Kansas v. Nebraska & Colorado

No. 126, Orig., U.S. Supreme Court

Rebuttal Report

Prepared by

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1.0 Introduction

This report is prepared in response to the opinions stated in the report prepared by Tom Riley, P.E., titled "Responsive Report to the Kansas Analysis of Nebraska's Overuse in 2005 and 2006" [1] (Riley report). In that report, Mr. Riley criticizes several aspects of the analysis of losses to Kansas that I submitted in the report titled "Engineering Analysis of Losses to Kansas Water Users from Nebraska's Overuse of Republican River Water in 2005 and 2006" [2] (Losses report). Specific points raised in the Riley report include consideration of the effect of precipitation on KBID's use of additional water, and the availability of water for KBID during the two years in question as a result of reduced use in Nebraska, which was analyzed in my report titled "Analysis of Measures that Would Have Been Required for Nebraska to Achieve Water-Short Year Compliance with Republican River Compact in 2006" [3] (Nebraska benefits).

2.0 Precipitation at KBID

Mr. Riley criticizes the analysis of additional water supply to KBID for 2005 and 2006, on the basis that precipitation was not considered. He states that the rainfall amounts during the irrigation season and the effect they might have on whether KBID actually would have called for irrigation water from Harlan County Reservoir (HCR) were not examined. (pg. 5, Riley report) This criticism is not warranted, based on the historical practice in KBID and comparison of conditions for the two years with previous years. Mr. Riley points to 2005 as a concern, citing precipitation data from Lovewell Reservoir and at Courtland (as compiled by KBID).

Water deliveries from KBID are often expressed in depths (i.e., number of inches). KBID records these values each year, which are based on the total deliveries and amount of acreage reported to be irrigated that season. As noted in the Losses report, the allocation to KBID users is 15 inches. Historical data show deliveries in years when water supply was not limited by availability to average slightly more than 15 inches. Since 1980, the average was 14.5 inches. Over time, some of the service area has been converted from gravity to sprinkler irrigation. As a result, application rates are less. Use of sprinklers can reduce per acre irrigation demand by 20%, when compared to gravity irrigation, due to reduced deep percolation that occurs with sprinklers. Where sprinklers are used for approximately half of the total land served, as is currently the situation on KBID, overall per-acre demand can be reduced by 10%. The KBID delivery records generally indicate this when comparing delivery records from recent years to earlier periods.

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[1] The Flatwater Group (Thomas Riley), "Responsive Report to the Kansas Analysis of Nebraska's Overuse in 2005 and 2006." (March 15, 2012)

[2] Spronk Water Engineers (Dale Book), "Engineering Analysis of Losses to Kansas Water Users from Nebraska's Overuse of Republican River Water in 2005 and 2006" (November 18, 2011)

[3] Spronk Water Engineers (Dale Book), "Analysis of Measures that Would Have Been Required for Nebraska to Achieve Water-Short Year Compliance with Republican River Compact in 2006" (November 18, 2011)

KBID recorded precipitation and delivery depths were tabulated for the 1960 – 2010 time period. Years that KBID began the season with water supply restrictions were excluded. Precipitation amounts are reported in three-month blocks in the KBID annual reports. Table 1 summarizes the April – September precipitation for comparison with the historical amount of water delivered to the farms over the 1960 – 2010 period and the adjusted deliveries for the 2005 and 2006 years evaluated in my report. Amounts of water that would have been delivered to and used by KBID were projected at 10.5 inches, in 2005, and 11.3 inches, in 2006, as described in the Losses report.

The KBID historical data shows that in the earlier period precipitation averaged approximately 21.8 inches and corresponded to an average delivery depth of 16.9 inches. The delivery amount decreased slightly in the later, 1980 – 2010, period to 14.5 inches and there was also a slight decrease in precipitation. Over the entire period there were 13 years that experienced greater precipitation amounts than the 22.69 inches in 2005. In twelve of those years delivery amounts to the farm exceeded the 10.5 inches projected for 2005. The most recent was in 2010. Figure 1 is a graph of the historical precipitation and the historical and adjusted deliveries. As shown by the graphs, precipitation in 2005 was just above average while the adjusted delivery amount was 4 inches below average for the years since 1980.

In conclusion, the historical practice of KBID water users indicates that water deliveries were normally taken in amounts that are greater than the amounts projected in the Kansas loss analysis in years when precipitation amounts were comparable to or exceeded what occurred in 2005 and 2006. In my opinion the amounts computed to be available for the two years are within the range of historical practice for years of comparable precipitation amounts and are reasonable. The basis for this opinion is the record of historical practice.

Mr. Riley also notes the irrigation season of KBID and implies that the season may be overstated in the Kansas losses analysis. The loss analysis is based on the historical operation of KBID. Records indicate that deliveries for irrigation have historically occurred from June to mid-September. Shorter seasons have occurred when water supply was limited, usually at the end of the season. However, it was not critical to the analysis of supply to KBID to assume a specific season, since the water supply is available as needed to be released from storage. The analysis did make assumptions about the season, based on historical records, to evaluate the timing of return flows to downstream water rights. Mr. Riley did not state a specific problem with the assumptions used in the Kansas analysis based on the irrigation season.

3.0 Timing and Volume of Water Presumed to be Available

Mr. Riley states the opinion that the results of the Nebraska benefits analysis are inconsistent with the assumptions used in the analysis of Kansas losses regarding the timing of water that would have been available if Nebraska had not overused its allocation. This opinion is based on a comparison of the timing of reduced pumping impacts extracted from our analysis of Nebraska benefits with the assumption in the losses analysis that the amount of Nebraska overuse could have been used during the 2005 and 2006 irrigation seasons. His criticism is that not all of the water generated by reduced pumping in Nebraska would have been available in 2005 or 2006.

This criticism is based on an assumption by Mr. Riley that the means for reducing Nebraska's consumption to the allocation for the two years must be identical for the two analyses. This assumption was not used for the two analyses and is not necessary. The analysis of Kansas losses is based on the assumption that the amount of overuse in Nebraska for the two years, 2005 and 2006, would have been available and regulated through storage for KBID. The two-year water short test is made at Guide Rock, the point of diversion for KBID.

Nebraska use in excess of its allocation each year was translated to an amount of water delivered to KBID and was within the historical water supply of the system, as described above. The means by which past consumptive use in Nebraska could have been reduced sufficiently to be within its allocation could have varied in terms of timing and location. Water not used in Nebraska is either stored in the project reservoirs, diverted to KBID at Guide Rock or flows across the Stateline at Hardy. Nebraska's overuse in 2003 and 2004 resulted in low water supplies for storage and diversion during those years. The five-year overuse for 2003 – 2007 totaled 117,800 acre-feet. Some accumulation of storage in HCR from years prior to 2005 would have been possible if Nebraska's use in those years had corresponded more closely to their allocations.

The analysis for Nebraska benefits required that specific water uses be selected for reduction to achieve the necessary reduction in CBCU. This was accomplished by reducing the surface water supply and some reservoir storage first, and then completing the reduction with reduced groundwater pumping for irrigation. The assumption was made that reductions for this analysis would only occur during the two years. This resulted in reductions to irrigation water supply on identified acreage and specific stream impacts, which extend throughout the two-year period. In other words, some of the well depletions being removed occurred after the 2006 irrigation season.

Mr. Riley states the opinion that the Nebraska benefit analysis demonstrates that some of the water assumed to be used in 2006 would not have been available if the remedy used in that analysis were applied. However, this conclusion was not based on an analysis of the stream gains that would have occurred assuming that remedy, but simply totaled the well depletions occurring after the irrigation season. The actual effect of the reductions that were assumed for the benefits analysis also includes changes to streamflow due to reduced surface water diversions. The timing of surface water effects includes both depletions and accretions, as further described below.

When diversions of surface water are discontinued, the effect on stream flows is the full amount of the diversion, less return flows occurring concurrently. Depletions to flows are computed as diversions less return flows. To the extent return flows occur due to seepage, either from canals or on the farm, return flows are delayed. Due to the delayed effect of return flows from irrigation systems, stream depletions exceed consumptive use during the irrigation season. Return flows extend beyond the end of the diversion season.

Most of the diversions considered to be discontinued for the Nebraska benefits analysis occurred in the Frenchman Cambridge service area, located just upstream of HCR. The resulting increase to the water supply would be equal to the depletions. The amount of depletion during the irrigation season exceeds the consumption associated with the surface water use by the amount of the delayed return flows. Return flows were estimated using parameters from the RRCA accounting to determine consumptive use of surface water.

The amounts of diversion and an estimate of the amount of delayed return flow were compared to the quantities of changed pumping impacts in Nebraska occurring after the end of each irrigation season. The reduced pumping impacts obtained from the Nebraska benefits analysis are listed in Table 2 on a monthly basis. The totals for each year were 13,000 and 19,500 acre-feet respectively. Of these amounts, 7,100 and 8,500 acre-feet occur in October through December. These totals do not match the impacts reported in the Riley report because Table 2 lists the change in pumping impacts whereas the Riley report lists the net impacts, which include model calculated imported water supply credit (pg. 4, Riley report).

The effects of reduced surface water use in the two years are summarized in Table 3. The reductions to diversions and return flows are combined to show the change in stream depletion. Stream depletions during the irrigation season were estimated to exceed the annual consumptive use by approximately 9,000 acre-feet in 2005 and 6,700 acre-feet in 2006. This represents gain in streamflow exceeding the annual consumptive use during the irrigation season. Figure 2 is a graphical illustration of the timing of diversions and return flows. The removal of the delayed return flows actually causes reduced streamflow after the irrigation season. The difference between the depletion and consumptive use during the irrigation season is the delayed return flow. This quantity is estimated to be approximately equal to the amount of reduced pumping impact after the irrigation season each year. This is the amount that was asserted by Mr. Riley to be unavailable to KBID in 2005 or 2006. However, this quantity would have been available during the irrigation season, if the effect of reduced surface diversions is considered.

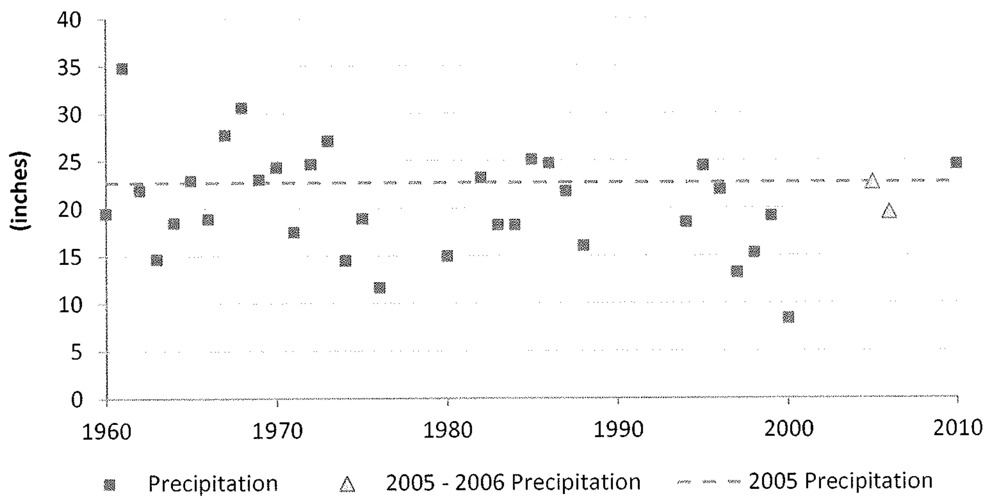
In conclusion, the opinion of Mr. Riley that not all of the additional water computed to be delivered to KBID in 2005 and 2006 would have been available those years was based on an assumption that the Kansas losses analysis should be made using the same remedy approach as that used to compute Nebraska benefits. I do not agree with that assumption. However, even if the same remedy were assumed, with the resulting stream effects determined in the Nebraska benefit study, an analysis of the timing of those effects which considers the effects of both surface water and pumping reductions demonstrates that more water would have been available in the two irrigation seasons than determined by Mr. Riley. The quantities assumed to be available each year in the Kansas losses analysis are consistent with the results of the Nebraska benefit analysis when considering the effect of reducing surface water diversions in Nebraska.

FIGURES

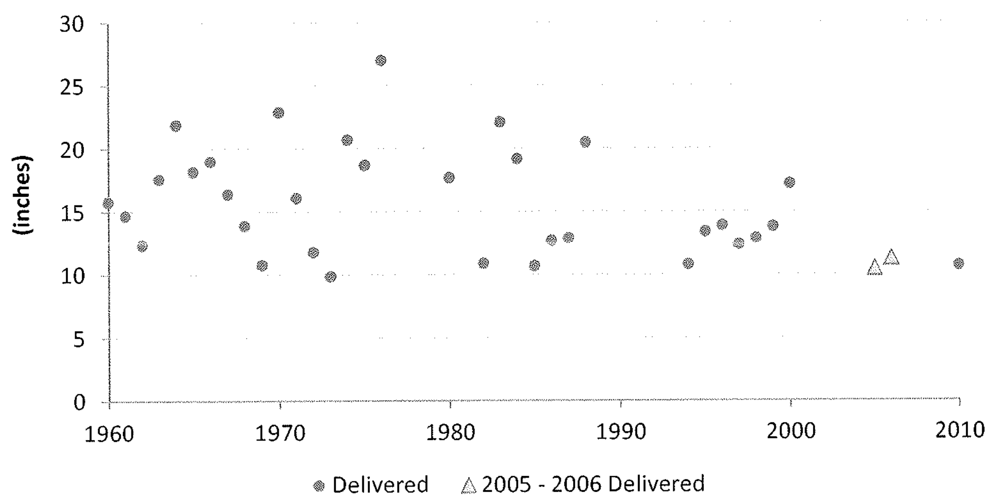
Figure 1

Historical KBID Precipitation and Deliveries for Years without Shortages Compared to 2005 and 2006 Deliveries from the Kansas Analysis 1960 - 2010 (inches)

Historical Precipitation (April - September)



Historical Deliveries [1] and 2005 and 2006 Deliveries from the Kansas Analysis [2]



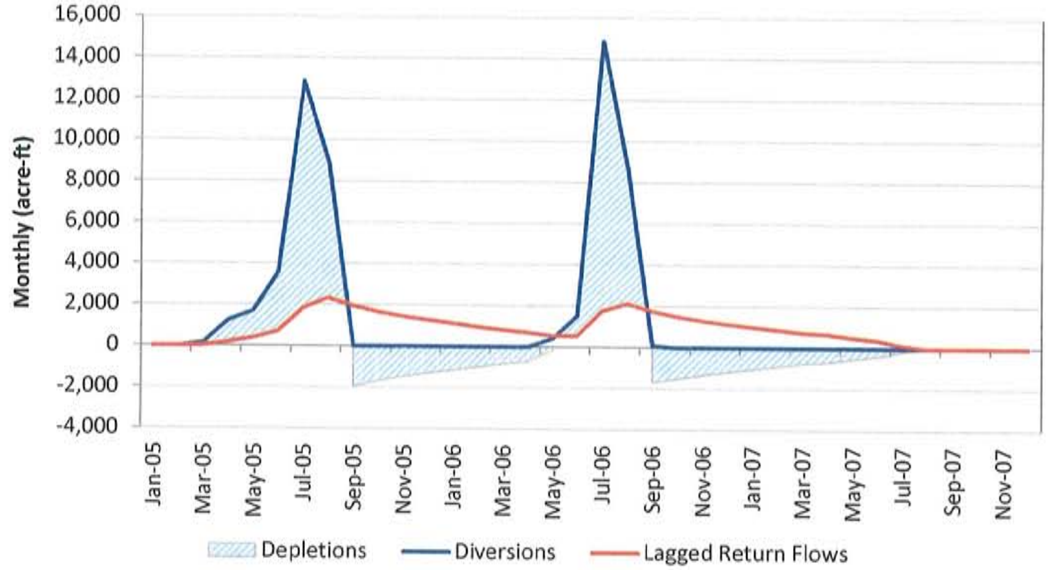
Source: Kansas Bostwick Irrigation District Annual Report 2010

Notes:

(1) Historical deliveries were limited to years that KBID did not start the season with restrictions.

(2) Adjusted deliveries calculated by SWE - Nebraska overuse added to the historical water supply.

Figure 2
Historical Diversions, Lagged Return Flows and Depletions
Nebraska Canals [1] with Reduced Diversions in 2005 and 2006
(acre-ft)



Notes:

(1) Canals with surface water reductions from the SWE's Nebraska Benefits analysis. 2005 canals were the Riverside, Culbertson and Cambridge and 2006 canals were the Cambridge and Bartley.

TABLES

Table 1
Comparison of KBID Historical Precipitation and Deliveries
1960 - 2010
(inches)

	Year	Irrigation Season Precipitation Apr-Jun	Jul-Sep	Total	Water Delivered
	Deliveries from Kansas Analysis				
	2005	**10.1**	**12.6**	**22.7**	**10.5**
	2006	**8.0**	**11.6**	**19.6**	**11.3**
(1)	**Historical (years without water shortages in KBID)**				
	1960	11.1	8.4	19.5	15.8
	1961	15.2	19.6	34.8	14.7
	1962	10.2	11.6	21.9	12.4
	1963	7.8	6.9	14.7	17.6
	1964	8.6	9.8	18.4	21.9
	1965	12.5	10.4	22.9	18.2
	1966	7.0	11.9	18.9	19.0
	1967	15.8	11.9	27.7	16.4
	1968	11.2	19.4	30.6	13.9
	1969	9.8	13.2	23.0	10.8
	1970	15.3	9.0	24.3	22.9
	1971	10.0	7.5	17.5	16.1
	1972	13.4	11.2	24.6	11.8
	1973	8.4	18.7	27.1	9.9
	1974	9.9	4.6	14.5	20.7
	1975	13.1	5.8	18.9	18.7
	1976	7.8	3.8	11.6	27.0
	1980	7.4	7.6	15.0	17.7
	1982	12.5	10.7	23.2	10.9
	1983	8.7	9.5	18.2	22.1
	1984	14.8	3.5	18.2	19.2
	1985	12.0	13.1	25.1	10.7
	1986	10.7	14.0	24.7	12.7
	1987	15.5	6.3	21.7	12.9
	1988	10.3	5.8	16.0	20.5
(2)	1994	10.9	7.6	18.5	10.8
	1995	14.7	9.7	24.4	13.4
	1996	9.5	12.5	21.9	13.9
	1997	6.5	6.6	13.2	12.4
	1998	8.0	7.3	15.3	12.9
	1999	13.5	5.7	19.1	13.8
	2000	5.2	3.2	8.4	17.2
	2010	16.8	7.7	24.5	10.7
	Averages				
	1960 - 1976	11.0	10.8	21.8	16.9
	1980 - 2010	11.1	8.2	19.2	14.5
	1960 - 2010	11.0	9.5	20.5	15.7

Source: Kansas Bostwick Irrigation District Annual Report 2010

Notes:

(1) Years in which KBID started the season with restrictions were not included in this summary.

(2) 1994 Delivery calculated using total delivery information obtained from US BOR data due to an erroneous figure in the KBID Report.

Table 2

Summary of Reduced Groundwater Computed Beneficial Consumptive Use in Nebraska above Guide Rock
2005 - 2006
(1000 acre-ft)

	Change in NE Pumping Impacts Above Guide Rock	
Month	2005	2006
Jan	0.0	2.0
Feb	0.0	1.6
Mar	0.0	1.3
Apr	-0.1	0.8
May	-0.1	0.4
Jun	0.8	0.6
Jul	1.4	1.0
Aug	2.0	1.6
Sep	2.0	1.7
Oct	2.5	2.4
Nov	2.5	3.5
Dec	2.1	2.5
Total	13.0	19.5
Oct - Dec	7.1	8.5

*As derived for "Analysis of Measures that Would Have Been Required for Nebraska to Achieve Water-Short Year Compliance with Republican River Compact in 2006" (Book, 2011)

Source: Nebraska's supplied spreadsheet
NE_impacts_bgn2005_RapResp10_2AVU_noTriBsn_MONTHLY.xls
and "Pumping Reduction Impacts for 2005-2006" (Perkins/Larson, 2011)

Table 3
Summary of Surface Water Use, Losses, Returns and Depletions in Nebraska
2005 - 2006
(1000 acre-ft)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		Reduction to Surface Water Use				Return Flow and Depletions from Historical Deliveries		
Year	Canal Diversions	SW CBCU	Canal Loss	On-Farm Loss	Total Return Flows	Lagged Return Flows	Depletions	Irrigation Season Difference
2005 Irrigation Season	28.4	11.8	16.1	3.9	16.5	7.5	20.9	**9.1**
Oct. 2005 - Apr. 2006						7.3	-7.3	
2006 Irrigation Season	25.5	11.4	13.7	3.5	14.2	7.5	18.0	**6.7**
After 2006 Irrigation Season						8.4	-8.4	
Total	53.9	23.2	29.8	7.4	30.7	30.7	23.2	

(1) Change in historical and adjusted annual canal diversions in Nebraska.
(2) SW CBCU = Diversions * unique consumptive use factor by canal or pump
(3) Canal Loss = Diversions * canal loss factor (canal loss factor calculated for each canal based on data in RRCA accounting spreadsheets, Attachment 7)
(4) On-Farm Loss = (Diversions - Canal Loss) * on-farm loss factor (on-farm loss factor from RRCA accounting spreadsheets, Attachment 7). All loss from Riverside considered
(5) Total Return Flows = (4) + (5) less 18% consumption, except on the Riverside Canal.
(6) Lagged return flows from losses occurring from historical irrigation operations. Lagging factors taken from SWE's future compliance analysis.
(7) Depletions = Diversions - Lagged Return flows.
(8) Irrigation Season Difference = (8) - (3)