

Stream Flow Impacts in the Republican Basin

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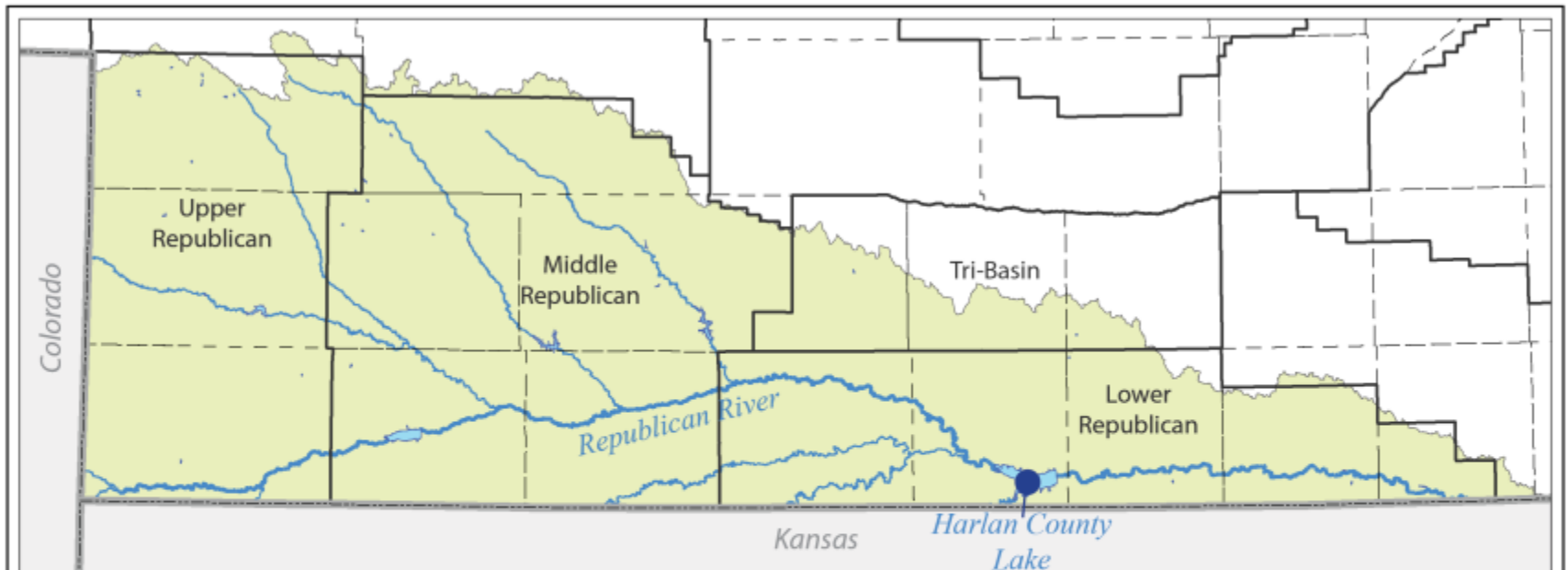
March 25, 2016

Overview

- Correlations between streamflows and other activities
- Actual causes of streamflow reductions
 - Groundwater Pumping
 - Reductions in Runoff
 - Drought
- Improving Streamflows through Augmentation from Groundwater








Correlations

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

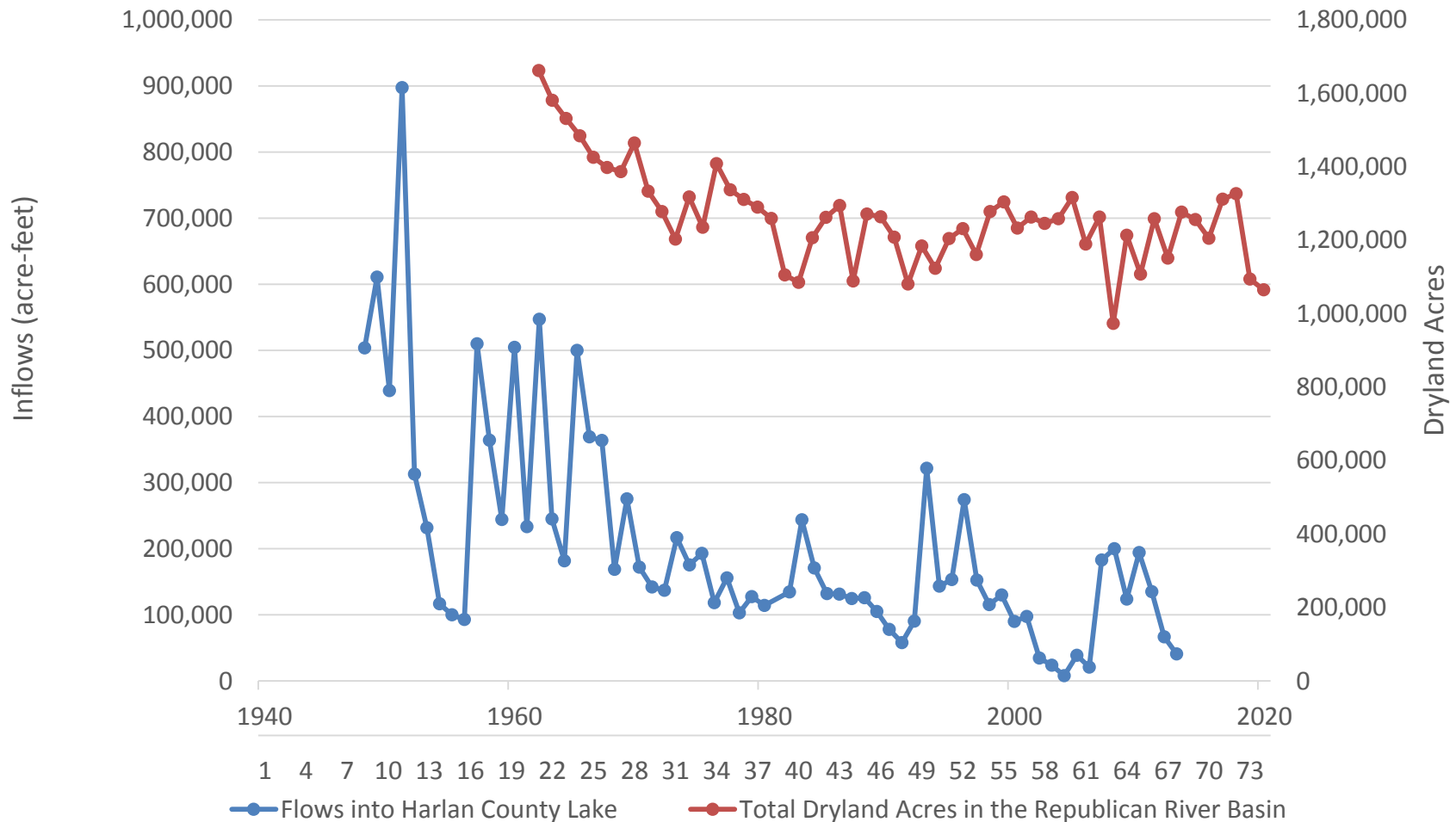


Harlan County Lake

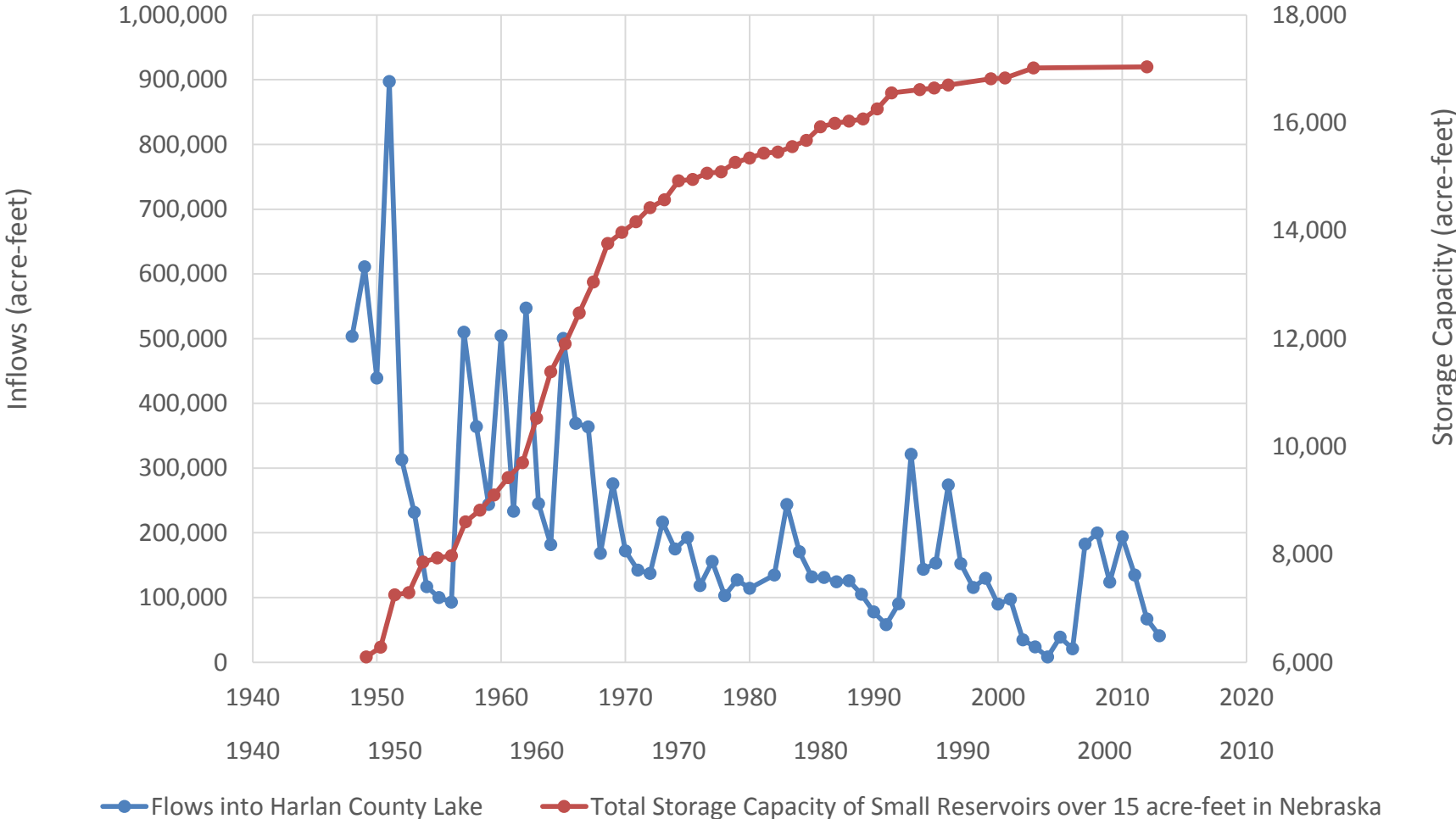
Legend

 Republican Basin (NE)	 Lake
 Other States	 Stream
 NRD	 Reservoir of Interest
 County	

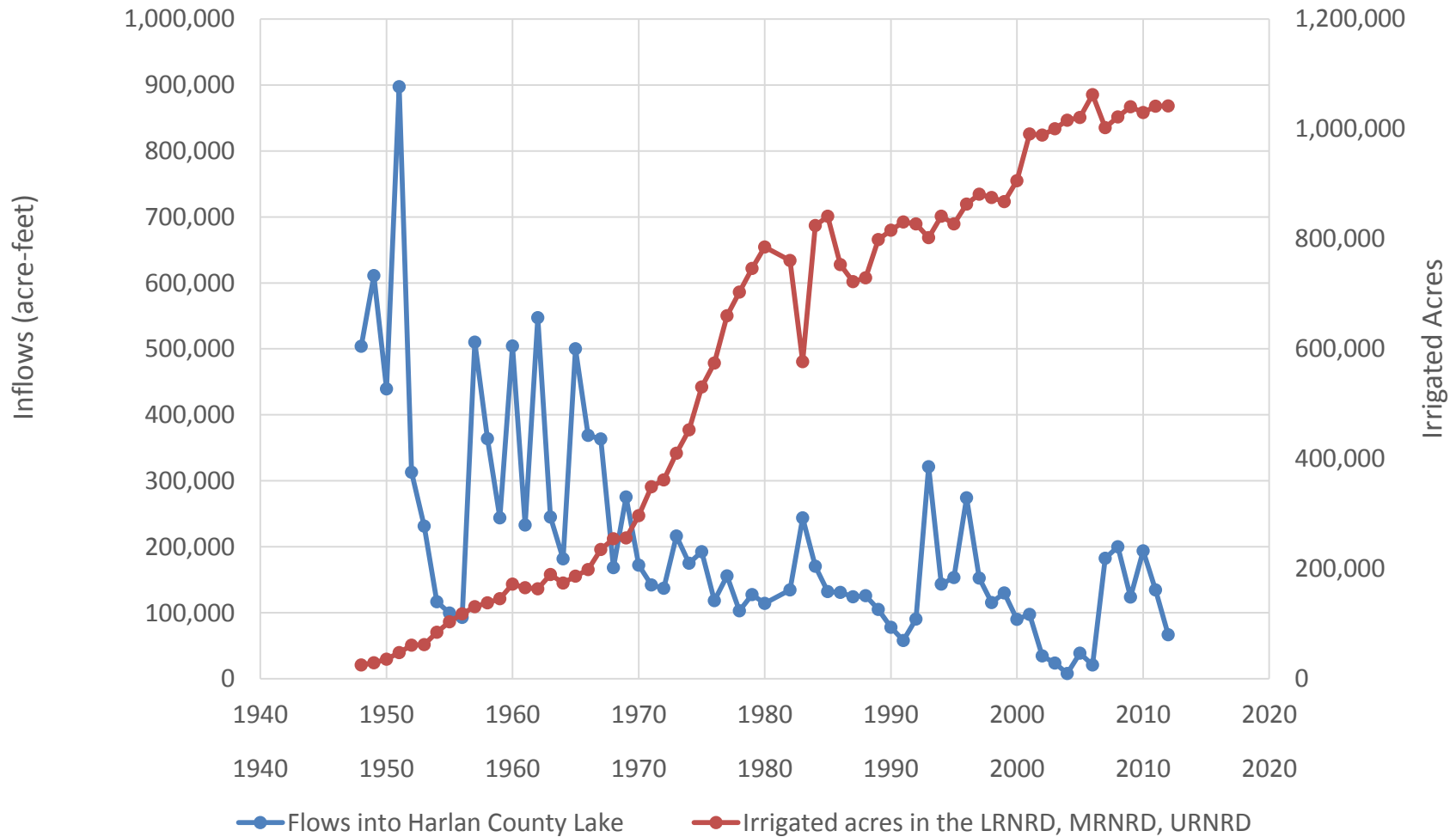
Inflows vs. Dryland Acres



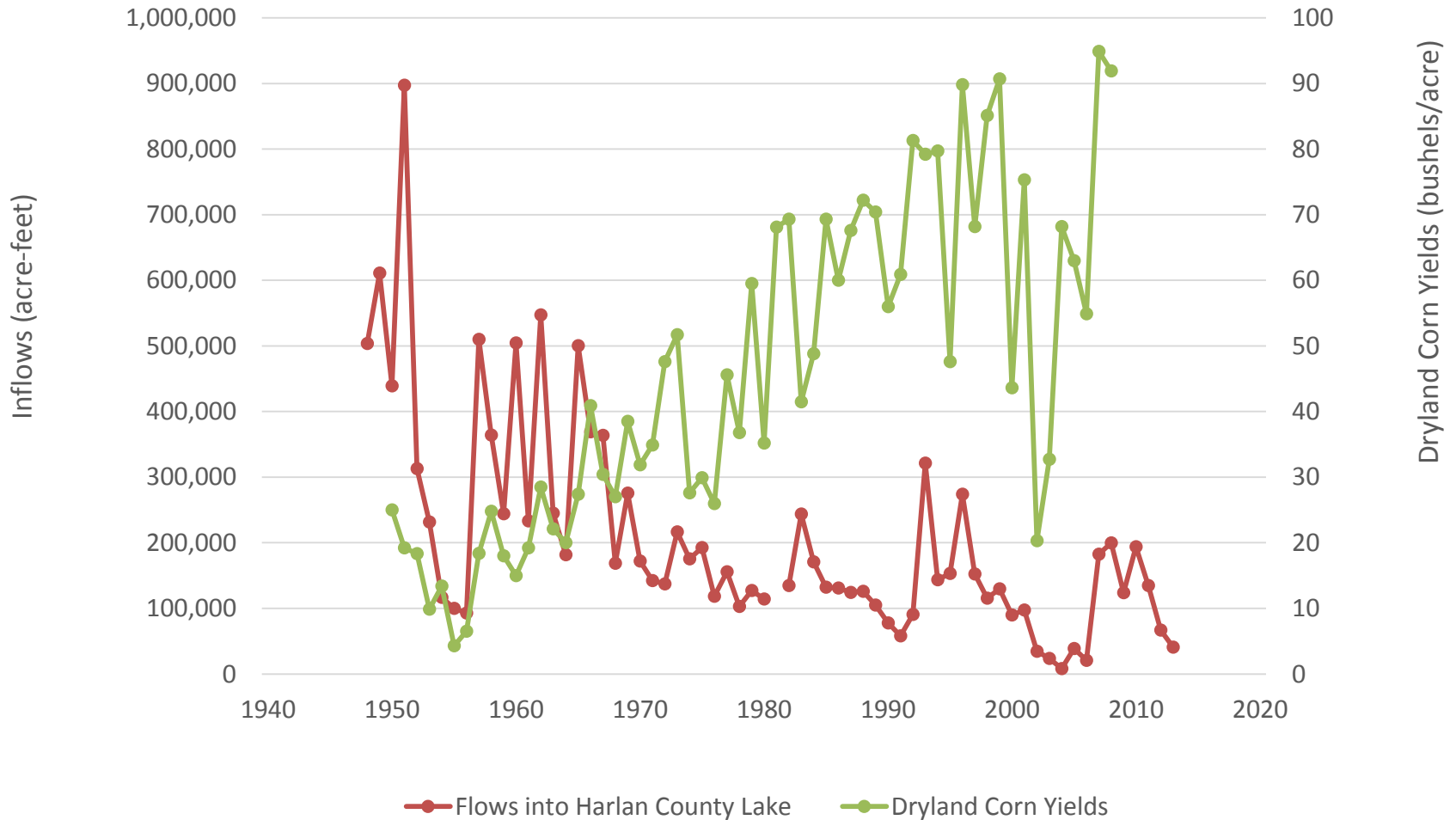
Inflows vs. Small Reservoirs



Inflows vs. Groundwater Irrigated Acres



Inflows vs. Dryland Corn Yields

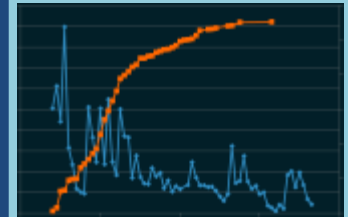


Observations Based on Correlations

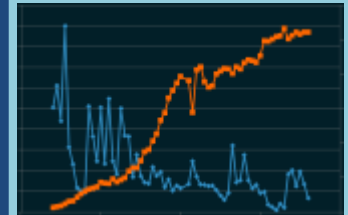
- Inflows into Harlan County Lake are inversely correlated with:
 - Development of groundwater irrigation
 - Development of conservation practices such as farm ponds
 - Increase in dryland crop yields
- The most significant declines in runoff appear to have occurred:
 - Prior to 1970
 - i.e., during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

Inflows

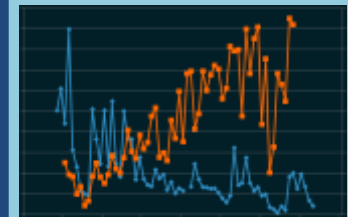
vs. Small Reservoirs



vs. Irrigated Acres



vs. Dryland Yields



Causes of Reduced Streamflow Supply

Causes of Reduced Streamflow Supply

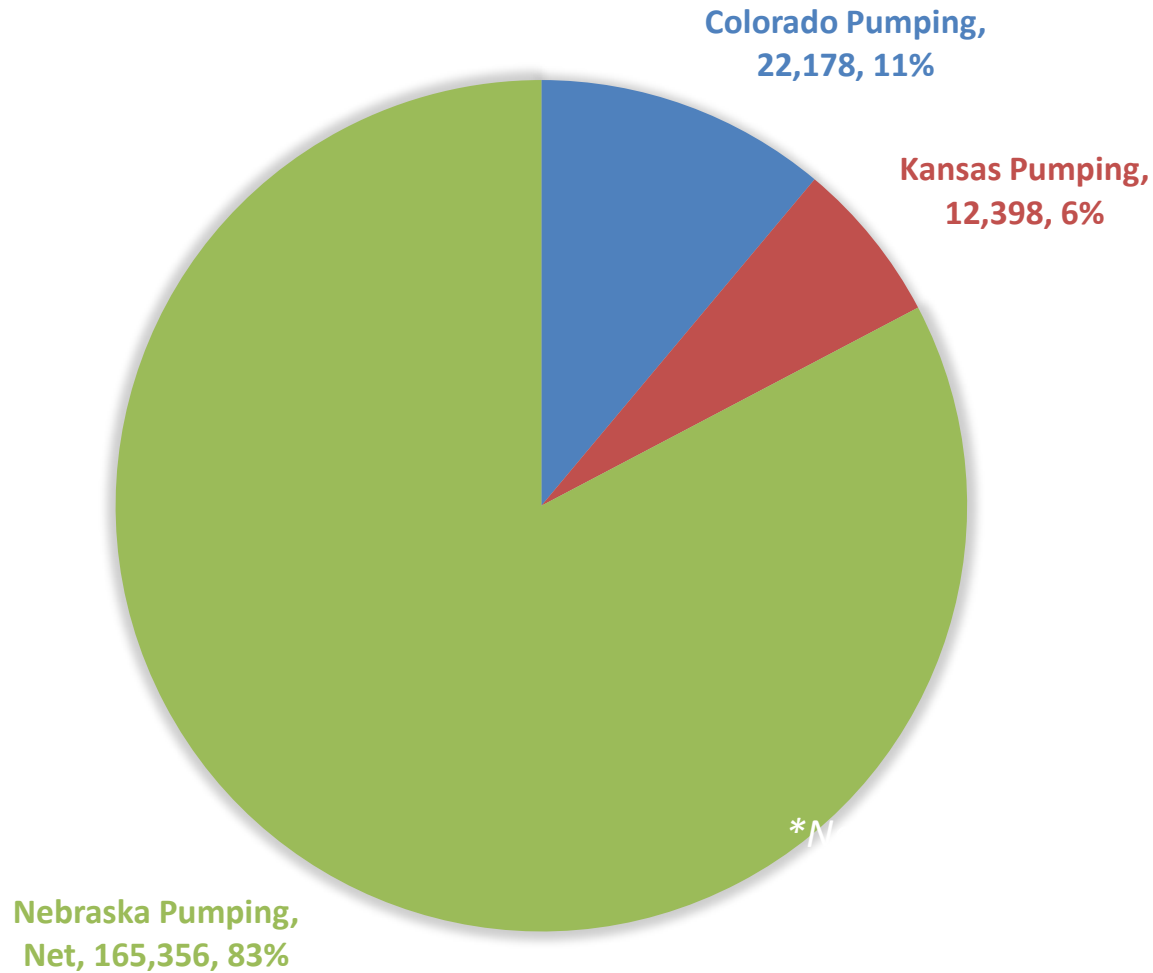
Causes	Quantifying these impacts
Groundwater pumping by the three states	→ Estimates of streamflow depletions due to groundwater pumping from the RRCA groundwater model
Reductions in runoff	→ RRCA Conservation Study, analysis of historic streamflow and baseflow information to estimate reductions in runoff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

Effects of Groundwater Pumping on Streamflow

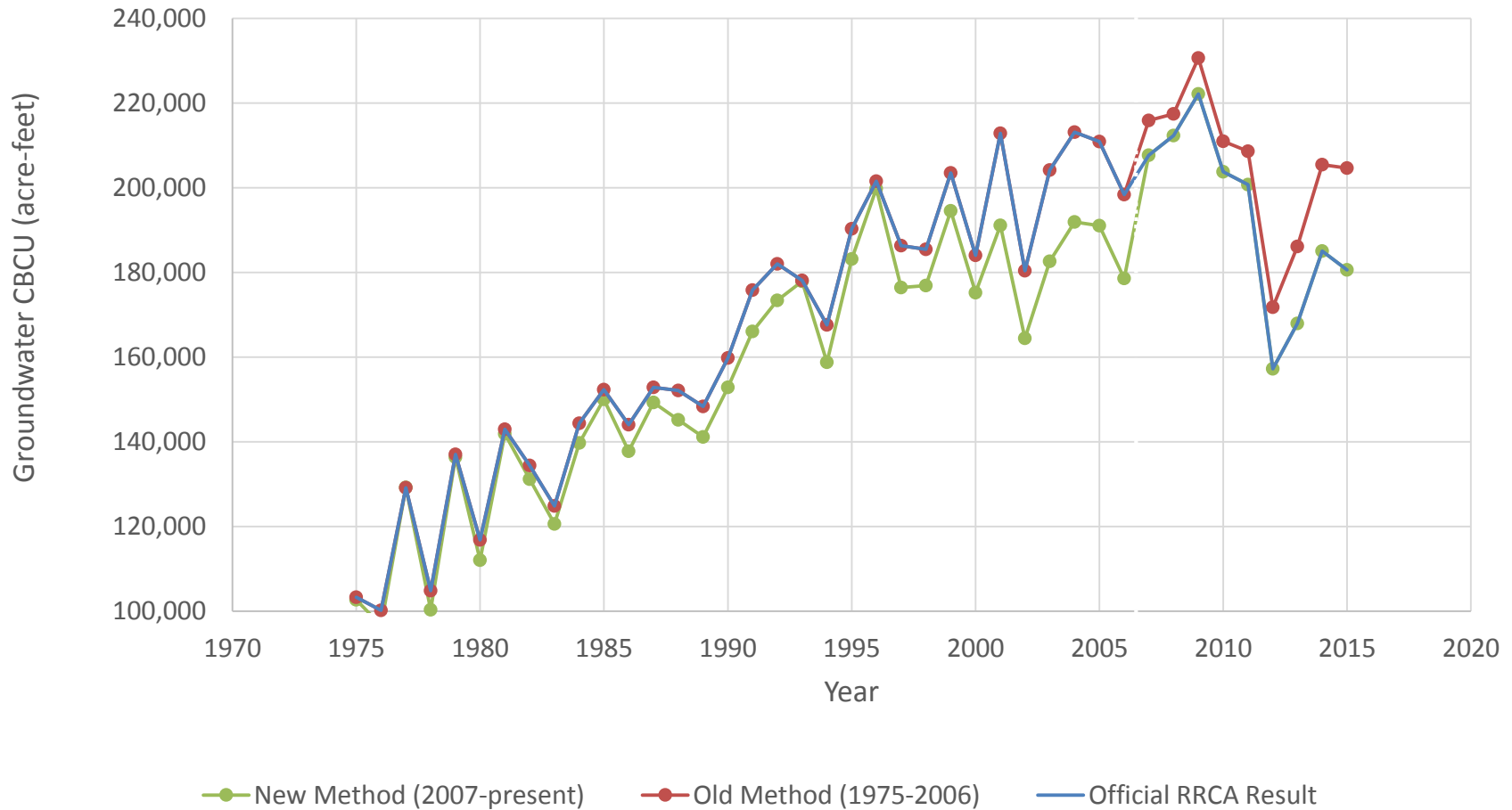
Stream depletions from groundwater pumping 1975-2015

Total Depletions Due to Groundwater Pumping

Basin-Wide Impacts, 2000 (acre-feet)



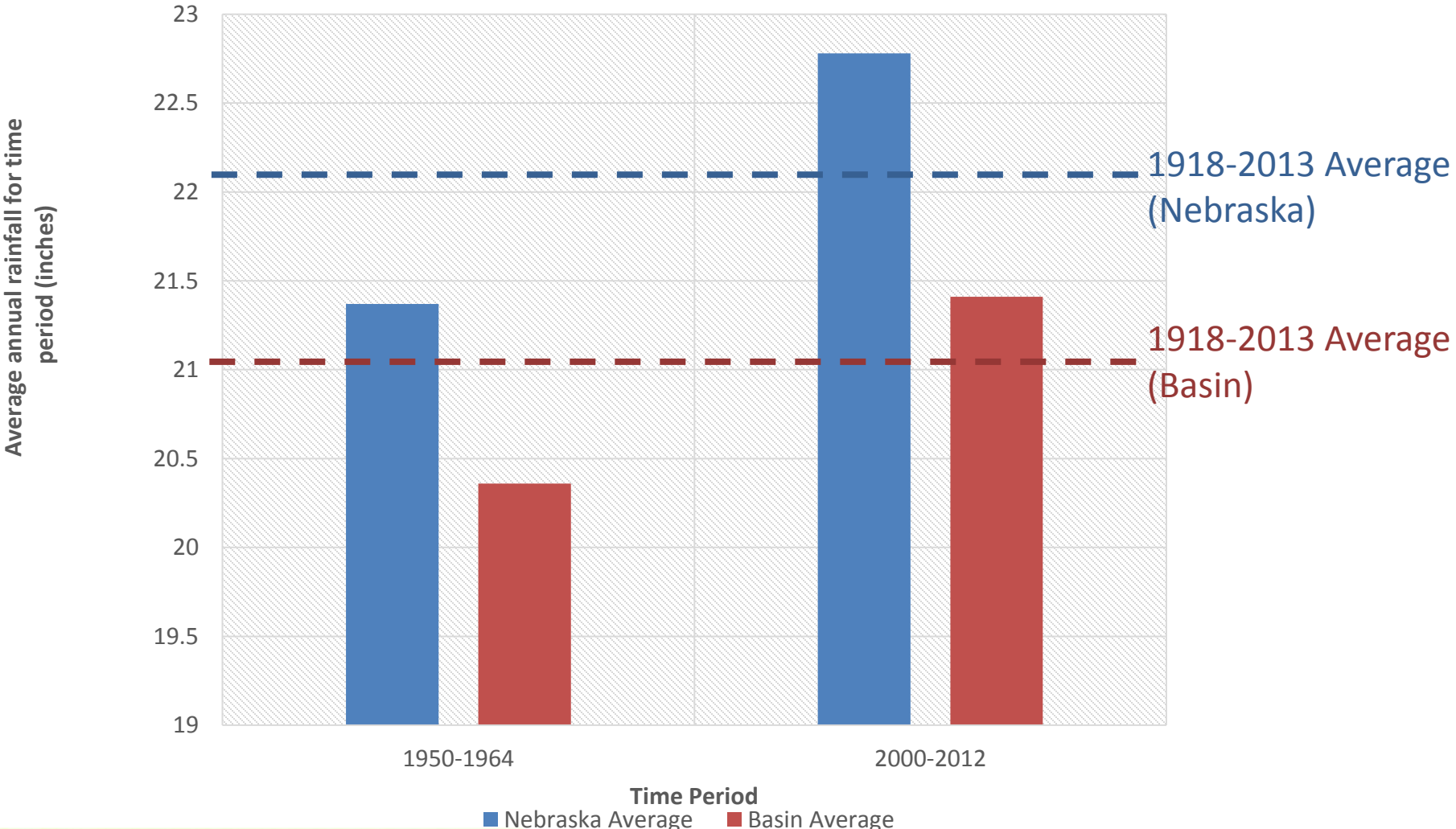
Nebraska Groundwater Computed Beneficial Consumptive Use (CBCU)

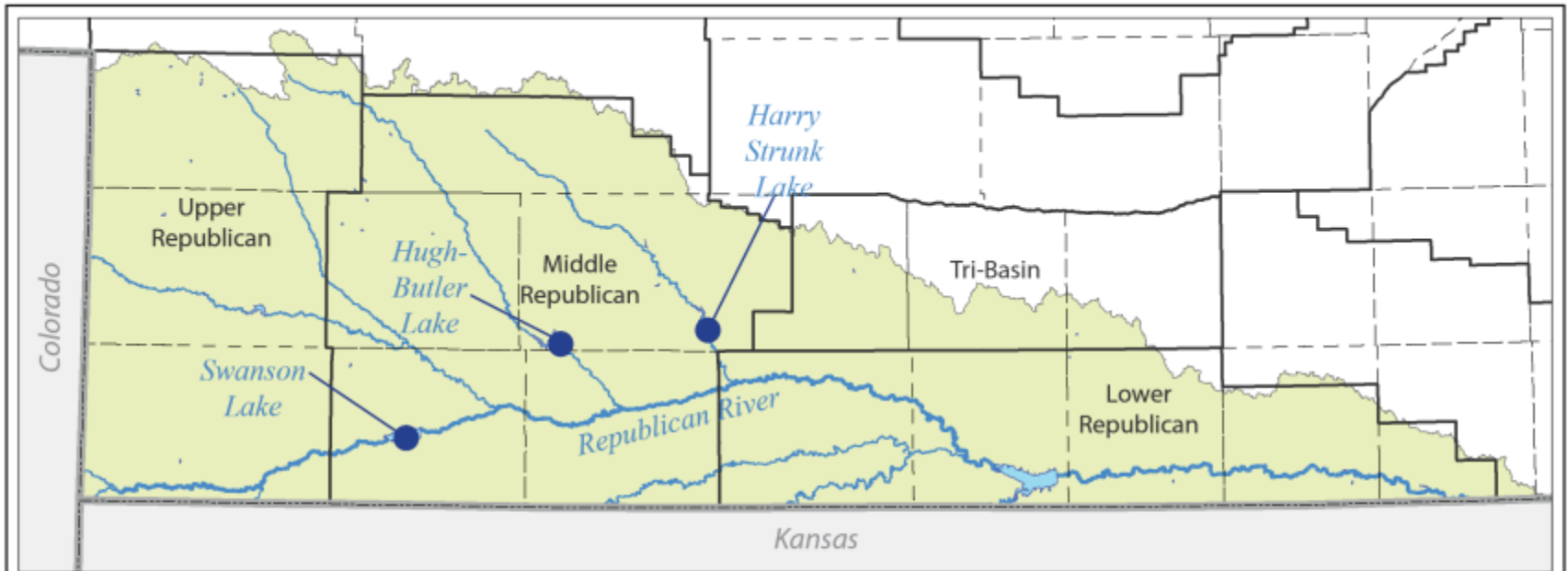


Impacts to Runoff, Using Streamflow and Baseflow Data

1950-1964 and 2000-2012 time periods

Rainfall Comparison



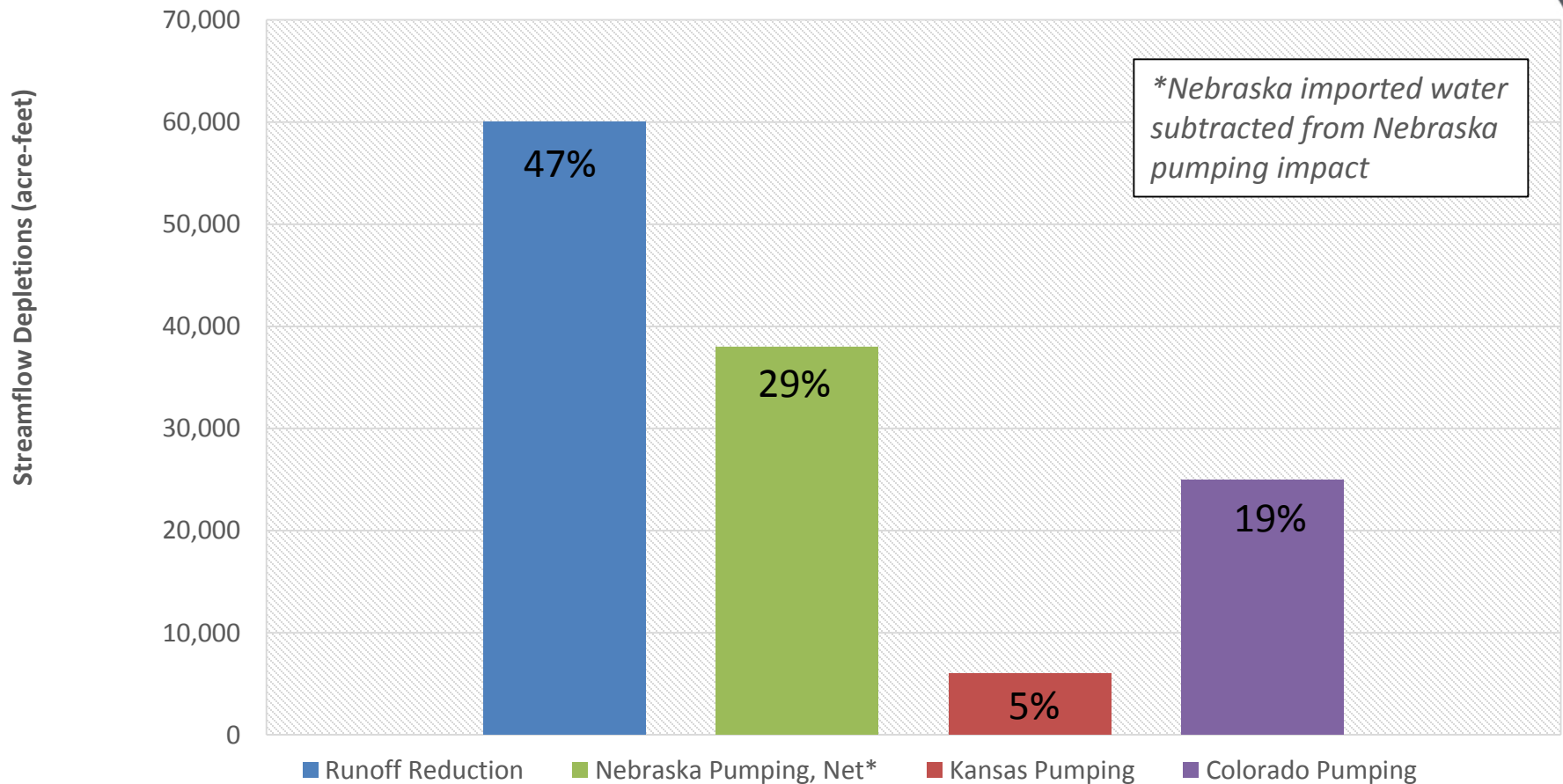


Legend

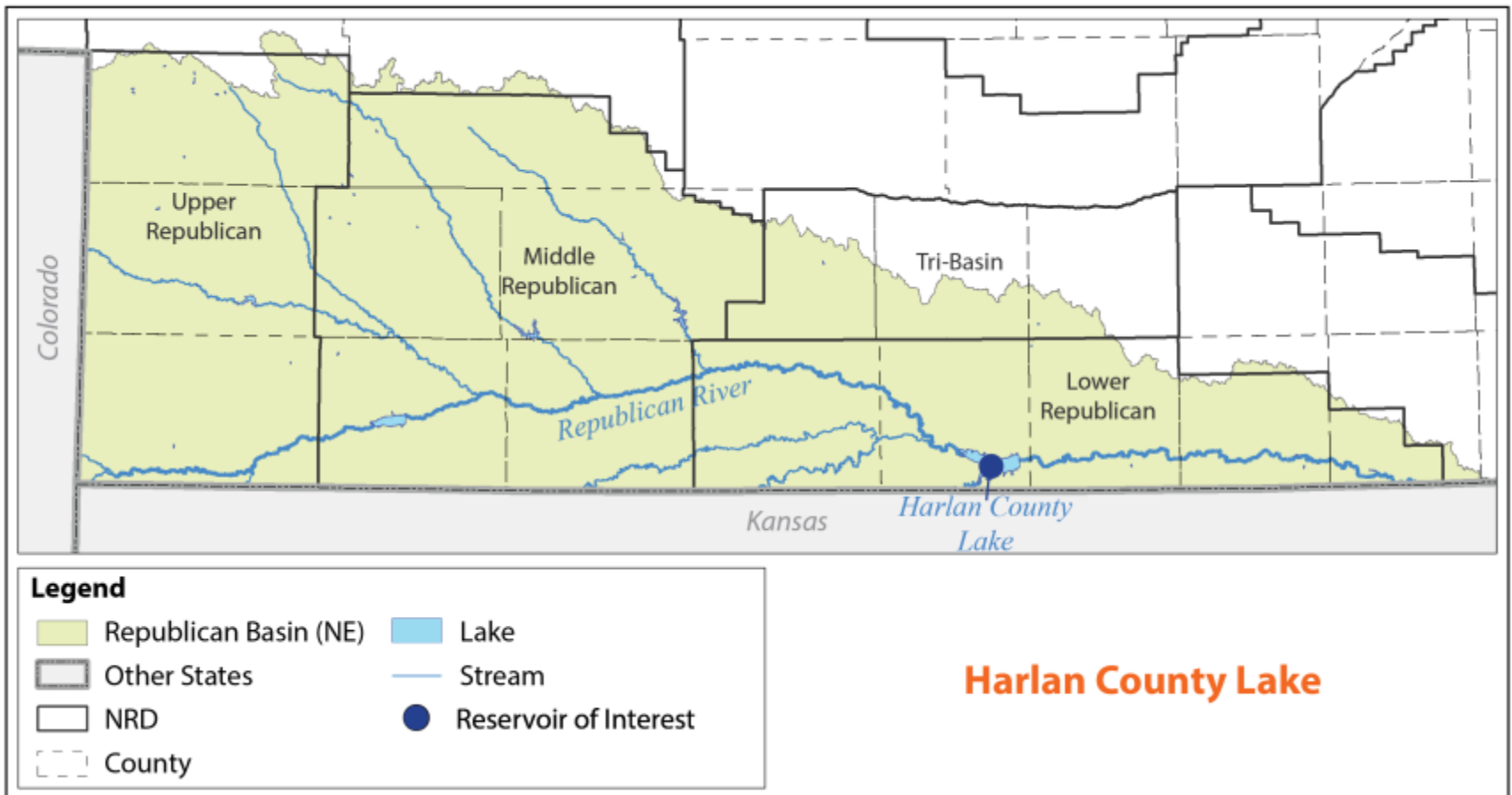
- Republican Basin (NE)
- Other States
- NRD
- County
- Lake
- Stream
- Reservoir of Interest

**Reservoirs Serving
Frenchman-Cambridge
Irrigation District**

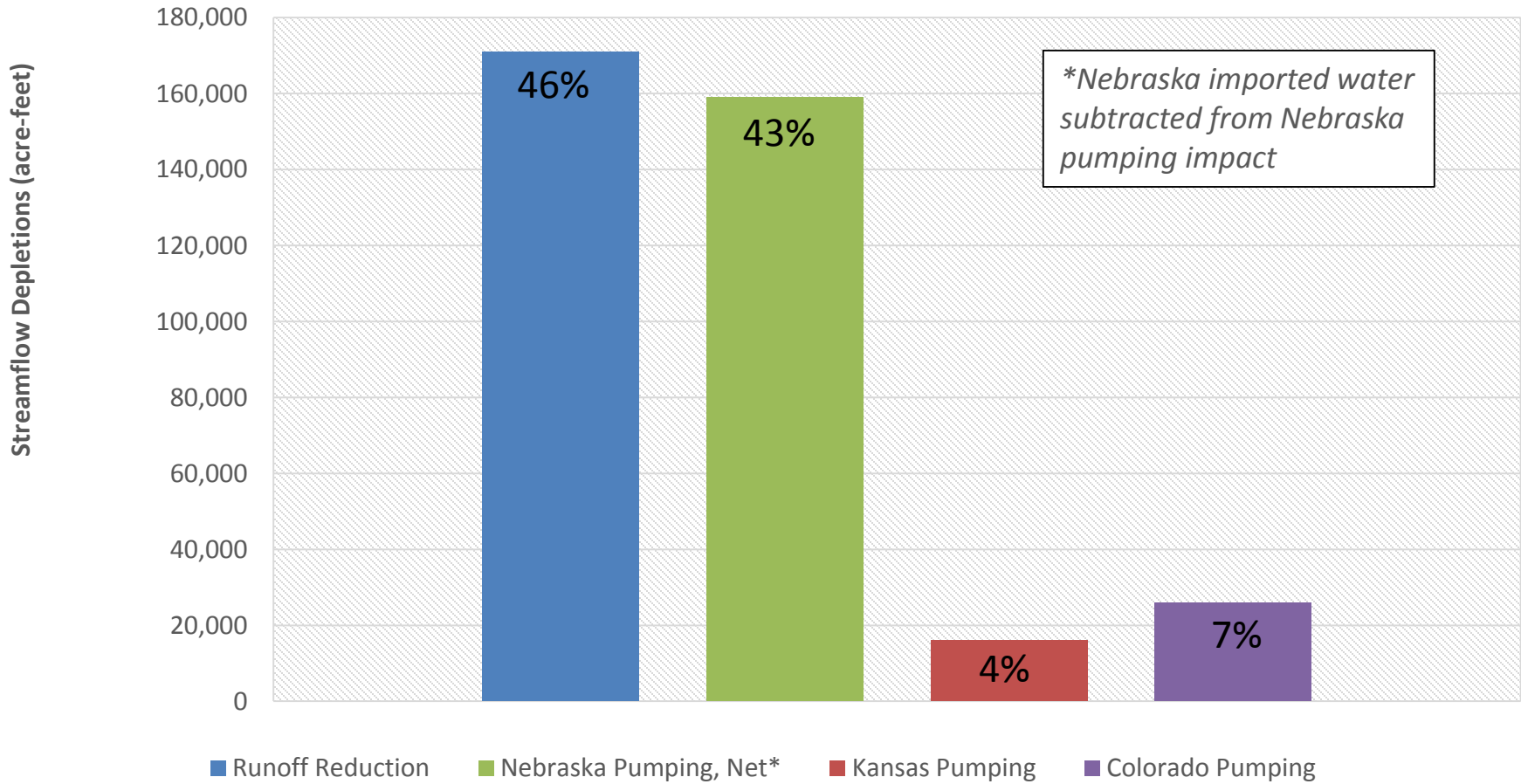
Impacts to Reservoirs Serving Frenchman Cambridge Irrigation District



Impacts, 1950-1964
Compared to 2000-2012



Impacts Above Harlan County Lake



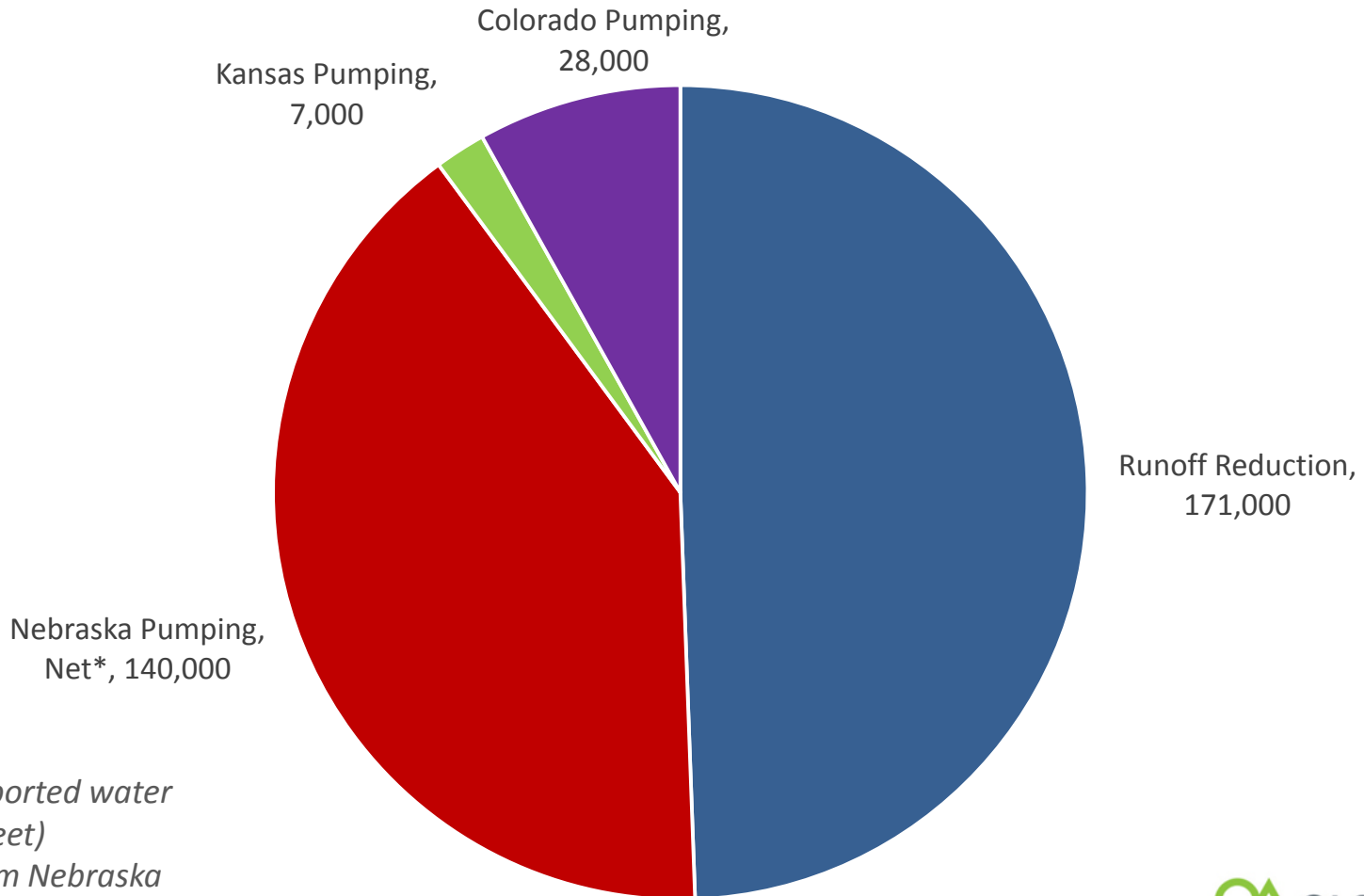
Impacts, 1950-1964
Compared to 2000-2012

Additional Impacts of Drought

2013 Comparison

2013 Impacts, without the effects of the Drought

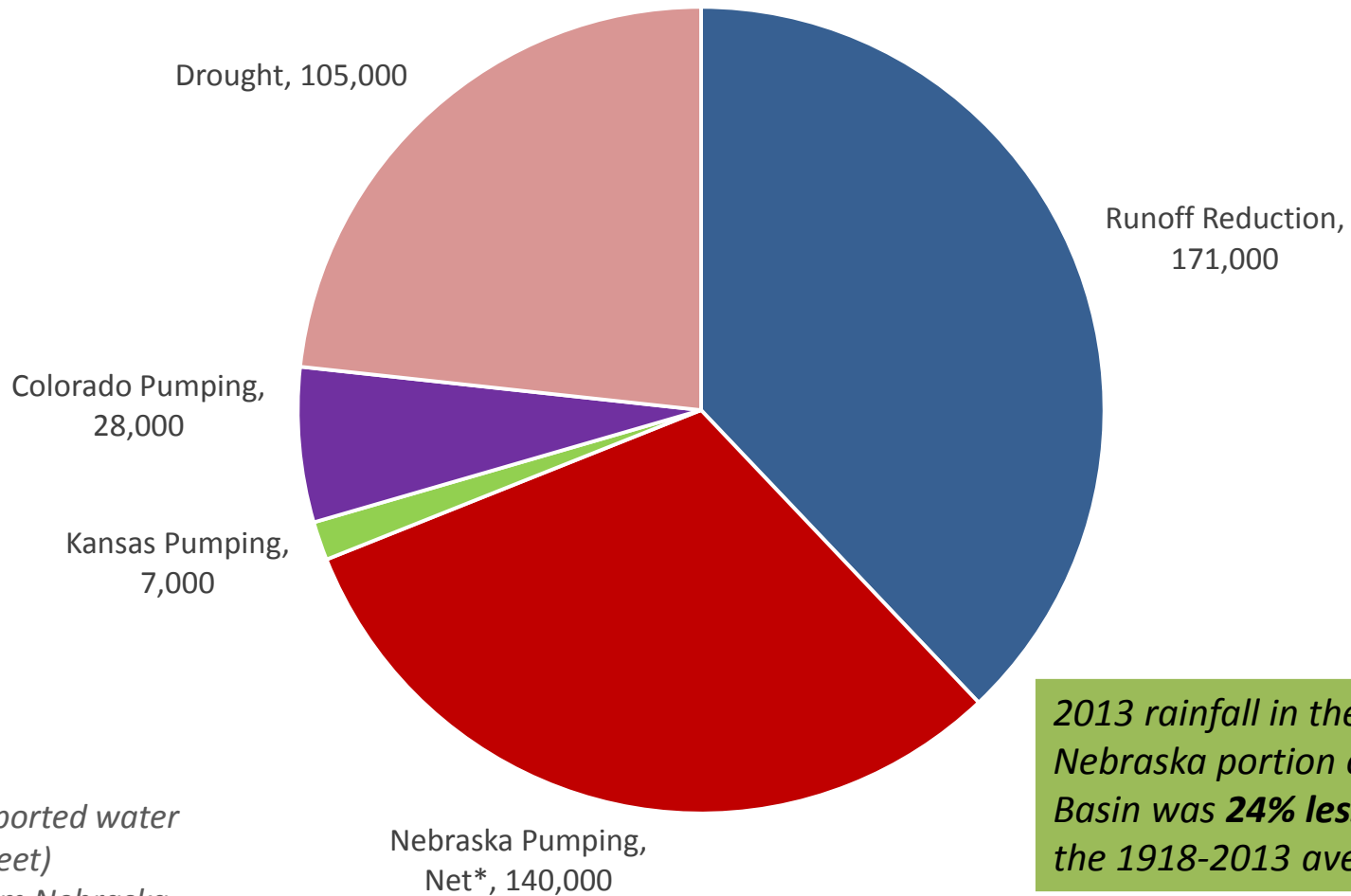
Above Harlan County Lake (acre-feet)



**Nebraska imported water (12,000 acre-feet) subtracted from Nebraska pumping impact (152,000 acre-feet)*

2013 Impacts, Including Drought

Above Harlan County Lake (acre-feet)



**Nebraska imported water (12,000 acre-feet) subtracted from Nebraska pumping impact (152,000 acre-feet)*

*2013 rainfall in the Nebraska portion of the Basin was **24% less** than the 1918-2013 average.*

Improving Streamflows through Augmentation from Groundwater

Streamflow Augmentation Projects

- Two Projects
 - Rock Creek
 - Nebraska Cooperative Platte Republican Enhancement (N-CORPE) Project
- Provide Streamflows for Compact Compliance
- Previous Analysis of Net Impacts on Streamflow
- Current Analysis of Impact on Aquifer

Rock Creek Project

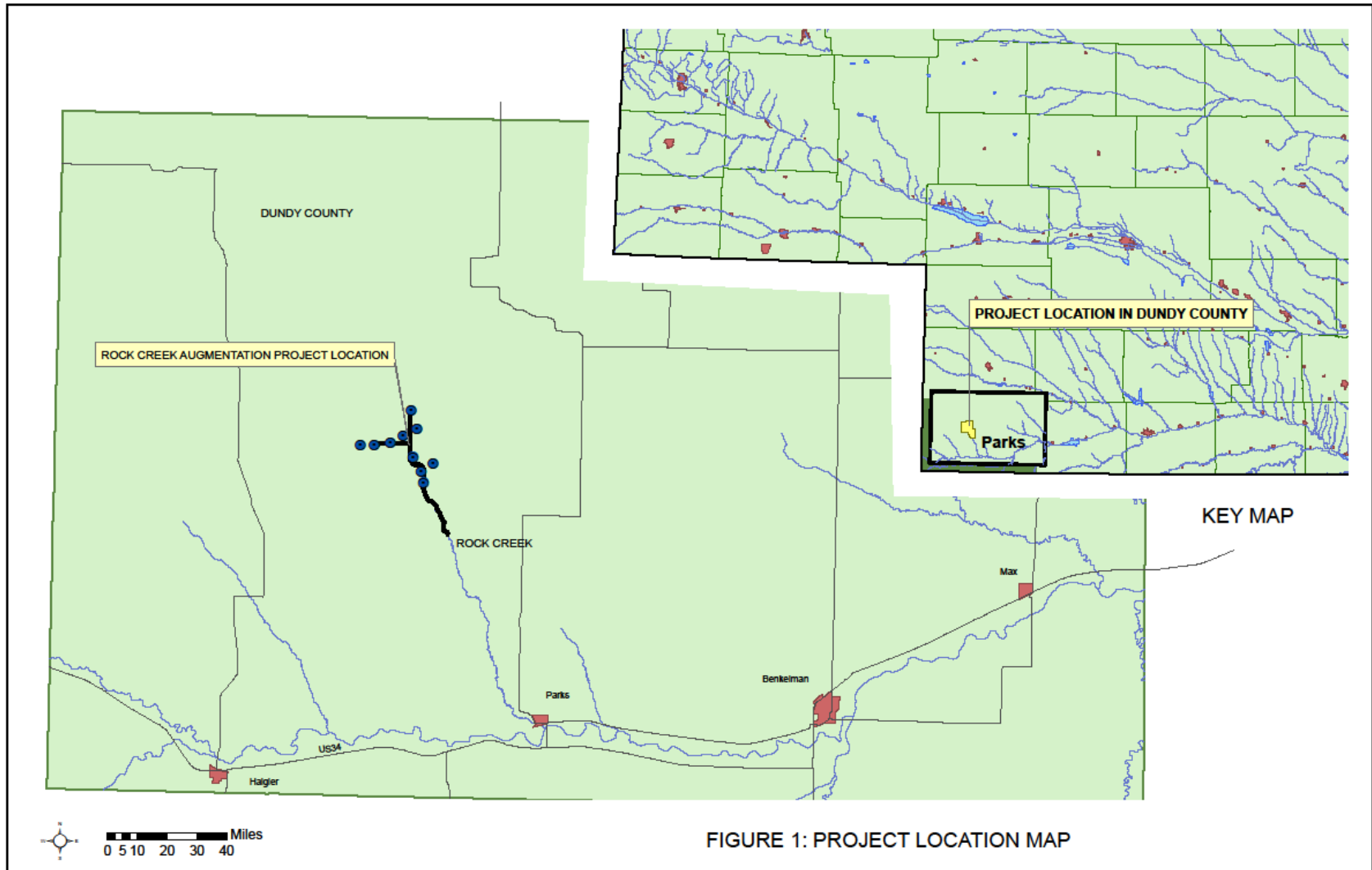
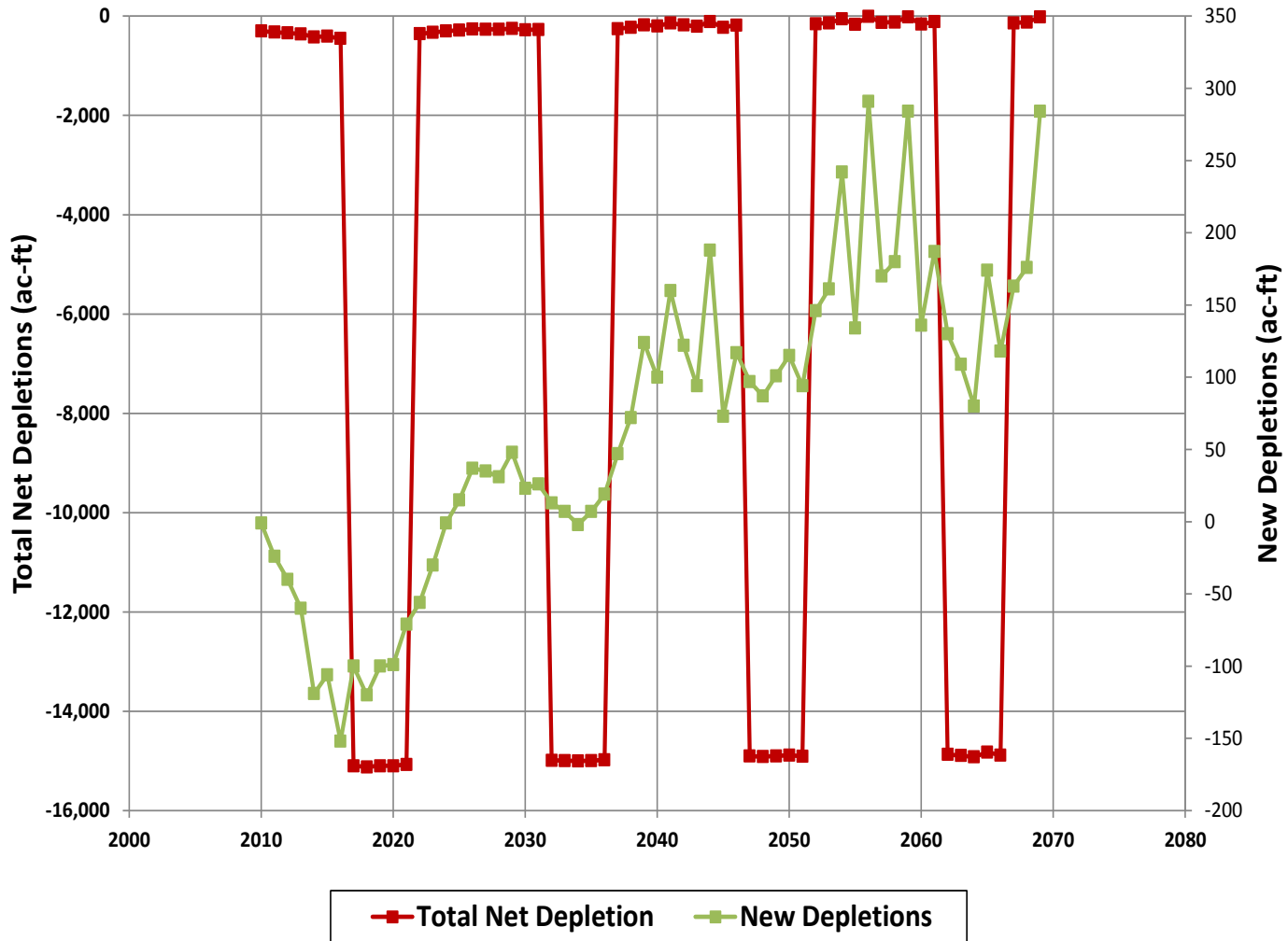


FIGURE 1: PROJECT LOCATION MAP

The Difference in Annual Nebraska Groundwater CBCU between the Future Baseline Simulation and Future Project Operations Simulation (Net Depletions and Total Net Depletions)



N-CORPE Project

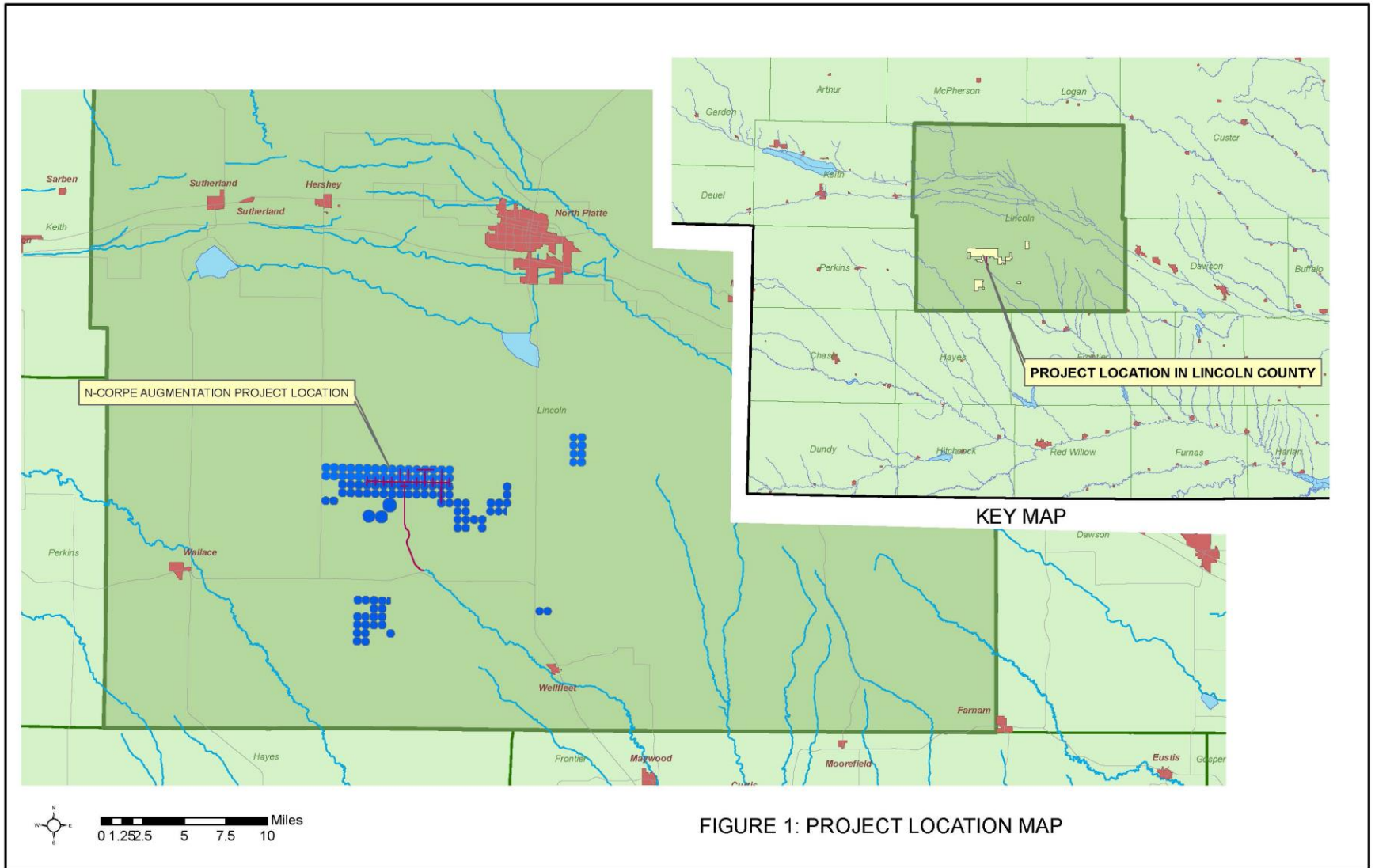


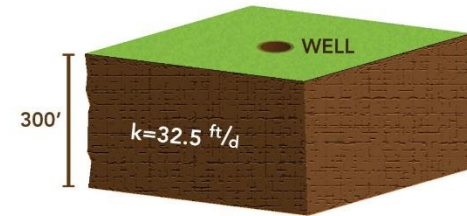
FIGURE 1: PROJECT LOCATION MAP

Sustainably Managing the Aquifer

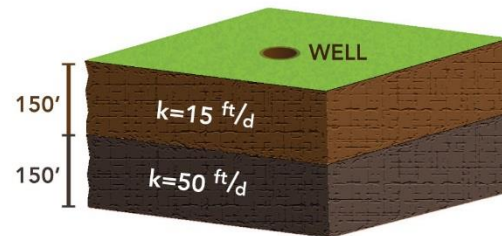
Another critical component of stream augmentation from the aquifer is ensuring that the operations of the augmentation well field are sustainable over the long term.

Olsson is currently working for the N-CORPE project to construct and calibrate a detailed model of the N-CORPE wellfield that will be used to evaluate various future scenarios and conduct other analyses that will help the N-CORPE managers understand any critical limitations for the operation of the N-CORPE wellfield.

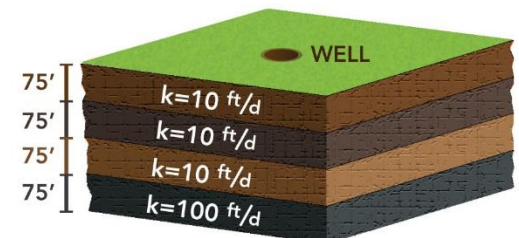
1-LAYER MODEL



2-LAYER MODEL



4-LAYER MODEL



Questions?