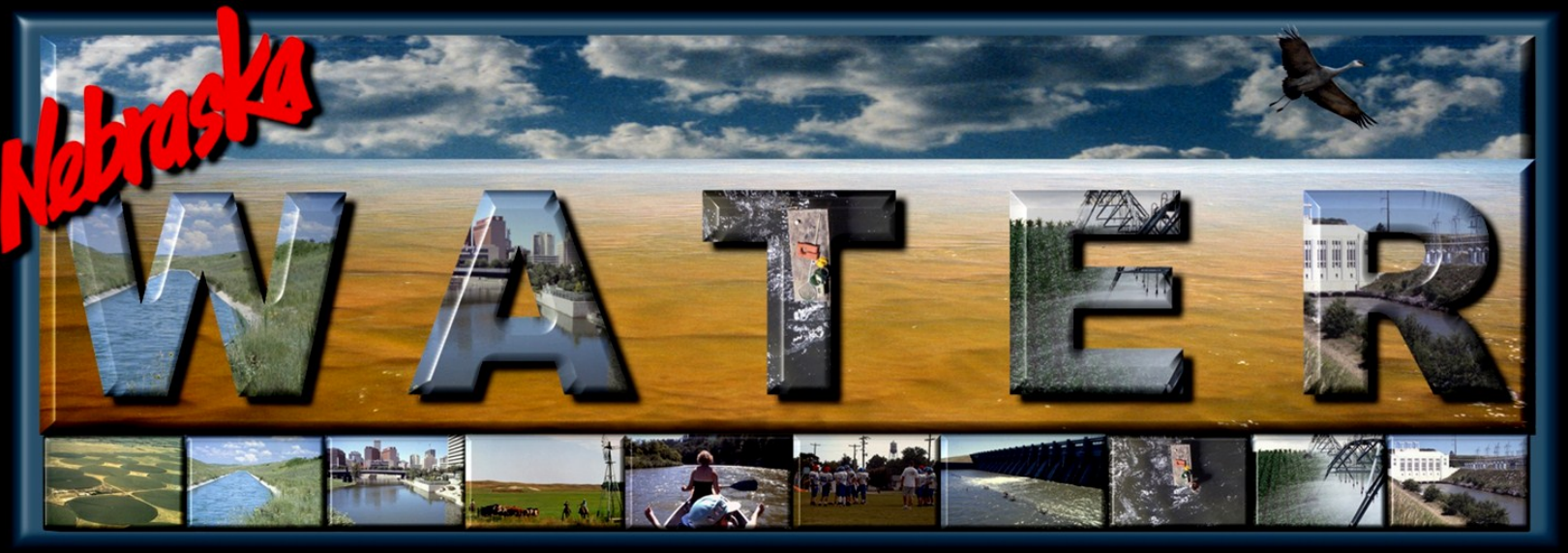

Upper Niobrara Basin Integrated Modeling: August 2012 Update

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Nebraska Department of Natural Resources

Nebraska
Department of Natural Resources

Overview

- Project Purpose & Goals
- Modeling Approach
- Status of project components
- Tentative Results & Application

Purpose

- A tool to inform management of ground and surface water
  - Needs to:
    - Establish base for forward-looking analysis
    - Be capable of evaluating conjunctive management scenarios
  - Requires such things as:
    - Quantifying uses, demands, supplies
    - Quantify and assess impacts to Niobrara River, groundwater from historic development

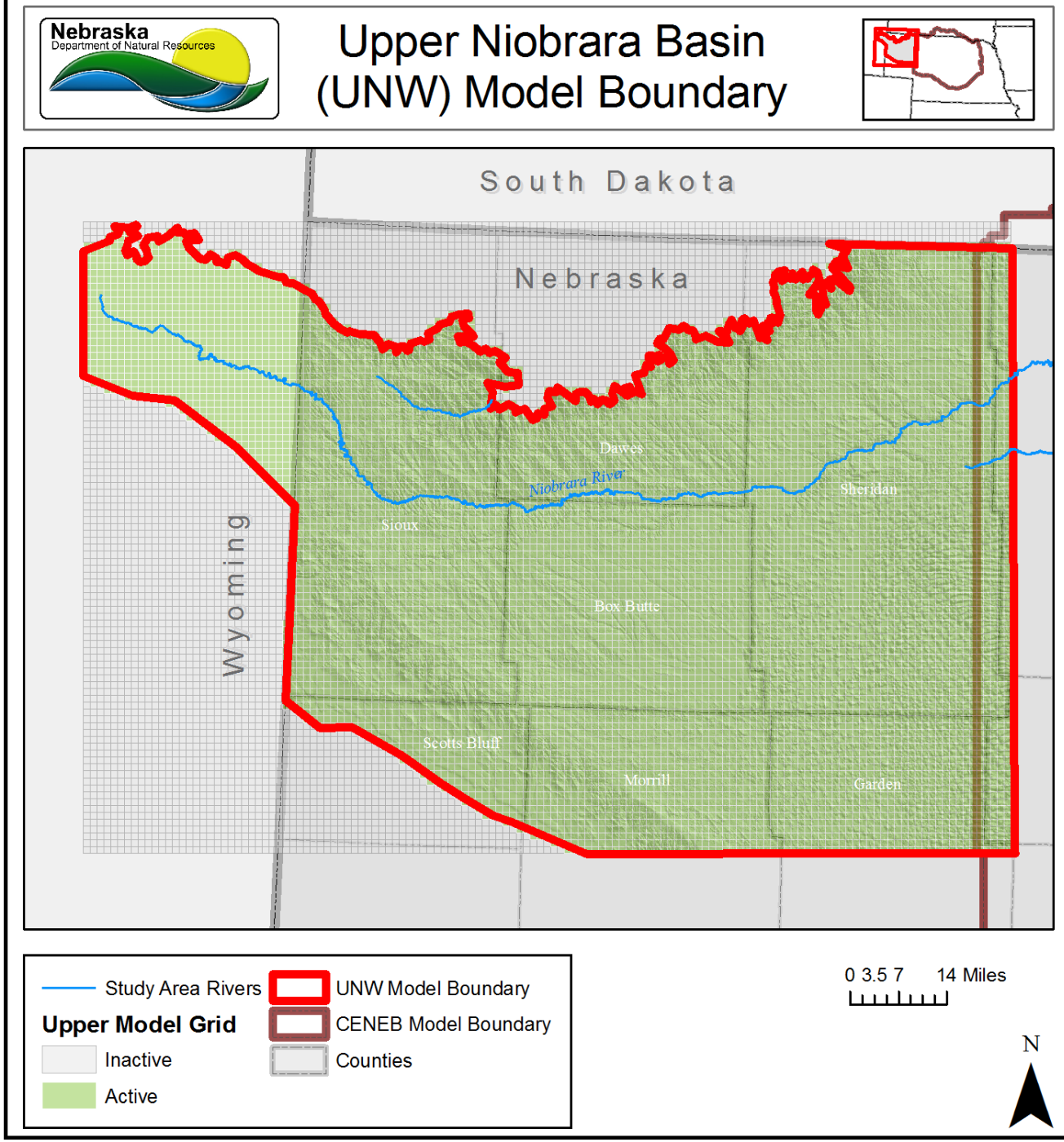
Additional Purposes

- Satisfy US Bureau of Reclamation WaterSMART grant
  - Modeling for upper Niobrara basin a part of basin-wide efforts
  - Tools to assess regional, basin water supply and management

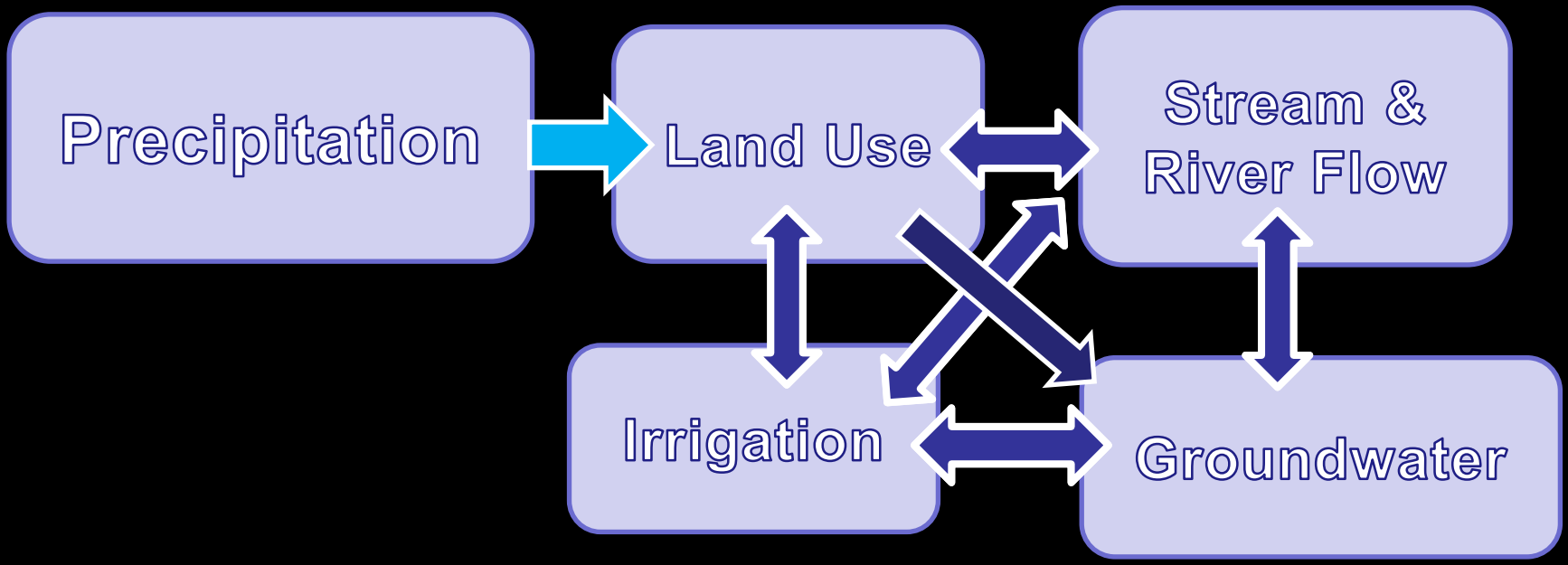
Modeling Approach

- Account for major flows of water, the regional water budget
  - Precipitation
  - Crop, plant use
  - Groundwater recharge, use
  - Flows to/from surface water
- Calculations to estimate these amounts
  - Over space and time – we do this with models

Upper Basin Model Area



Modeling Approach: Water Budget



Boxes = source, use, or body of water
Arrows = flow between different boxes

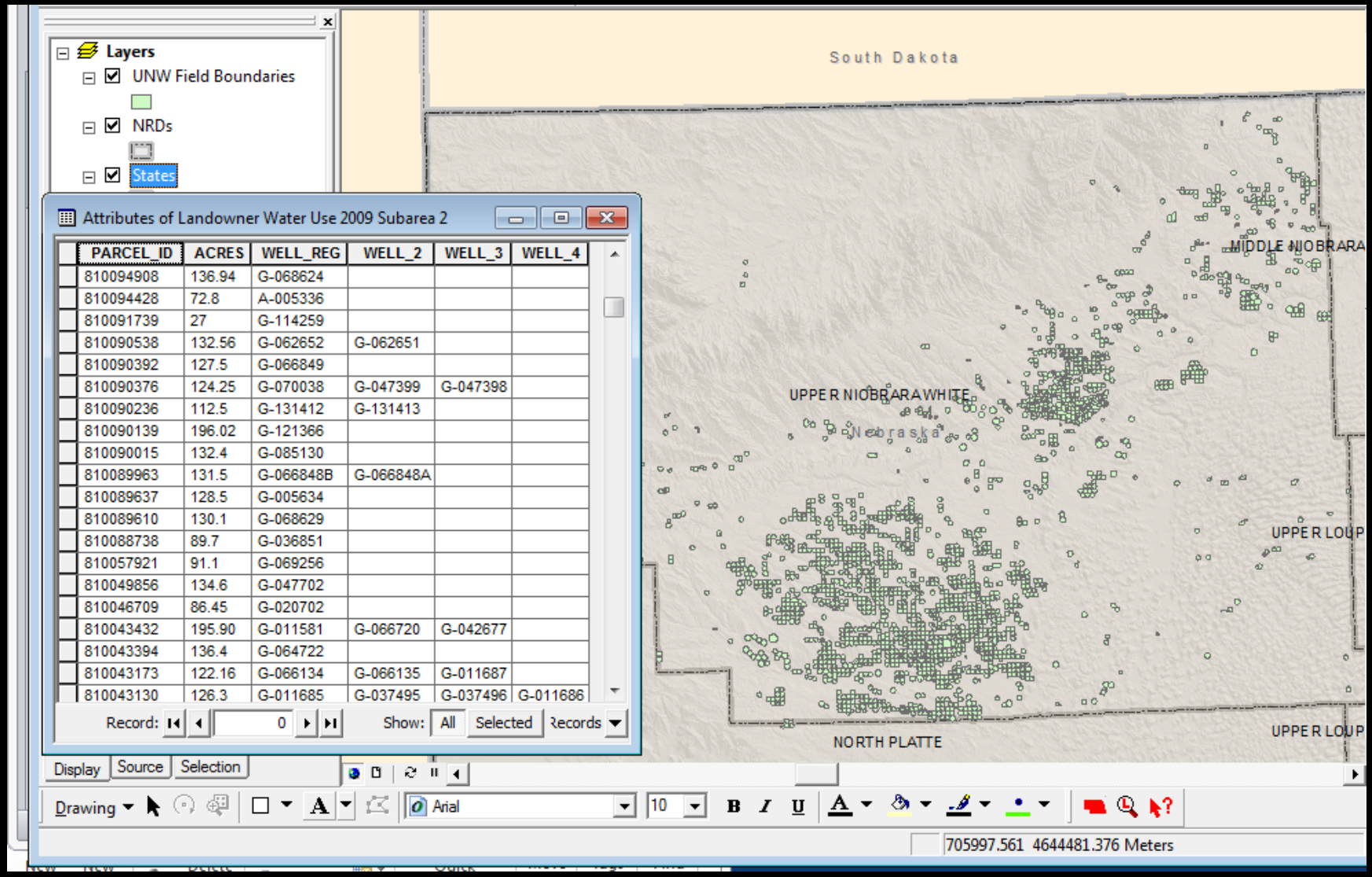
Models used to estimate volumes (boxes) and flows (arrows)

Modeling Approach: At the Land Surface

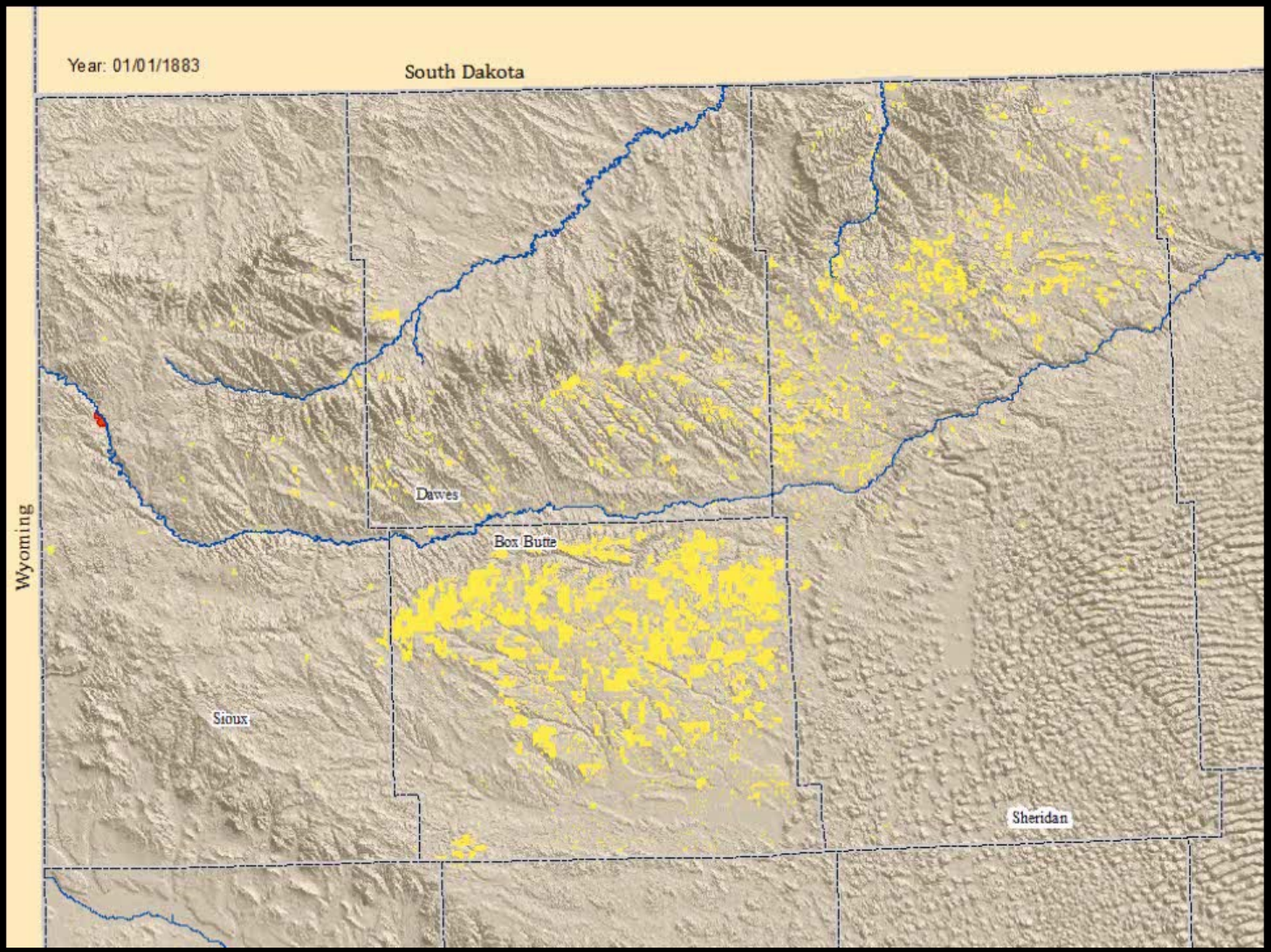
- Land use → water use
- Developed time series of land use for UNW area
  - UNWNRD certified acres integral to process
  - Annual land use dataset finalized for 1960-2010

  (Land use data extends farther – other datasets don't)

UNWNRD Certified Acres Dataset



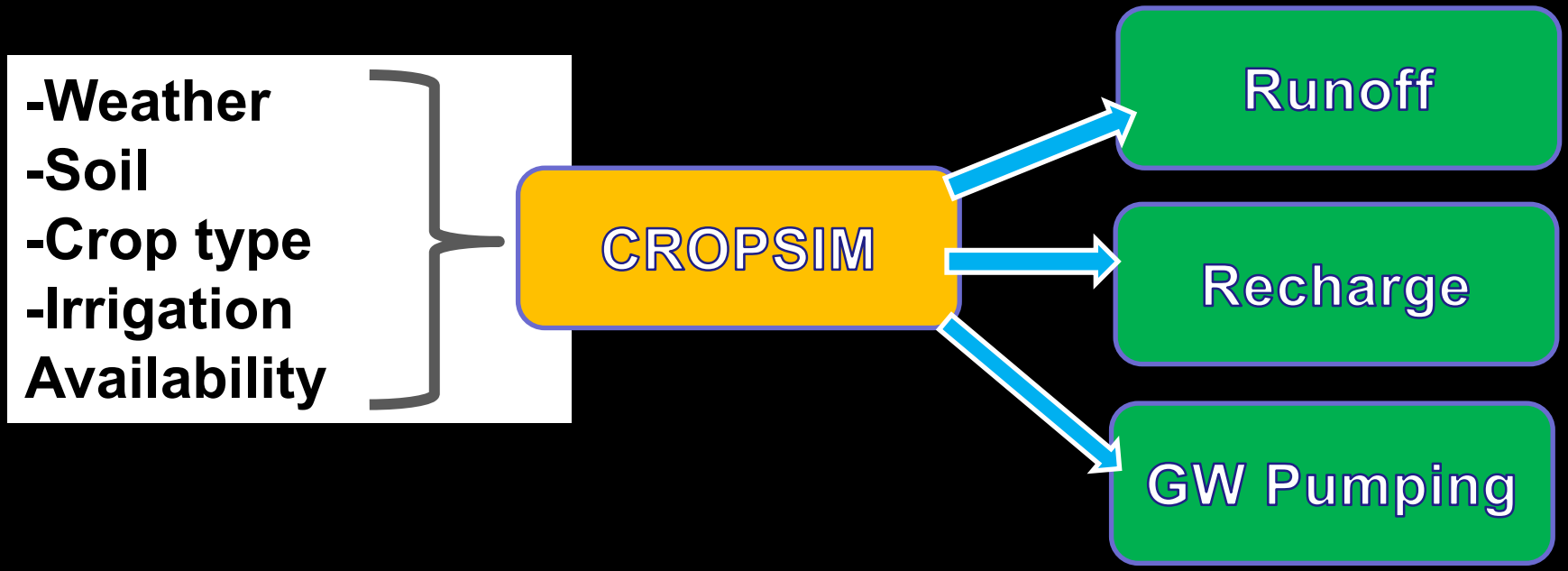
Modeling Approach: At the Land Surface



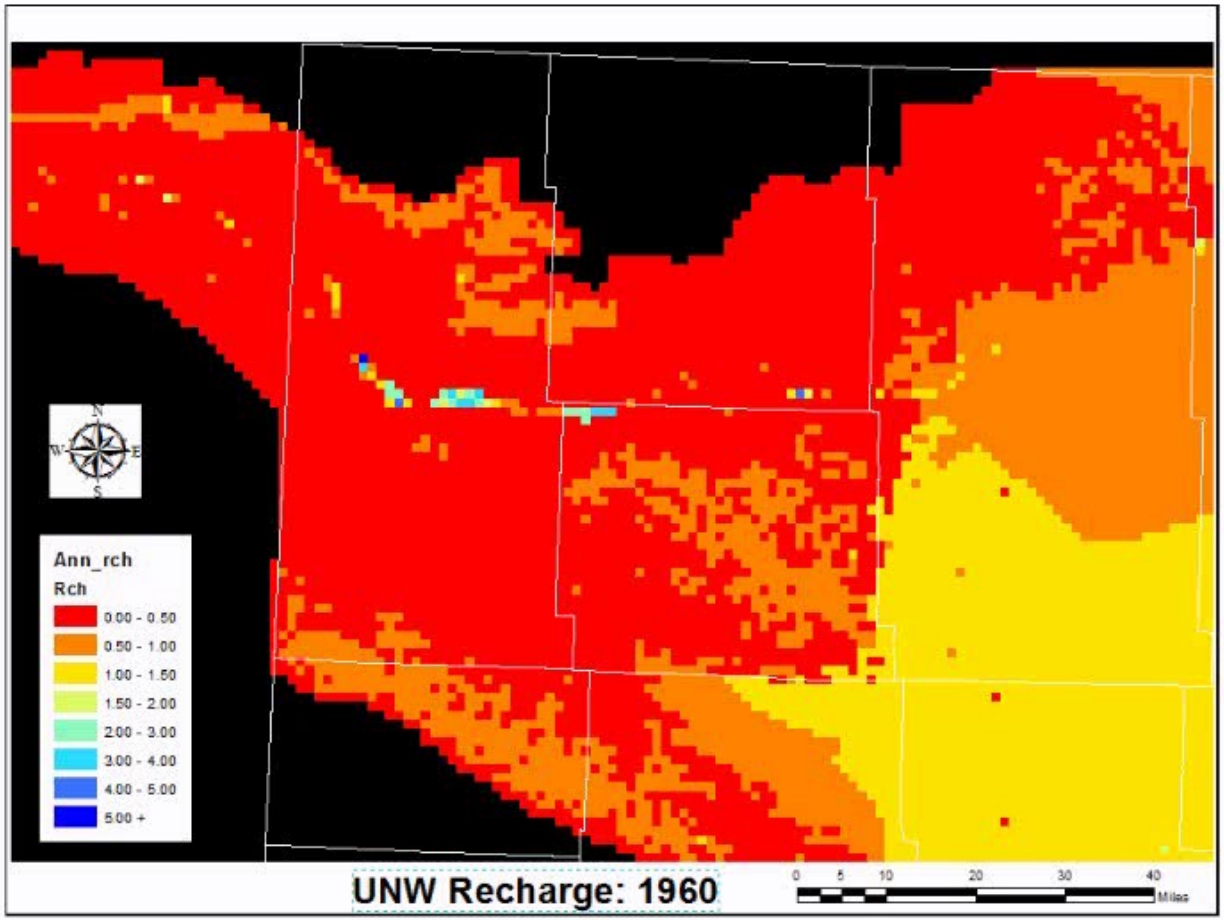
Land use → Water Use?

- CROPSIM – soil water balance model

- Partitions available 'source' water



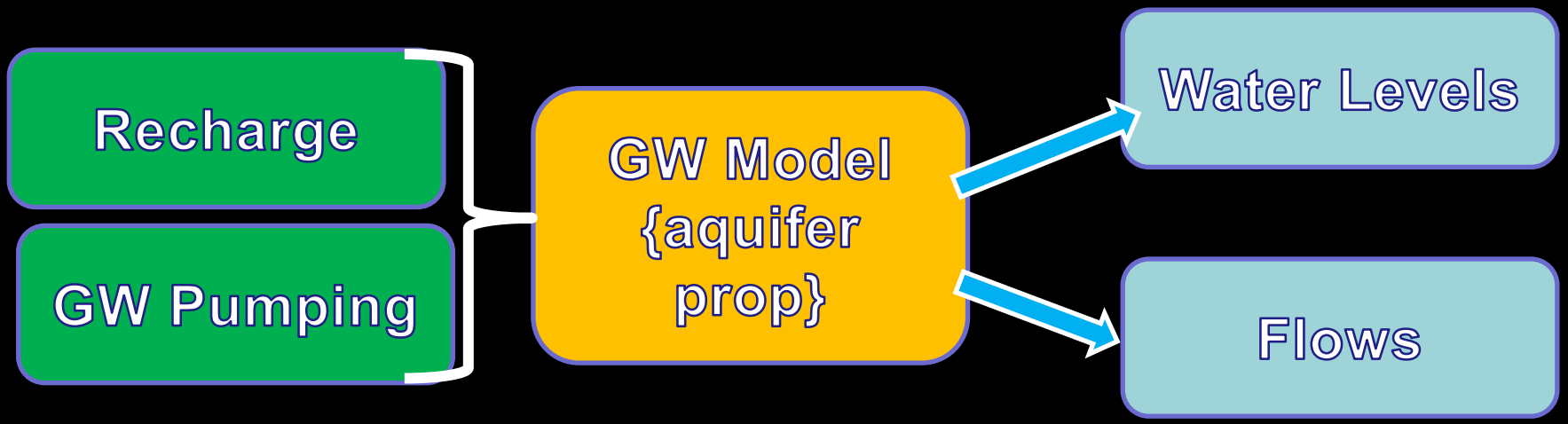
CROPSIM Annual Recharge



Modeling Approach: In the Ground

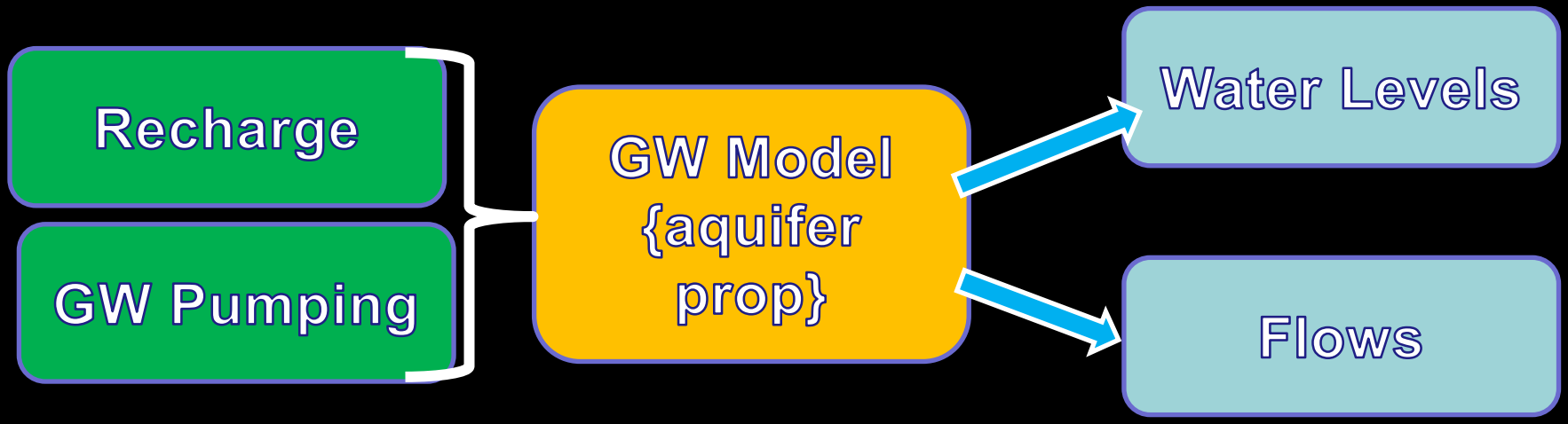
➔Estimates of groundwater pumping and recharge (from CROPSIM)

Goes to ➔ Groundwater model (MODFLOW)

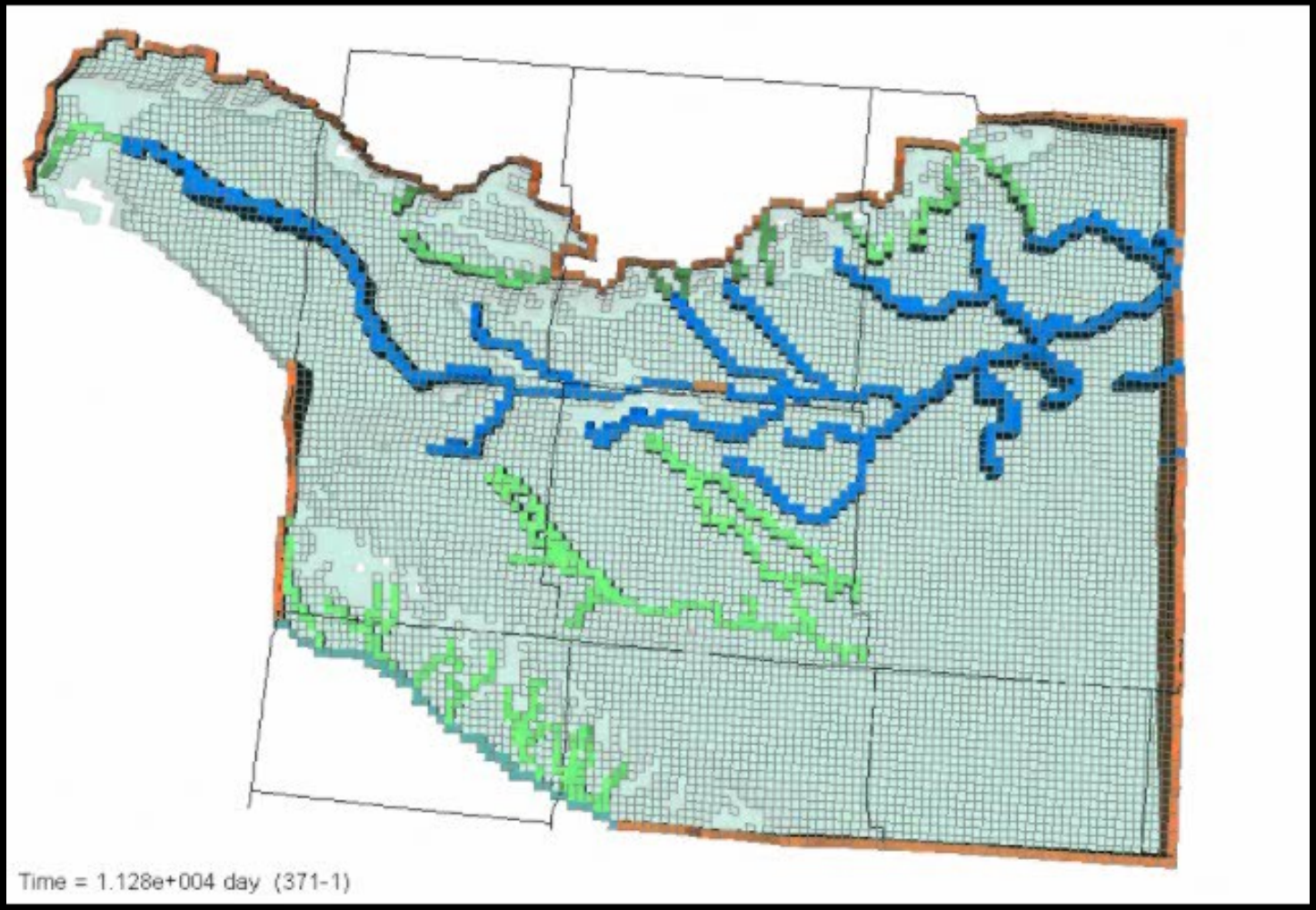


Modeling Approach: In the Ground

- ➔GW model allows:
  - ➔Simulate changes in water levels from pumping
  - ➔Assess if/how much pumping impacts surface water



Groundwater Model



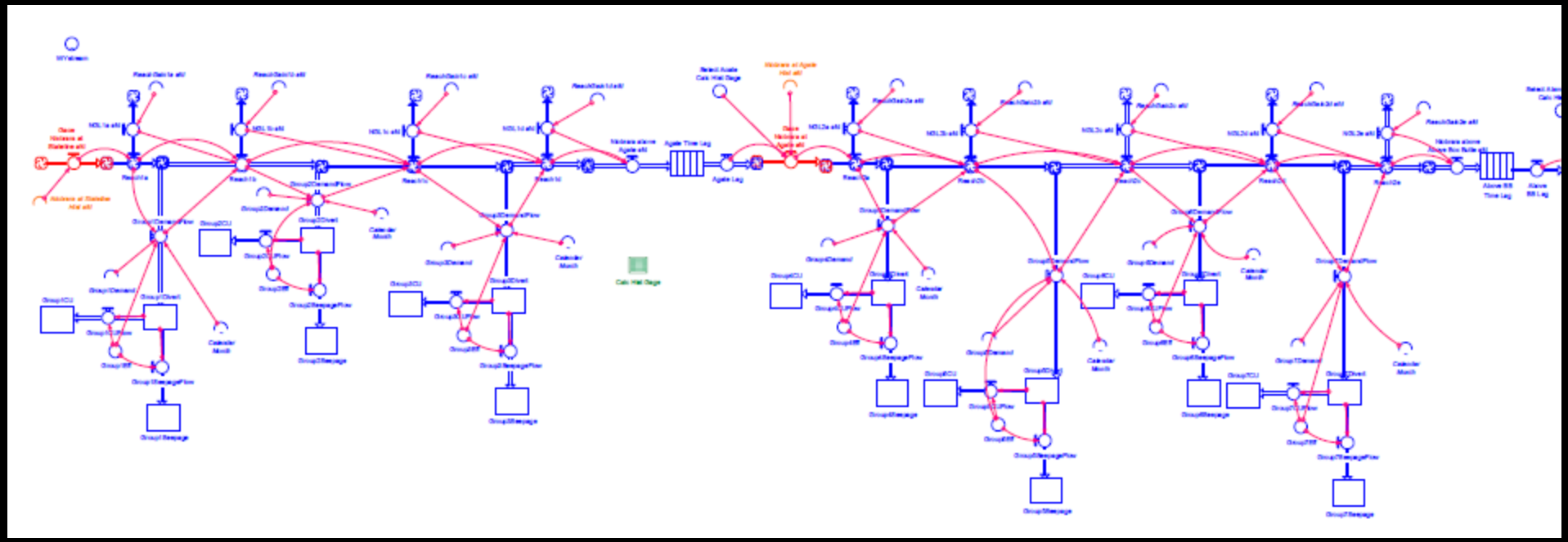
Modeling Approach: In the Rivers, Canals

- Water in rivers, streams, reservoirs
  - *To surrounding area* → canals
  - *From surrounding area* → runoff and baseflow
- How to simulate these connections, feedbacks, & rules?
  - STELLA operations tool

Modeling Approach: In the Rivers, Canals

- STELLA operations
  - Track how surface water is stored and moved through canal and reservoir infrastructure
    - *Track/simulate diversions*
    - *Estimate Box Butte Reservoir operations*
  - Can provide feedback to CROPSIM, groundwater models

Surface Water Operations Model



Project Status

- What has been done:
  - Land use dataset completed
  - Groundwater model (MODFLOW) assembled, simulating water levels and flows 1960-2010
  - CROPSIM assembled – simulating crop water usage, recharge, and pumping 1960-2010
  - STELLA operations – construction underway

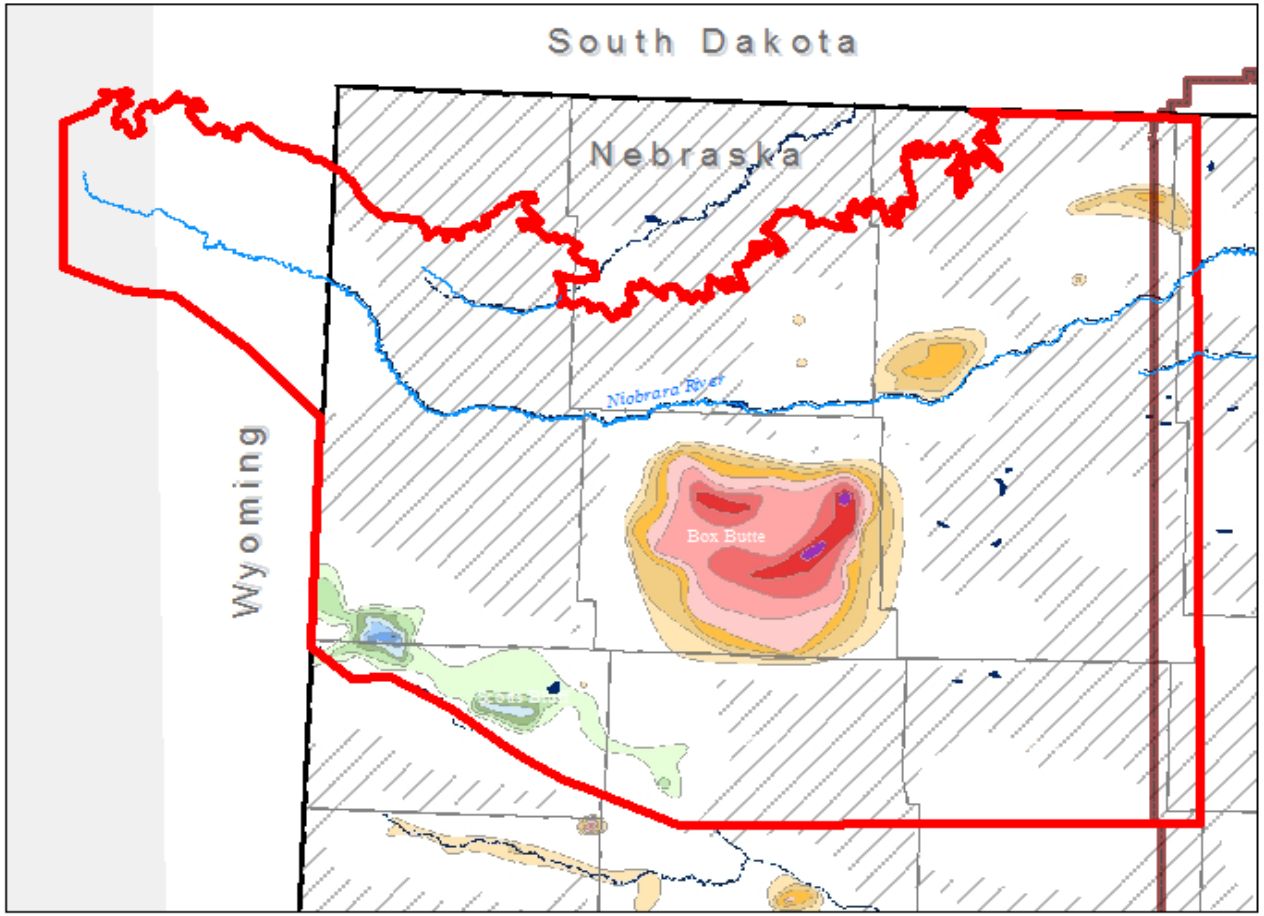
Project Status

- At present:
  - Analysis of results for models – working as we think they should?
  - Initial (rough) calibration – adjusting models to better match historic records
  - Example applications – meeting the purpose?

Results and Application

- Check model behavior in area of interest
- Groundwater Model – simulate water level declines in Box Butte County?
- Not fully calibrated yet – but a useful reality check during process

CSD Reported Drawdown
Predevelopment to Spring 2011



Study Area Rivers
UNW Model Boundary
CENEB Model Boundary
Counties

Decline in feet
0 to 10
10 to 20
20 to 30
30 to 40
40 to 50
50 to 60
60 to 70
> 70

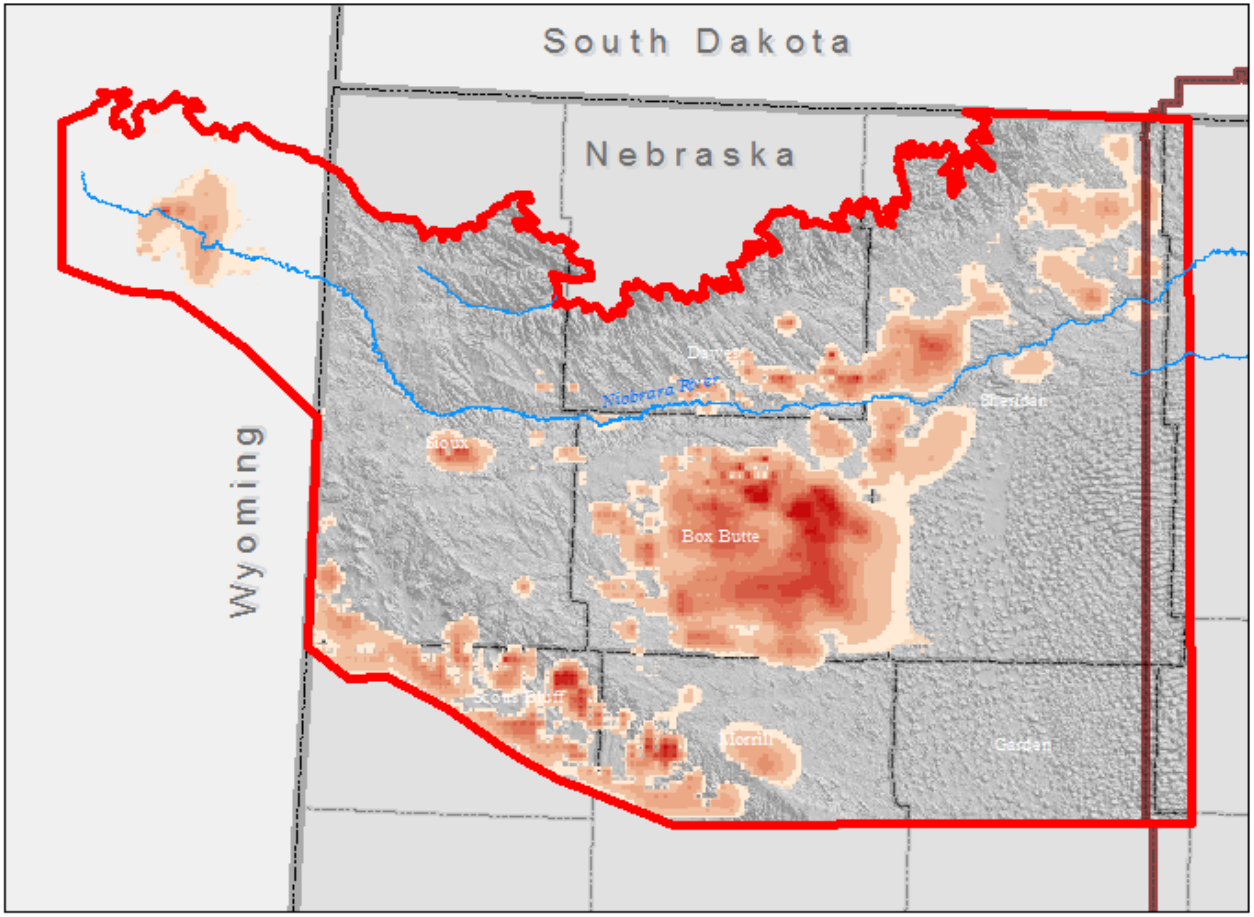
This image is a georeferenced Figure 13
from "Nebraska Statewide Groundwater-Level
Monitoring Report, 2011"
Nebraska Water Survey Paper Number 79
Conservation and Survey Division

0 5 10 20 Miles

N

Nebraska
Department of Natural Resources

Modeled Drawdown



Study Area Rivers
UNW Model Boundary
CENEB Model Boundary
Counties

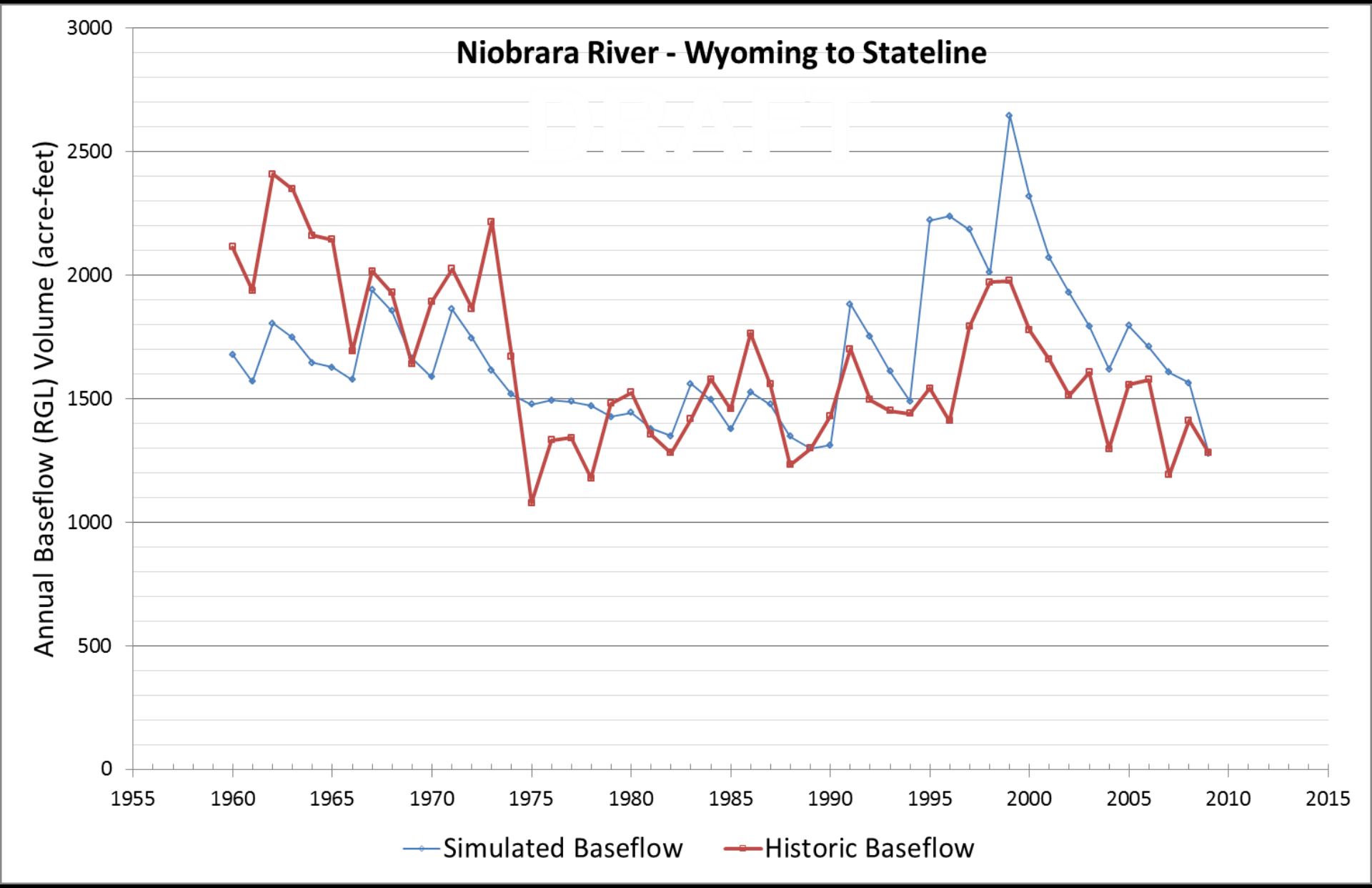
Modeled Drawdown
Low
High

0 5 10 20 Miles

N

Results and Application

- Groundwater Model – simulate flow of groundwater to Niobrara River over time?
- Understanding impacts to river important for management
- Again, models are not fully calibrated yet – but good status check during process


Niobrara River - Wyoming to Stateline
Annual Baseflow (RGL) Volume (acre-feet)
3000
2500
2000
1500
1000
500
0
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
Simulated Baseflow
Historic Baseflow

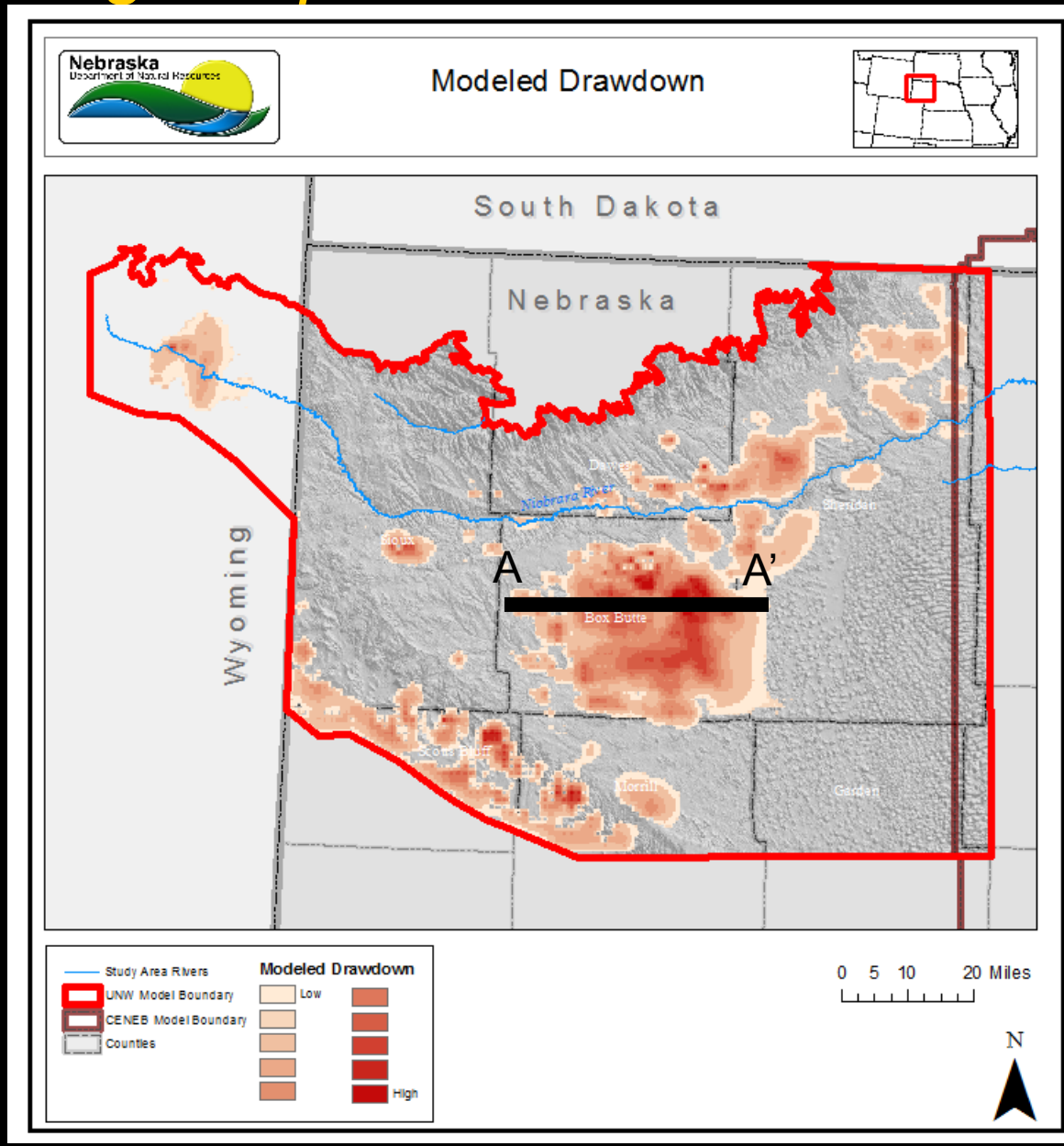
Results and Application

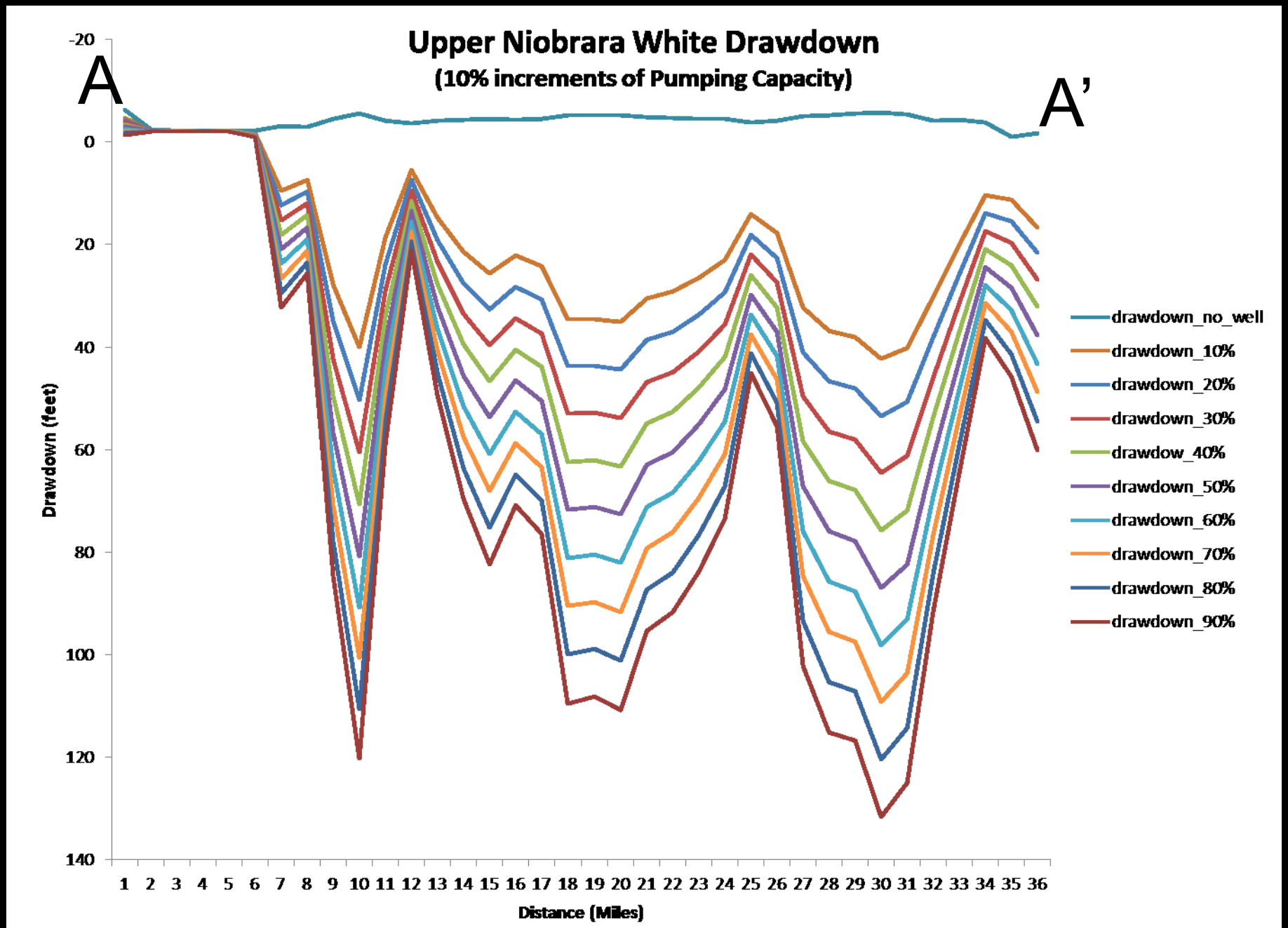
- Application – what questions can we answer with these models?
  - *Effect of reducing pumping in Box Butte County to some percentage of present values?*
  - *What are the long-term impacts of shutting down groundwater irrigation near the Niobrara River upstream of Box Butte Reservoir?*
  - *How might transfers of groundwater irrigation away from the river impact baseflow gains?*

Effect of reducing pumping in Box Butte County to some percentage of present values?

-Full analysis pending model completion

-"Back of the envelope" for now – manually adjust pumping inputs to groundwater model

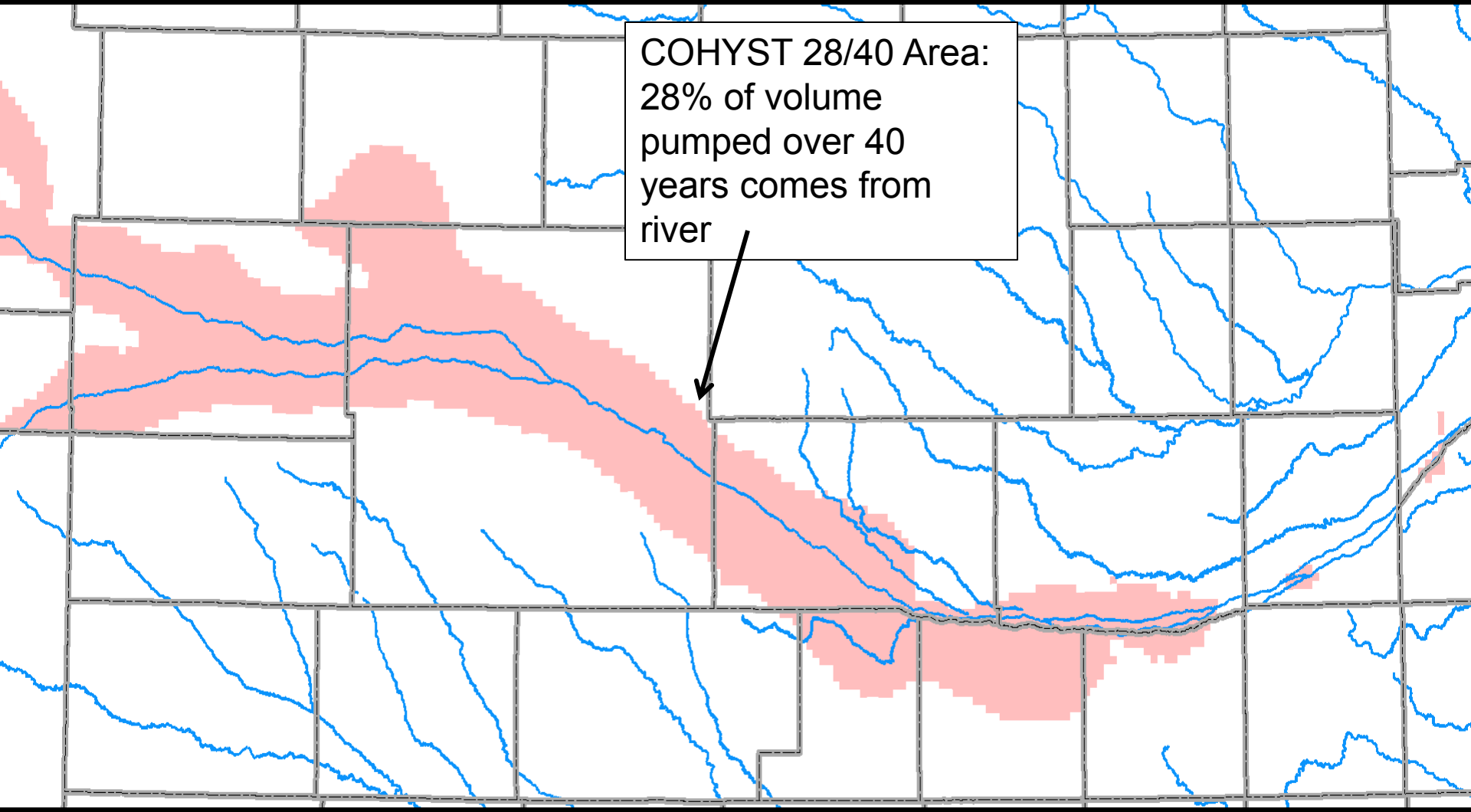



Upper Niobrara White Drawdown
(10% increments of Pumping Capacity)
A
A'
-20
0
20
40
60
80
100
120
140
Drawdown (feet)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36
Distance (Miles)
drawdown_no_well
drawdown_10%
drawdown_20%
drawdown_30%
drawdow_40%
drawdown_50%
drawdown_60%
drawdown_70%
drawdown_80%
drawdown_90%

How might transfers of groundwater irrigation away from the river impact baseflow?

- Numerical model like MODFLOW can be used to estimate stream depletion impacts
- 28/40 mapping → 28% of volume of water pumped over 40 years comes from the river
- Applied in the Platte & elsewhere, can be a useful tool

– *How might transfers of groundwater irrigation away from the river impact baseflow?*



Summary

- Work done:
  - Dataset development, GW and crop water use model construction, rough calibration
- Present status:
  - Stable runs, ‘gut check’ analysis favorable, developing surface water operations model
- Future work:
  - Fine tune adjustments to models – better match history, finalize STELLA operations, further detail scope of analysis

Nebraska
Department of Natural Resources

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