Nebraska has not fully confronted the imperative need to reduce excessive groundwater pumping in the Basin. DNR lacks the power to do so, and apparently, does not seek such a power; and the NRD’s, because they are dominated by groundwater interests, would probably oppose it. The Nebraska legislature has not resolved this problem: Nebraska’s system of allocating and regulating the use of groundwater has proved to be ineffective and unworkable. While there has been some evolution in Nebraska’s law to consider conjunctive management, the Nebraska system has failed to result in Compact compliance—largely because Nebraska law does not empower the director of DNR to reduce groundwater pumping.

To the extent that the Court might allow Nebraska to use means other than groundwater pumping reductions to achieve Compact compliance, these will need supervision by a disinterested party. In addition to supervision the implementation of required groundwater reductions noted above, the River Master would annually evaluate Nebraska’s plans for compliance, including its proposed sources of water and operation, and expected yields. This process would include conferring with Kansas on its evaluation of that plan. The River Master would approve the plan and ensure that it is accomplished; where deficiencies in execution are found, he or she could order actions to compensate.

The expert reports by Dr. Joel Hamilton and Dr. M. Henry Robison show that Nebraska enjoys a 14:1 ratio between the benefits and damages that accrue as a result of its noncompliance. See Hamilton and Robison, *Nebraska Benefits from Excessive Use of Irrigation Water in 2005 and 2006*, p.16 (benefits of \$69 million); Hamilton and Robison, *Kansas Damages from Irrigation Water Shortage in 2005 & 2006*, p. 19 (damages of \$4.9 million). This is an obvious incentive to overuse. A River Master would be an extension to the Court, to ensure that Nebraska does not allow its own economic self-interest to rise above its legal obligations to Kansas into the future.

Nebraska enjoys a luxury that Kansas does not: as an upstream state for the bulk of the river, it has initial possession of the water resource. The cost of interstate water litigation is a disincentive for Kansas to enforce its rights. From The States are far from equals, hydrologically speaking. A River Master will remedy this hydrological inequality, by requiring that a federally-appointed administrator supervise Compact compliance. If any unresolved aspect of Nebraska's ultimate compliance plan arises, than a River Master will be able to assess whether Nebraska's compliance actions are sufficient, and take steps accordingly.

c. Sanctions for future violations

Since Nebraska has shown a strong tendency to violate the Supreme Court's Decree, it is appropriate to establish, and put Nebraska on notice, that successively greater remedies will be imposed if further violations are committed. That remedy, whether in water or money or both, should be increased by a significant amount for each violation. In Kansas, for instance, civil penalties are increased significantly and water penalties are also routinely doubled for each new violation.

VIII. Conclusion

As set out above, Kansas has been pursuing enforcement of its rights under the Republican River Compact for more than two decades. This effort has not yet resulted in compliance by Nebraska, even though a Supreme Court Decree was entered more than eight years ago setting the quantitative tests of compliance. As a result, Kansas has been deprived of its rightful share in periods of need. The groundwater development that Nebraska has condoned is inconsistent with Compact and Decree compliance. The State of Nebraska has been aware of this significant problem, yet it has failed to respond sufficiently. Its current proposed remedy is an inadequate response to its repeated overuse. Instead of providing Kansas certainty in future compliance, Nebraska has effectively asked Kansas to trust it once again with a plan that does not address the long term and has many inadequacies in administration. Therefore, it is necessary for Kansas to propose a remedy that will ensure future compliance every year. Based on the foregoing analysis, that proposal includes the following remedies:

1. Requiring Nebraska to immediately (a) shut down wells and groundwater irrigation on 302,000 acres in Nebraska within the 5-mile nominal corridor of the Republican River and its

tributaries, and (b) make further reductions of Nebraska's Computed Beneficial Consumptive Use (CBCU) as are necessary to maintain yearly compliance, especially in Water-Short Year Administration years, or to order an alternative remedy that ensures annual compliance with the Court's Decree;

2. As necessary, requiring Nebraska to further reduce Nebraska's CBCU to the extent necessary to keep Nebraska within its Compact allocation until the effects of the reduction of groundwater pumping bring Nebraska into compliance with the Court's Decree;

3. Appointing a River Master to administer Decree compliance on an annual basis until such time as Nebraska can demonstrate an independent ability to achieve compliance; and

4. Establishing sanctions for future violations of the Decree.

Kansas remains open to equivalent remedies to ensure future compliance, but Nebraska has proposed none.

As Kansas chief engineer and its Compact representative, it is my duty to protect Kansas water users and to ensure that Kansas obtains its Compact entitlements. Nebraska's noncompliance has shorted Kansas water users of their rightful legal share in the past, and it is my duty to secure that share in the future.

In our last Court action, Kansas believed it had obtained an amicable and effective resolution to Nebraska's chronic noncompliance, through the jointly negotiated FSS. That was not the case. Sadly, the entry of a Decree of the United States Supreme Court was insufficient to overcome Nebraska's structural obstacles to noncompliance. In light of those obstacles and the noncompliance it has produced, and in light of the growth of Nebraska's groundwater depletions, Nebraska must be bound to a realistic, long-term plan for compliance. That plan must substantially reduce groundwater depletions by substantially reducing groundwater pumping. Just as importantly, Nebraska must transform its dysfunctional system of water rights administration, so that its leaders achieve and enforce its Compact obligations over the long term.

After a slow and ineffective implementation of two iterations of IMP's that accomplished little, Nebraska now promises a third iteration, by which it will annually determine the actions its NRD's should take to comply, while allowing them to choose from a variety of untested and questionable alternatives. But Nebraska has done little to substantially reduce its groundwater over-pumping. It has done little to secure reliable sources of water to help it through future dry-periods. Its current plan provides no opportunity for outside evaluation, and no transparent mechanisms for determining augmentation credits. It has not consulted with the RRCA to review whether such actions are consistent with its Compact entitlements.

Due to the degree of overdevelopment that Nebraska allowed, Nebraska must take substantial action to return to compliance. Governor Heineman and Dr. Bleed once recognized the size and scope of that necessary action: to implement significant reductions in groundwater over-pumping. Yet having recognized that task, Nebraska has since shrunk from it.

And so, Kansas has no choice but to seek the Court's intervention to resolve Nebraska's stubborn noncompliance and the equally stubborn hydrological problems that noncompliance has caused. Kansas seeks an Order that forces substantial reductions in groundwater pumping, and a River Master to superintend that difficult but necessary reduction. Kansas asks for an enduring solution. The Compact is perpetual, because the Basin's water supply must be sustainable.

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Table 1
Nebraska Overuse
2003 - 2006

1	2	3	4	5
Year	Water-Short Year Test Guide Rock		Statewide Test 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

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.

**Record of Nebraska Compact Allocation and Use of the
Republican River**

Year	Allocation	Computed Beneficial Consumptive Use (CBCU)	Imported Water Supply Credit (IWS)	Allocation - CBCU + IWS	5-year Totals	2-year Totals (when water short year criteria were met)
1959	266,080	216,710		49,370		
1960	459,180	204,810		254,370		
1961	280,270	205,210		75,060		
1962	414,310	135,710		278,600		
1963	303,200	252,950		50,250	707,650	
1964	257,430	246,240		11,190	669,470	
1965	266,140	161,430		104,710	519,810	115,900
1966	397,080	212,470		184,610	629,360	
1967	384,690	192,780		191,910	542,670	
1968	269,740	277,170		(7,430)	484,990	
1969	293,140	220,110		73,030	546,830	
1970	273,860	284,560		(10,700)	431,420	
1971	265,460	253,520		11,940	258,750	
1972	267,910	257,790		10,120	76,960	22,060
1973	333,970	244,560		89,410	173,800	
1974	374,510	315,050		59,460	160,230	
1975	346,500	312,630		33,870	204,800	
1976	293,150	390,690		(97,540)	95,320	
1977	331,670	301,910		29,760	114,960	(67,780)
1978	332,940	394,920		(61,980)	(36,430)	(32,220)
1979	304,730	243,460		61,270	(34,620)	(710)
1980	286,220	303,080		(16,860)	(85,350)	
1981	259,390	174,500		84,890	97,080	68,030
1982	342,860	233,080		109,780	177,100	
1983	337,620	248,130		89,490	328,570	
1984	399,940	266,910		133,030	400,330	
1985	307,510	257,130		50,380	467,570	
1986	298,660	311,090		(12,430)	370,250	
1987	362,140	275,680		86,460	346,930	
1988	270,290	263,630		6,660	264,100	
1989	258,660	296,060		(37,400)	93,670	(30,740)
1990	266,368	299,070		(32,702)	10,588	(70,102)
1991	210,960	263,220		(52,260)	(29,242)	(84,962)
1992	260,670	234,300		26,370	(89,332)	(25,890)

1993	512,950	105,970		406,980	310,988	
1994	333,539	309,800		23,739	372,127	
1995	332,550	295,880	17,902	54,572	459,401	
1996	377,300	278,900	24,394	122,794	634,455	
1997	337,700	315,680	16,434	38,454	646,539	
1998	315,410	297,750	17,677	35,337	274,896	
1999	299,050	302,890	18,444	14,604	265,761	
2000	291,920	296,530	18,656	14,046	225,235	
2001	299,380	292,320	18,242	25,302	127,743	
2002	236,550	265,910	13,996	(15,364)	73,925	9,938
2003	227,580	262,780	9,780	(25,420)	13,168	(40,784)
2004	205,630	252,650	10,380	(36,640)	(38,076)	(62,060)
2005	198,940	252,690	11,965	(41,785)	(93,907)	(78,425)
2006	187,360	236,670	12,214	(37,096)	(156,305)	(78,881)
2007	244,380	242,830	21,933	23,483	(117,458)	(13,613)

Sources: For 1959 - 1994, from Column C, Table 2C, "compliance tables.xls"

For 1995 - 2007, RRCA Accounting Spreadsheets as listed in sheet "sources_1995-2007" in "NE compliance 1959-2007.xls"

Notes: 2-year Water Short Year test and 5-year compliance requirements implemented by the Final Settlement Stipulation (2003)

2006 and 2007 accounting values are in dispute

Appendix C to Petition
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 groundwater 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 pumping 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 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 Groundwater 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 groundwater 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 to the best of my knowledge.

Executed on April 21, 2010.

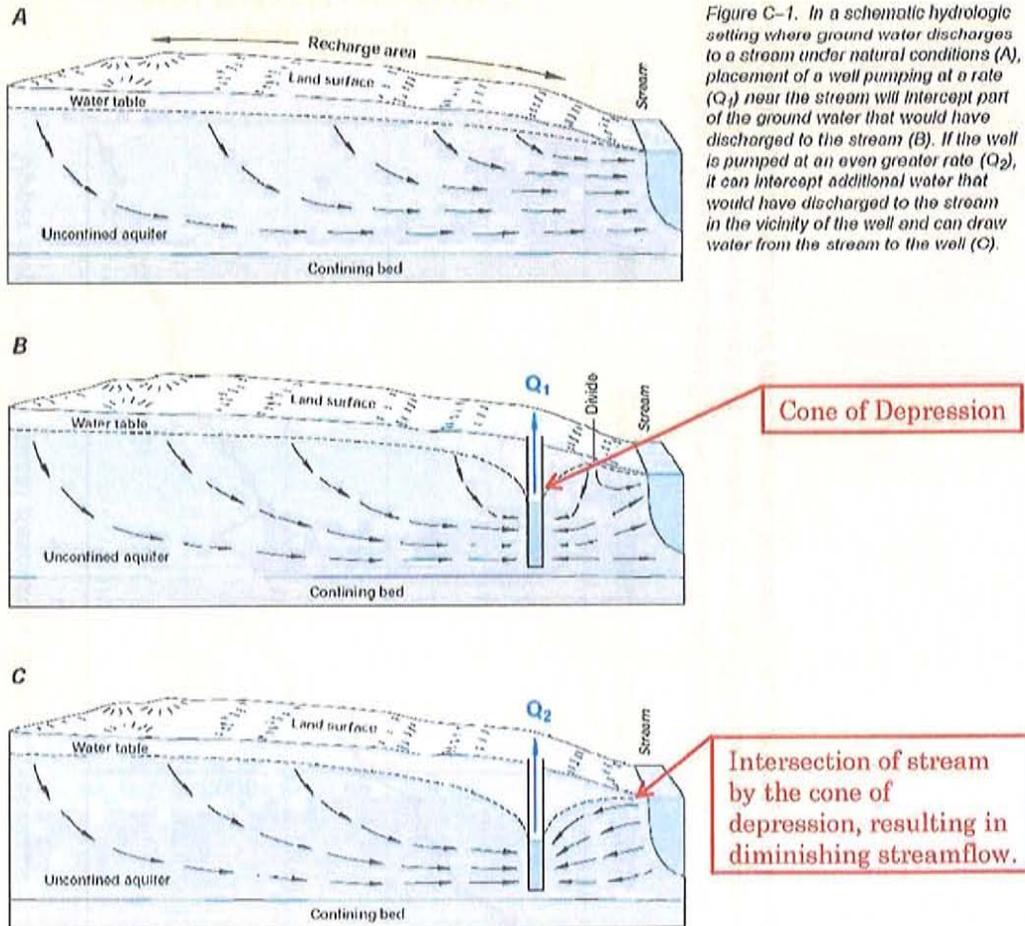
/s/ David W. Barfield
David W. Barfield

Attachments

- Figure 1: Illustration of the Effect of Groundwater Pumping on Streamflow
- Figure 2: Average Groundwater Level Decline, Upper Republican Natural Resources District, Nebraska
- Figure 3: Frenchman Creek Annual Streamflow, Upper Republican Natural Resources District, Nebraska
- Figure 4: Annual Republican River Streamflow and Local Precipitation, Harlan County Lake, Nebraska
- Figure 5: Groundwater Irrigated Area, Republican River Basin, Nebraska and Kansas
- Figure 6: Groundwater Irrigation Pumping by Nebraska, Republican River Basin, Nebraska

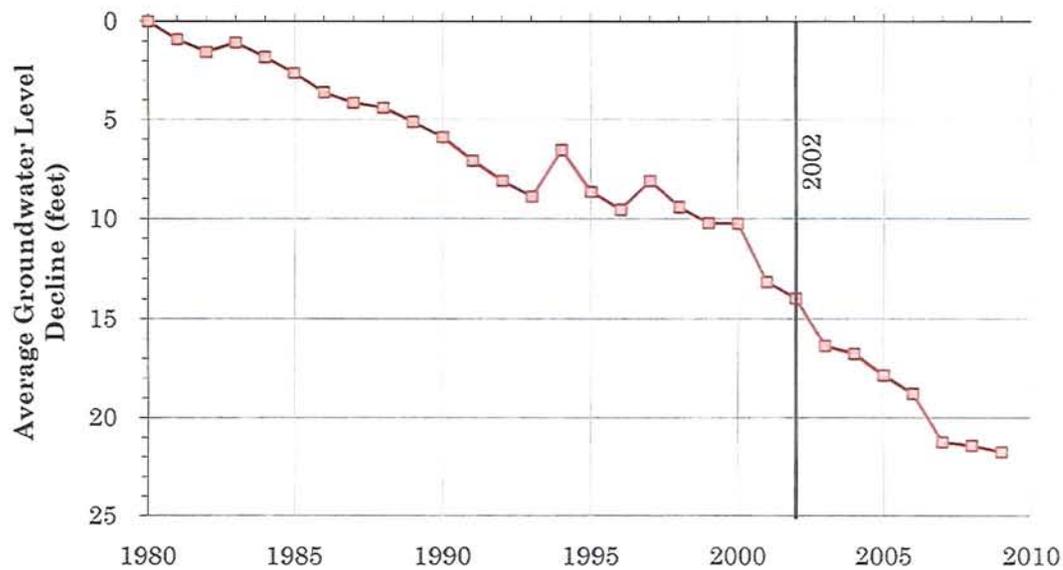
- Figure 7: Depletions of Republican River Streamflow Above Guide Rock, Nebraska, By Nebraska Groundwater Pumping, Historical and Projected
- Figure 8: Nebraska Groundwater Irrigation and Precipitation, Republican River Basin, Nebraska
- Table 1: Nebraska Overuse, 2003-2006

Figure 1
 Illustration of the Effect of Groundwater Pumping on Streamflow



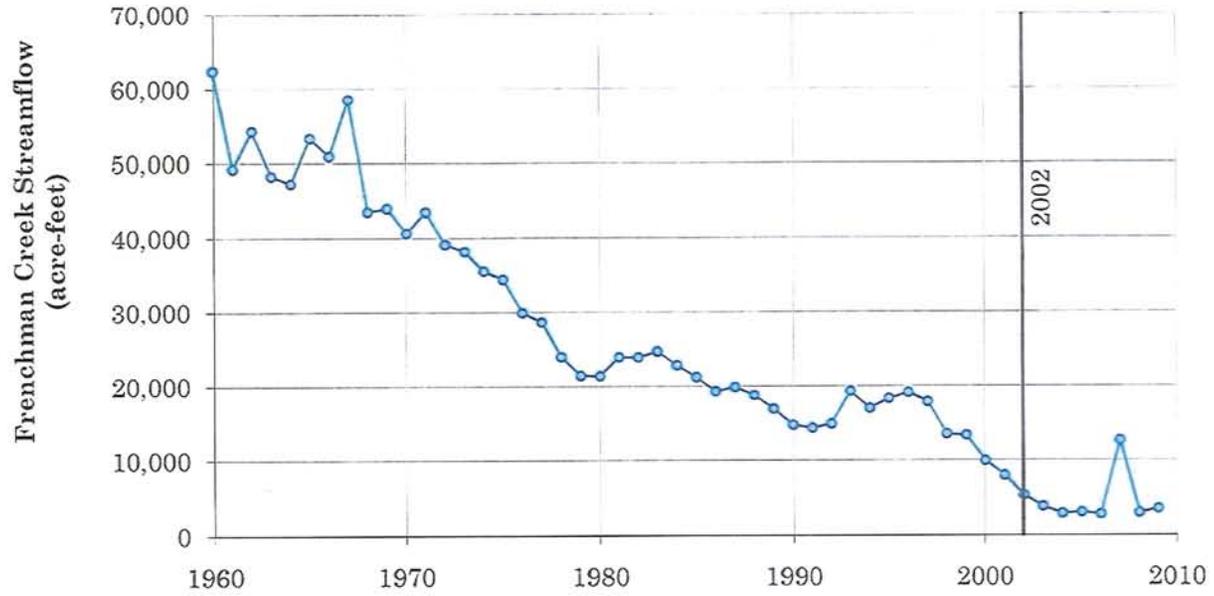
Source: United States Geological Survey, Circular 1139, *Ground Water and Surface Water: A Single Resource* (1998), Figure C-1, p. 15 (Figure title and boxed annotations in red added).

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



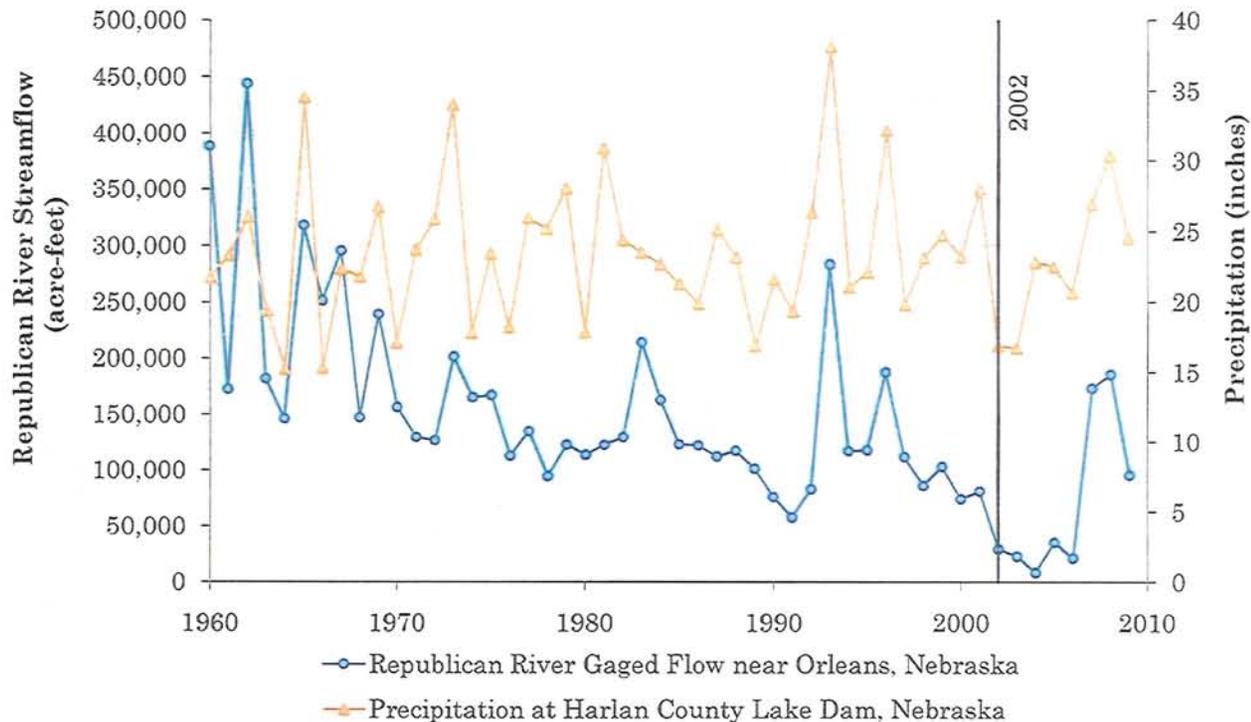
Source: United States Geological Survey National Water Information System
 Note: Each data point represents the average for wells with data in 1980 and each corresponding year. Number of observations included in each average value varies from 190 to 238.

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

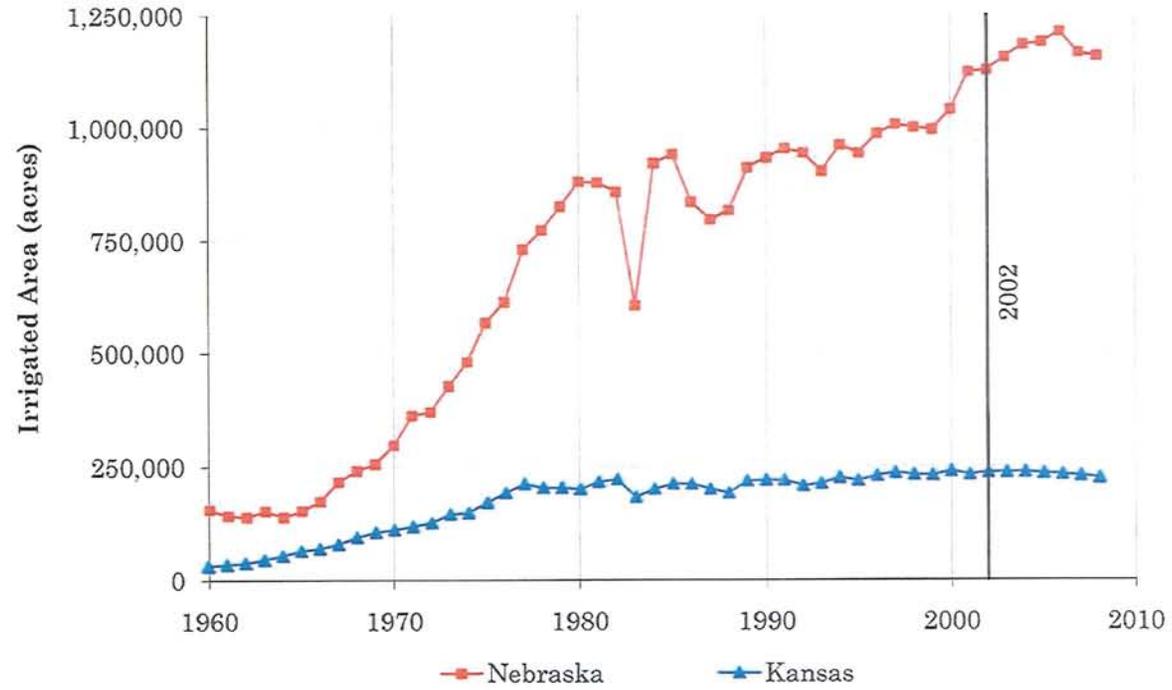


Source:

(1) United States Geological Survey Gage 06844500 Republican River near Orleans, Nebraska

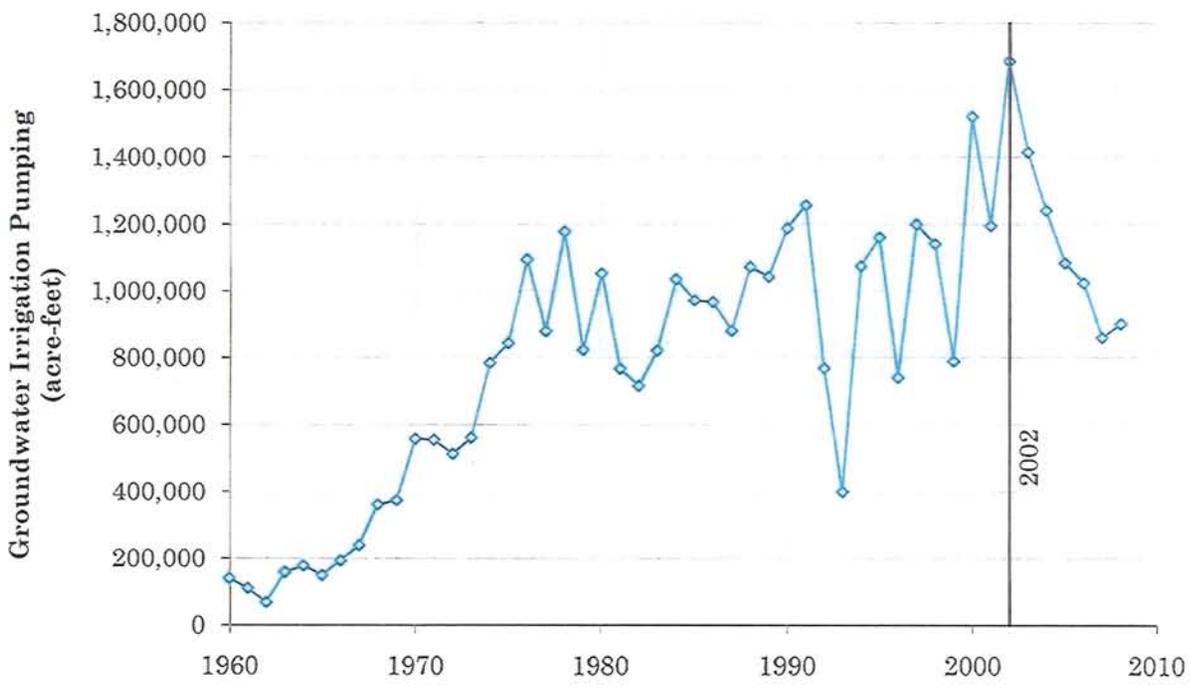
(2) United States Bureau of Reclamation precipitation at Harlan County Lake Dam

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



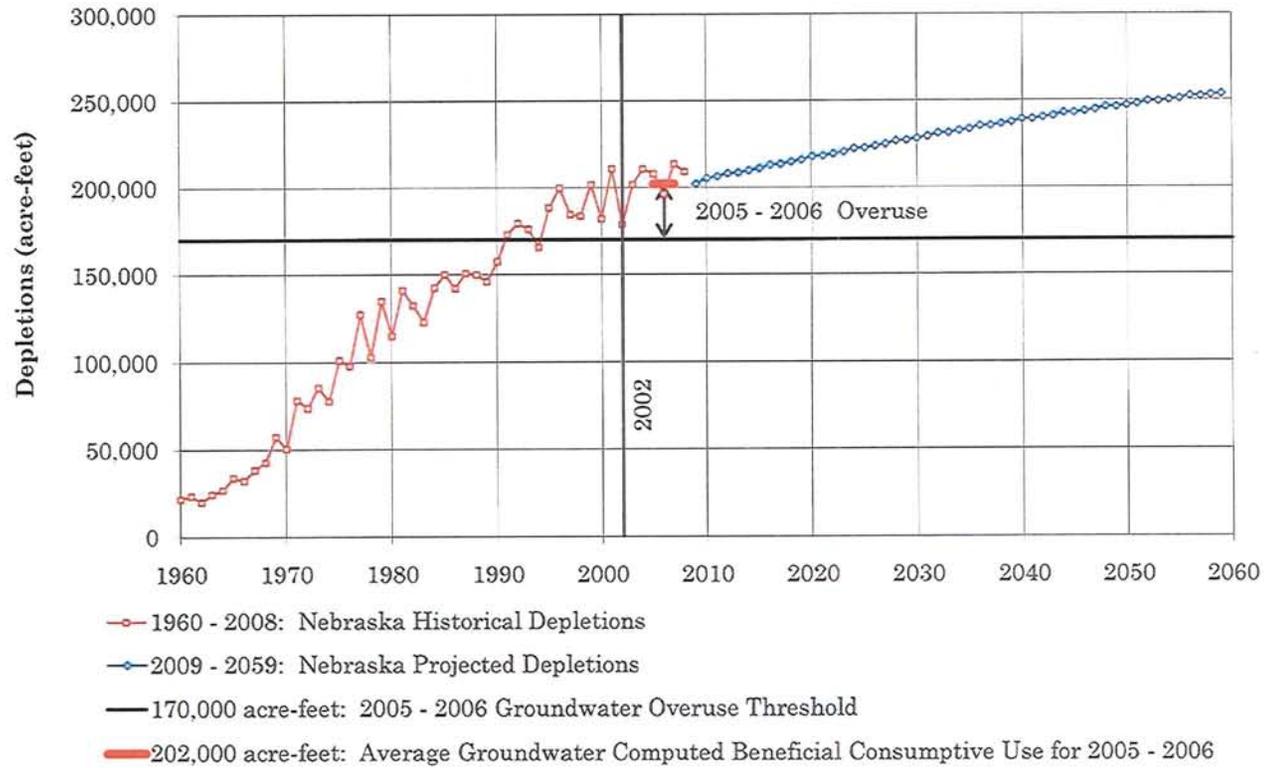
Source: Republican River Compact Administration Groundwater Model data.

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



Source: Republican River Compact Administration Groundwater Model data.

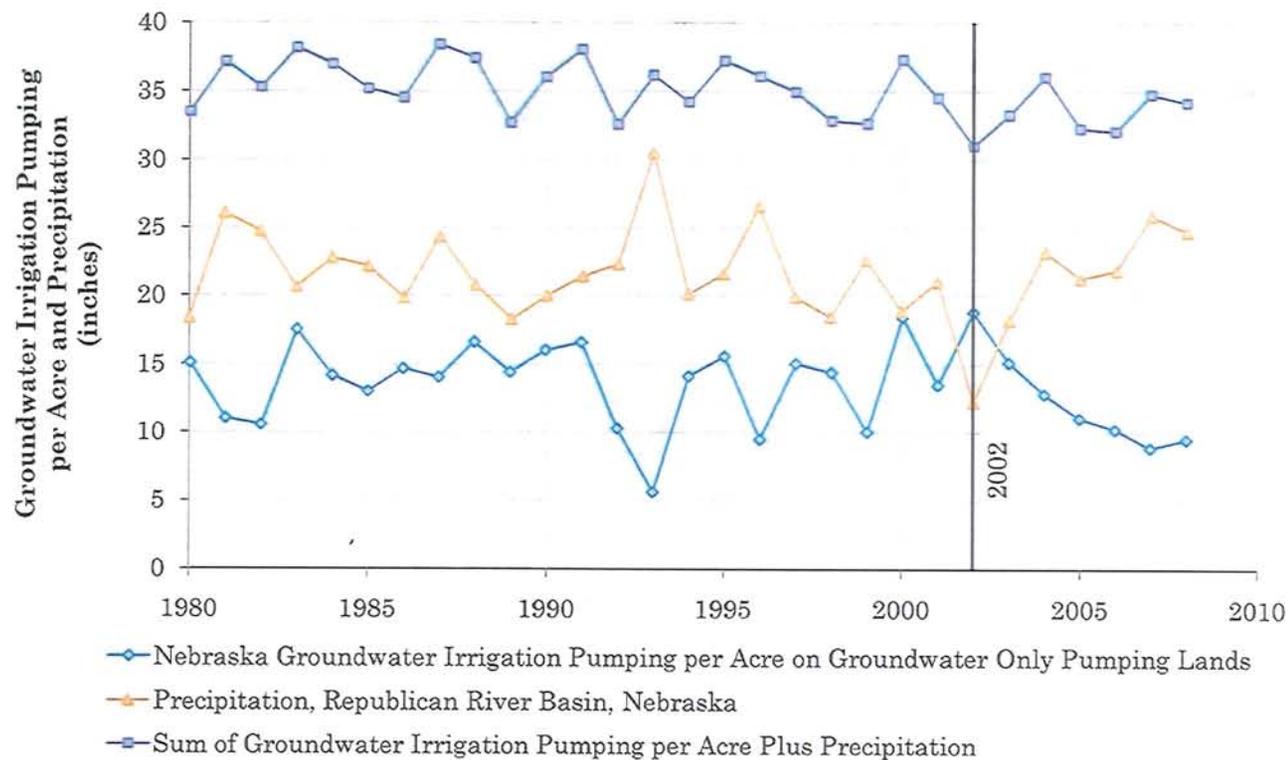
Figure 7
 Depletions of Republican River Streamflow Above Guide Rock, Nebraska
 By Nebraska Groundwater Pumping
 Historical and Projected



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.