DNR/USBR Technical Meeting

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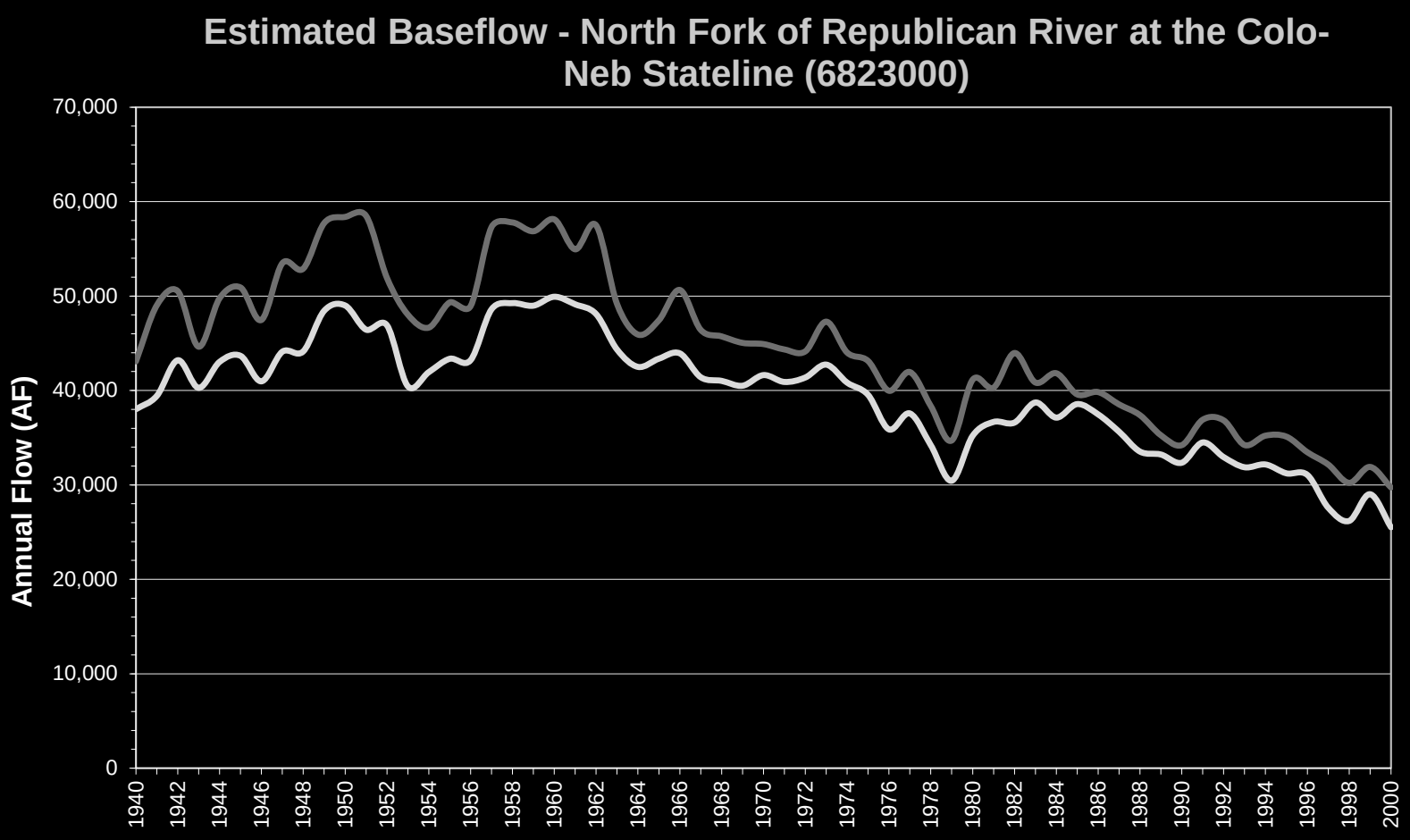
Nebraska
Department of Natural Resources

Overview

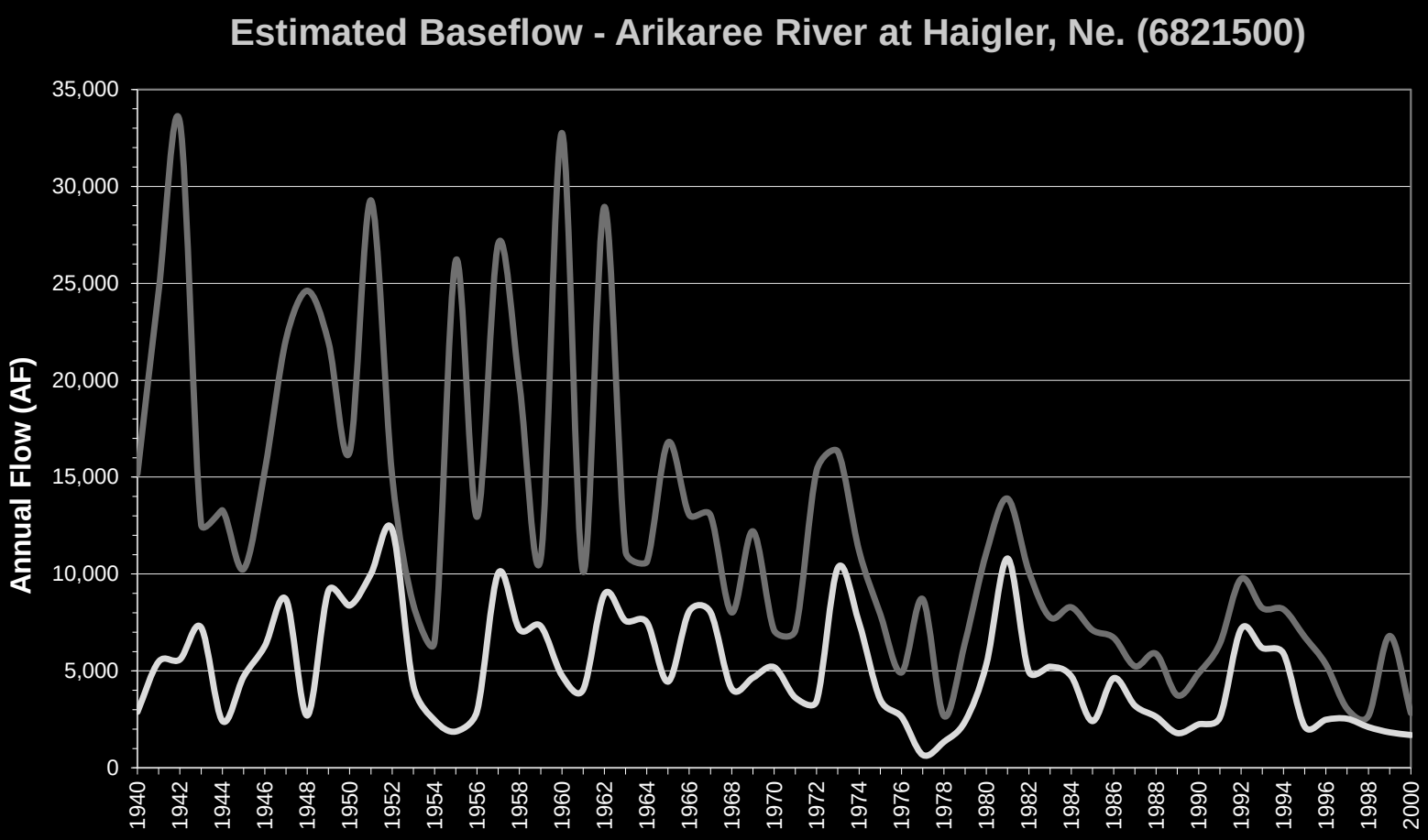
- Past impacts to Republican River surface water supply – trends, correlations, and causes
- Situation in 2013
- Situation in 2014
- Benefits of the current IMPs and additional reductions in groundwater pumping in Nebraska
- Future of surface water and issues regarding State of Kansas
- Example of conjunctive management successes – Platte River

TRENDS IN STREAMFLOW AND BASEFLOW

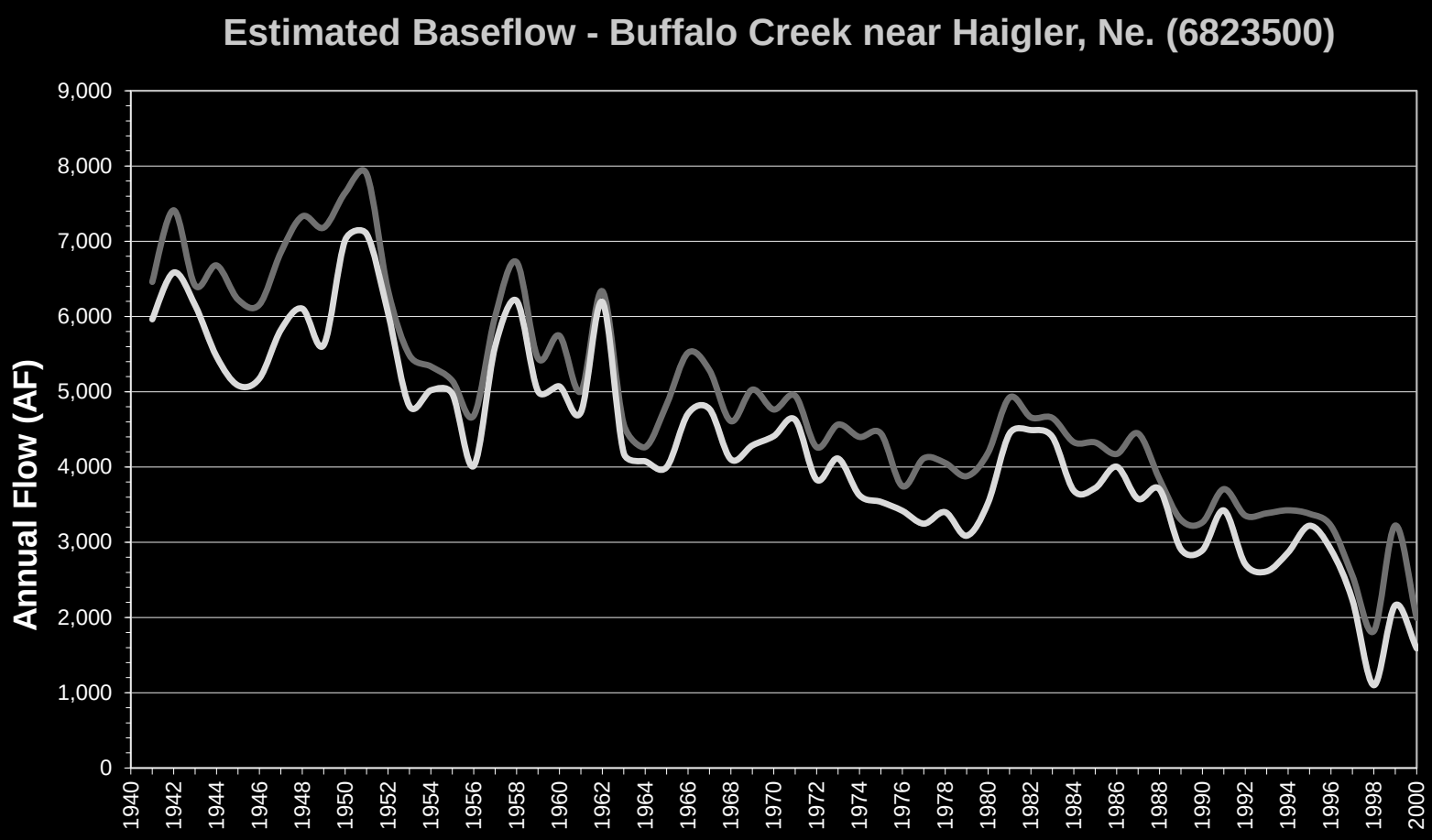
Data developed and summarized by the RRCA modeling committee consisting of members from the three states and USBR



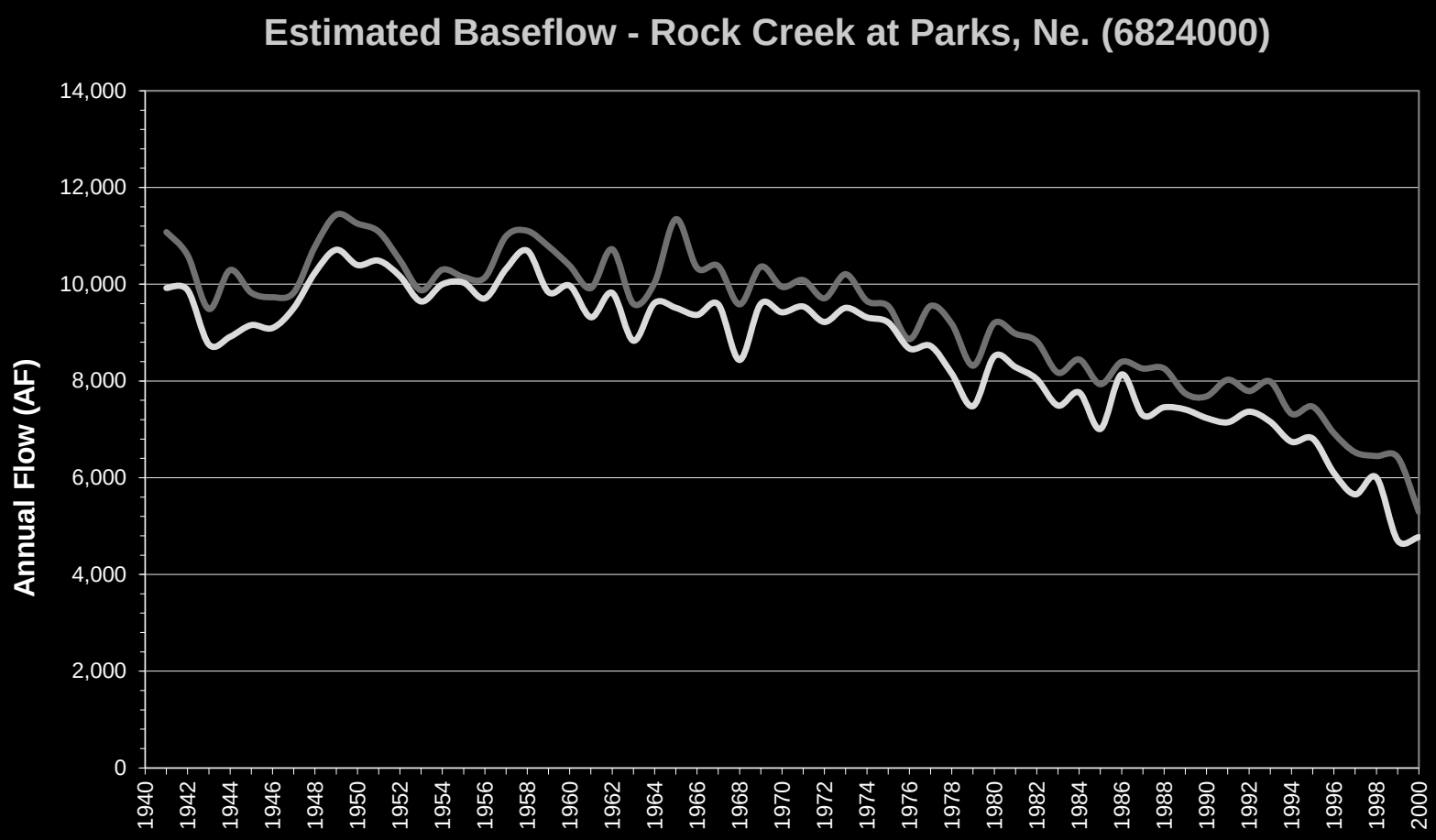
(values in AF)	Avg. 1950-1964	Avg. 1986-2000	Difference
Total	53,287	34,730	**-18,558**
Baseflow	46,139	31,616	**-14,523**



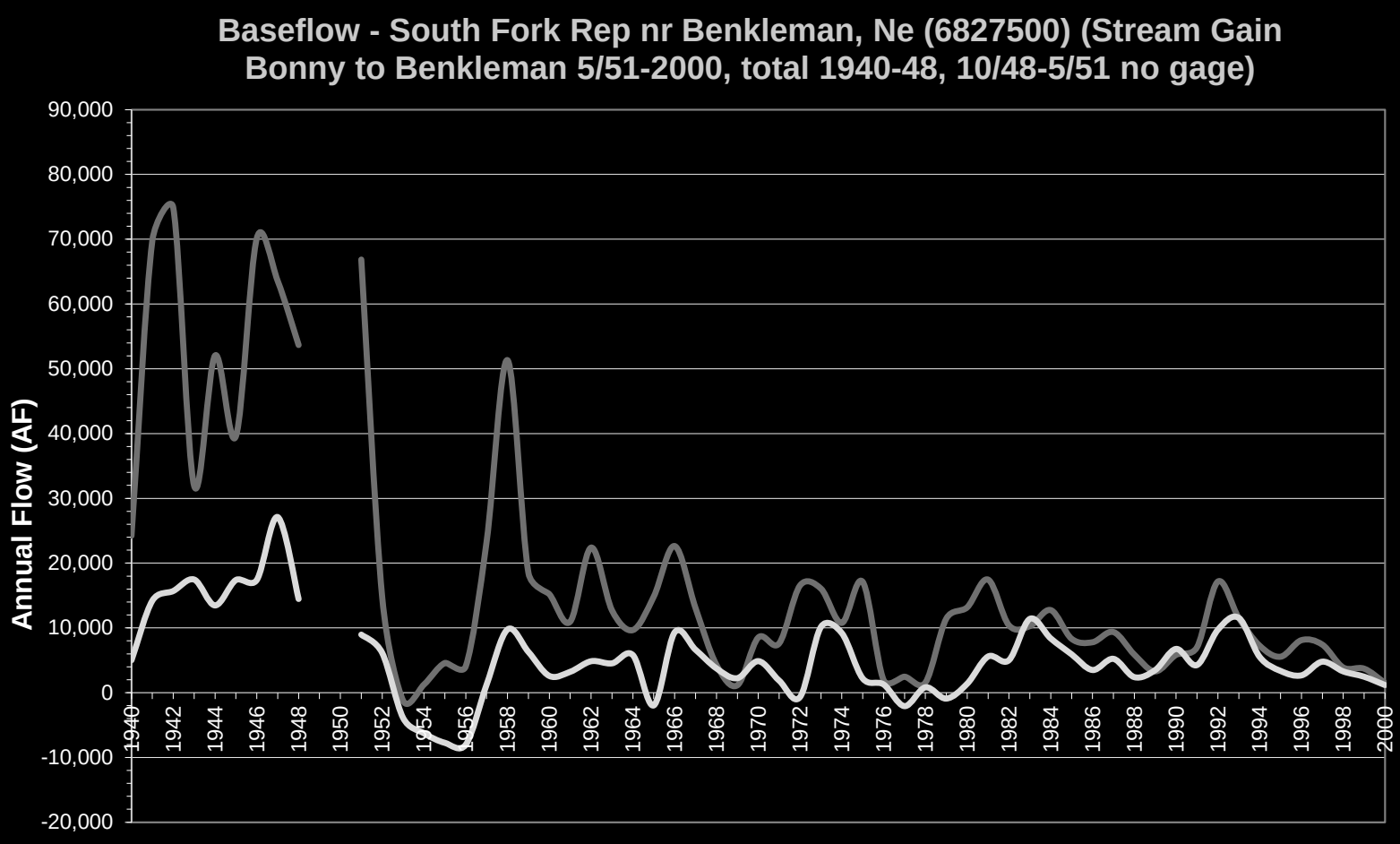
(values in AF)	Avg. 1950-1964	Avg. 1986-2000	Difference
Total	17,729	5,766	**-11,962**
Baseflow	6,636	3,275	**-3,360**



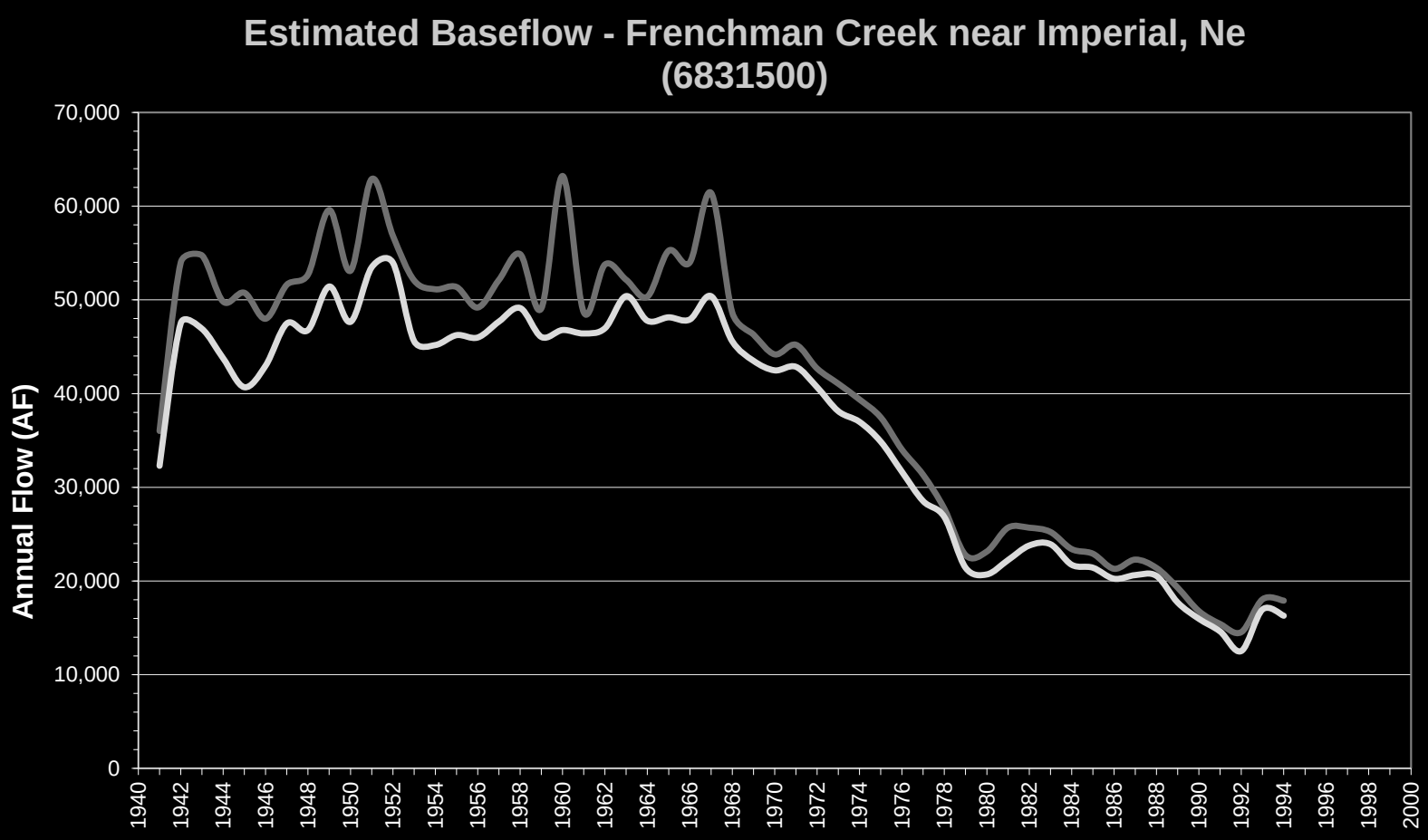
(values in AF)	Avg. 1950-1964	Avg. 1986-2000	Difference
Total	5,775	3,271	**-2,503**
Baseflow	5,336	2,793	**-2,543**



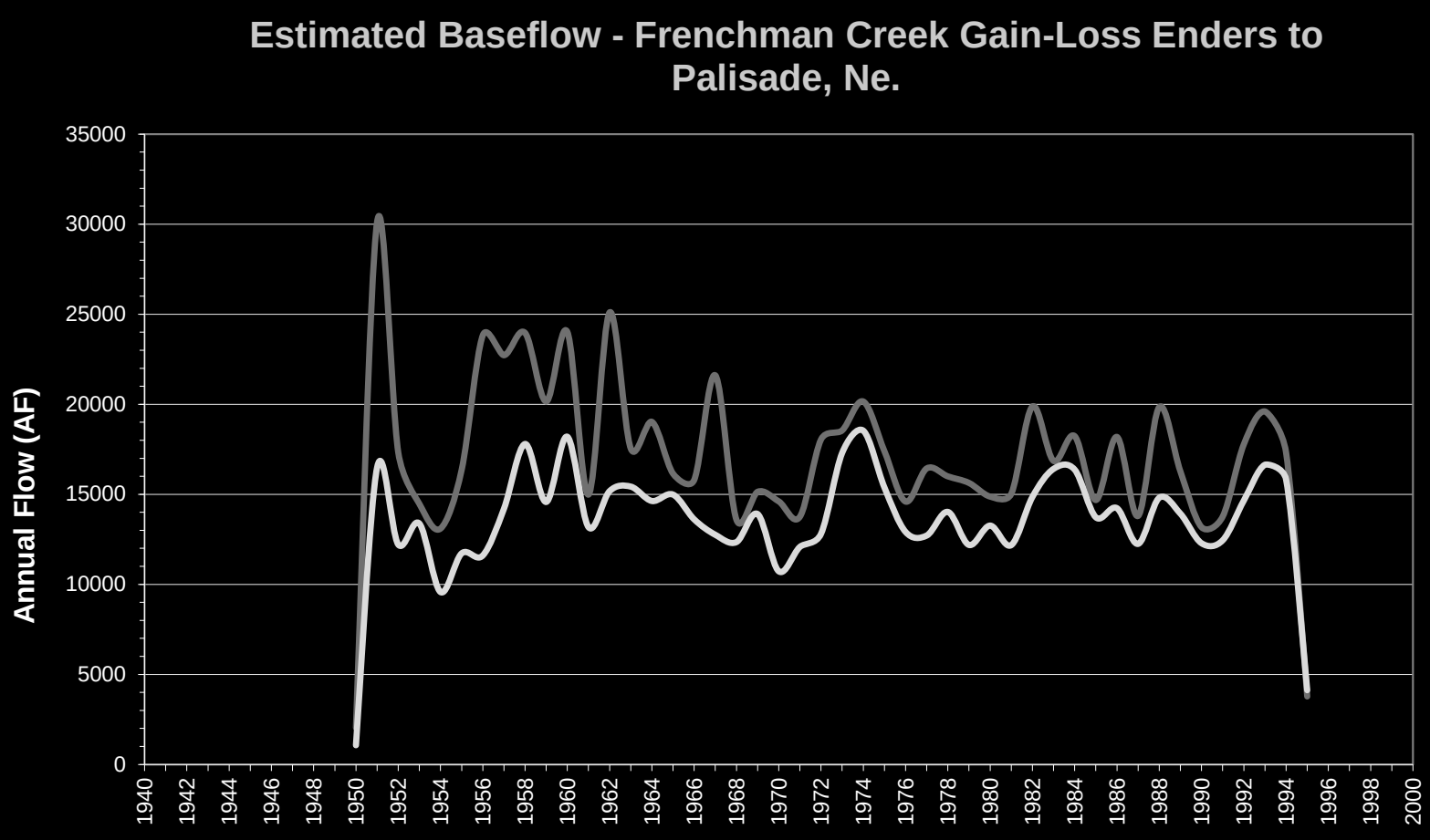
(values in AF)	Avg. 1950-1964	Avg. 1986-2000	Difference
Total	10,546	7,370	**-3,086**
Baseflow	9,922	6,665	**-3,257**



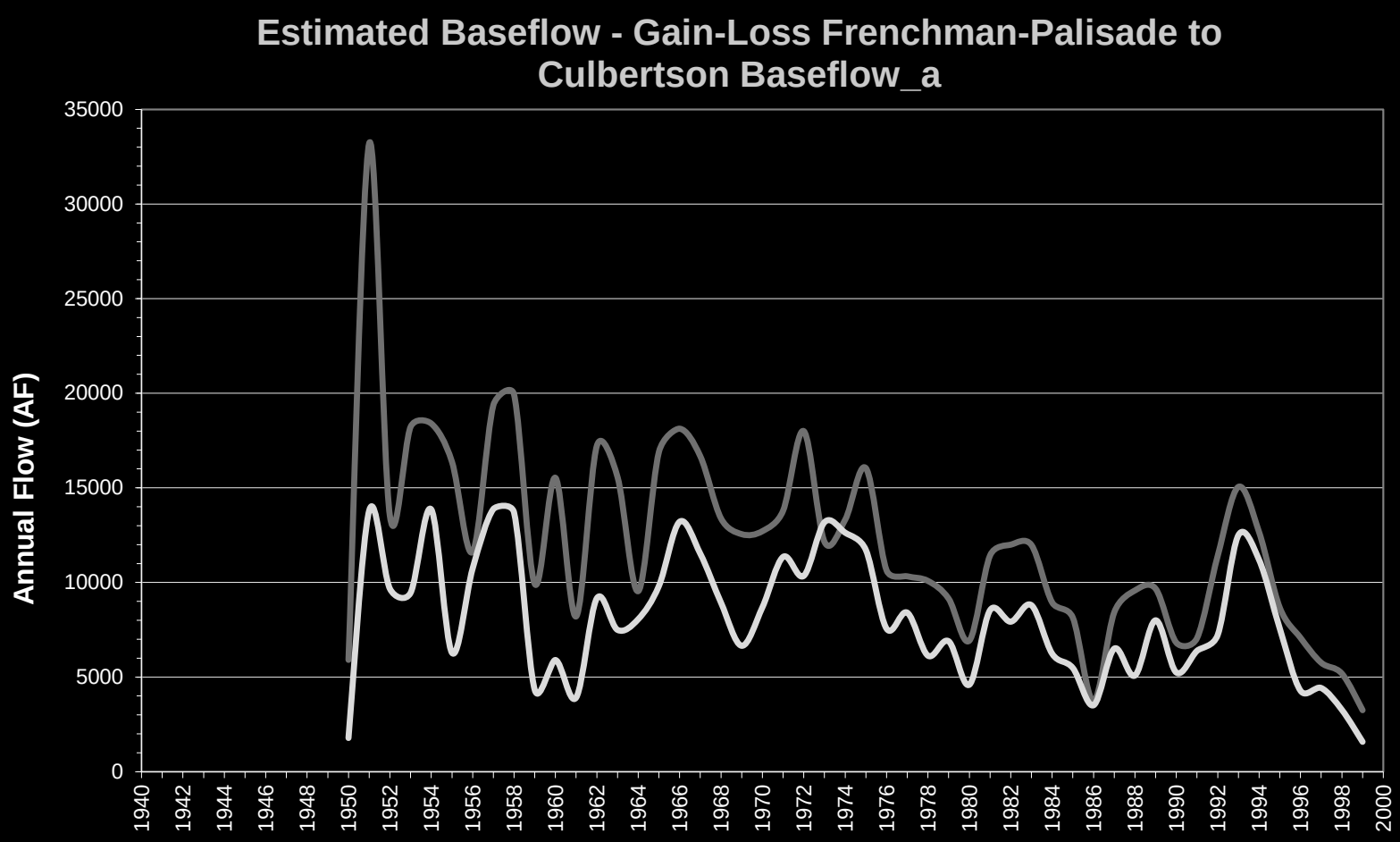
(values in AF)	Avg. 1950-1964	Avg. 1986-2000	Difference
Total	18,172	7,019	**-11,153**
Baseflow	1,963	4,678	**-2,715**



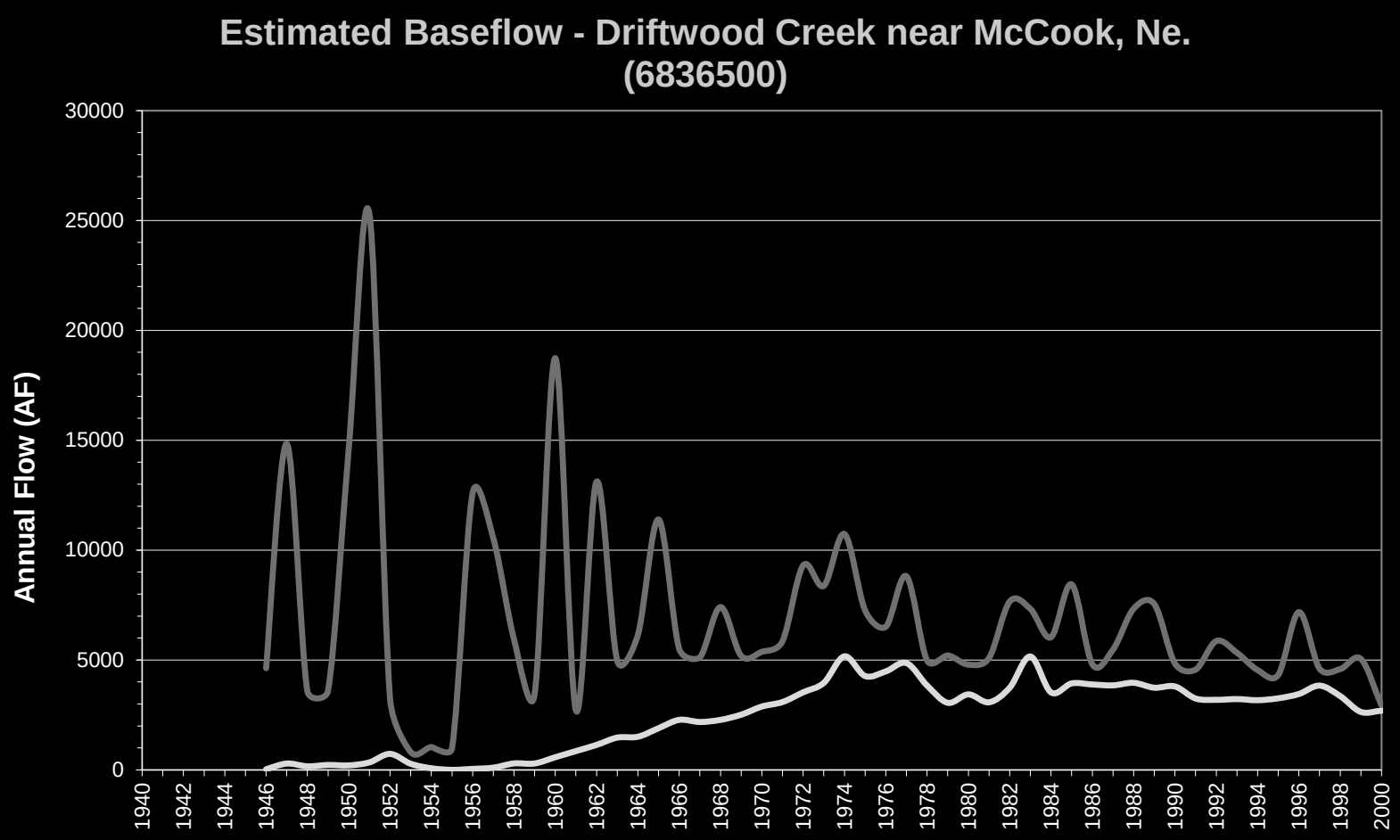
(values in AF)	Avg. 1950-1964	Avg. 1986-2000	Difference
Total	53,390	18,552	**-34,838**
Baseflow	47,952	17,278	**-30,674**



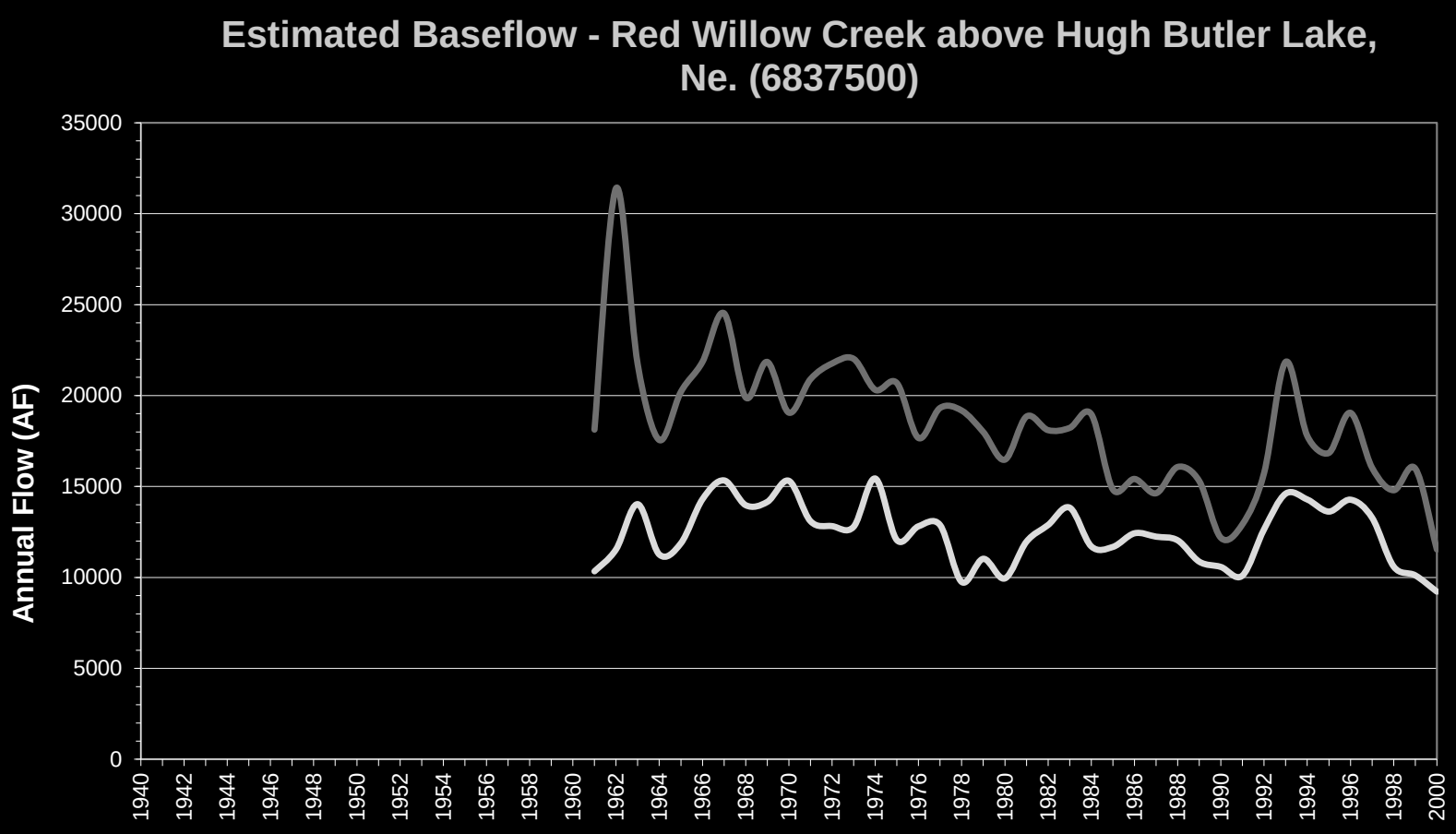
(values in AF)	Avg. 1950-1964	Avg. 1986-2000	Difference
Total	18,984	15,351	**-3,633**
Baseflow	13,281	13,119	**-162**



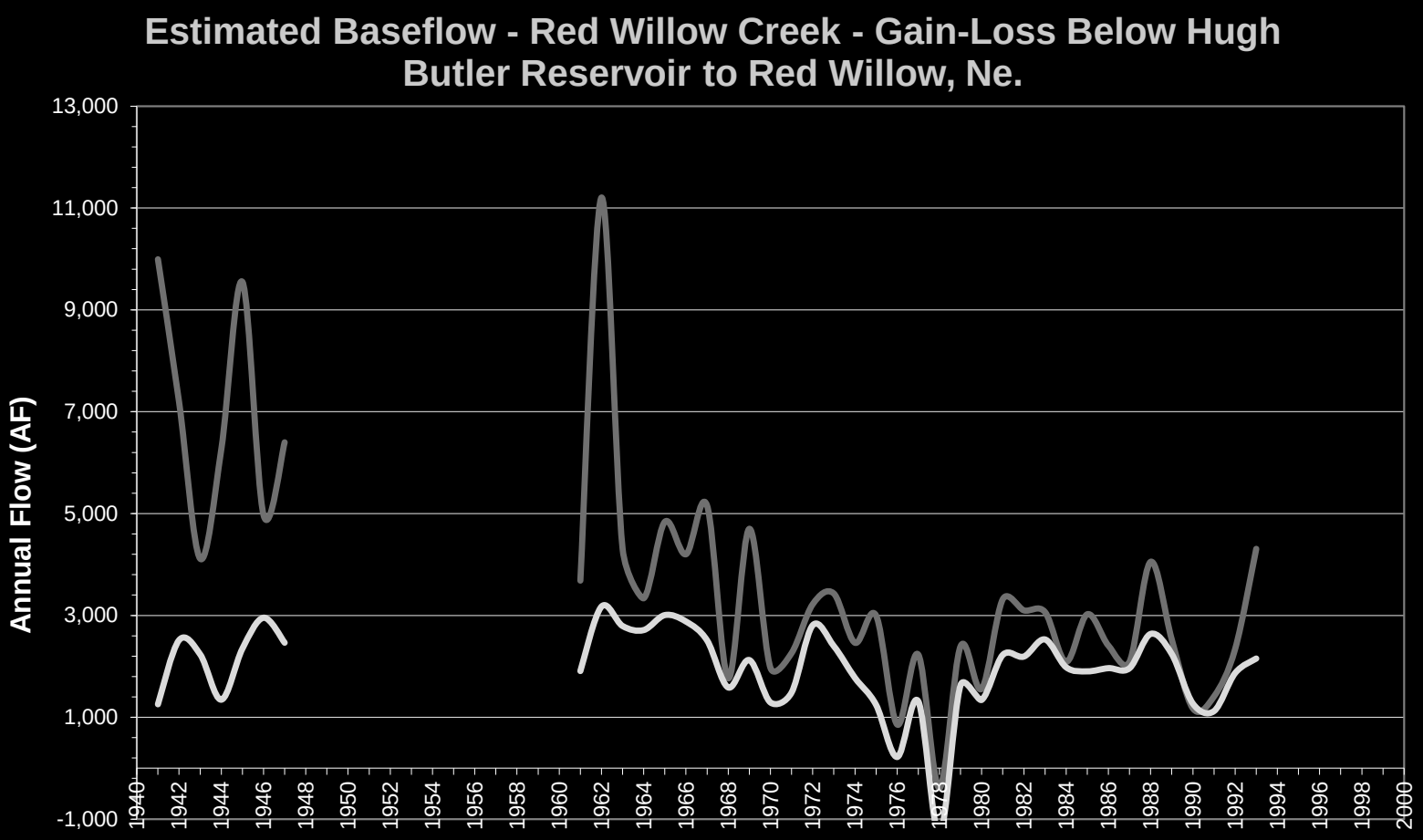
(values in AF)	Avg. 1950-1964	Avg. 1986-2000	Difference
Total	15,503	8,166	**-7,336**
Baseflow	8,801	6,197	**-2,604**



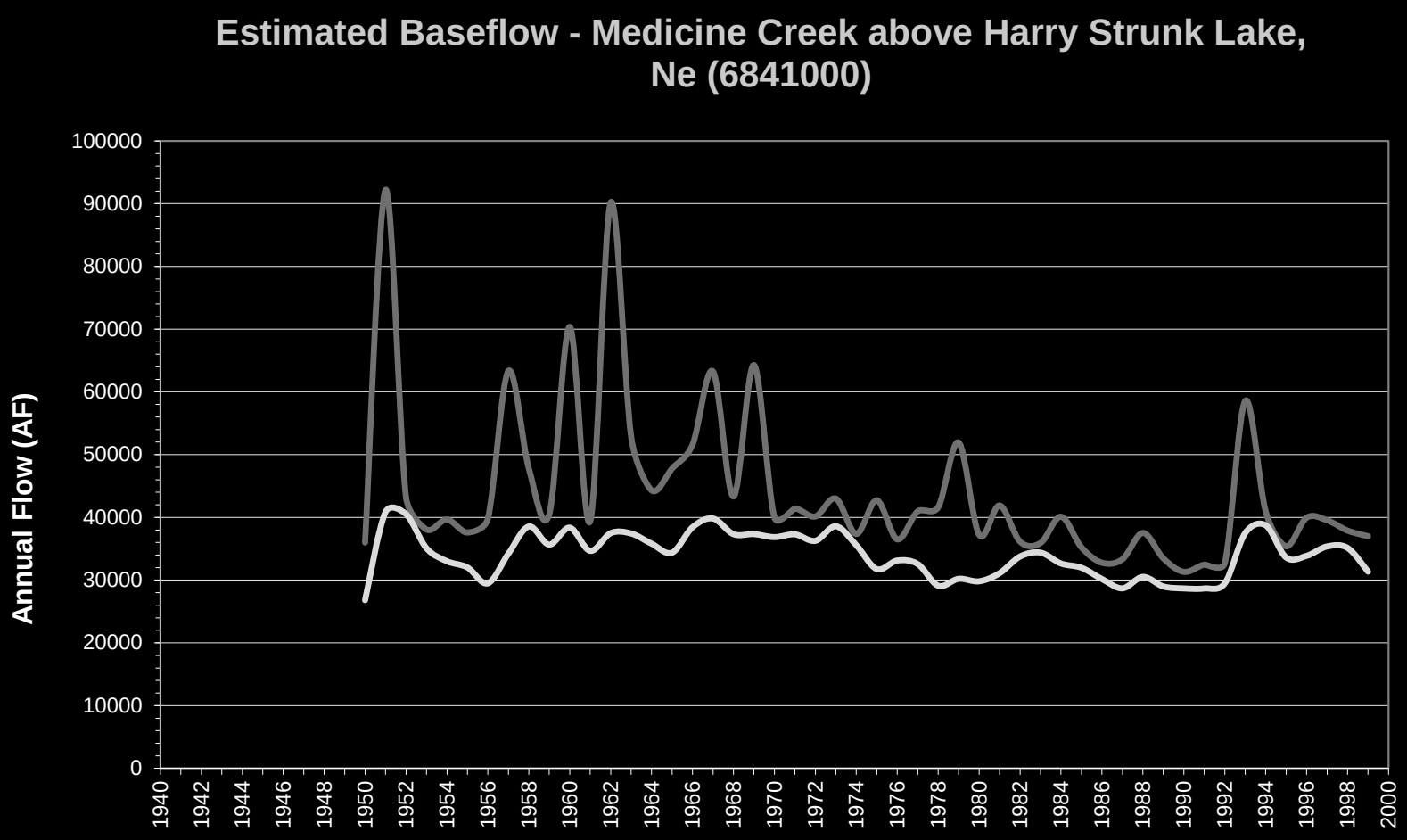
(values in AF)	Avg. 1950-1964	Avg. 1986-2000	Difference
Total	8,280	5,264	**-3,015**
Baseflow	525	3,418	**2,893**



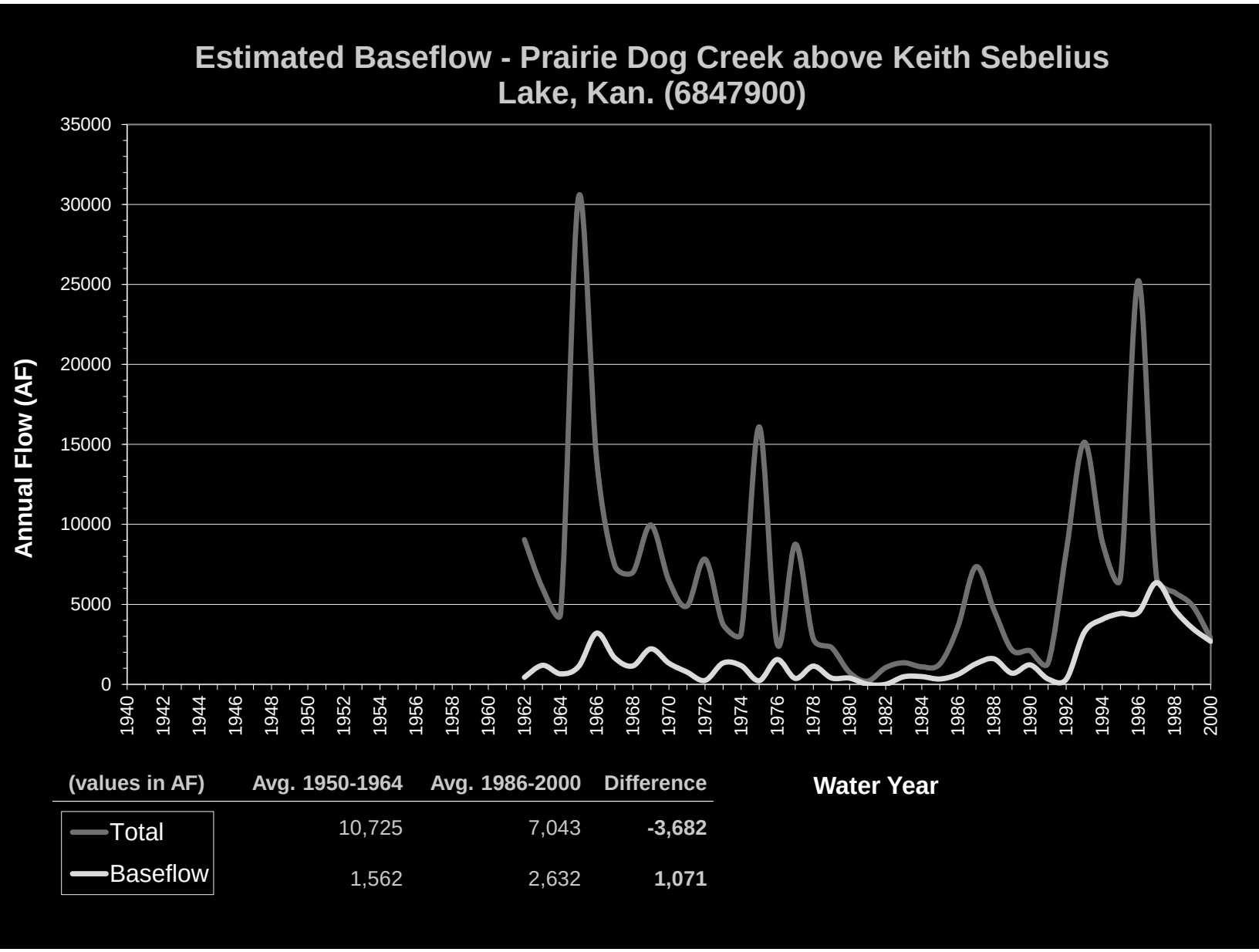
(values in AF)	Avg. 1950-1964	Avg. 1986-2000	Difference
Total	22,203	15,743	**-6,460**
Baseflow	11,793	12,060	**268**



(values in AF)	Avg. 1950-1964	Avg. 1986-2000	Difference
Total	5,633	2,539	**-3,095**
Baseflow	1,963	4,678	**-2,715**

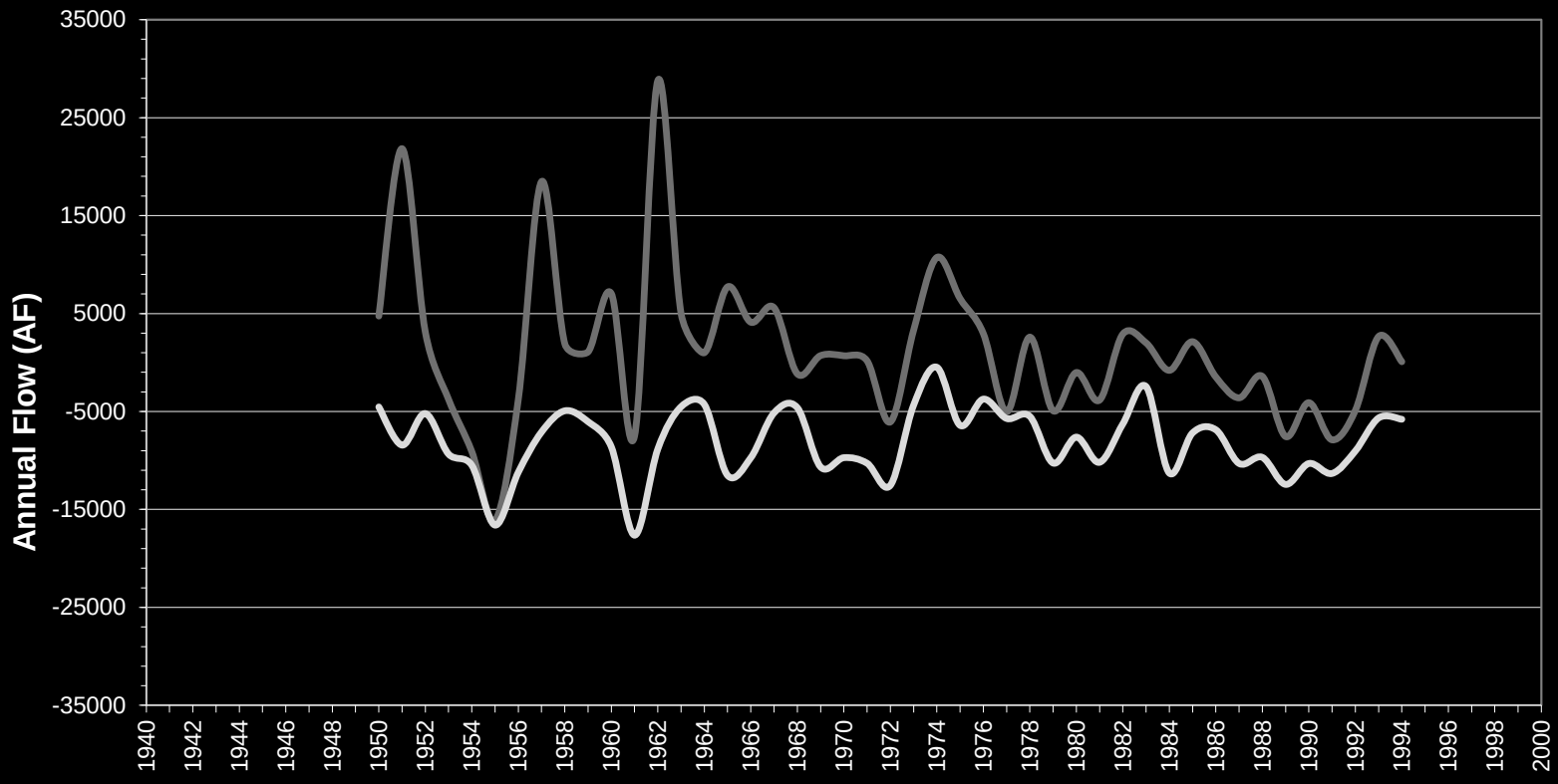


(values in AF)	Avg. 1950-1964	Avg. 1986-2000	Difference
Total	51,686	37,350	**-14,336**
Baseflow	35,332	32,198	**-3,134**



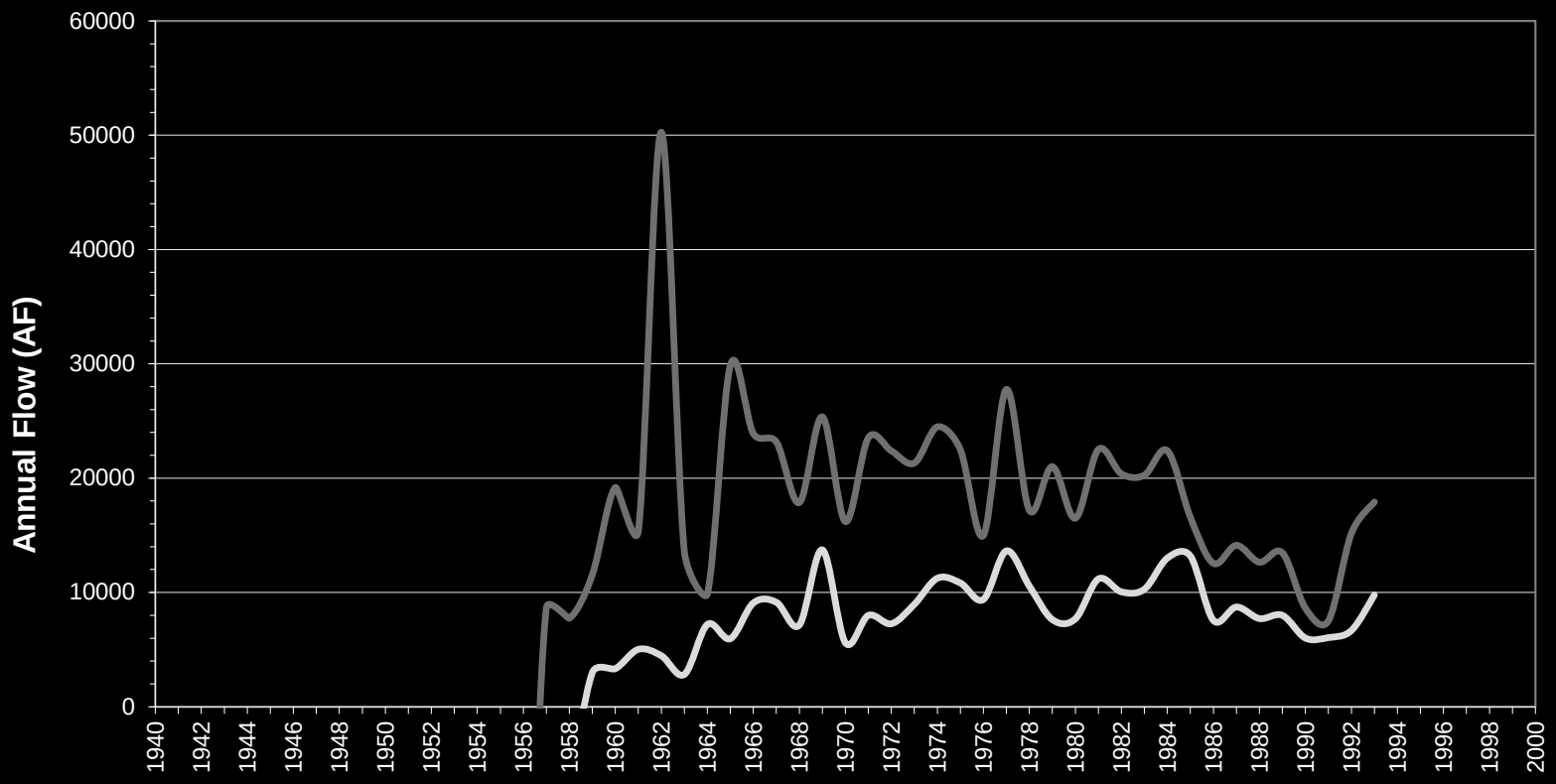
(values in AF)	Avg. 1950-1964	Avg. 1986-2000	Difference
Total	10,725	7,043	**-3,682**
Baseflow	1,562	2,632	**1,071**

Estimated Baseflow - Republican River - Gain-Loss Benkleman to Swanson, Ne.



(values in AF)	Avg. 1950-1964	Avg. 1986-2000	Difference
Total	3,517	-3,135	**-6,652**
Baseflow	-8,516	-9,047	**-531**

Estimated Baseflow - Gain-Loss Below Swanson Reservoir to McCook Gage, Nebr.



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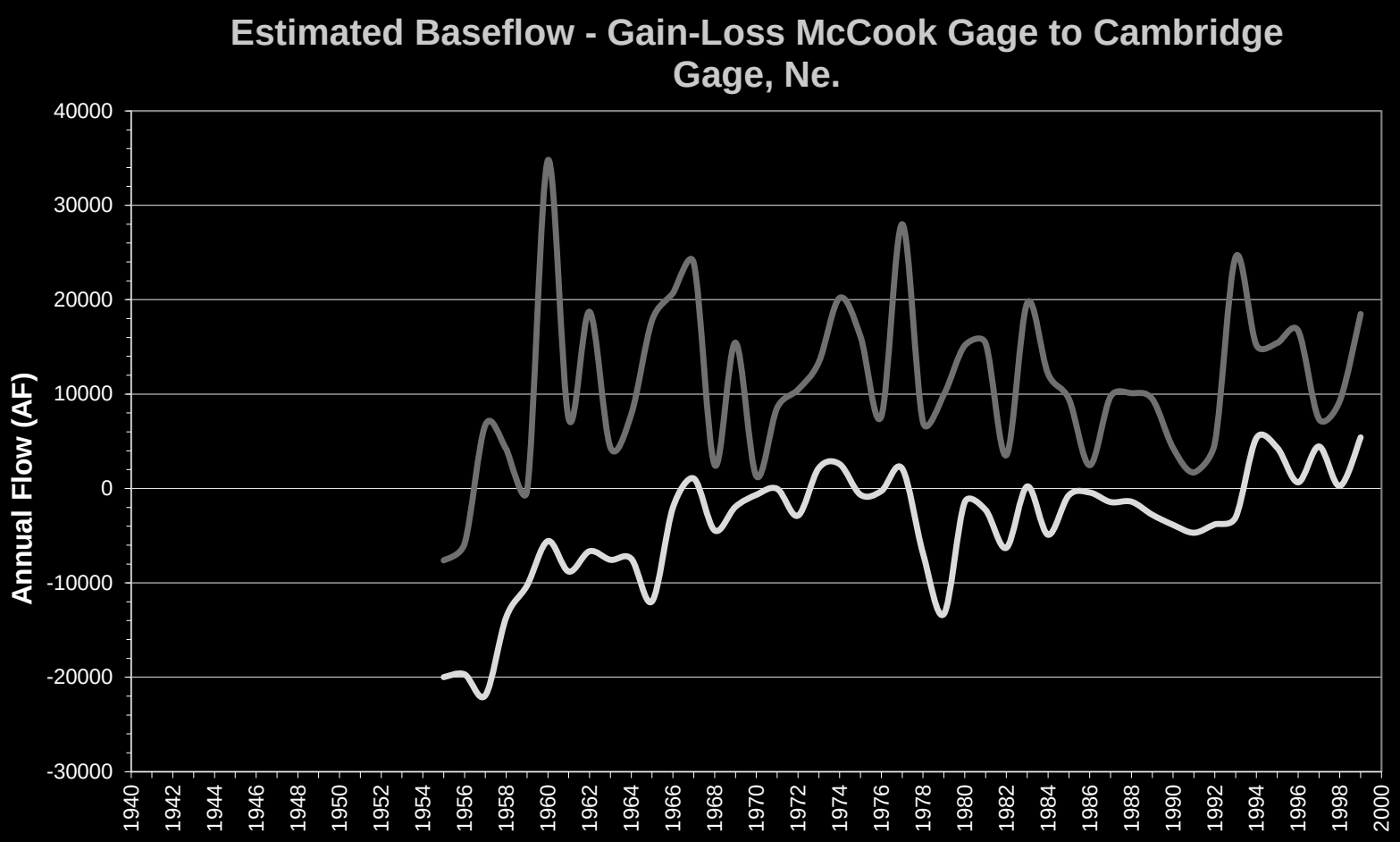
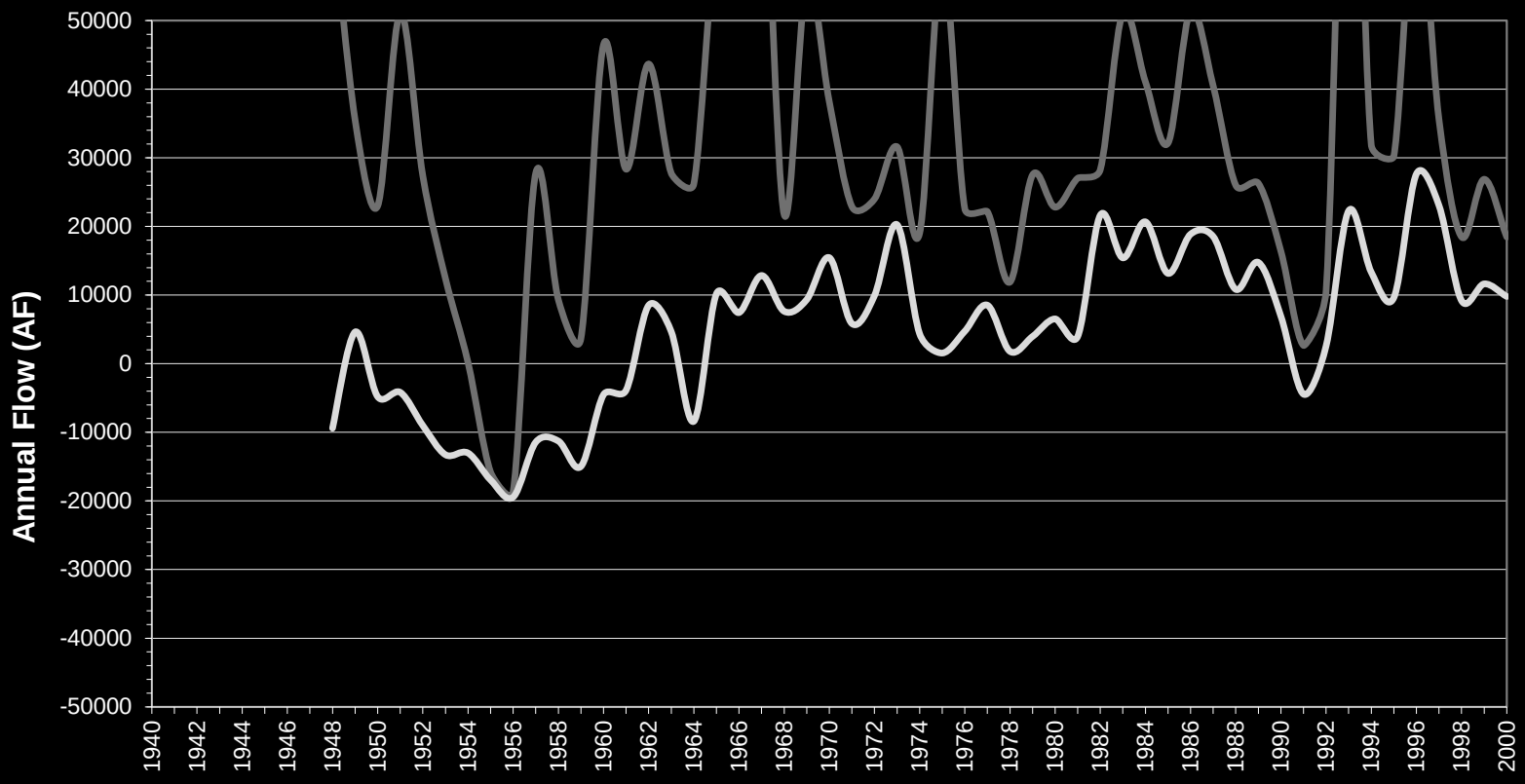


(values in AF)	Avg. 1950-1964	Avg. 1986-2000	Difference
Total	7,032	10,680	**3,648**
Baseflow	-12,149	-72	**12,077**

Est Baseflow - Gain-Loss Cambridge Gage to Orleans Gage, Ne.
(gain includes inflow from several tributaries)



(values in AF)	Avg. 1950-1964	Avg. 1986-2000	Difference
Total	18,172	7,019	**-11,153**
Baseflow	1,963	4,678	**-2,715**

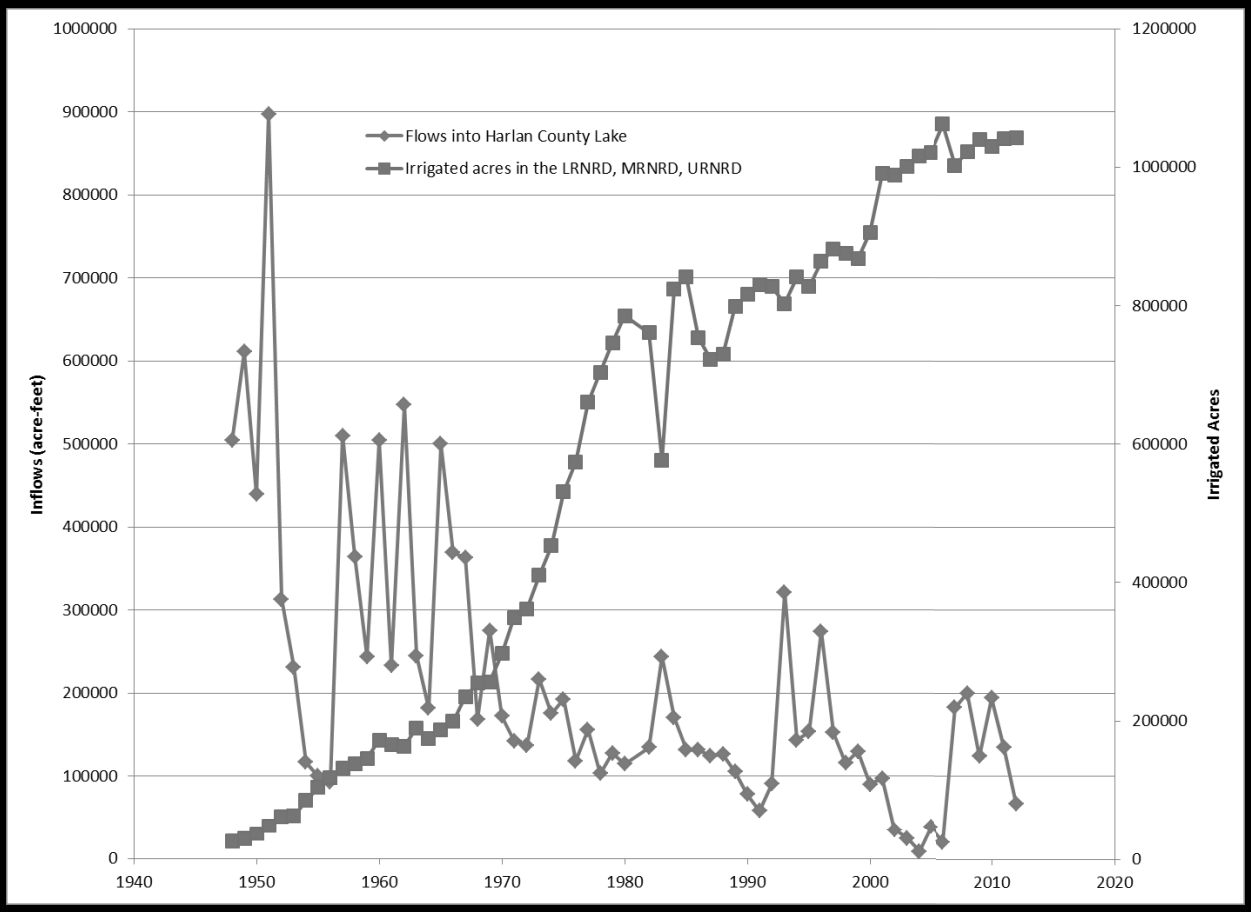
Observations Based on Trends

- Streamflows have generally declined in the Basin, particularly in the western and central portions
- There are noticeable declines in both baseflow and runoff

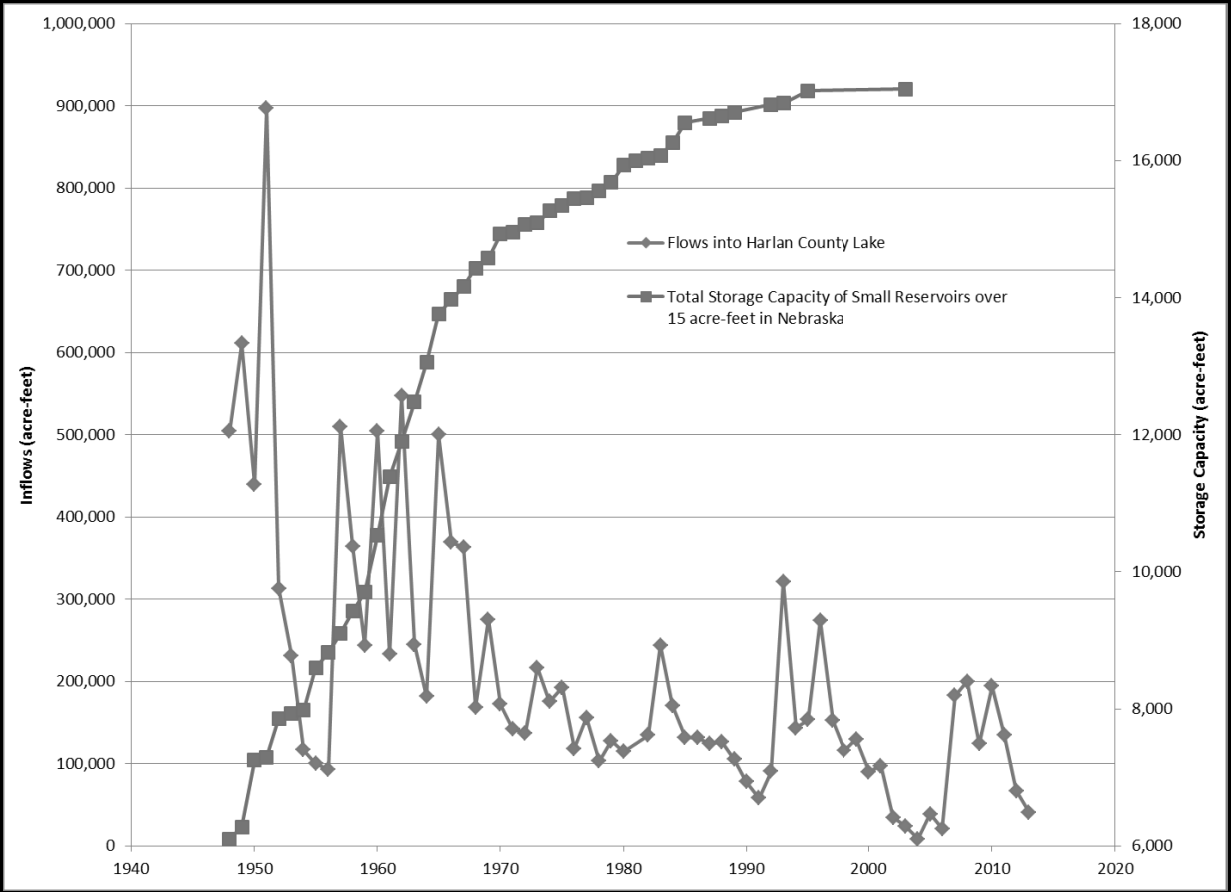
CORRELATIONS

Comparison between inflows to Harlan County Lake and other changes in the Republican River Basin

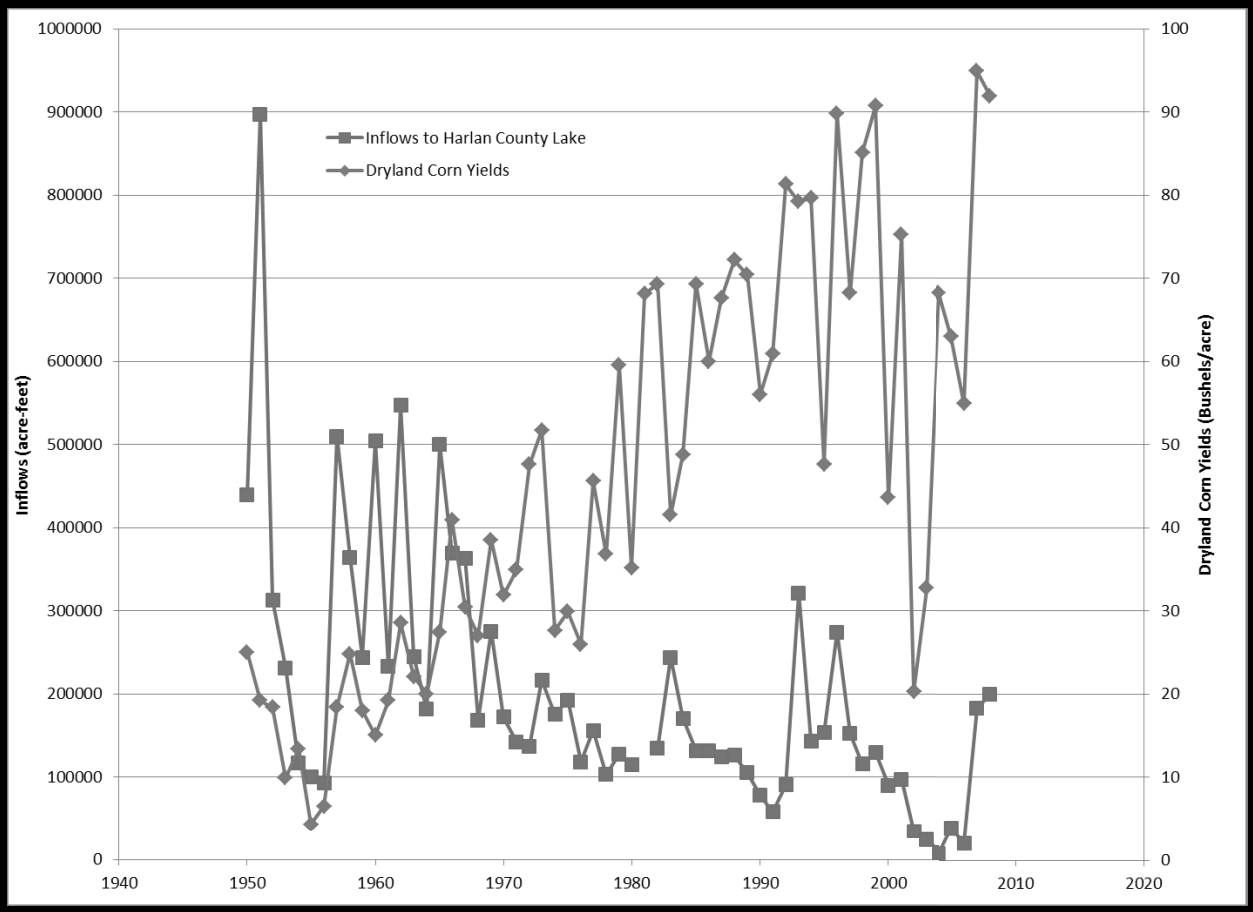
Inflows vs. Irrigated Acres



Inflows vs. Reservoirs



Inflows vs. Dryland Yields



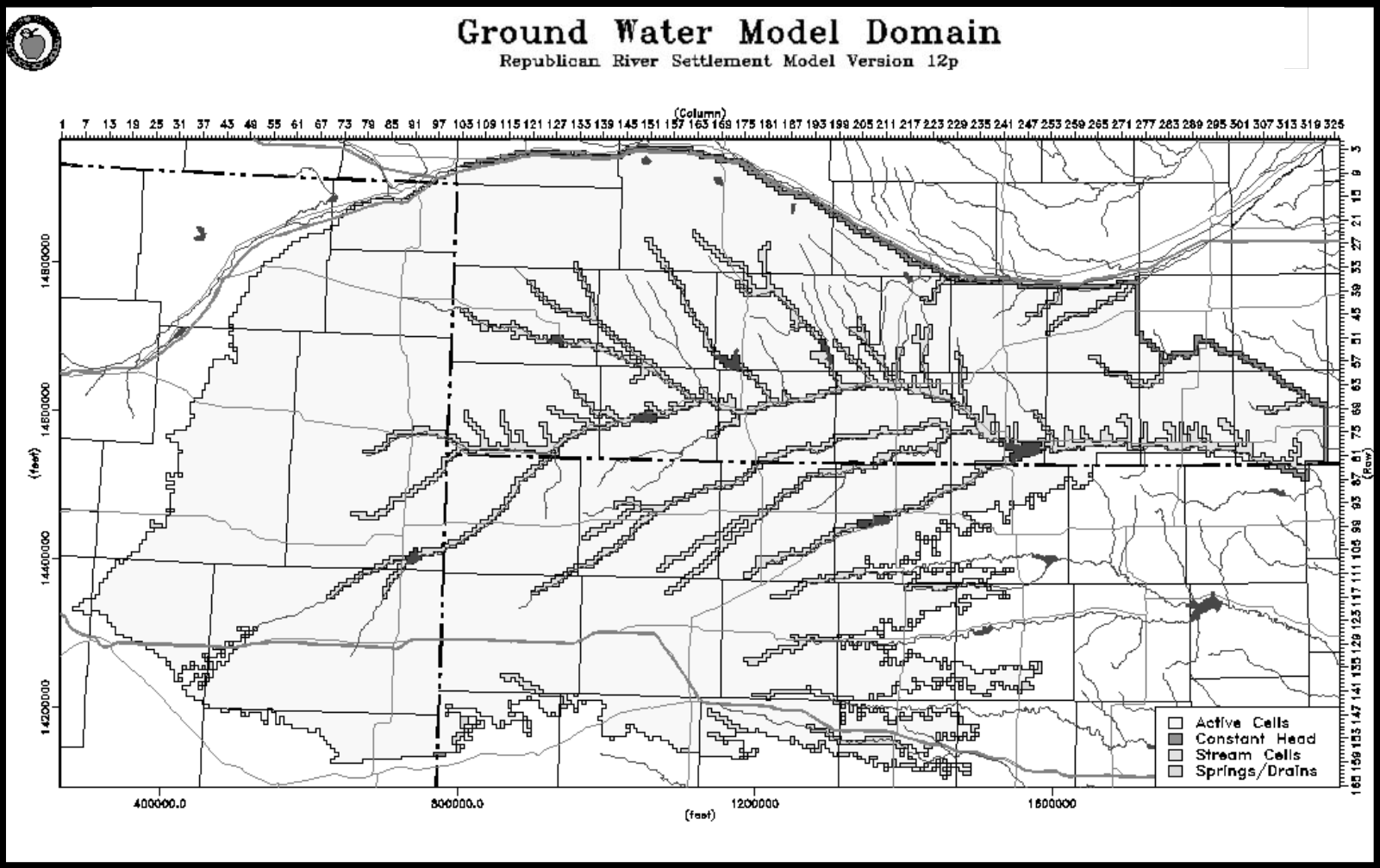
Observations Based on Correlations

- Inflows into Harlan County Lake are inversely correlated with the development of groundwater irrigation, with the development of conservation practices such as farm ponds, and with the increase in dryland crop yields in the Basin.
- The most significant declines in runoff appear to have occurred prior to 1970, during the time that the development of conservation practices increased the most.
- Baseflow declines have occurred more steadily over time in a manner more similar to the increase in groundwater irrigation and to the increase in dryland yields.

Causes of Reduced Streamflow Supply

Causes		Quantifying these impacts
Groundwater pumping by the three states	➔	Estimates of streamflow depletions due to groundwater pumping from the RRCA groundwater model
Reductions in runoff	➔	RRCA Conservation Study, analysis of historic streamflow and baseflow information to estimate reductions in runoff
Drought	➔	Comparison of 2013-2014 with longer-term averages to assess the impact of drought

RRCA Groundwater Model



Depletions Due to Groundwater Pumping

Impacts 2000 (acre-feet)				
Location	Colorado Pumping	Kansas Pumping	Nebraska Pumping	Nebraska Mound
Arikaree	1918	128	196	0
Beaver	0	4560	3568	0
Buffalo	234	0	2912	0
Driftwood	0	0	1153	0
Frenchman	599	0	74876	0
North Fork	13173	15	1156	0
Above Swanson	-4253	159	10260	0
Swanson - Harlan	0	-224	30831	9412
Harlan - Guide Rock	0	0	25316	155
Guide Rock - Hardy	0	257	1926	0
Medicine	0	0	14585	9058
Prairie Dog	0	1392	0	0
Red Willow	0	0	5179	31
Rock	42	0	3125	0
Sappa	0	-670	792	0
South Fork	9280	6320	982	0
Hugh Butler	0	0	1601	0
Bonny	1170	0	0	0
Keith Sebelius	0	407	0	0
Enders	0	0	3848	0
Harlan	0	42	989	0
Harry Strunk	0	0	505	0
Swanson	11	0	220	0
Mainstem	-4252	196	68334	9564
Total	**22,178**	**12,398**	**184,020**	**18,664**

RRCA Conservation Study

- *"Land terracing and Non-Federal Reservoirs are having a substantial effect on the water resources of the Republican River Basin above Hardy, Nebraska."*
- With land terracing and Non-Federal Reservoirs (average annual values):

	Average annual change
Net evapotranspiration	Increased by ~ 36,000 AF/year
Groundwater recharge	Increased by ~ 88,000 AF/year
Surface runoff	Decreased by ~ 63,000 AF/year
Transmission loss	Decreased by ~ 63,000 AF/year

RRCA Conservation Study

- *"The reduction in runoff and stream transmission losses from both Non-Federal Reservoirs and land terraces operating totals about 125,000 acre-feet per year. To put the magnitude of the impact in perspective,* ***this is comparable to estimated average annual inflow to Harlan County Reservoir.****"*

RRCA Conservation Study

- *“This study only evaluated the impacts of Non-Federal Reservoirs and land terraces on water supplies in the Republican River Basin above Hardy, Nebraska. The study did not evaluate other impacts such as tillage practices, on-farm irrigation practices, or other water conservation practices, or reservoirs that do not meet the criteria for Non-Federal Reservoirs. These practices may influence water supplies but they are not part of this evaluation.”*
- Quotes from draft USBR report.

COMPARISON BETWEEN 1950-1964 TIME PERIOD AND 1986-2000 TIME PERIOD

Using data from preceding streamflow and baseflow plots

(values in AF)	Total (50-64)	Baseflow (50-64)	Total (86-00)	Baseflow (86-00)	Total Difference	Baseflow Difference	Runoff Difference
North Fork	53,287	46,139	34,730	31,616	18,557	14,523	4,034
Arikaree	17,729	6,636	5,766	3,275	11,963	3,361	8,602
Buffalo	5,775	5,336	3,271	2,793	2,504	2,543	(39)
Rock	10,456	9,922	7,370	6,665	3,086	3,257	(171)
South Fork	18,172	1,963	7,019	4,678	11,153	(2,715)	13,868
Frenchman (Imperial)	53,390	47,952	18,552	17,278	34,838	30,674	4,164
Frenchman (Enders-Palisade)	18,984	13,281	15,351	13,119	3,633	162	3,471
Frenchman (Palisade-Culbertson)	15,503	8,801	8,166	6,197	7,337	2,604	4,733
Driftwood	8,280	525	5,264	3,418	3,016	(2,893)	5,909
Red Willow Abv.	22,203	11,793	15,743	12,060	6,460	(267)	6,727
Red Willow Blw.	5,633	2,646	2,539	1,902	3,094	744	2,350
Medicine Abv.	51,686	35,332	37,350	32,198	14,336	3,134	11,202
Prarie Dog Abv.	10,725	1,562	7,043	2,632	3,682	(1,070)	4,752
MS Benkleman-Swanson	3,517	(8,516)	(3,135)	(9,047)	6,652	531	6,121
MS Swanson-McCook	8,833	(3,202)	12,750	7,563	(3,917)	(10,765)	6,848
MS McCook-Cambridge	7,032	(12,149)	10,680	(72)	(3,648)	(12,077)	8,429
MS Cambridge-Orleans	19,515	(8,131)	33,784	12,967	(14,269)	(21,098)	6,829
Total	330,720	159,890	222,243	149,242	108,477	10,648	97,829

Rainfall Comparison

Time Period	1918-2013	1950-1964	1986-2000
Nebraska Average	22.12 inches	21.37 inches (44%)	23.35 inches (65%)
Basin Average	21.05 inches	20.36 inches (43%)	22.17 inches (62%)

- Earlier period had slightly below average rainfall
- Later period had significantly above average rainfall
- Runoff was reduced by 98,000 acre-feet despite the increased rainfall

Impacts in Frenchman Creek

Reduction in Runoff	12,000 AF
Pumping Impacts	
• **Nebraska**	67,000 AF
Total Impacts	**79,000 AF**

- Reduction in runoff from baseflow and streamflow data – sum of tributaries and reaches in Frenchman Creek
- Pumping impacts from RRCA groundwater model

Frenchman Valley Appraisal Study

- Joint Appraisal Study involving USBR, NDNR, MRNRD, URNRD, FVID, and H&RWID
- NDNR provided all groundwater modeling in 2007
- Results showed that even if all groundwater irrigation was shut off in Nebraska, FVID and H&RWID would only receive half of a full supply, and this would only happen after 40 years of time had elapsed
- Draft Final Report – (USBR never finalized) does not contain an irrigation alternative http://www.usbr.gov/gp/nkao/frenchman/index.html
- Report recognized potential recharge and recreation alternatives
- NDNR has partnered with FVID on pilot recharge project

Impacts Above Swanson Reservoir

Reduction in Runoff	32,000 AF
Pumping Impacts	
• **Nebraska**	14,000 AF
• **Kansas**	8,000 AF
• **Colorado**	21,000 AF
Total Impacts	**75,000 AF**

- Reduction in runoff from baseflow and streamflow data – sum of tributaries and reaches above Swanson Reservoir
- Pumping impacts from RRCA groundwater model

1950-1964 compared to 1986-2000

Impacts on Red Willow

Reduction in Runoff	9,000 AF
Pumping Impacts	
• **Nebraska**	6,000 AF
Total Impacts	**15,000 AF**

- Reduction in runoff from baseflow and streamflow data – sum of tributaries and reaches in Red Willow Creek sub-basin
- Pumping impacts from RRCA groundwater model

1950-1964 compared to 1986-2000

Impacts Above Harry Strunk Reservoir

Reduction in Runoff	11,000 AF
Pumping Impacts	
• **Nebraska ***	13,000 AF
Imported Water (Nebraska)	8,000 AF
Total Impacts	**16,000 AF**

- Reduction in runoff from baseflow and streamflow data – sum of tributaries and reaches above Harry Strunk Reservoir
- Pumping impacts from RRCA groundwater model

* Includes impacts below Harry Strunk

1950-1964 compared to 1986-2000

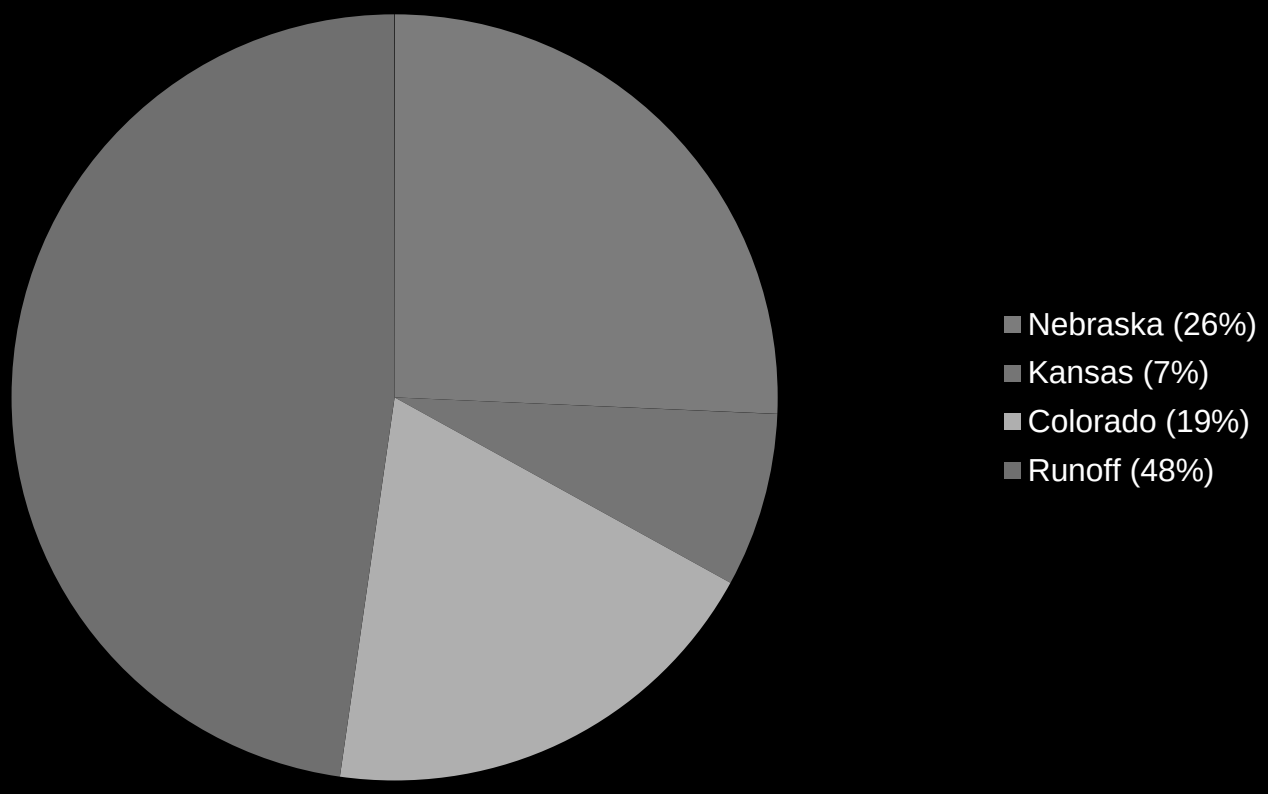
Impacts to Reservoirs Serving Frenchman Cambridge

Runoff Reduction	52,000 AF
Pumping Impacts	
• **Nebraska**	36,000 AF
• **Kansas**	8,000 AF
• **Colorado**	21,000 AF
Imported Water (Nebraska)	8,000 AF
Total Impacts	**109,000 AF**

- Reduction in runoff from baseflow and streamflow data – sum of above Swanson, Red Willow, and above Harry Strunk
- Pumping and imported water impacts from RRCA groundwater model
- Imported water subtracted from Nebraska pumping impact for a net Nebraska impact of 28,000 acre-feet

1950-1964 compared to 1986-2000

Impacts to Reservoirs Serving Frenchman Cambridge



1950-1964 compared to 1986-2000

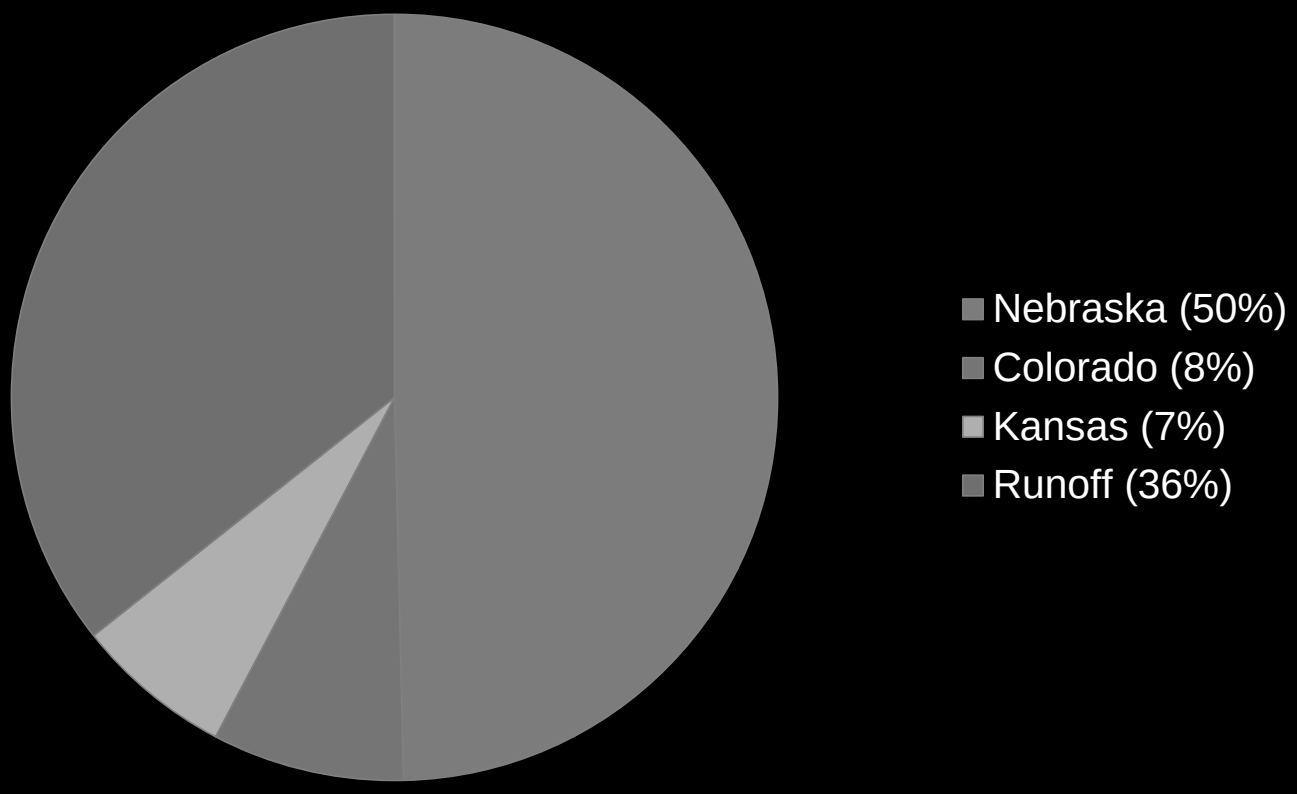
Impacts Above Harlan County Lake

Runoff Reduction	97,000 AF
Pumping Impacts	
• **Nebraska**	152,000 AF
• **Kansas**	18,000 AF
• **Colorado**	22,000 AF
Imported Water (Nebraska)	17,000 AF
Total Impacts	**272,000 AF**

- Reduction in runoff from baseflow and streamflow data – sum of tributaries and reaches above Harlan County Lake including reservoirs serving FCID
- Pumping and imported water impacts from RRCA groundwater model
- Imported water subtracted from Nebraska pumping impact for a net Nebraska impact of 135,000 acre-feet

1950-1964 compared to 1986-2000

Impacts Above Harlan County Lake



1950-1964 compared to 1986-2000

Post-2000 impacts

- 2000-2012
  - Increase in depletions due to groundwater pumping
  - Are there additional reductions in runoff?
  - Precipitation
    - Average Nebraska = 22.78 inches (58%)
    - Average Basinwide = 21.41 inches (53%)
  - No baseflow separations
    - Use streamflow data
    - Account for changes in GWCBCU
    - Add in SWCBCU so comparable with baseflow separations (which accounted for all major diversions)
    - Use pre-2000 runoff reductions for Red Willow (data likely skewed by dam repair and releases) and for Medicine Creek (almost 90% baseflow by 1986-2000 period)

Impacts above Swanson Reservoir

	1951-1964	1986-2000	2000-2012
Average Annual Flow (Straton Gage)	112,000 AF	51,000 AF	21,000 AF
Reduction from Early to Late Period			91,000 AF

Pumping Impacts	
• **Nebraska**	20,000 AF
• **Kansas**	6,000 AF
• **Colorado**	25,000 AF
Total Pumping Impacts	51,000 AF
Reduction in Runoff	40,000 AF

1950-1964 compared to 2000-2012

Impacts on Red Willow

Reduction in Runoff	9,000 AF
Pumping Impacts	
• **Nebraska**	8,000 AF
Total Impacts	**17,000 AF**

1950-1964 compared to 2000-2012

Impacts Above Harry Strunk Reservoir

Reduction in Runoff	11,000 AF
Pumping Impacts	
• **Nebraska ***	20,000 AF
Imported Water (Nebraska)	10,000 AF
Total Impacts	**21,000 AF**

* Includes impacts below Harry Strunk

1950-1964 compared to 2000-2012

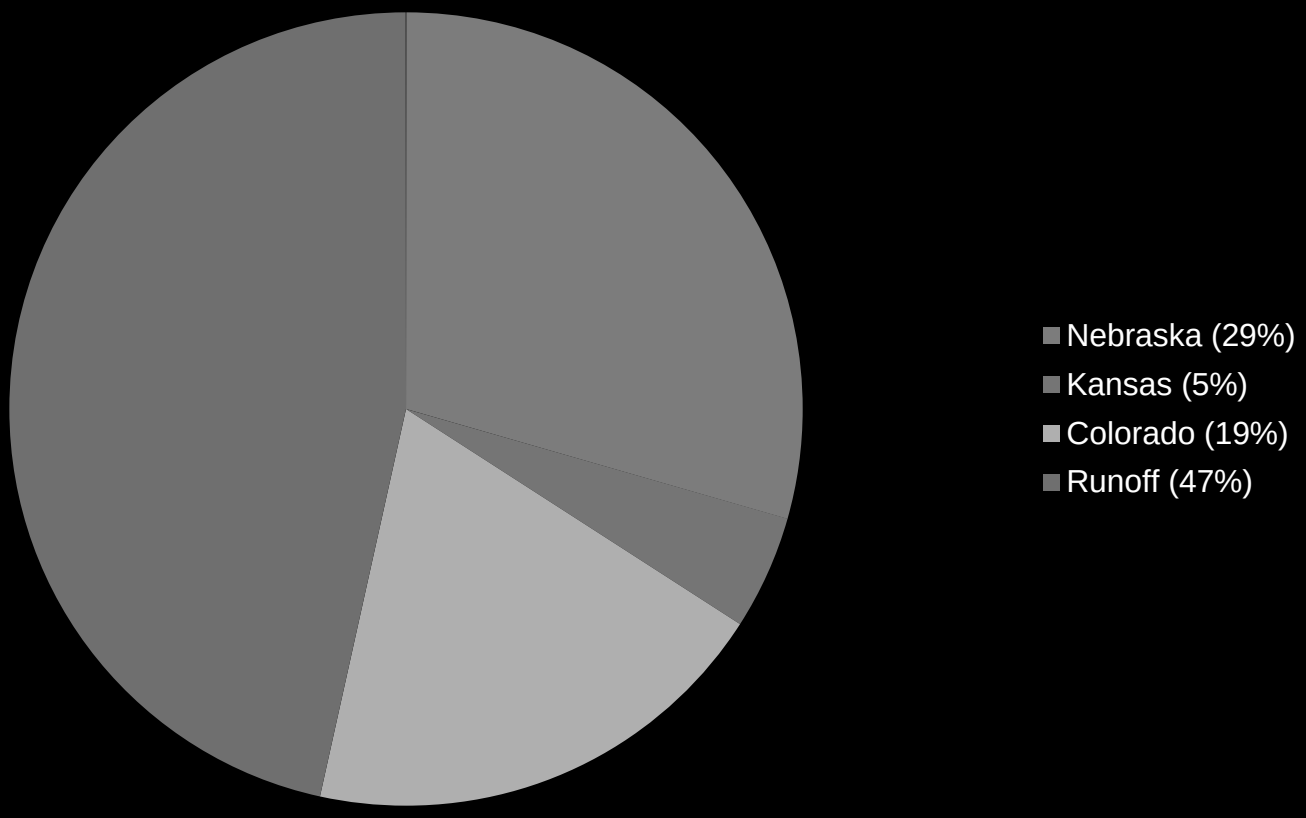
Impacts to Reservoirs Serving Frenchman Cambridge

Runoff Reduction	60,000 AF
Pumping Impacts	
• **Nebraska**	48,000 AF
• **Kansas**	6,000 AF
• **Colorado**	25,000 AF
Imported Water (Nebraska)	10,000 AF
Total Impacts	**129,000 AF**

Imported water subtracted from Nebraska pumping impact for a net Nebraska impact of 38,000 acre-feet

1950-1964 compared to 2000-2012

Impacts to Reservoirs Serving Frenchman Cambridge



1950-1964 compared to 2000-2012

Above Harlan County Lake

- 2000-2012

Orleans, Stamford, and Woodruff gages	93,000 AF
NE Surface Water CBCU above Harlan County Lake	30,000 AF
Total Streamflow available above Harlan County Lake	123,000 AF
Total Reduction from 1986-2000 period (222,000 AF)	99,000 AF

Impacts Above Harlan County Lake

	2000-2012	Increase from 1986-2000
Pumping Impacts		
• **Nebraska**	175,000 AF	23,000 AF
• **Kansas**	16,000 AF	-2,000 AF
• **Colorado**	26,000 AF	4,000 AF
Imported Water (Nebraska)	17,000 AF	Unchanged
Reduction in Runoff		74,000 AF

Accounts for 25,000 AF of the 99,000 AF reduction

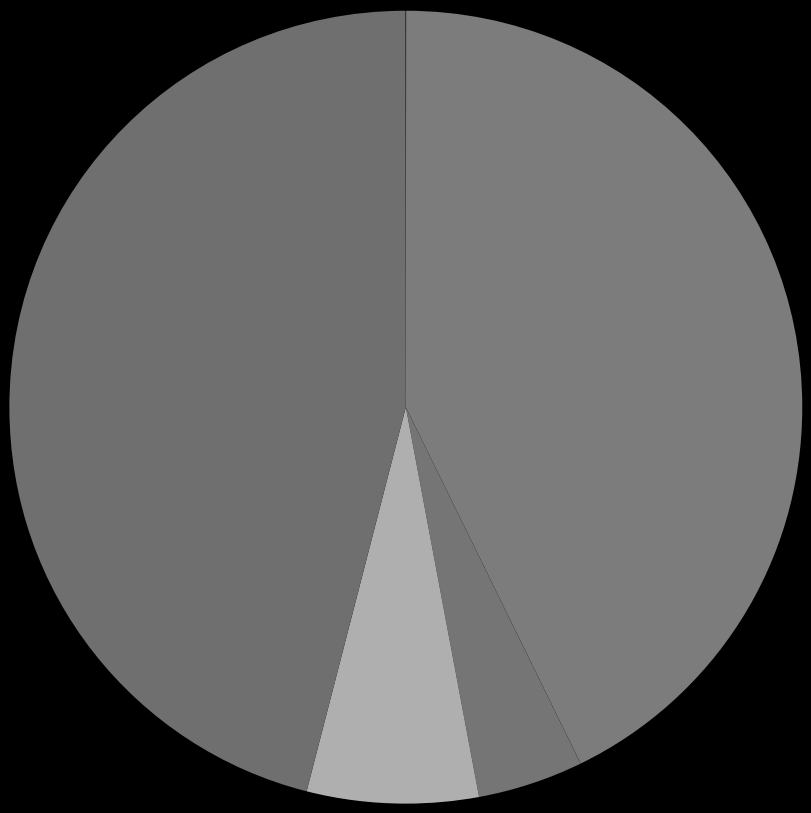
Impacts Above Harlan County Lake

Runoff Reduction	171,000 AF
Groundwater Depletions	
• **Nebraska**	176,000 AF
• **Kansas**	16,000 AF
• **Colorado**	26,000 AF
Imported Water (Nebraska)	17,000 AF
Total Impacts	**372,000 AF**

Imported water subtracted from Nebraska pumping impact for a net Nebraska impact of 159,000 acre-feet (inclusive of impacts above FCID)

1950-1964 compared to 2000-2012

Impacts above Harlan County Lake



1950-1964 compared to 2000-2012

Changes from 1986-2000 to 2000-2012

- Inflows to Harlan County Lake were reduced by about 100,000 acre-feet from the earlier to the later period
- This is largely (i.e., 75%) attributable to additional reductions in runoff, which could be due to more normal precipitation in the later period and/or could also be due to increased conservation practices
- The forecast in the IMPs relies on some data from this earlier period

Implications for the IMP Forecast

- These changes might explain (at least in-part) why the forecast is generating larger dry-year projections of streamflow and surface water CBCU than those actually occurring (2012 was also the hottest, driest year on record, which also likely played some role)
- This would mean that a revision to the forecast to reflect more recent data might yield a forecast that would project less streamflow and surface water use than the current forecast
- These changes would likely approximately offset, producing similar projections of dry-year shortfalls, and thus similar levels of required management actions

HDR Study

- Hydrologic Trends and Correlations in the Republican River Basin in Nebraska, 2006
- This study provides another source of information for comparison
- Compares total streamflow and baseflow in the Basin between two periods
  - 1950-1967
  - 1999-2005
- Looks at individual streamgages and creates a summation of inflows to the Republican River

(values in AF)	Total (50-67)	Baseflow (50-67)	Total (99-05)	Baseflow (99-05)	Total Difference	Baseflow Difference	Runoff Difference
North Fork	52,418	45,612	27,150	23,747	25,268	21,865	3,403
Arikaree	17,159	6,661	1,231	579	15,928	6,082	9,846
Buffalo	10,498	9,846	5,502	4,778	4,996	5,068	(72)
Rock	5,647	5,213	2,317	1,882	3,330	3,330	--
South Fork	37,720	14,643	1,882	886	35,838	13,757	22,081
Frenchman (Imperial)	53,142	48,074	7,674	6,661	45,467	41,413	4,054
Stinking Water	32,435	25,195	11,222	9,195	21,213	16,000	5,213
Frenchman (Enders-Culbertson)	35,548	23,385	14,987	13,104	20,562	10,281	10,281
Driftwood	8,109	796	2,027	1,376	6,082	(579)	6,661
Red Willow Abv.	22,227	12,670	9,195	7,312	13,032	5,358	7,674
Medicine Abv.	52,128	35,693	28,670	23,820	23,458	11,874	11,584
Prarie Dog	33,883	2,606	4,344	2,100	29,539	507	29,032
MS Above Stratton	5,213	(13,032)	(13,104)	(16,869)	18,317	3,837	14,480
MS Swanson-McCook	12,742	(579)	(145)	(4,344)	12,887	3,765	9,122
MS McCook-Cambridge	27,367	(5,068)	10,570	3,620	16,797	(8,688)	25,485
MS Cambridge-Orleans	27,367	(5,068)	10,570	3,620	16,797	(8,688)	25,485
Total	433,604	206,647	124,094	81,467	309,510	125,180	184,330

Rainfall Comparison

Time Period	1950-1967	1999-2005
Nebraska Average	21.84 inches (49%)	20.99 inches (41%)
Basin Average	20.76 inches (46%)	20.05 inches (40%)

Impacts Above Swanson Reservoir

Runoff Reduction	50,000 AF
Pumping Impacts	
• **Nebraska**	22,000 AF
• **Kansas**	7,000 AF
• **Colorado**	25,000 AF
Total Impacts	**104,000 AF**

1950-1967 compared to 1999-2005

Impacts Above Hugh Butler Reservoir

Runoff Reduction	8,000 AF
Pumping Impacts	
• **Nebraska ***	8,000 AF
Total Impacts	**16,000 AF**

* Includes impacts below Hugh Butler

1950-1967 compared to 1999-2005

Impacts Above Harry Strunk Reservoir

Runoff Reduction	12,000 AF
Pumping Impacts	
• **Nebraska ***	20,000 AF
Imported Water (Nebraska)	9,000 AF
Total Impacts	**23,000 AF**

* Includes impacts below Harry Strunk

1950-1967 compared to 1999-2005

Impacts to Reservoirs Serving Frenchman Cambridge

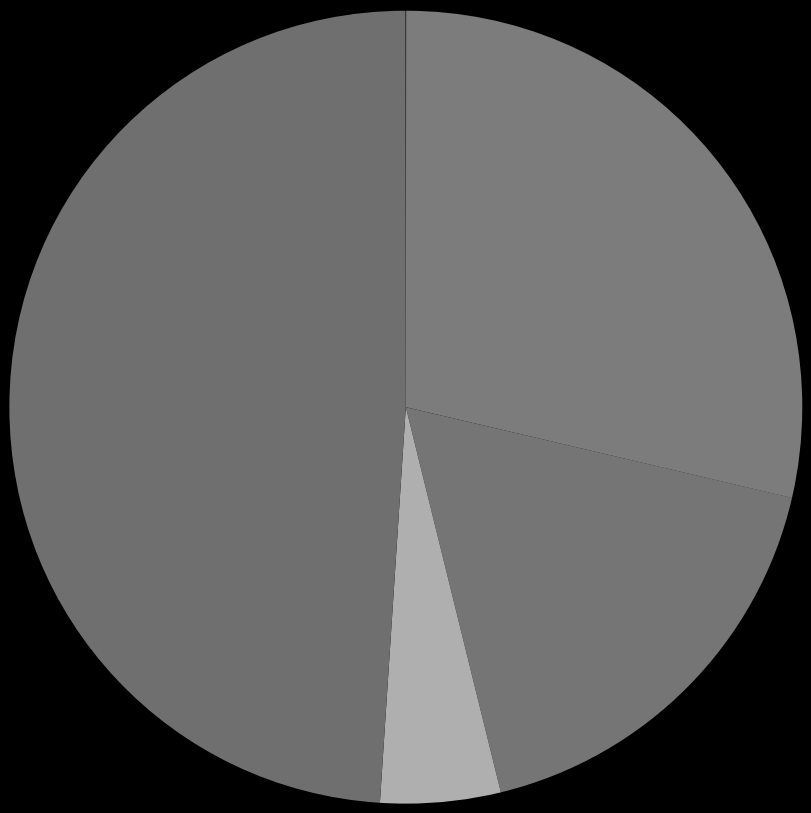
Runoff Reduction	70,000 AF
Pumping Impacts	
• **Nebraska ***	50,000 AF
• **Kansas**	7,000 AF
• **Colorado**	25,000 AF
Imported Water (Nebraska)	9,000
Total Impacts	**143,000 AF**

Imported water subtracted from Nebraska pumping impact for a net Nebraska impact of 41,000 acre-feet

* Includes impacts below Harry Strunk and Hugh Butler

1950-1967 compared to 1999-2005

Impacts to Reservoirs Serving Frenchman Cambridge



1950-1967 compared to 1999-2005

Impacts Above Harlan County Lake

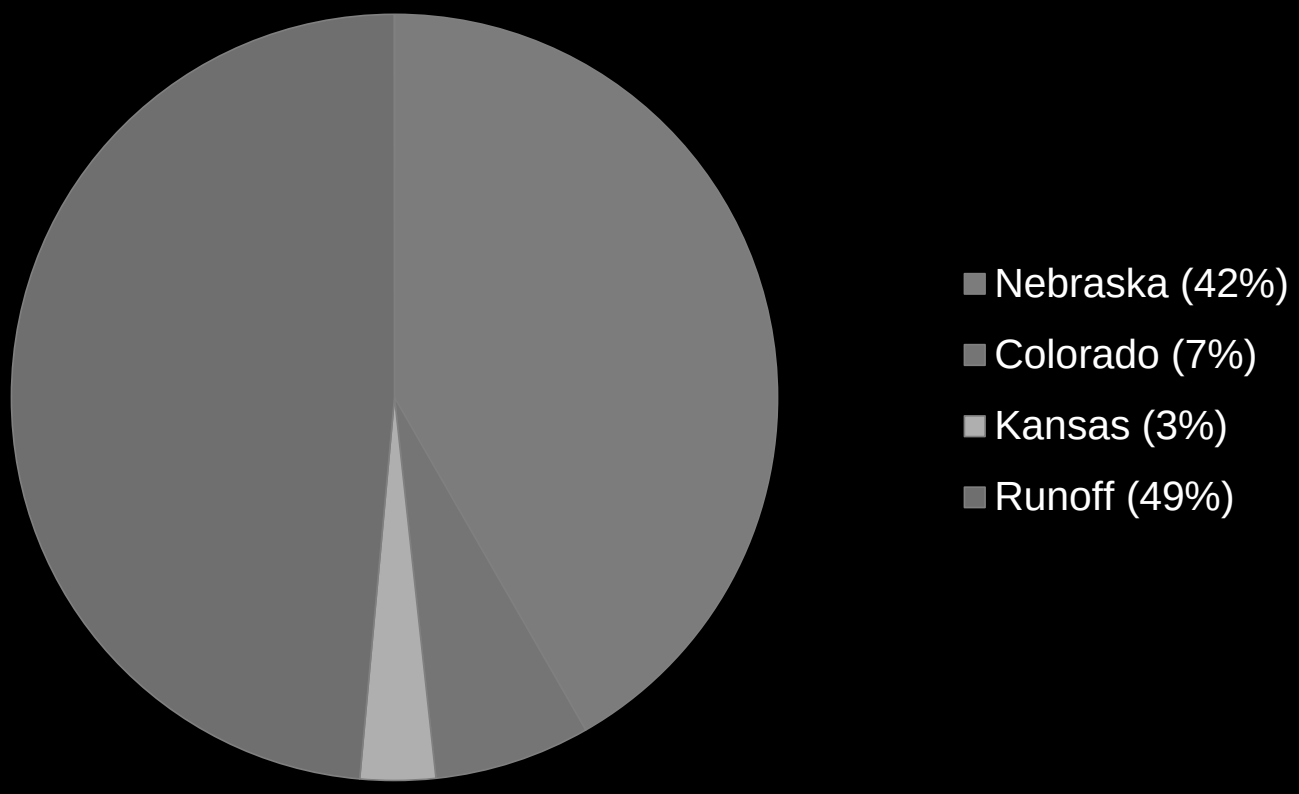
Runoff Reduction	184,000 AF
Pumping Impacts	
• **Nebraska ***	172,000 AF
• **Kansas**	12,000 AF
• **Colorado**	25,000 AF
Imported Water (Nebraska)	14,000 AF
Total Impacts	**379,000 AF**

Imported water subtracted from Nebraska pumping impact for a net Nebraska impact of 158,000 acre-feet

* This is significantly effected by the consumption of imported water, which Special Master Kayatta has ruled, and the U.S. has confirmed, Nebraska is being improperly charged (average effect of ~10,000 acre-feet per year)

1950-1967 compared to 1999-2005

Impacts Above Harlan County Lake



1950-1967 compared to 1999-2005

Summary of Impacts

- Basin streamflows have been dramatically reduced since the 1950s and 1960s

	Above Reservoirs serving FCID	Above Harlan County Lake
Streamflow reductions	~ 110,000 – 140,000 AF	~ 375,000 AF
Nebraska groundwater pumping causes	~ 20 - 30%	~ 40%
Streamflow reductions as a percentage of reservoir conservation (i.e. irrigation) storage capacity	~75-90% (Swanson, Hugh Butler, Harry Strunk)	~100% (Harlan, Swanson, Enders, Hugh Butler, Harry Strunk)

- These results are consistent across multiple studies

Review of 2013 Compact Call Results

- Augmentation Delivery = 16,000 acre-feet (Credit = ~11,000 acre-feet)
- Groundwater Impacts in 2013

	Above Swanson Reservoir	Red Willow and Medicine Creek	Above Harlan County Lake
Nebraska	19,000 AF	28,000 AF	163,000 AF (145,000 IWS issue)
Kansas	3,000 AF		7,000 AF
Colorado	27,000 AF (16,000 Bonny issue)		28,000 AF (18,000 Bonny issue)
IWS Credit		10,000 AF	12,000 AF

Rainfall Comparison

Time Period	1918-2013	2013
Nebraska Average	22.12 inches	18.80 inches (24%)
Basin Average	21.05 inches	18.28 inches (25%)

Impact of Drought in 2013

	Stratton	Orleans / Stamford / Woodruff
2013 Streamflow	22,000 AF	41,000 AF
Streamflow less AWS	6,000 AF	--
Streamflow less upstream releases	--	18,000 AF
2000-2012 Average Streamflow	21,000 AF	123,000 AF
2013 Drought Impact	**15,000 AF**	**105,000 AF**

Impacts above Swanson in 2013

Runoff Reduction	40,000 AF
Pumping Impacts	
• **Nebraska ***	8,000 AF
• **Kansas**	3,000 AF
• **Colorado**	27,000 AF
Drought	15,000 AF
Total	**93,000 AF**

* 19,000 acre-feet pumping depletion minus 11,000 acre-feet augmentation credit

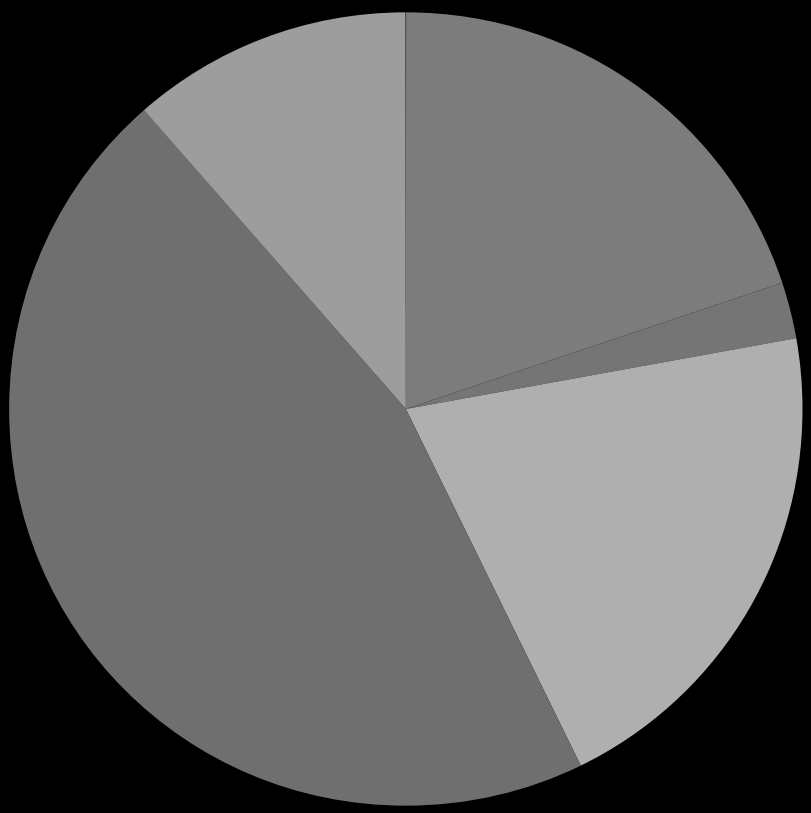
Impacts to Reservoirs Serving Frenchman Cambridge in 2013

Runoff Reduction *	60,000 AF
Pumping Impacts	
• **Nebraska**	36,000 AF
• **Kansas**	3,000 AF
• **Colorado**	27,000 AF
Imported Water (Nebraska)	10,000 AF
Drought *	15,000 AF
Total	**131,000 AF**

Imported water subtracted from Nebraska pumping impact for a net Nebraska impact of 26,000 acre-feet

* Assumes no change from 2000-2012 average for Red Willow Creek and Medicine Creek due to their baseflow dominated nature.

Impacts to Reservoirs Serving Frenchman Cambridge in 2013

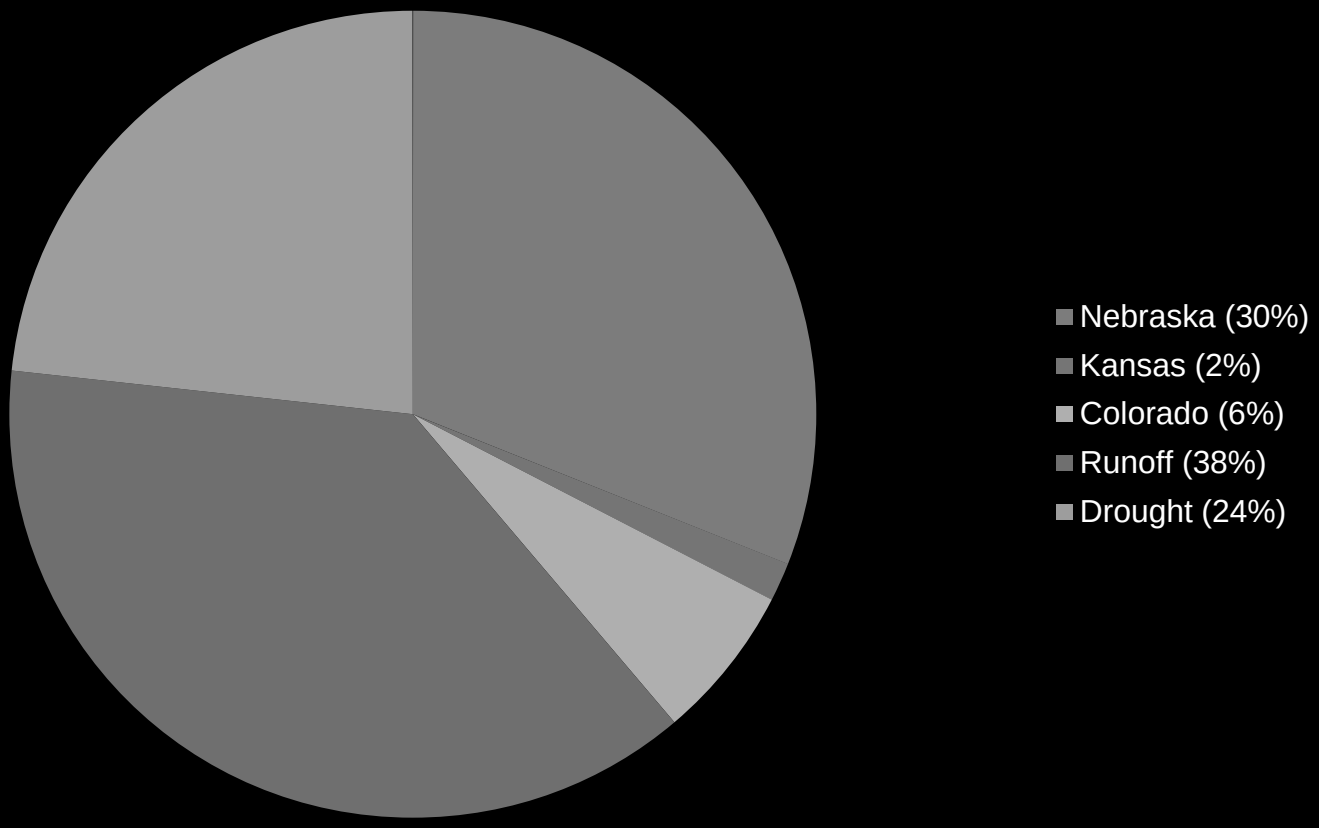


Impacts above Harlan County Lake in 2013

Runoff Reduction	171,000 AF
Pumping Impacts	
• **Nebraska**	152,000 AF
• **Kansas**	7,000 AF
• **Colorado**	28,000 AF
Imported Water (Nebraska)	12,000 AF
Drought	105,000 AF
Total	**451,000 AF**

Imported water subtracted from Nebraska pumping impact for a net Nebraska impact of 140,000 acre-feet

Impacts above Harlan County Lake in 2013



What Will Happen in 2014?

- The drought impacts appear to be persisting
- Nebraska management actions will produce about 66,000 acre-feet of water for a credit (i.e., depletion offset) of about 40,000 acre-feet
- Nebraska's pumping impacts will be less as an absolute volume and as a percentage of total impacts
- Impacts can be estimated based on 2000-2012 averages, using the 2012 drought impact, and incorporating the augmentation offsets

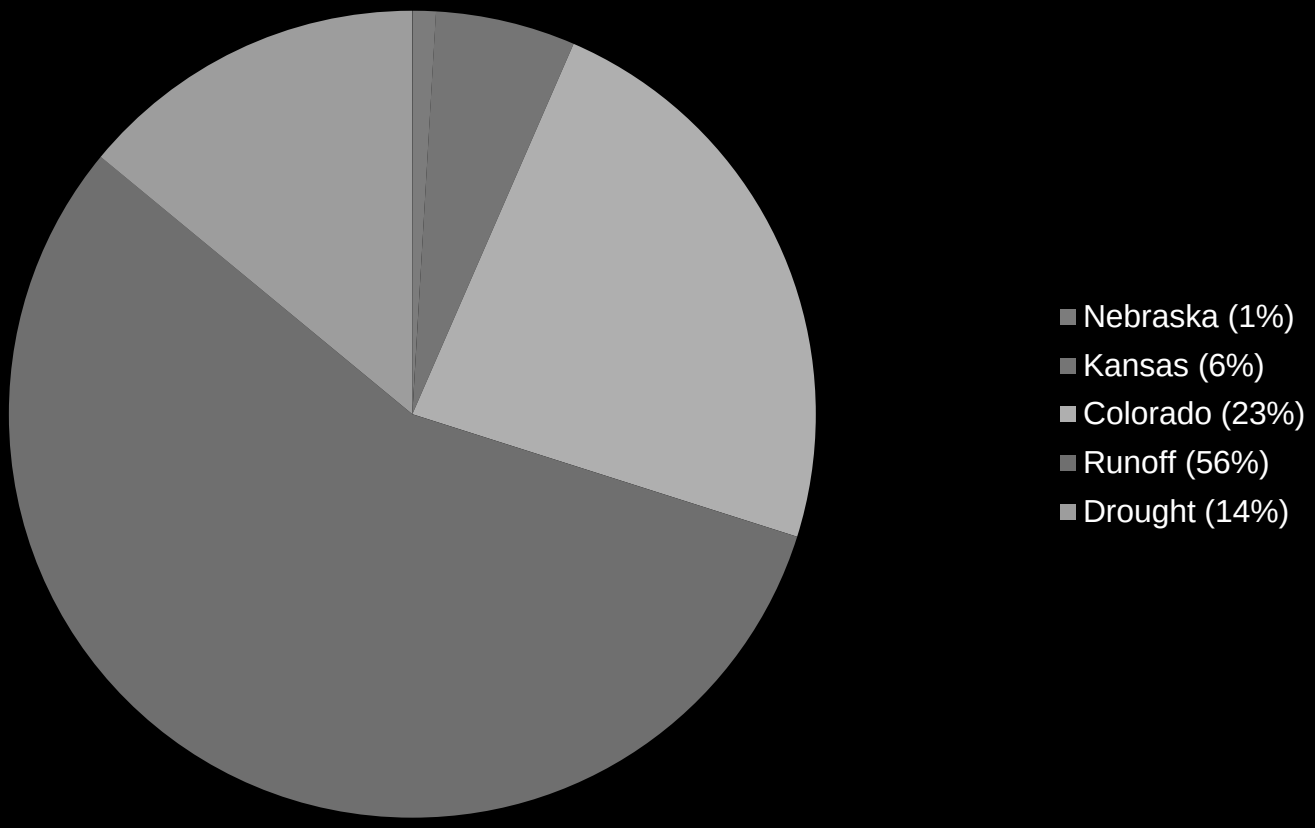
Estimated Impacts to Reservoirs Serving Frenchman Cambridge in 2014

Runoff Reduction	60,000 AF
Pumping Impacts	
• **Nebraska ***	11,000 AF
• **Kansas**	6,000 AF
• **Colorado**	25,000 AF
Imported Water (Nebraska)	10,000 AF
Drought	15,000 AF
Total	**107,000 AF**

Imported water subtracted from Nebraska pumping impact for a net Nebraska impact of 1,000 acre-feet

* Augmentation deliveries are 20,000 acre-feet from Rock Creek and 42,000 acre-feet from N-CORPE. Under the current accounting procedures Nebraska only receives 37,000 acre-feet of credit for these deliveries. This number is based on the average Nebraska depletion of 48,000 acre-feet adjusted by 37,000 acre-feet.

Estimated Impacts to Reservoirs Serving Frenchman Cambridge in 2014



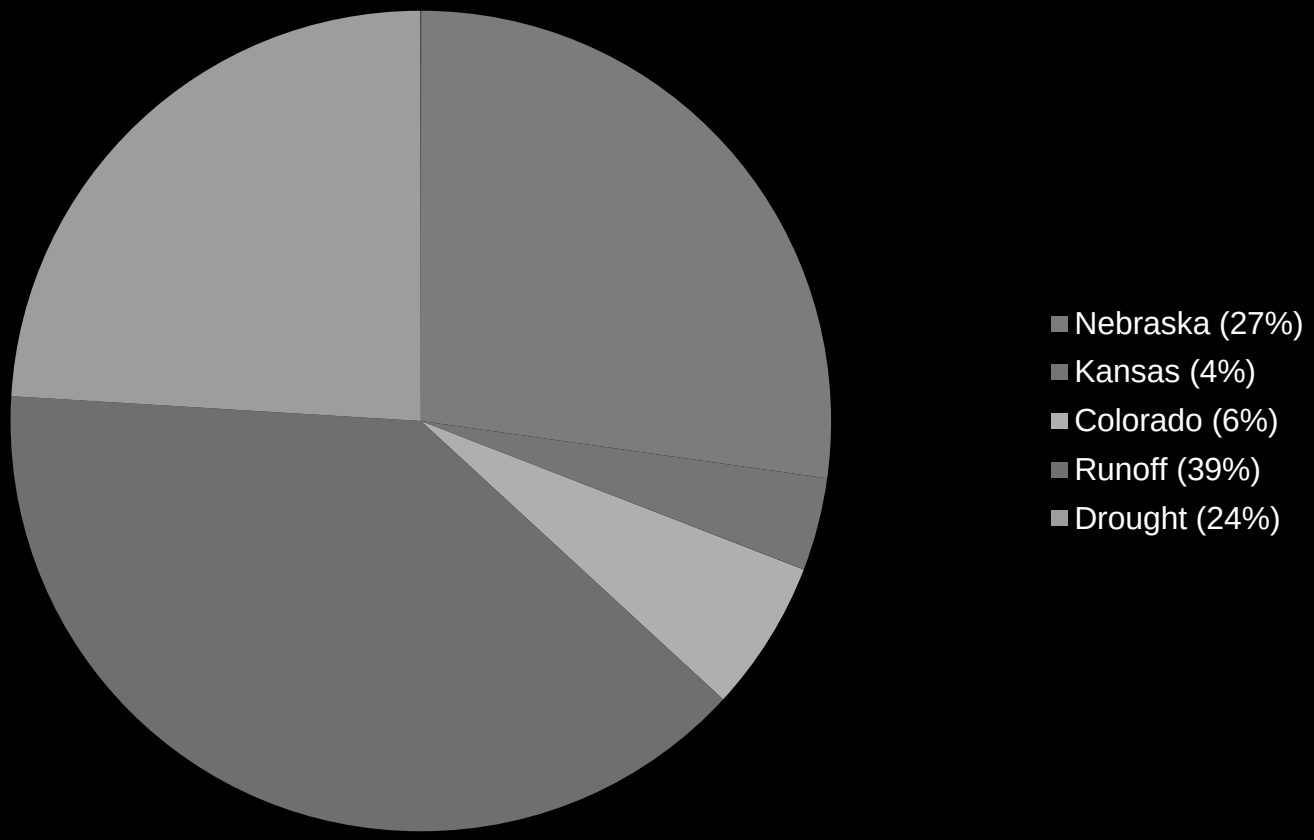
Estimated Impacts above Harlan County Lake in 2014

Runoff Reduction	171,000 AF
Pumping Impacts	
• **Nebraska ***	136,000 AF
• **Kansas**	16,000 AF
• **Colorado**	26,000 AF
Imported Water (Nebraska)	17,000 AF
Drought	105,000 AF
Total	**454,000 AF**

Imported water subtracted from Nebraska pumping impact for a net Nebraska impact of 119,000 acre-feet

* This represents the long-term average of 176,000 acre-feet adjusted for 37,000 acre-feet from the augmentation projects and 3,000 acre-feet from the purchase of storage water in Enders Reservoir.

Estimated Impacts above Harlan County Lake in 2014



Future Impacts to Basin Reservoirs

- Assumptions:
  - Reductions in runoff will not increase from 2000-2012 levels
  - Pumping impacts by Kansas and Colorado will not increase from 2000-2012 levels
  - Two scenarios for Nebraska pumping and IWS Credit
    - Current IMPs with stream augmentation estimated at an average of 5,000 acre-feet per year for Rock Creek and 20,000 acre-feet per year for N-CORPE
    - The “Kansas Remedy” – 90% reduction in pumping on 302,000 acres along river and tributaries
    - Used data provided by State of Kansas during discovery
    - Groundwater depletions are the average annual depletions from 2010-2069, which was modeled by repeating 1995-2009 four times

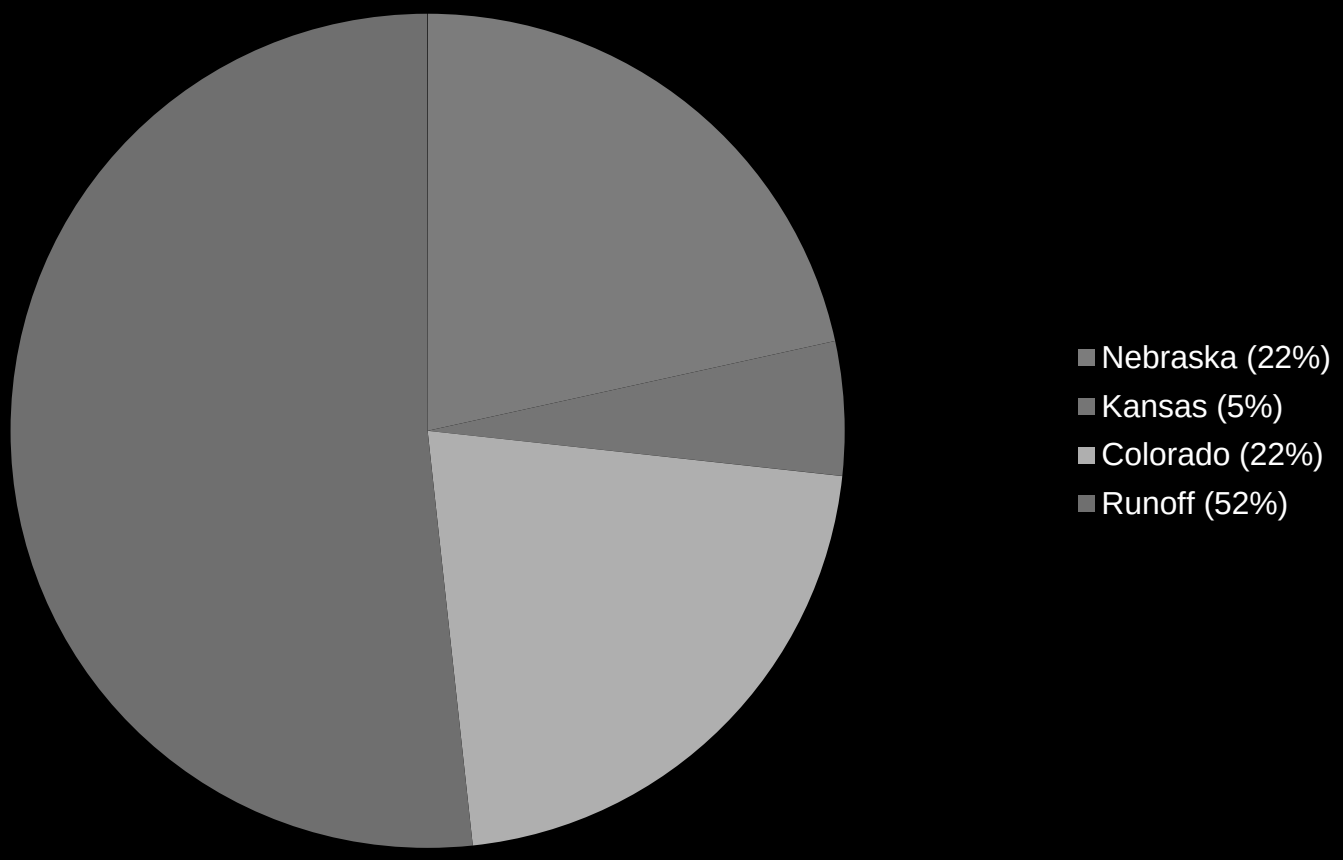
Future Impacts to Reservoirs Serving Frenchman Cambridge

	IMPs	KS Remedy
Runoff Reduction	60,000 AF	60,000 AF
Pumping Impacts		
• **Nebraska ***	58,000 AF	54,000 AF
• **Kansas**	6,000 AF	6,000 AF
• **Colorado**	25,000 AF	25,000 AF
Imported Water (Nebraska)	8,000	12,000 AF
Augmentation Water Supply	25,000	0 AF
Total Impacts	**116,000 AF**	**133,000 AF**

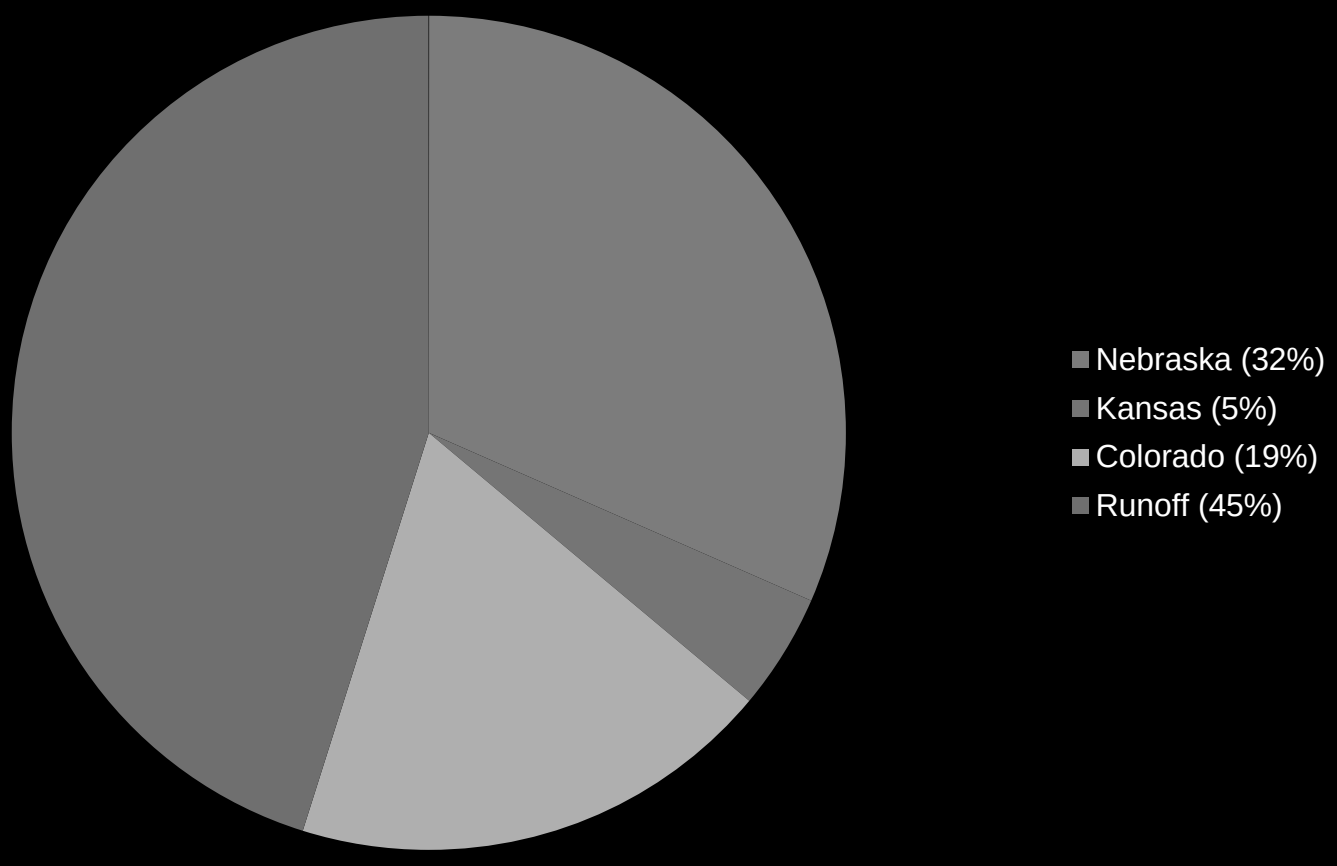
Imported water and augmentation water supply subtracted from Nebraska pumping impact for a net Nebraska impact of 25,000 acre-feet under the IMPs and a net Nebraska impact of 42,000 acre-feet under the Kansas Remedy

* Includes impacts below Harry Strunk and Hugh Butler

Future Impacts to Reservoirs Serving Frenchman Cambridge - IMPs



Future Impacts to Reservoirs Serving Frenchman Cambridge – Kansas Remedy



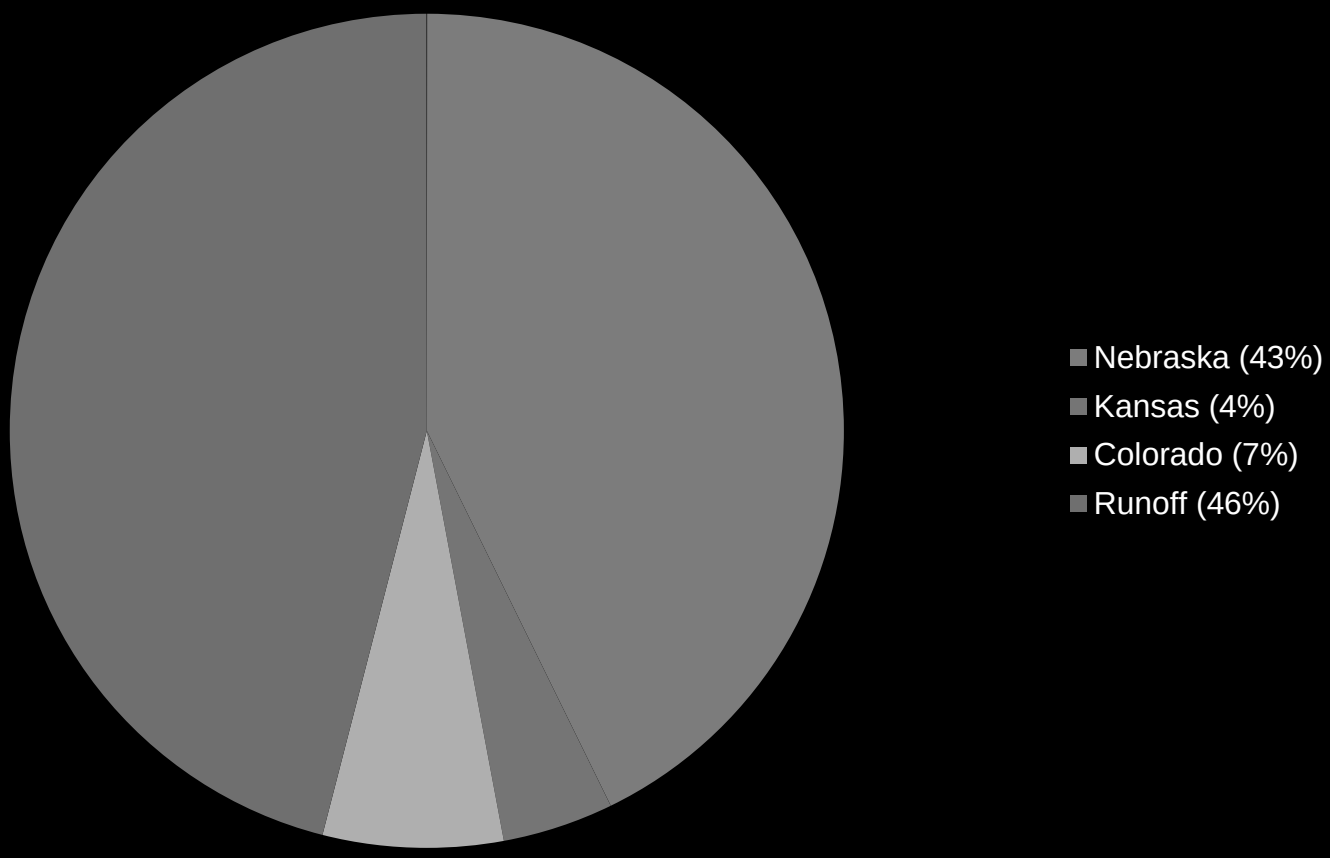
Future Impacts Above Harlan County Lake

	IMPs	KS Remedy
Runoff Reduction	171,000 AF	171,000 AF
Pumping Impacts		
• **Nebraska ***	202,000 AF	187,000 AF
• **Kansas**	16,000 AF	16,000 AF
• **Colorado**	26,000 AF	26,000 AF
Imported Water (Nebraska)	18,000 AF	23,000 AF
Augmentation Water Supply	25,000 AF	
Total Impacts	**372,000 AF**	**377,000 AF**

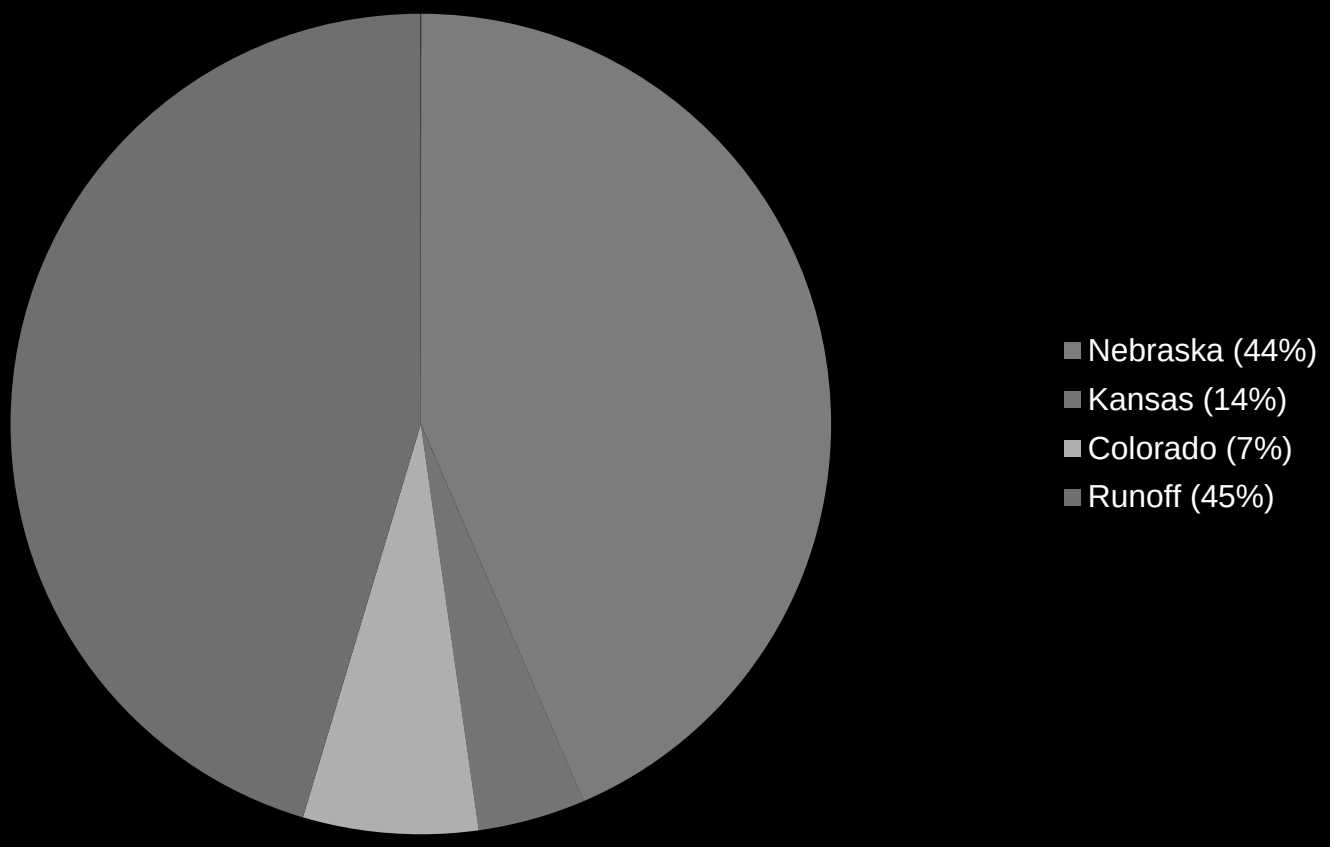
Imported water and augmentation water supply subtracted from Nebraska pumping impact for a net Nebraska impact of 159,000 acre-feet under the IMPs and a net Nebraska impact of 164,000 acre-feet under the Kansas Remedy

* This is significantly affected by the consumption of imported water, which Special Master Kayatta has ruled, and the U.S. has confirmed, Nebraska is being improperly charged (average effect of ~10,000 acre-feet per year)

Future Impacts Above Harlan County Lake - IMPs



Future Impacts Above Harlan County Lake – KS Remedy



Result of Kansas Remedy vs. the IMPs

- Kansas claim for injunctive relief – 90% reduction in pumping in 5-mile corridor (or groundwater allocations of 1-2 inches)
- The net result for the impacts above Harlan County Lake is essentially the same under the Nebraska IMPs
- One notable benefit to the IMPs and the augmentation projects is the Nebraska impacts are generally offset further upstream in the Basin

Result of Kansas Remedy vs. the IMPs

- Total average reductions in streamflow (from 50-60's baseline) still ~375,000 acre-feet (excluding additional drought impacts) under either plan
- Under the Kansas Remedy groundwater use would be limited to approximately 1 inch in the 5-mile stream corridor
- Users with both surface and groundwater would have significantly less water under the Kansas Remedy
- Users with only surface water would not have more water under the KS Remedy as compared to the IMPs

Future of surface water?

- If groundwater pumping had never been developed in Nebraska, average streamflows would still be ~200,000-225,000 acre-feet less today than when the USBR projects were built.
- Recent drought has reduced streamflow by an additional ~100,000 acre-feet for a total impact to the USBR reservoirs not attributable to Nebraska groundwater pumping of ~300,000-325,000 acre-feet.
- This equates to approximately 85% of the conservation (i.e., irrigation) storage allocation in the USBR reservoirs in Nebraska.

Future of surface water?

- Nebraska is offsetting a significant proportion of the impacts due to Nebraska groundwater pumping through stream augmentation in dry years for Compact compliance purposes
- Additional offsets through dramatic cuts in groundwater pumping, such as those proposed by Kansas, would only provide a minimal increase (~1 inch on all project acres) in surface water deliveries while essentially eliminating supplemental groundwater sources
- Augmentation projects ensure that supplemental groundwater is available to those surface water users with a well

Future of surface water?

- Traditional model of operating solely to provide irrigation water may not be feasible
- Basin reservoirs may be able to sustain deliveries to a portion of the project acres if reductions in runoff and depletions caused by Kansas and Colorado do not increase significantly
- Cooperation through conjunctive management could open up new revenue sources for surface water projects which could provide for long-term viability
- Current situation with the surface water projects created by refusal to cooperate and instead siding with Kansas, apparently not realizing that a Kansas win would be no better than the IMPs for the surface water projects
- Kansas is the key to flexibility – cooperation between DNR, USBR, NRDs, and IDs is necessary

Kansas issues

- Nebraska charged with consumption of imported water
- Kansas rejected Nebraska's Alternative Water Short Year Plan
- Kansas rejected Nebraska's (and Colorado's) augmentation plans
- Kansas refuses to provide additional flexibility in managing water supplies in dry years without increasing Nebraska's risk of noncompliance

CONJUNCTIVE MANAGEMENT ON THE PLATTE RIVER

The DNR and the Platte Basin NRDs have developed the science and the relationships that have allowed the study and pursuit of many conjunctive management opportunities which have provided great benefits for the irrigation districts involved

2011 Demonstration Project

- For **groundwater recharge** and **flood reduction**
- Partners
  - 23 Canals
  - DNR
  - South Platte NRD
  - Tri-Basin NRD
  - Twin Platte NRD
  - Central Platte NRD
  - North Platte NRD
- Results
  - Diversion Total 142,000 AF
  - Seepage Total 64,000 AF
  - 2011-2019 Accretion Total 15,000 AF

Average annual accretion ~1,500 AF/yr

2013 Flood Flow Project

- Mitigate impact of Colorado flood flows while also recharging groundwater
  - DNR, NRDs, & irrigation districts

South Platte River Bridge, Buffalo Bill Road,
North Platte, NE
Friday, September 20,2013 at 8:30 a.m.

South Platte River Bridge, Buffalo Bill Road,
North Platte, NE
Saturday, September 21,2013 at 7:00 p.m.

State and Local Investment

- Portion of water diversions that were reimbursed by DNR and the NRDs

	Water Diverted	Cost
2011	~142,900 AF	~$426,800
2013	~35,800 AF	~$708,000

J-2 Re-Regulating Reservoir

- Increase flexibility of hydrocycling and reduce its impact on Platte River flows for habitat and wildlife
- Reduce FWS target flows deficits
- Provide short-duration high flows

Cozad Canal & Thirty-Mile Canal

- Cozad Canal (2014-2019) ~8,000 AF/yr
- Thirty-Mile Canal (2014-2019) ~8,000 AF/yr

Average annual accretion ~16,000 AF/yr

Project Funding Summary

Project Type	Approximate Total
Easements & Permanent Retirement	~ $5,118,000
J-2 Re-Regulating Reservoir *	~ $75,000,000
Stream Flow Augmentation via Groundwater Wells (N-CORPE North Dry Creek)	~ $6,270,000
Excess Flow & Groundwater Recharge Projects	~ $24,293,000
Total	**~ $110,681,000**

* Approximately 25% Nebraska funded

Summary

- Current average streamflow supplies have been reduced from historic levels
- The causes are groundwater pumping in the three states and reduced runoff; these are exacerbated by drought
- Nebraska groundwater pumping is (and will continue to be) responsible for only:
  - about 20-30% of the reductions in inflows to reservoirs supplying the Frenchman Cambridge ID (only ~1-20% during 2013-2014)
  - about 40% of the reductions above Harlan County Lake (only ~25-30% during 2013-2014)
- These values have been derived from a general review of readily available data. While it provides a useful overview of hydrologic changes in the Basin, the conclusions should be considered approximate and general in nature.

Summary

- The current IMPs are more beneficial to the surface water projects that the Kansas Remedy would be
- Additional dramatic reductions in groundwater pumping will provide only minimal benefit to surface water projects (more than offset by the reduced availability of supplemental groundwater on comingled acres)
- Cooperation/conjunctive management can provide longterm viability for the irrigation districts

Nebraska
Department of Natural Resources

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