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Nebraska's most precious resource.

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**WATER SCIENCE:  
STREAM AND AQUIFER DEPLETION**

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JESSE BRADLEY, P.G., NATURAL RESOURCES PROGRAMS DIRECTOR  
Nebraska Department of Natural Resources

# Overview

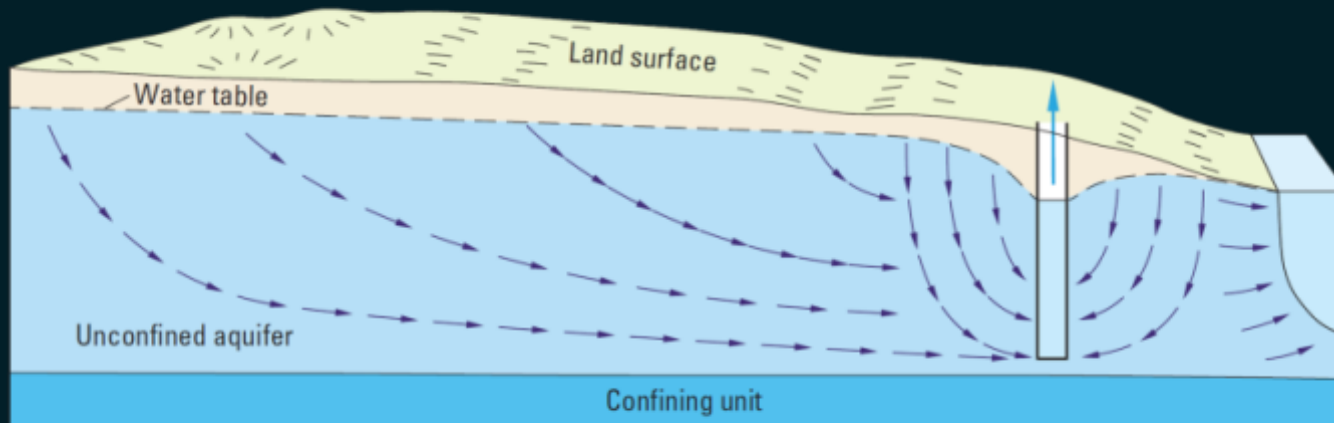
- Stream and Aquifer Depletion
  - The effects of well location on stream depletion
  - Review of well depletion zones
  - Wells in the Republican Basin through time
  - Stream depletion
  - Aquifer depletion

# WELL LOCATION AND STREAM DEPLETION

## Terminology:

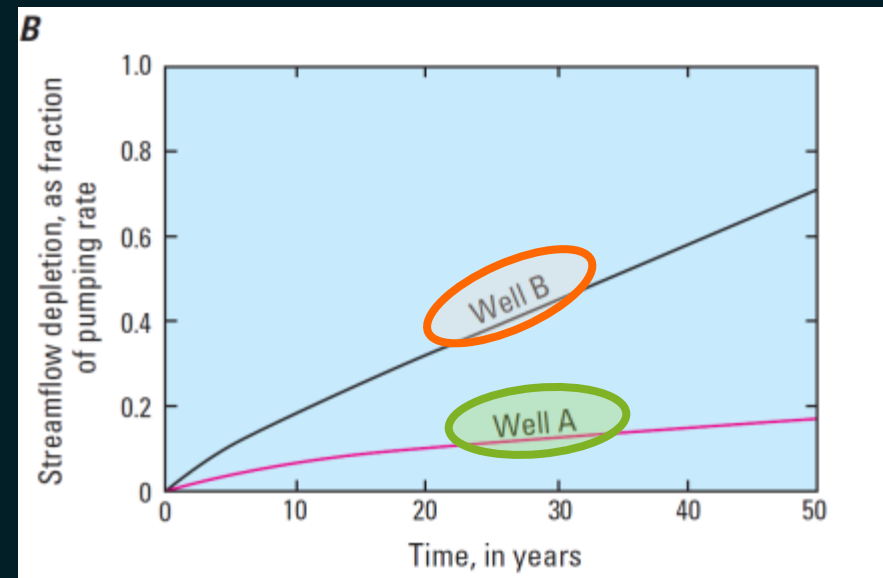
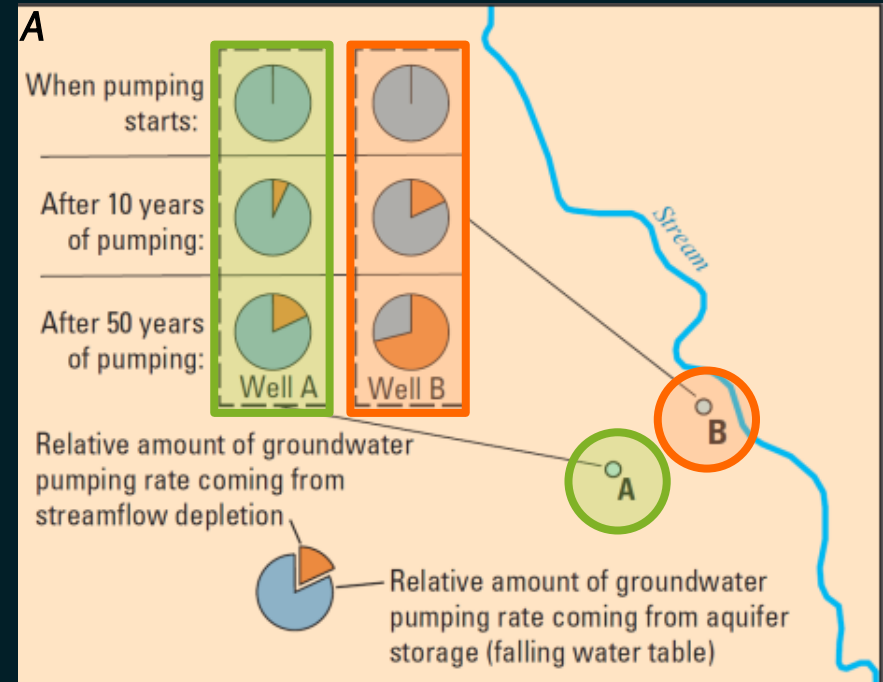
# Cone of Depression/Hydraulic Gradient

- As a well begins to pump water from an aquifer:
  - Groundwater levels around the well decline, creating a **cone of depression** in the water levels around the well
  - A **hydraulic gradient** is now present between the normal water table and the aquifer around the well
- The hydraulic gradient established within the cone of depression **forces water to move from the aquifer into the well**



# Effects of Well Location on the Rate of Stream Depletion

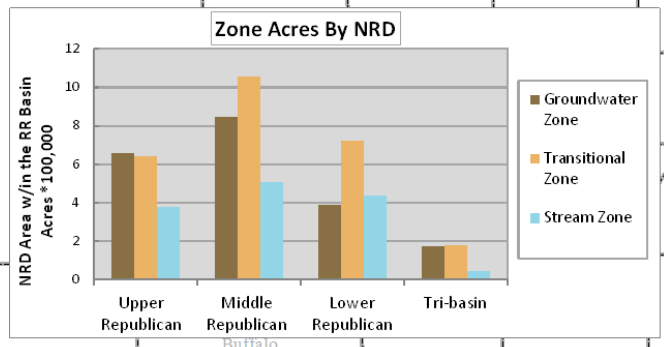
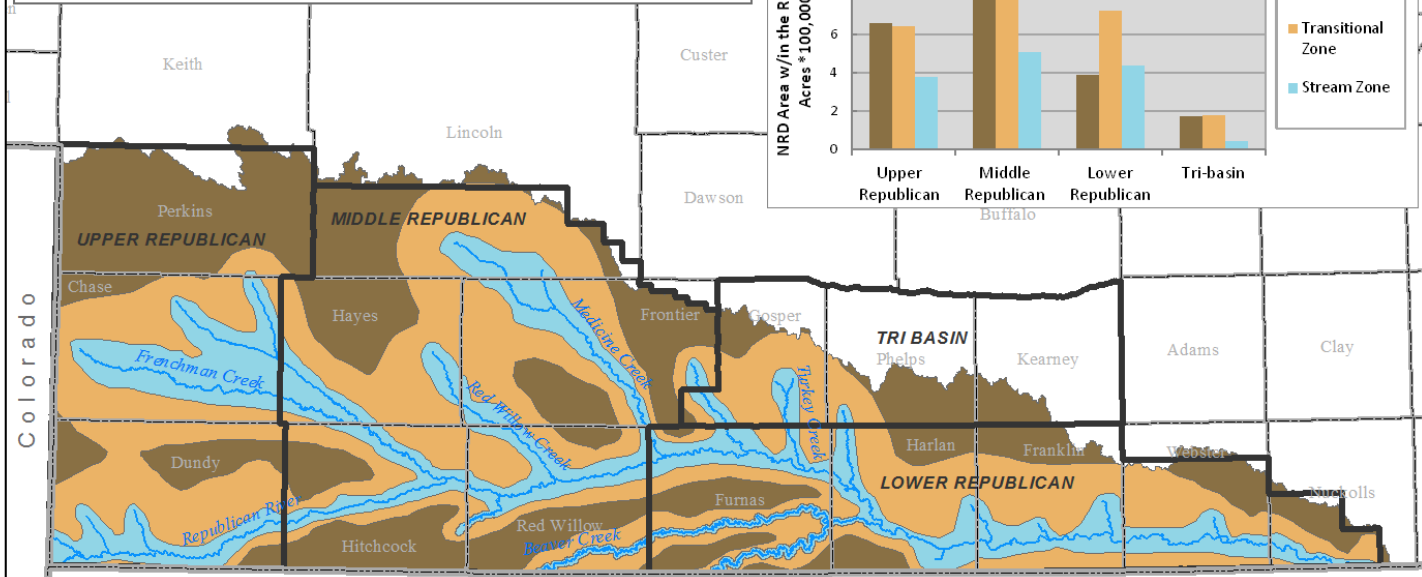
	Well A	Well B
Proximity to stream	Farther	Closer
When cone of depression reaches stream	Later	Sooner
Length of time groundwater storage is a source of water to the well	Longer	Shorter
Streamflow depletion becomes primary source of water	Later	Sooner



# Questions?

# REVIEW OF WELL DEPLETION ZONES

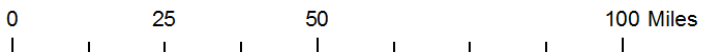
# Republican River Basin Generalized Well Depletion Zones



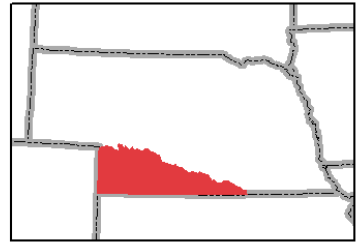
- Republican R. NRDs
- County
- Streams/Rivers

**Well Depletion Zones**

- Groundwater
- Transitional
- Stream

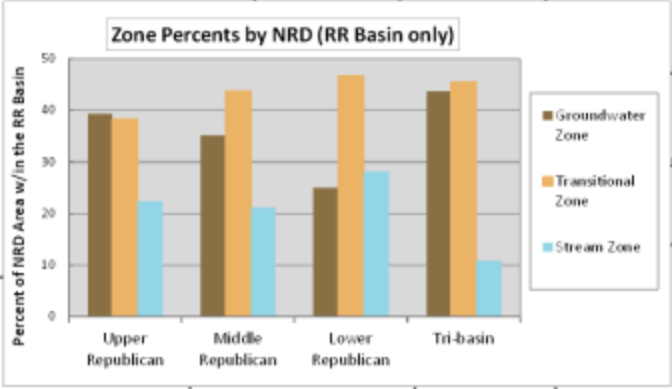
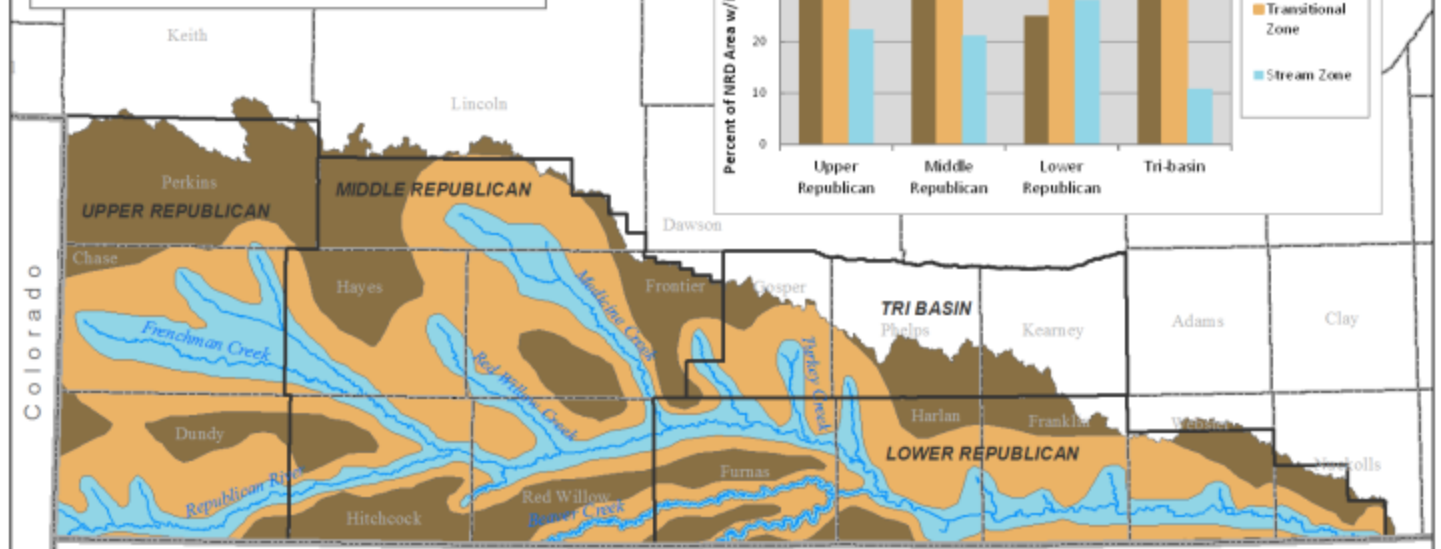


Created by NDNR, alz  
 Updated December 1, 2015, emj  
 Digitized at a scale of 1:750,000.





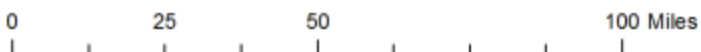
# Republican River Basin Generalized Well Depletion Zones



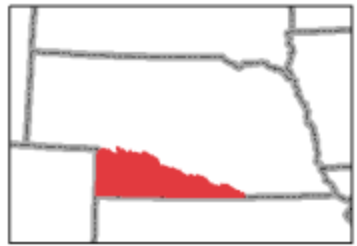
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- County
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**Well Depletion Zones**

- Groundwater
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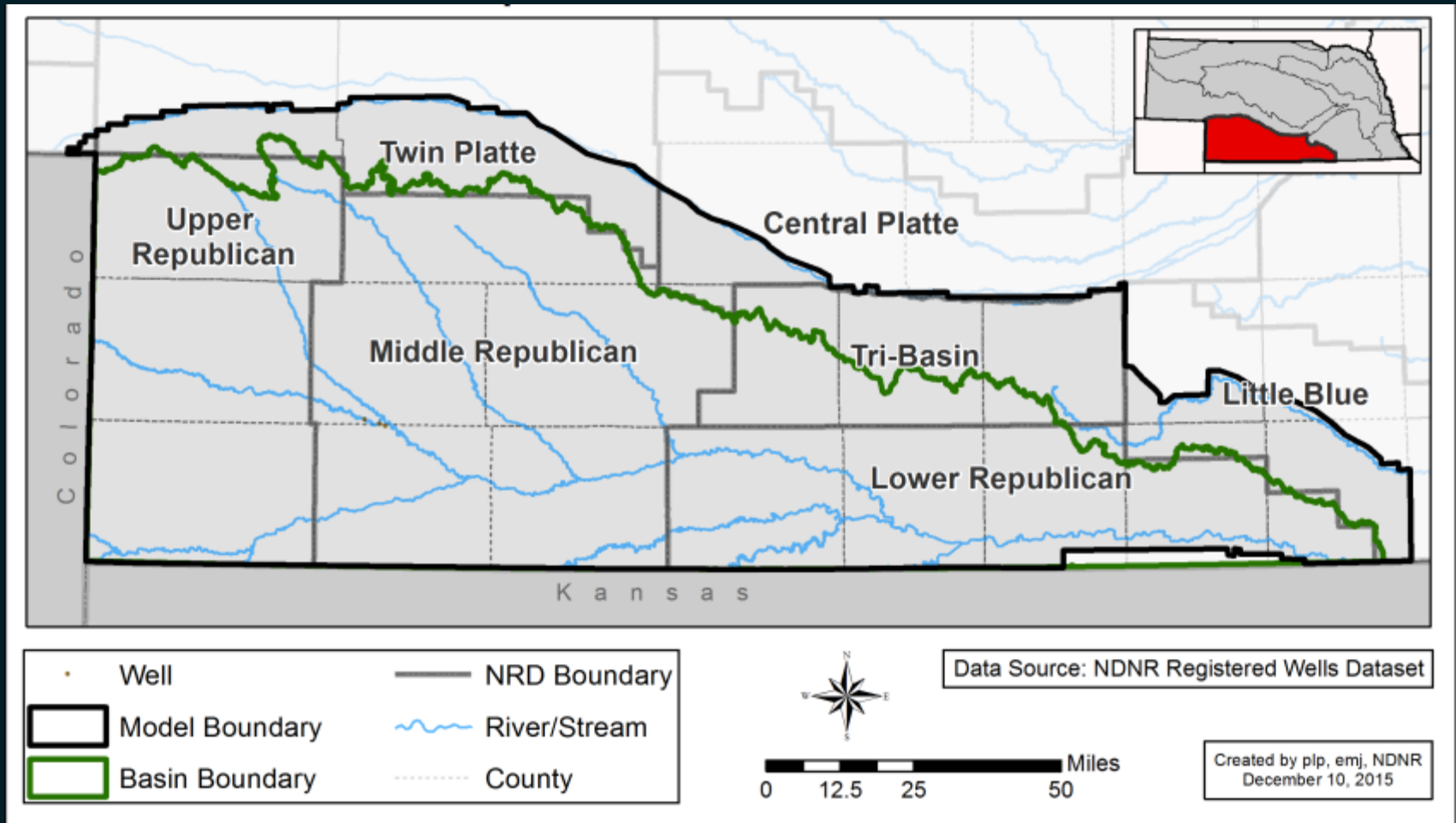
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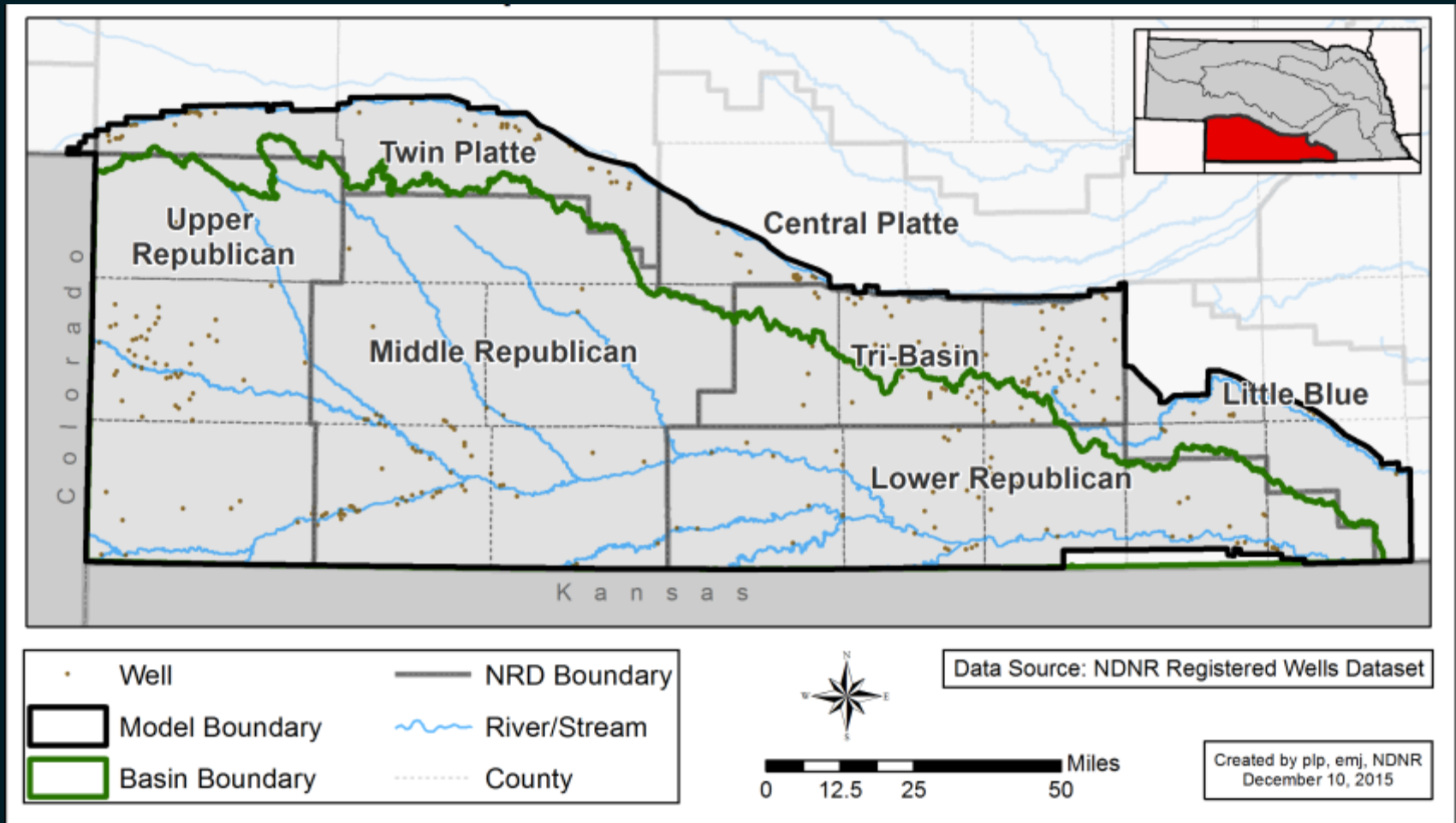
# Questions?

# WELLS IN THE REPUBLICAN BASIN THROUGH TIME

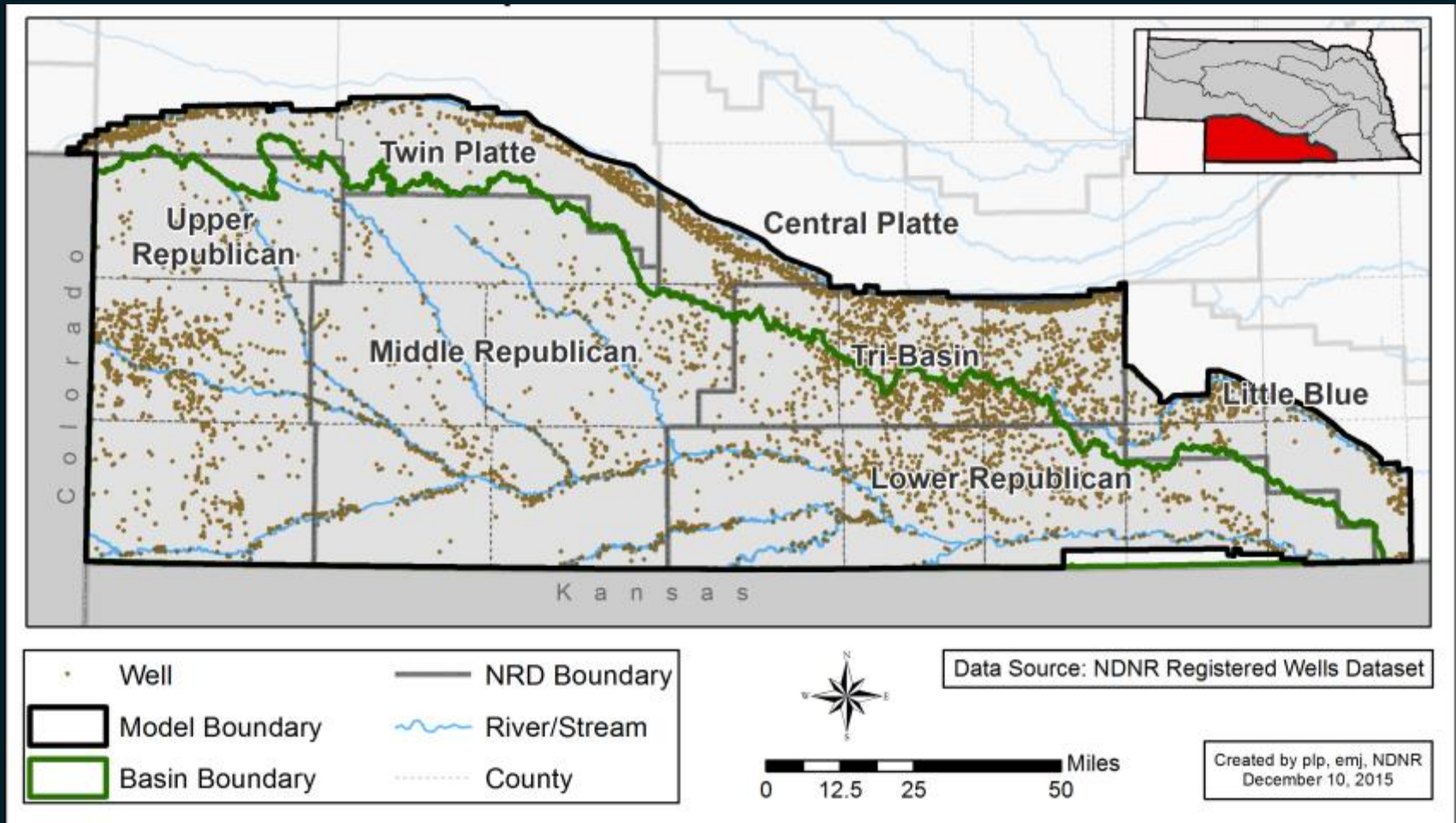
# 1940 Republican River Model Area Wells



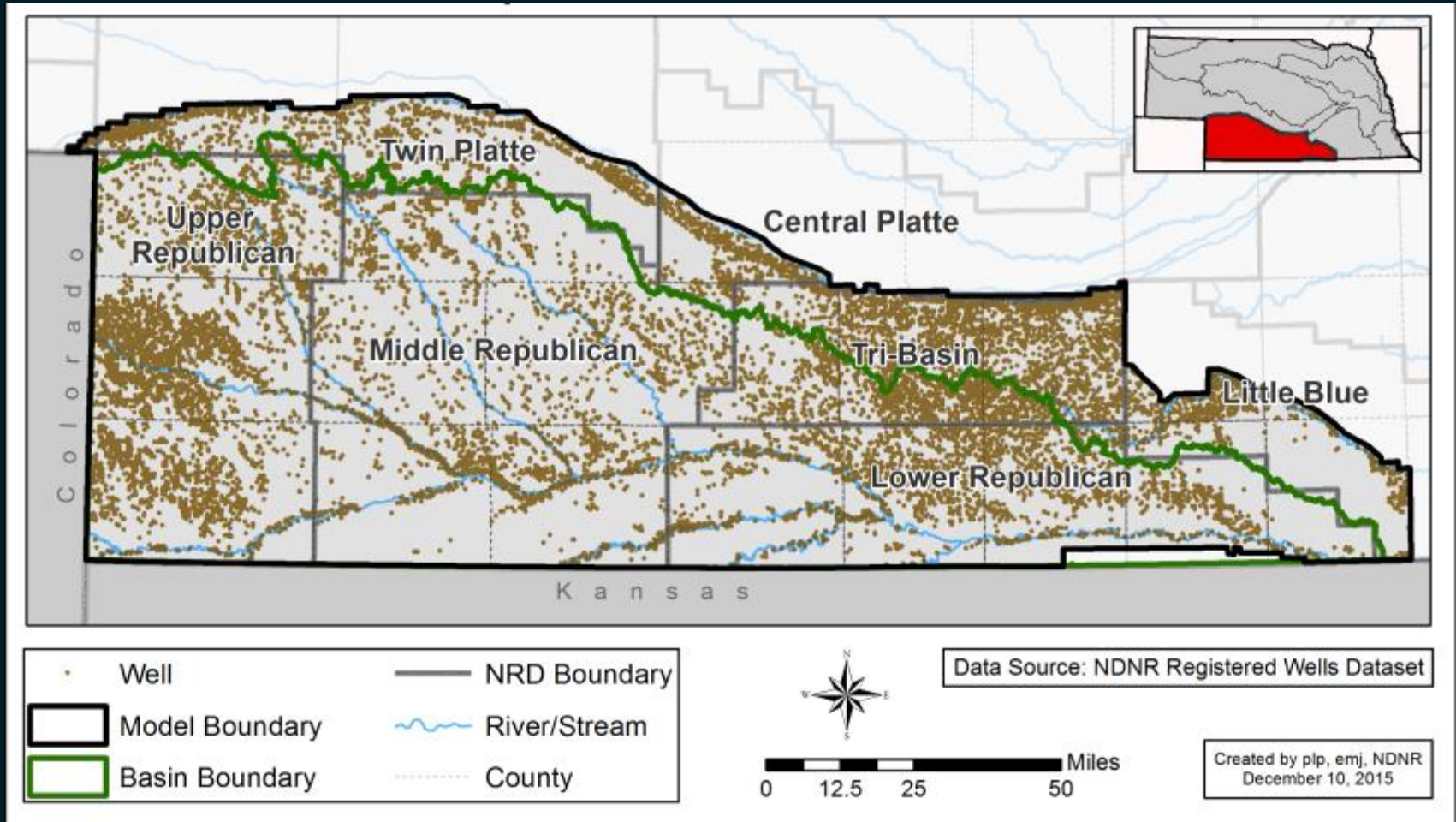
# 1955 Republican River Model Area Wells



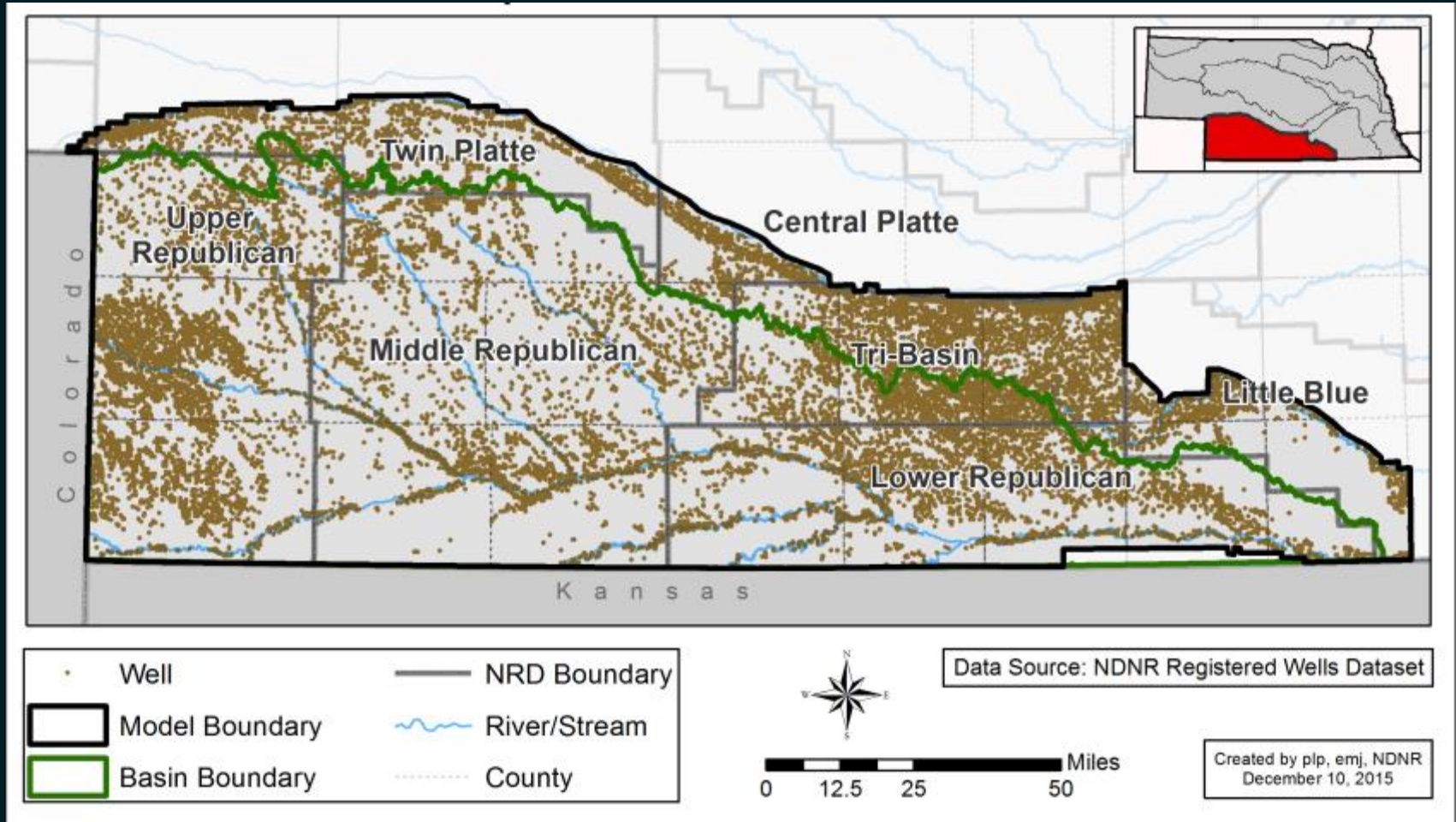
# 1970 Republican River Model Area Wells



# 1985 Republican River Model Area Wells

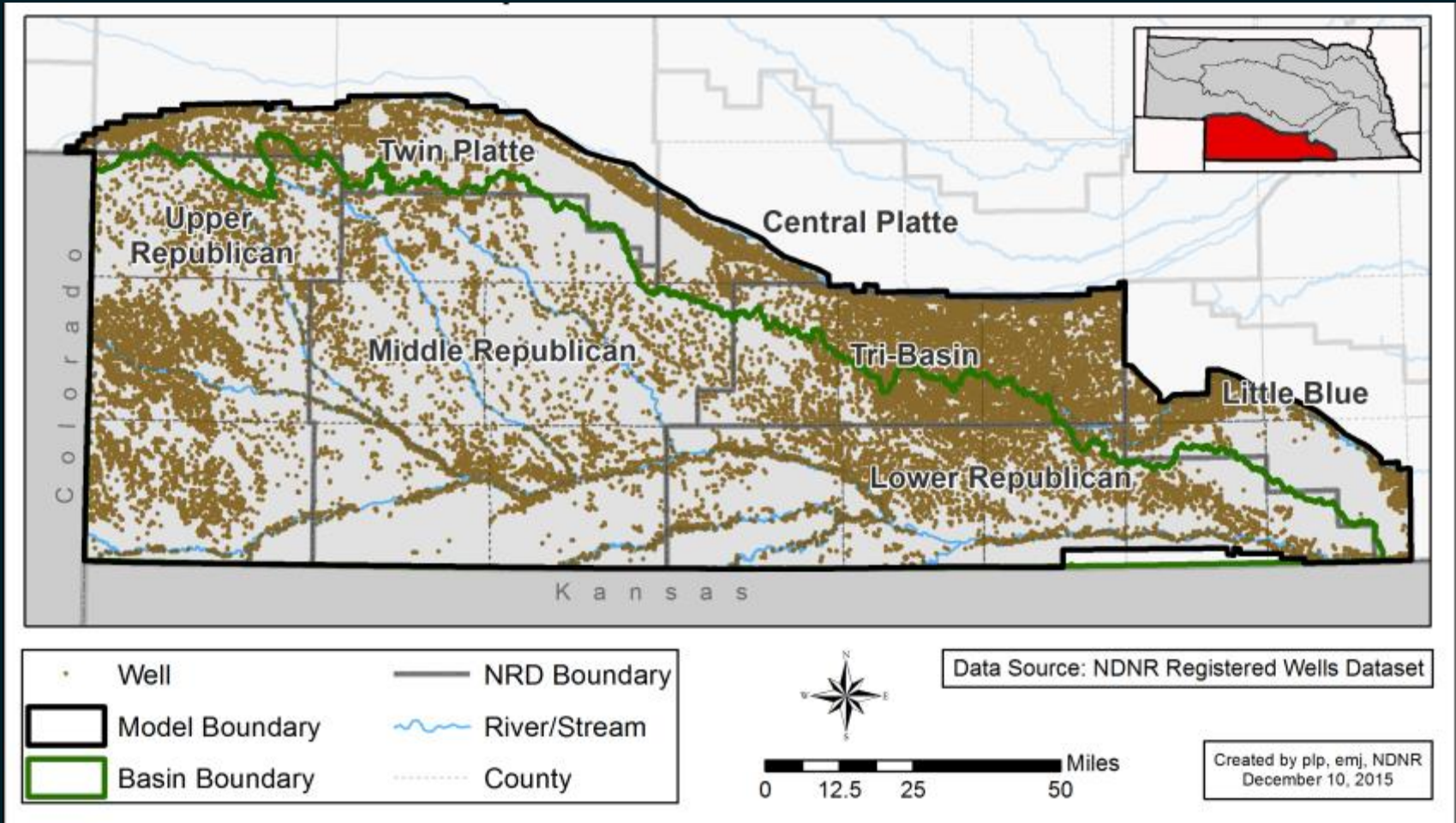


# 2000 Republican River Model Area Wells





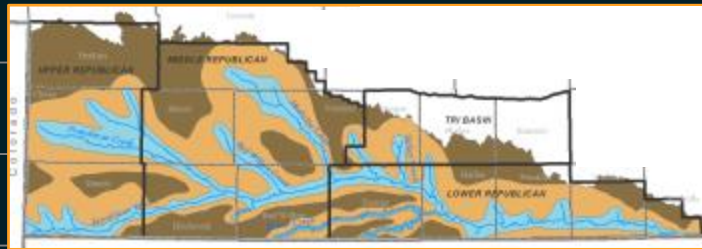
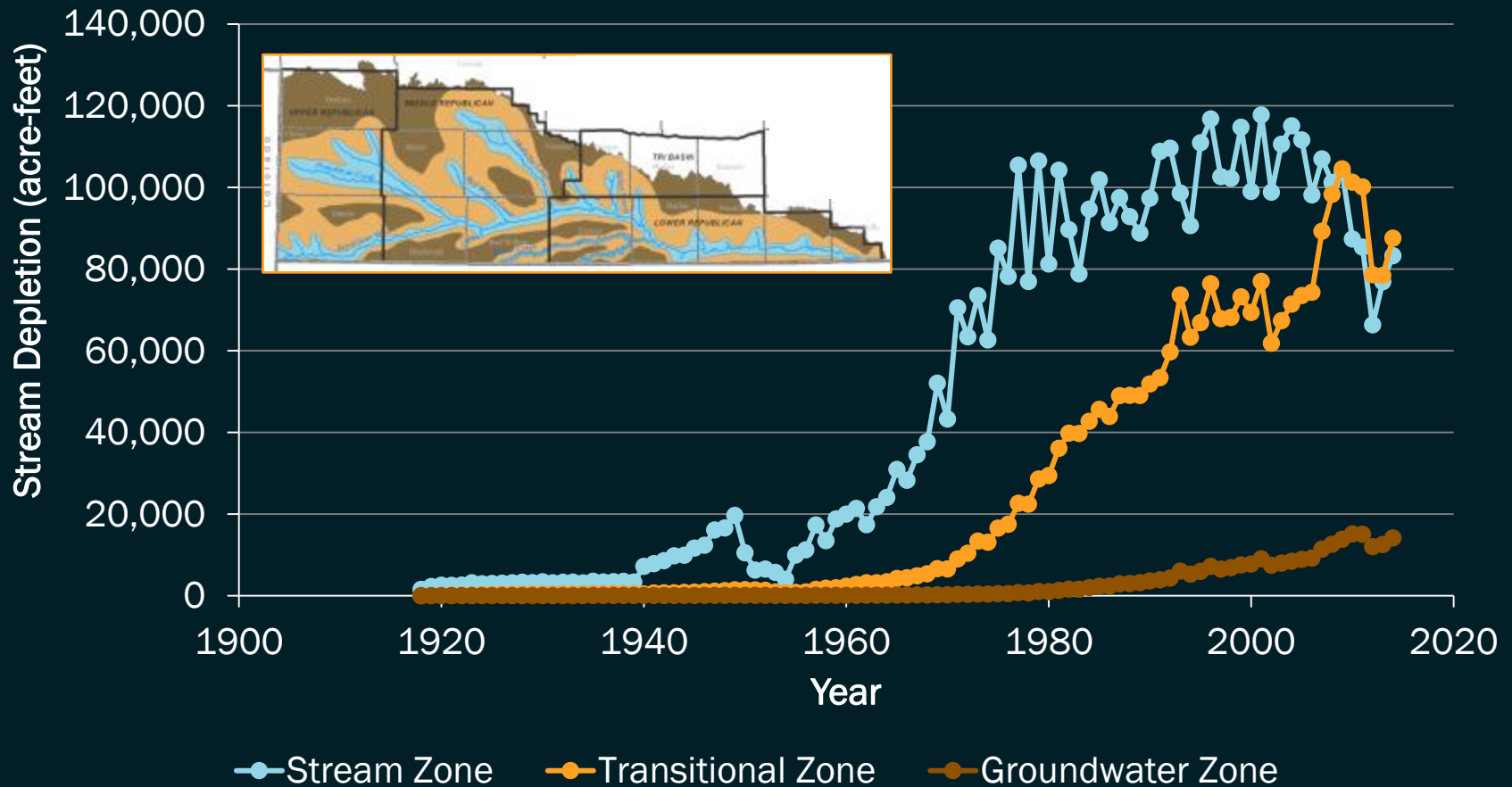
# 2015 Republican River Model Area Wells

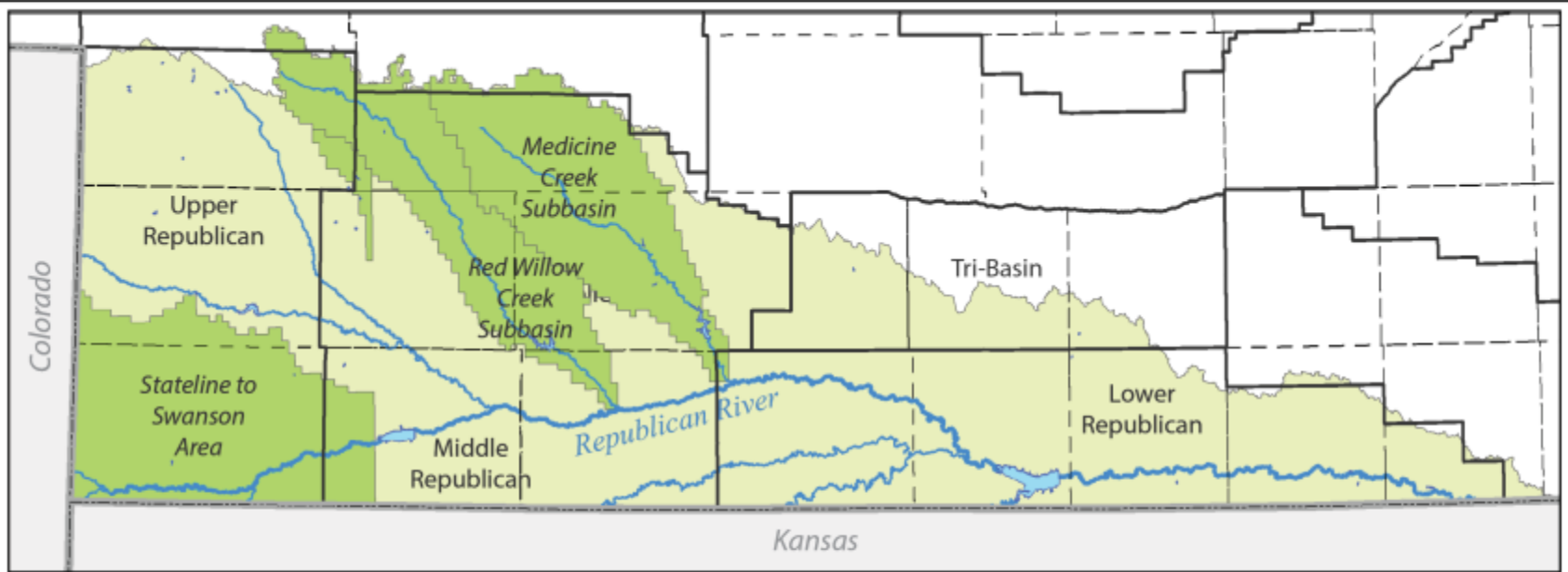


# Questions?

# STREAM DEPLETION

# Stream Depletions by Well Depletion Zone





**Legend**

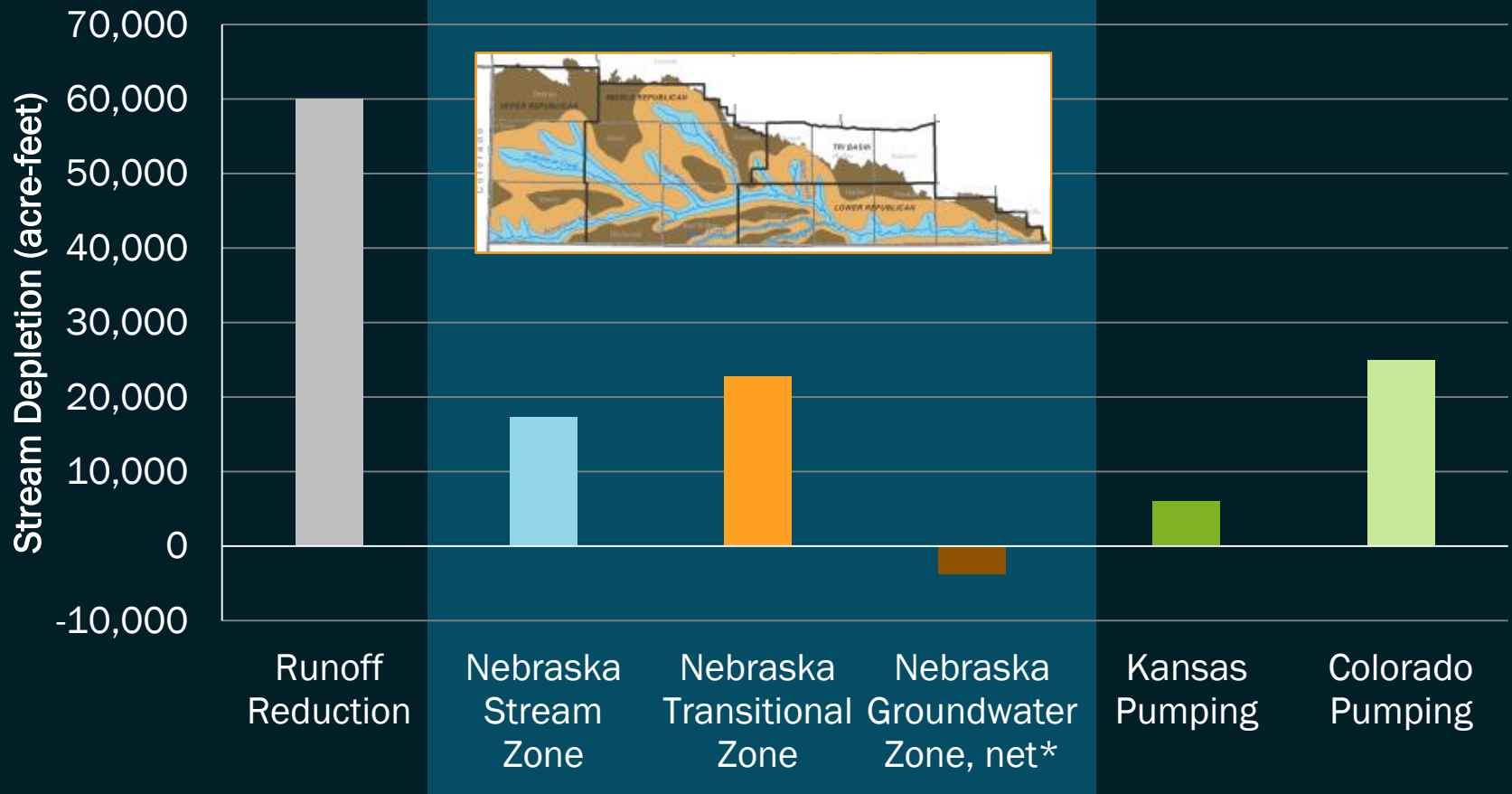
- Republican Basin (NE)
- Other States
- NRD
- County
- Lake
- Stream
- Subbasins of Interest

**Frenchman-Cambridge  
Irrigation District Subbasins**

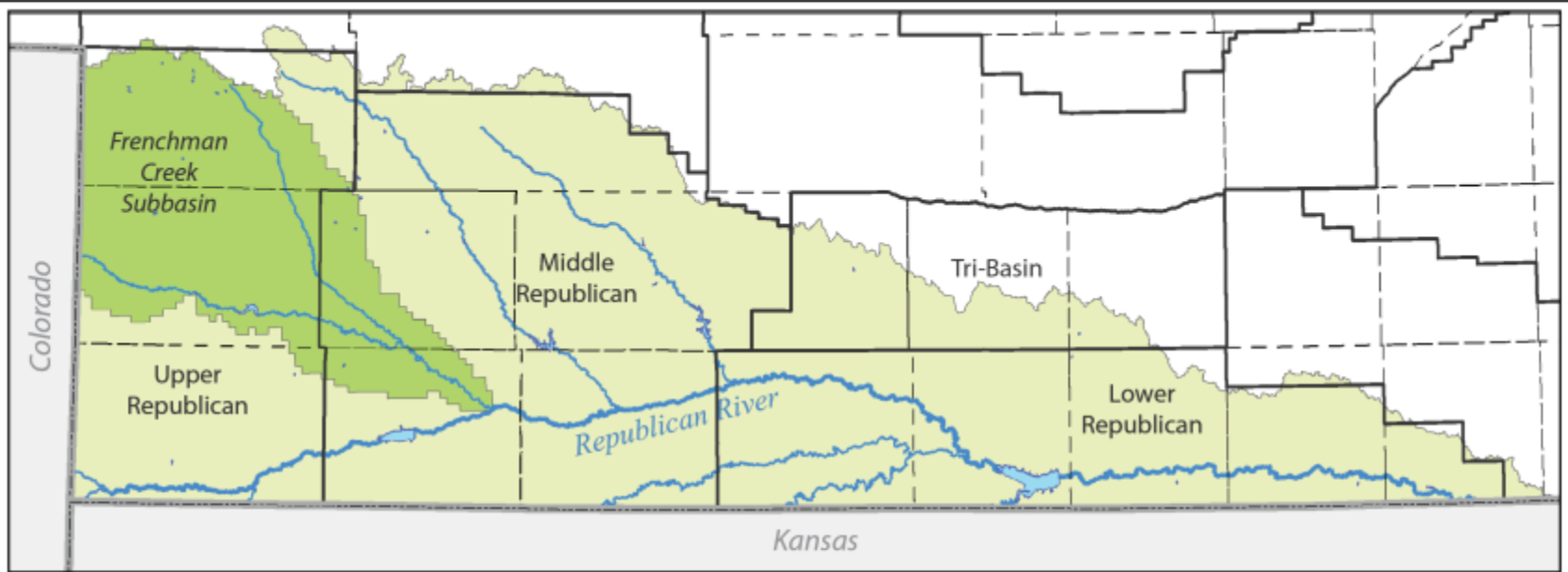
# Impacts above Reservoirs Serving Frenchman Cambridge Irrigation District










Impacts 1950-1964 compared to 2000-2012



\*Net = Pumping impact minus imported water



**Legend**

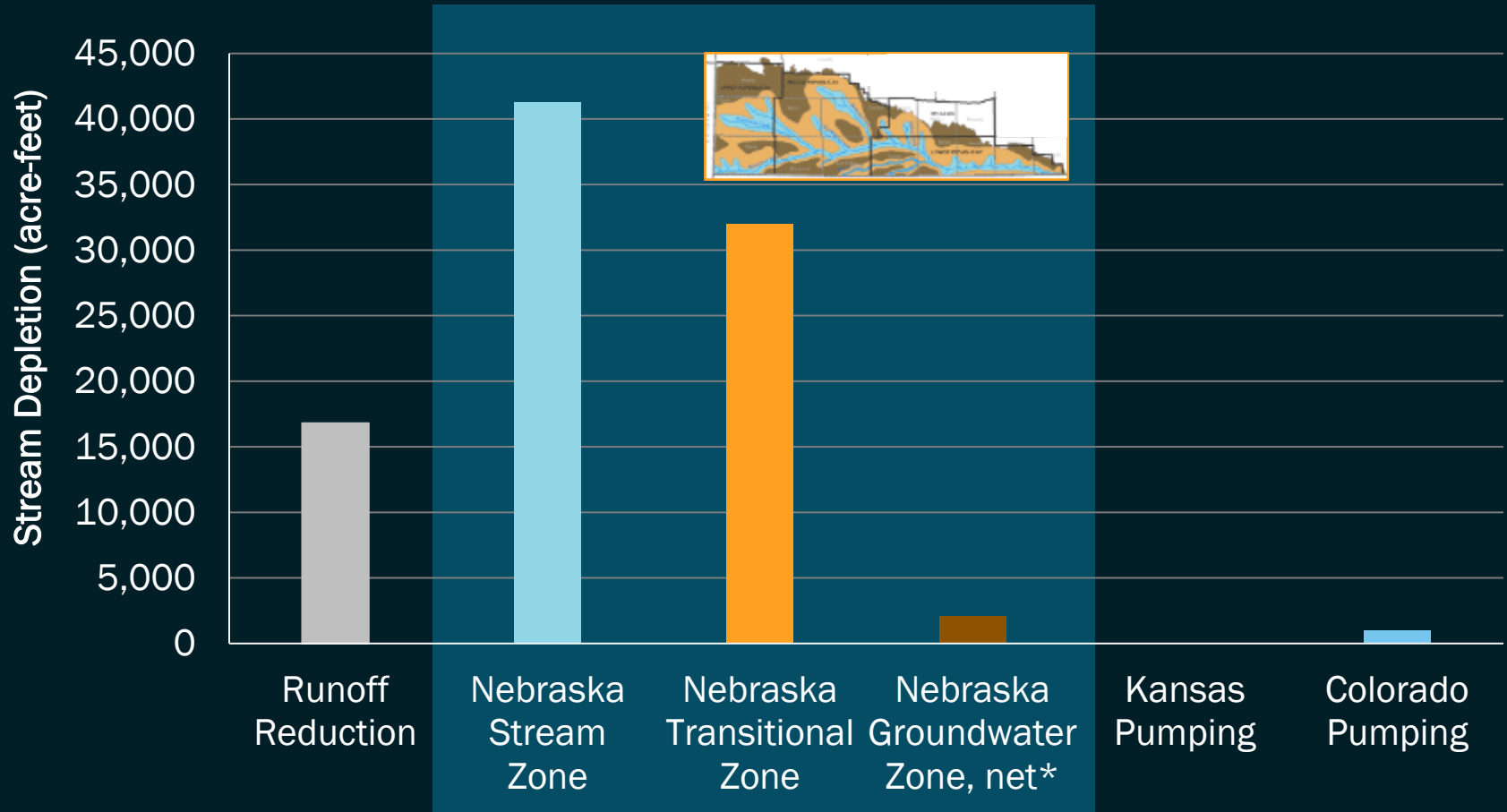
 Republican Basin (NE)	 Lake
 Other States	 Stream
 NRD	 Subbasin of Interest
 County	

**Frenchman Creek  
Subbasin**

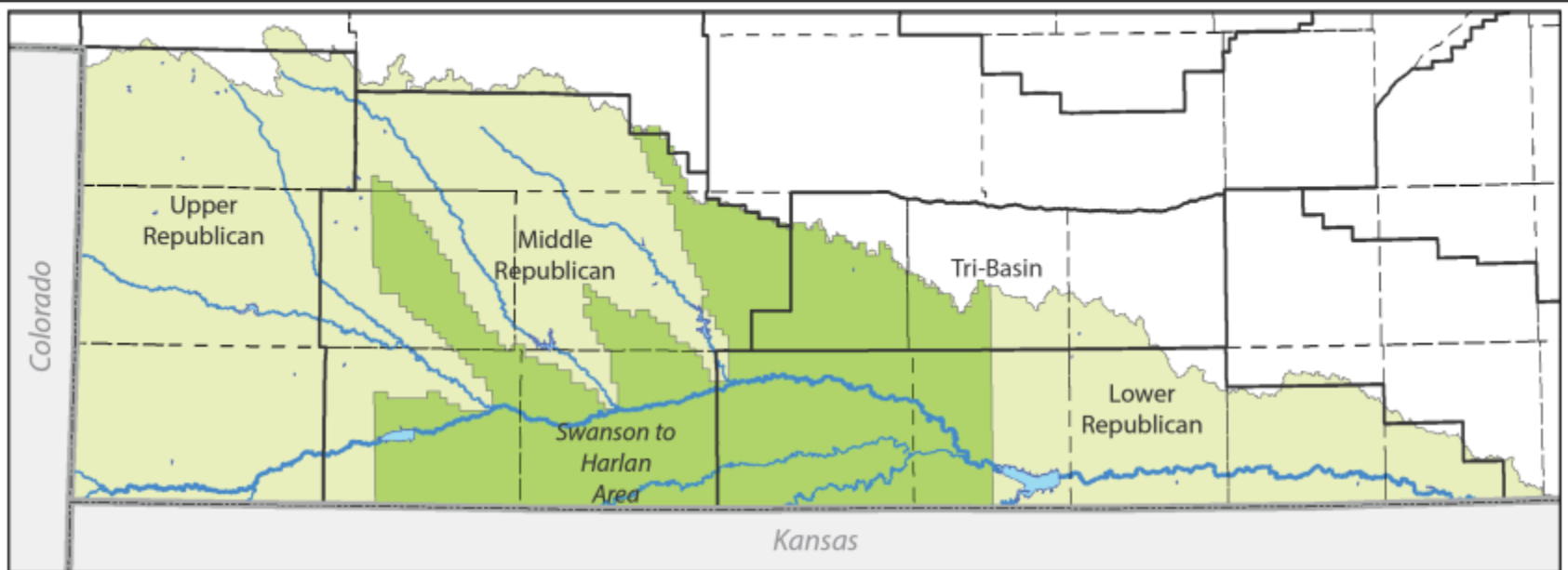
# Impacts to Frenchman Creek Subbasin



Impacts, 1950-1964 compared to 2000-2012







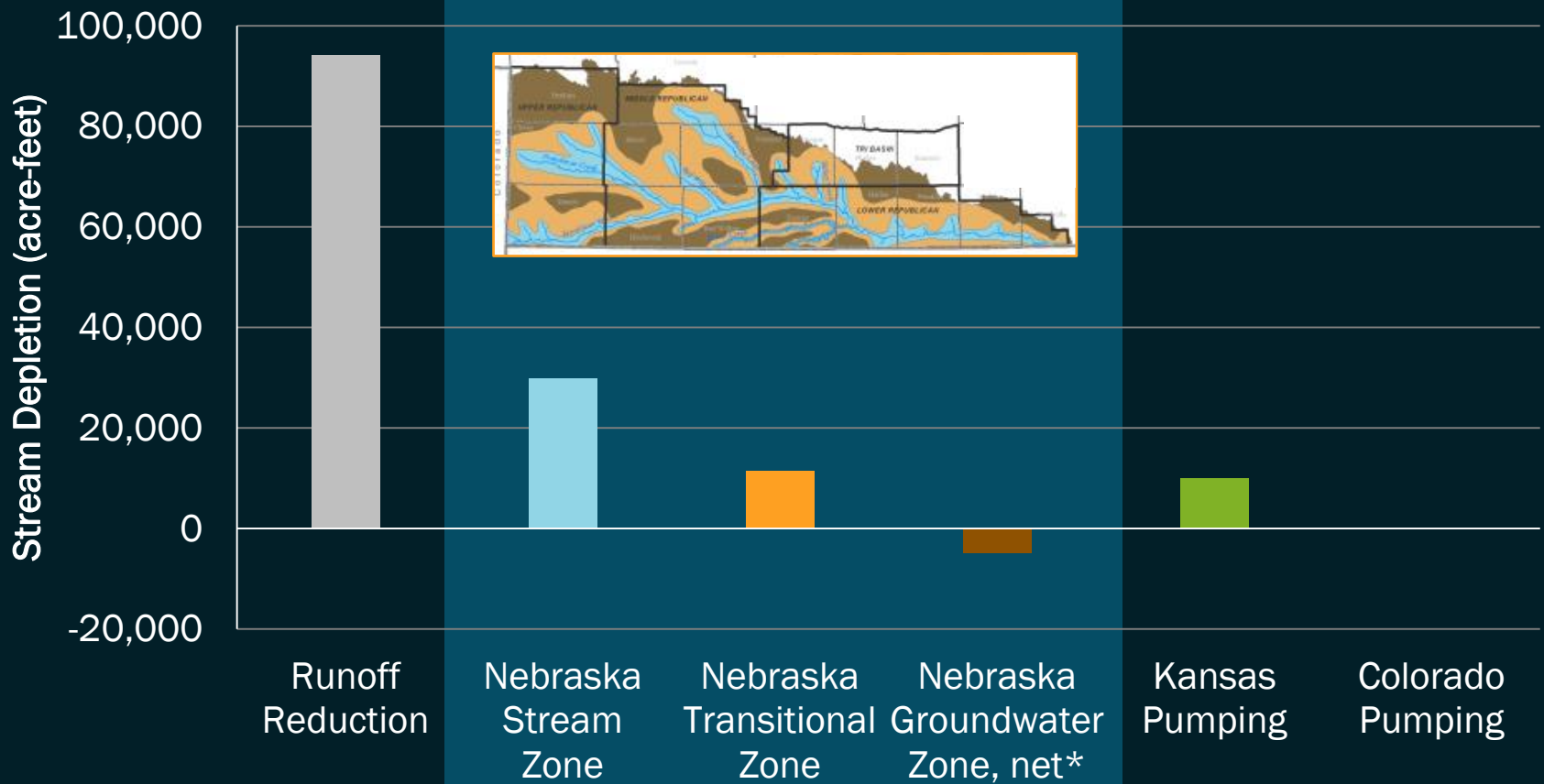
**Legend**

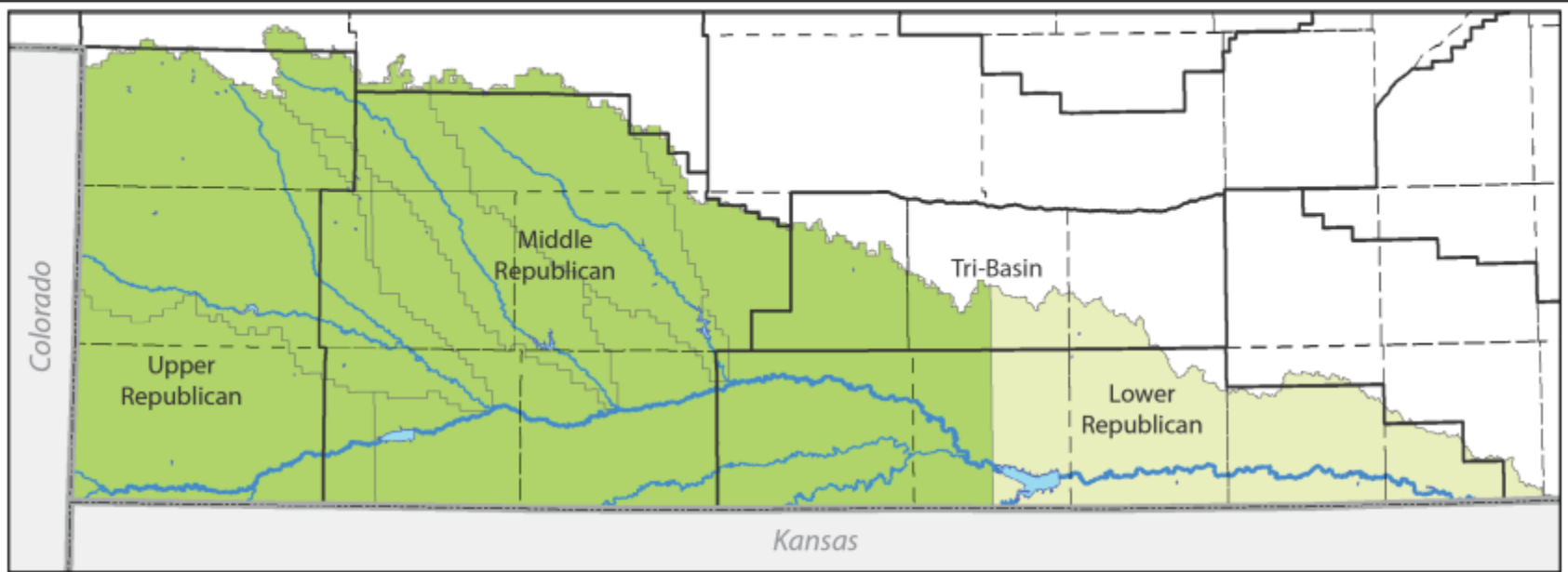
- Republican Basin (NE)
- Other States
- NRD
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- Lake
- Stream
- Subbasin of Interest

**Republican River Mainstem,  
Swanson to Harlan**

# Impacts to Mainstem, Swanson to Harlan

Impacts, 1950-1964 compared to 2000-2012





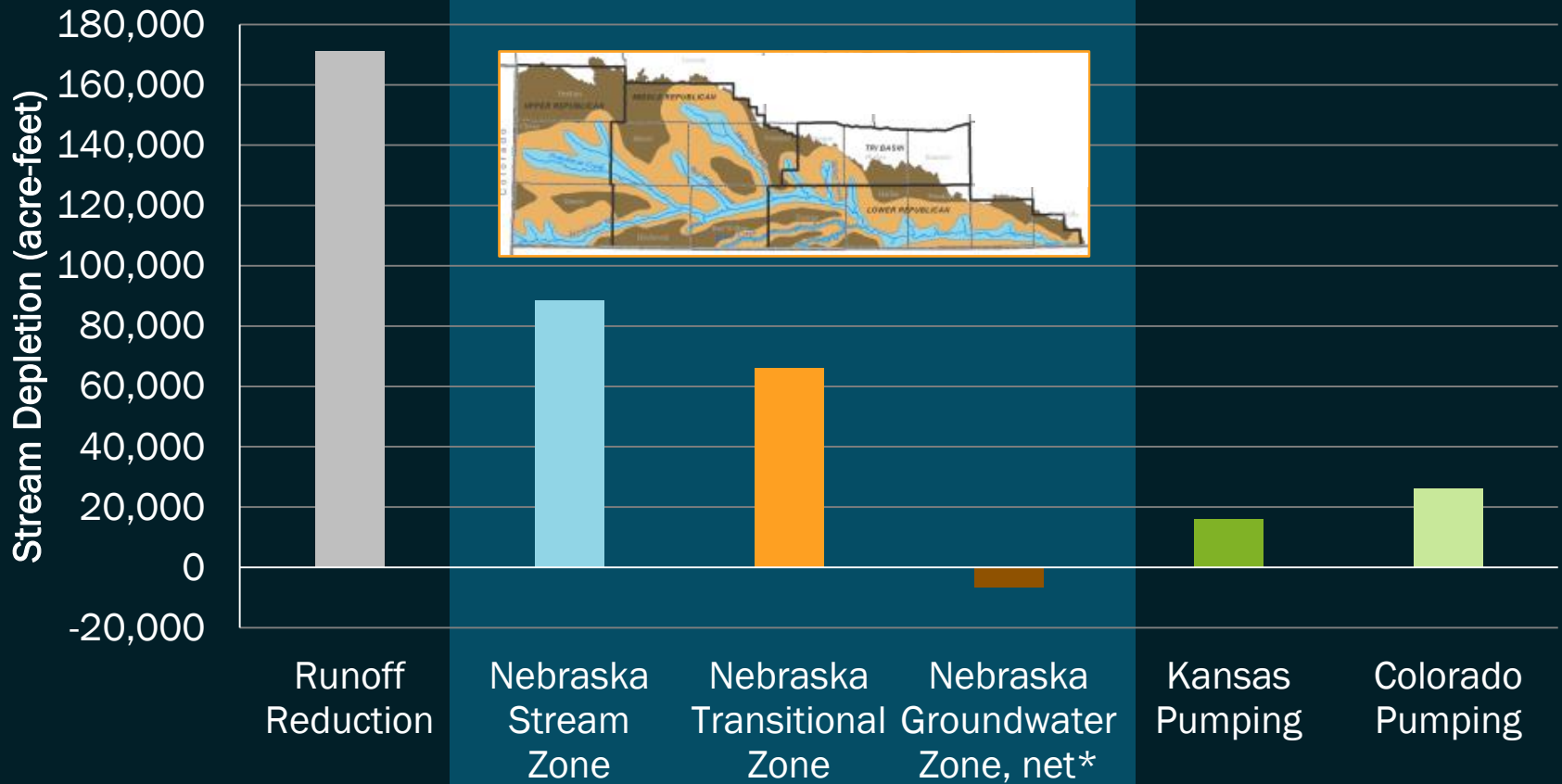
**Legend**

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

**Above Harlan County Lake**

# Total Impacts above Harlan County Lake

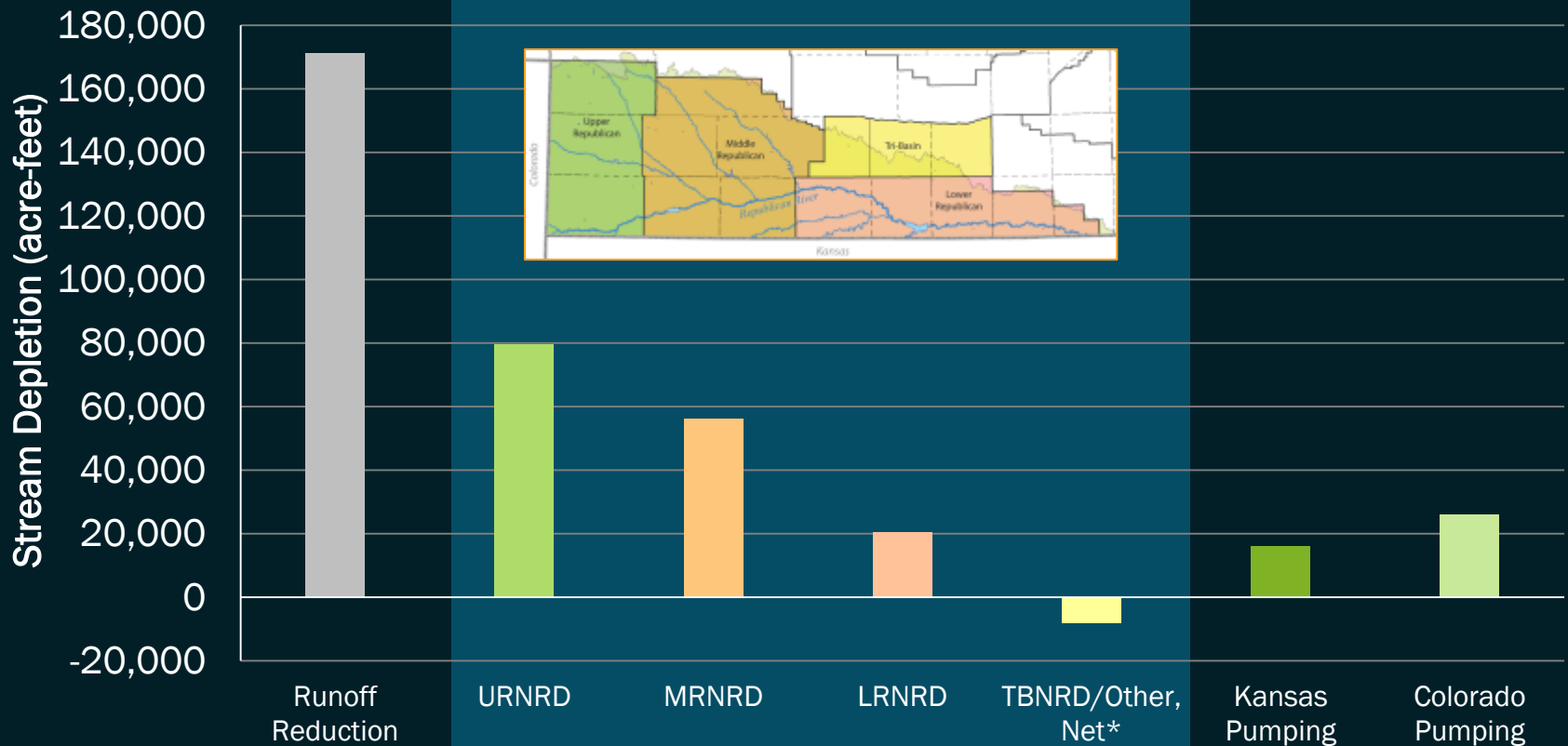
Impacts, 1950-1964 compared to 2000-2012



\*Net = Pumping impact minus imported water

# Total Impacts above Harlan County Lake

Impacts, 1950-1964 compared to 2000-2012



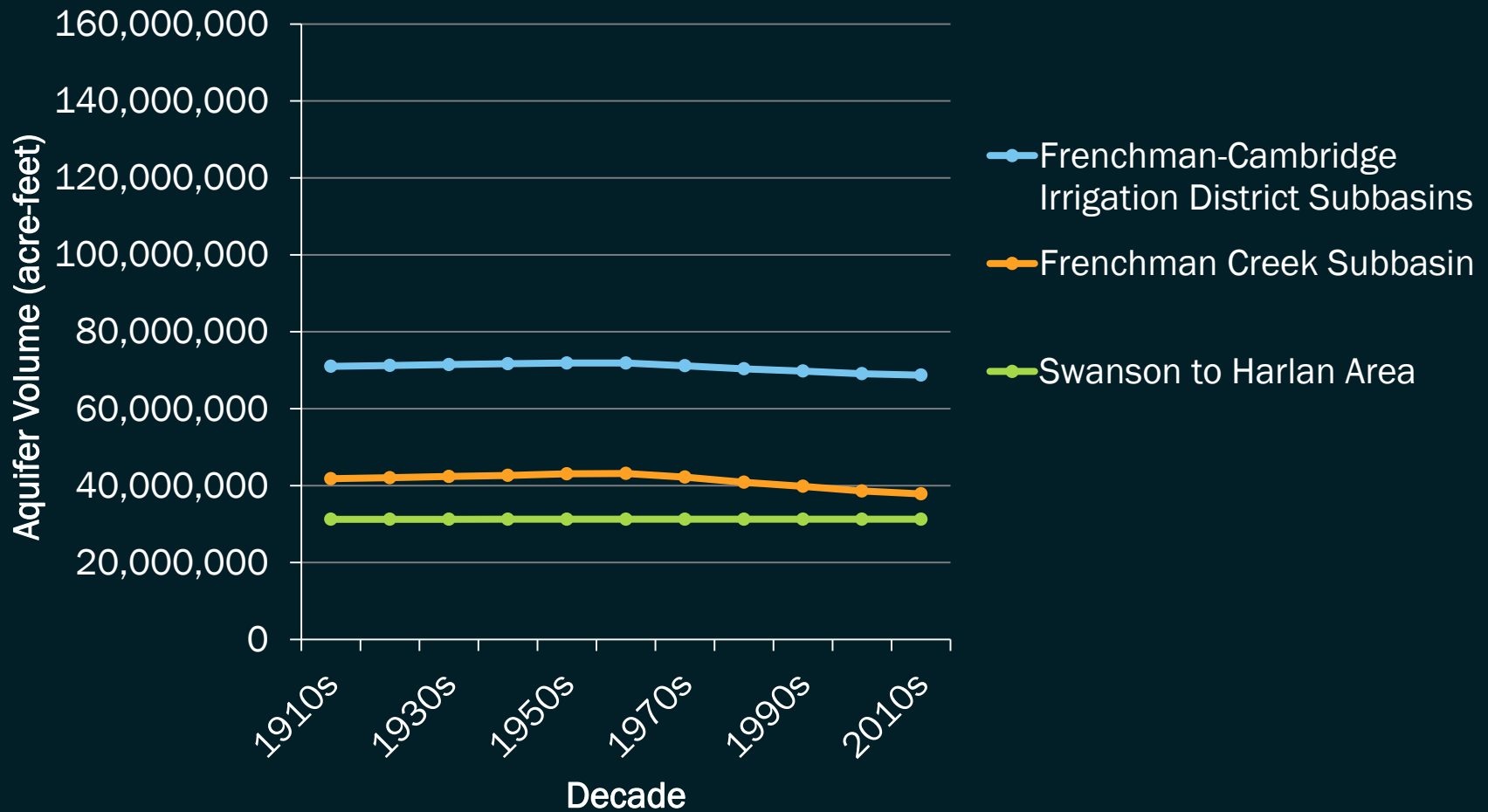
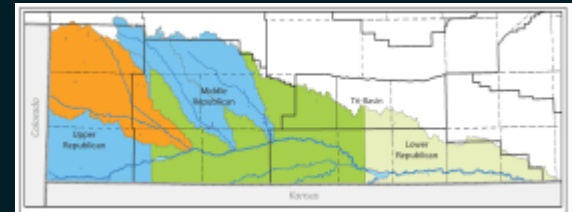
\*Net = Pumping impact minus imported water

# Questions?

# AQUIFER DEPLETION

# Aquifer Volume

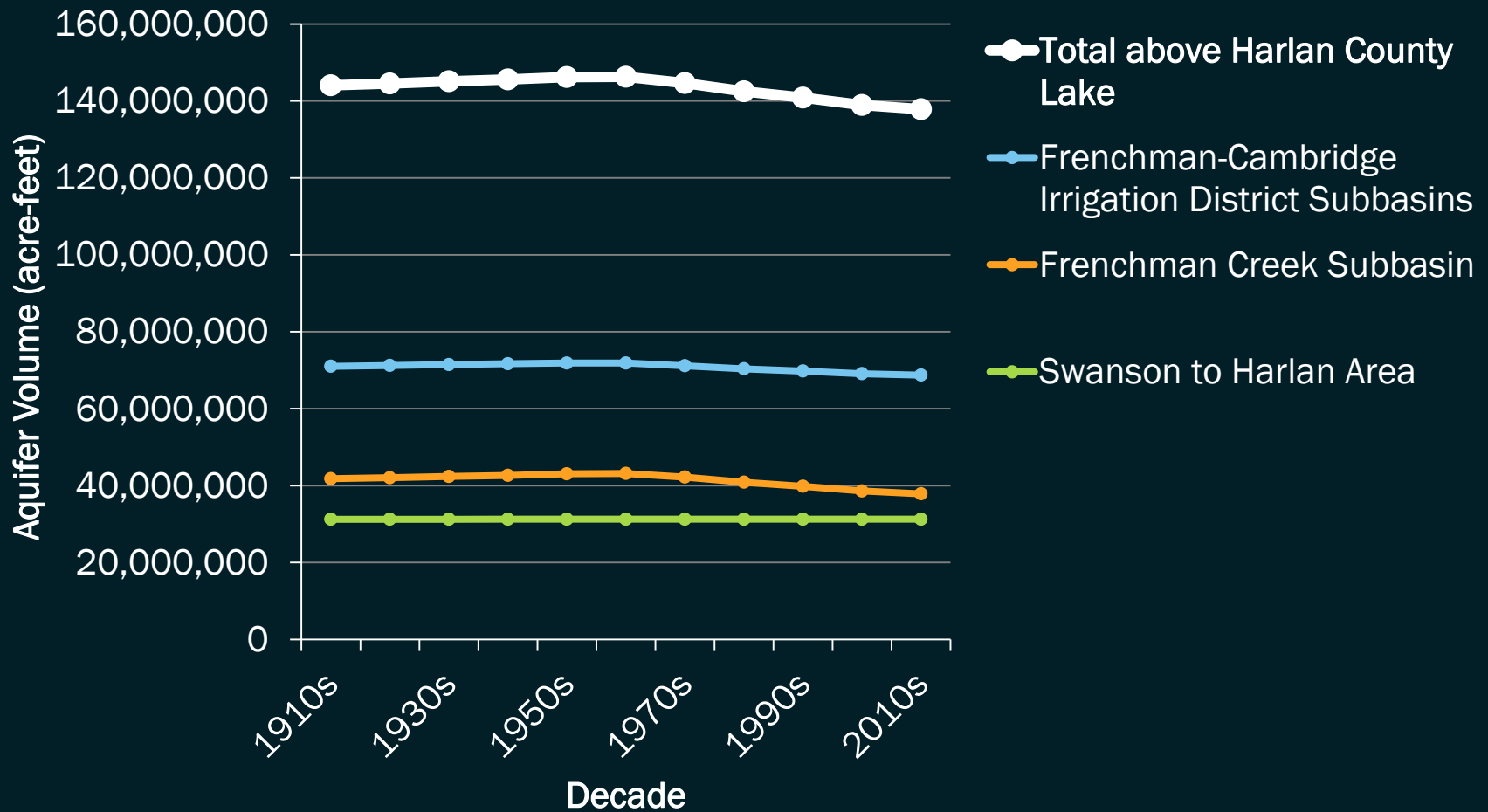
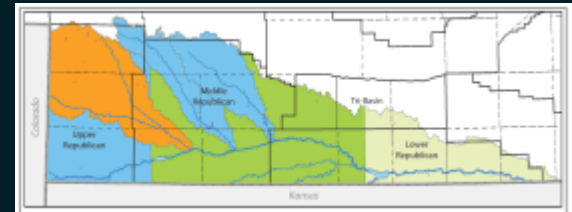
## by Subbasin



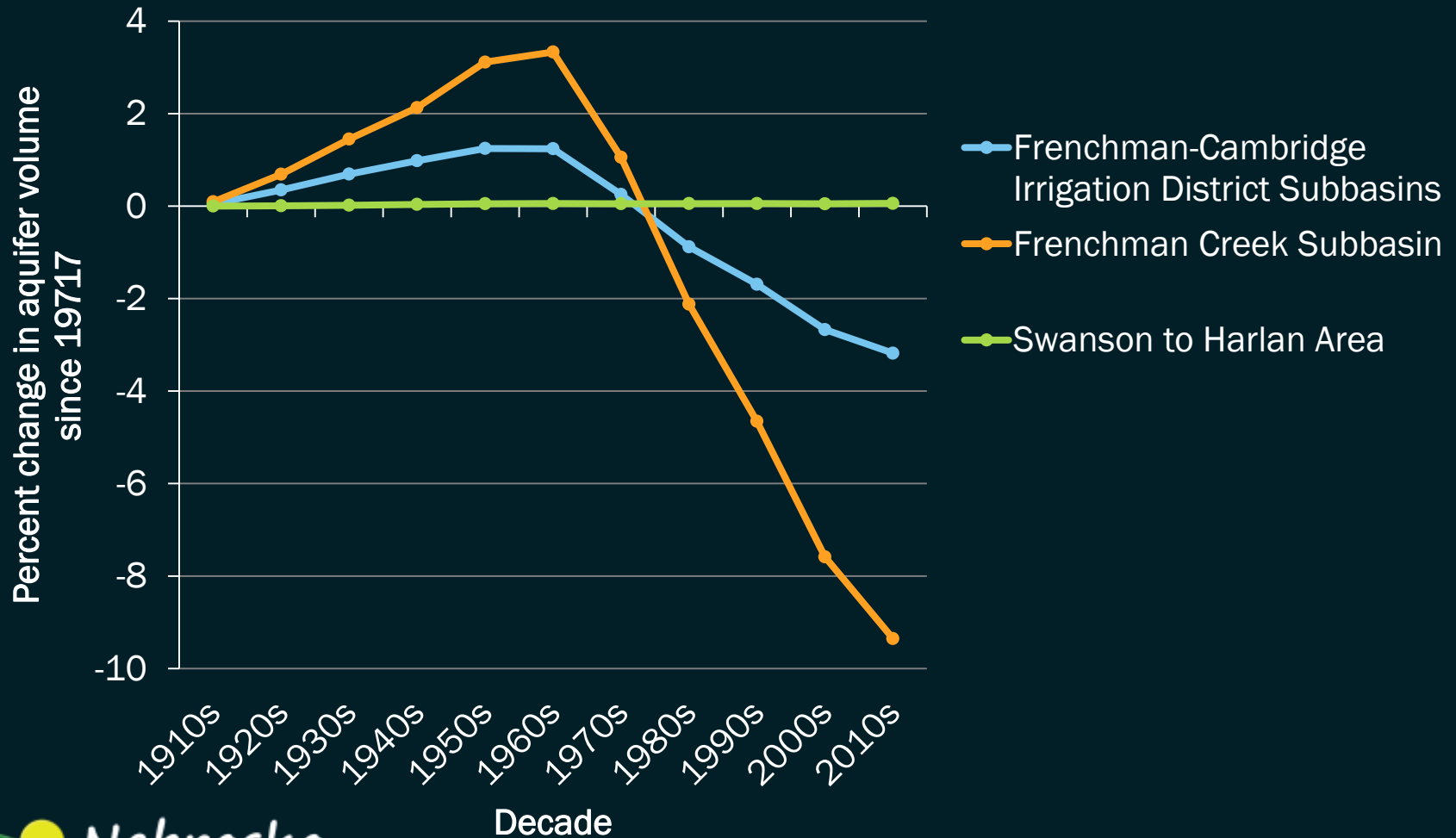
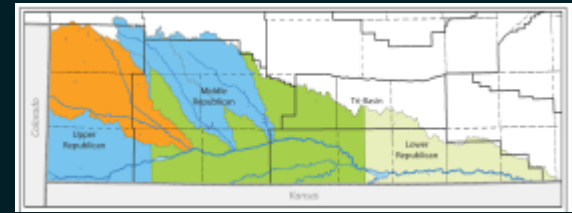


# Aquifer Volume

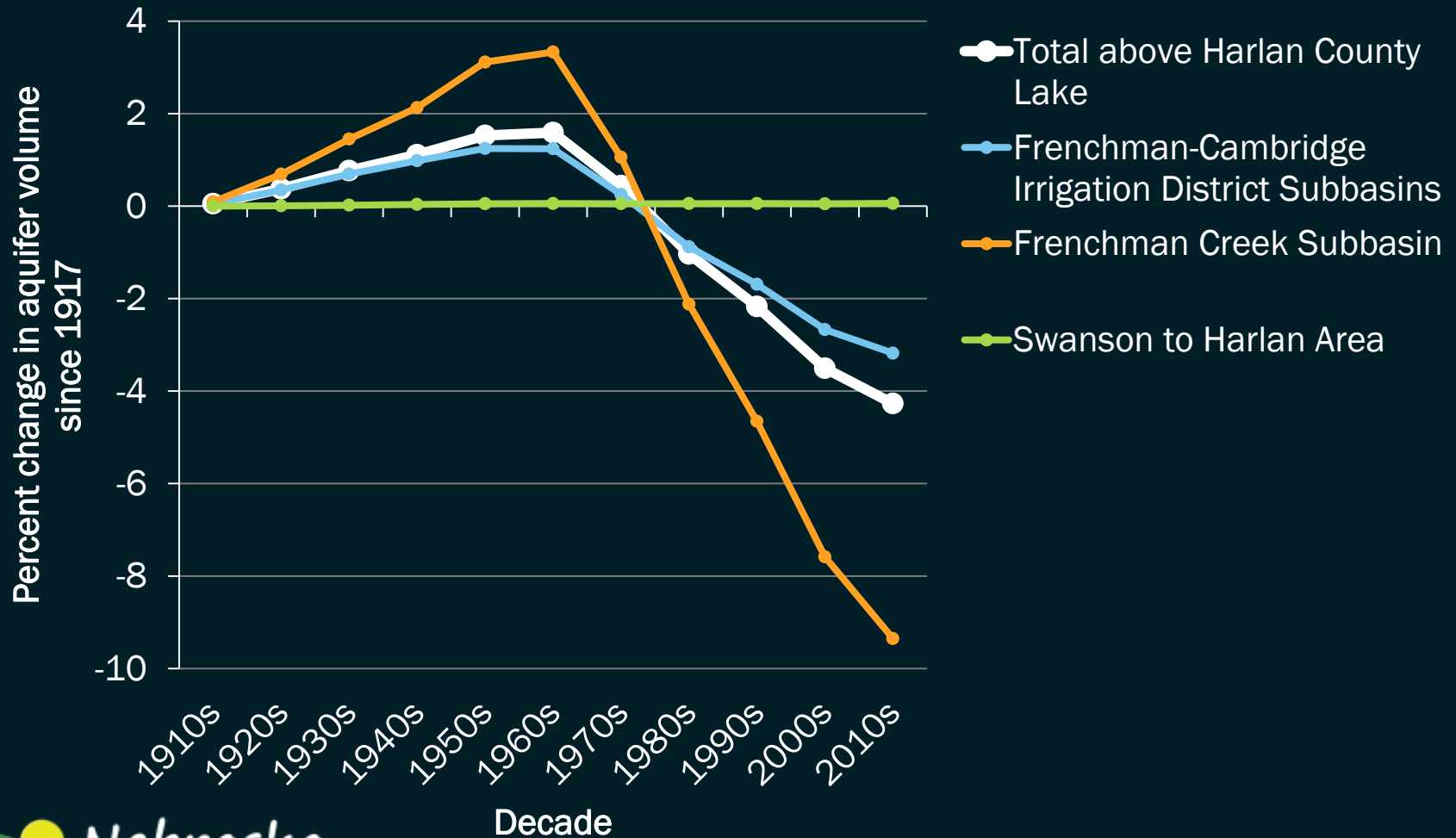
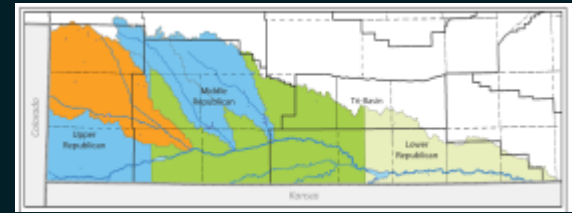
## by Subbasin



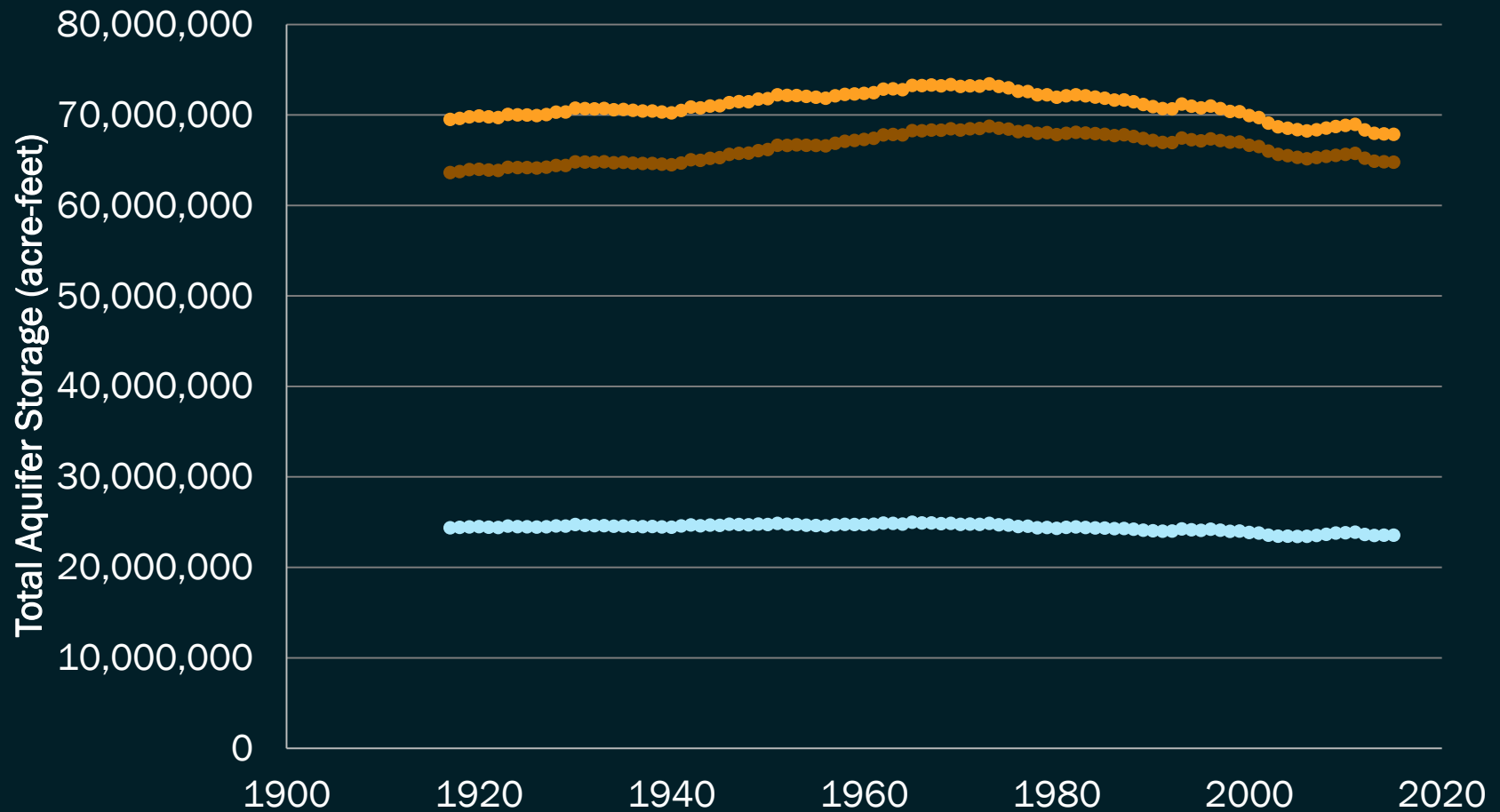
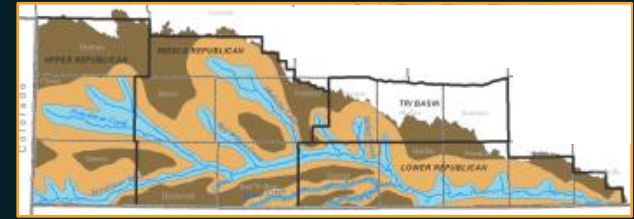
# Percent Change Since 1917 by Subbasin



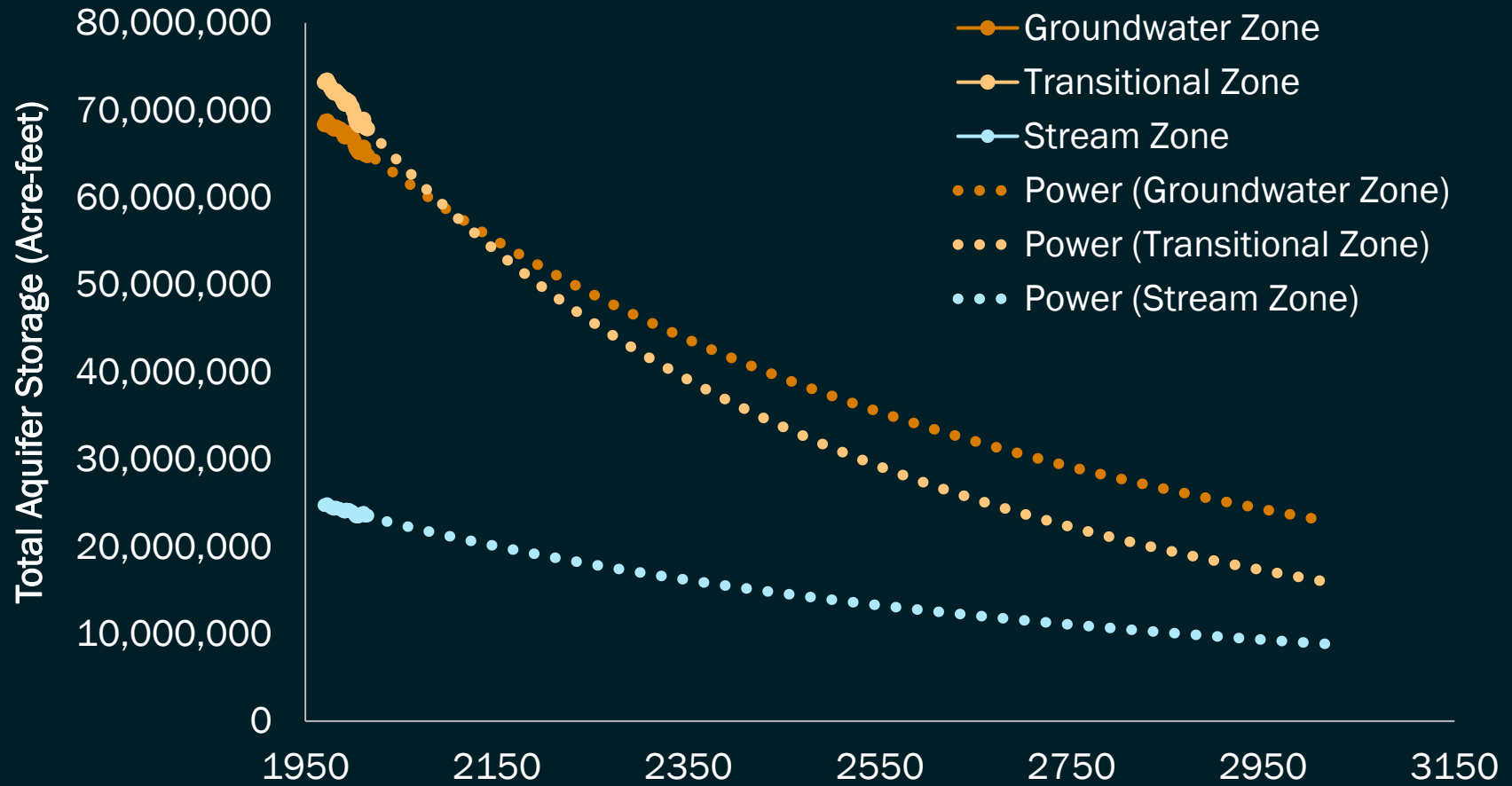
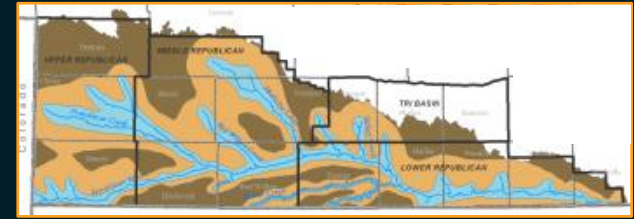
# Percent Change Since 1917 by Subbasin



# Actual Aquifer Storage by Depletion Zone



# Projection\* of Storage Reduction by Depletion Zone



\*Trends are projected 1000 years (power function) based 1970-2015 data

# Questions?



# Nebraska

## Department of Natural Resources

WATER TODAY. WATER TOMORROW.

Providing the sound science and support for managing  
Nebraska's most precious resource.

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# THANK YOU

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