



# *Hydrogeologic Study of the Laramie County Control Area*

AMEC Environment & Infrastructure, Hinckley Consulting, and HDR  
Prepared for the Wyoming State Engineer's Office - March 2014

Informal Overview for Laramie County Commission Workshop  
December 1, 2014

- Bern Hinckley

Organization (slides assembled from various sources):

Introduction / Orientation

Hydrogeology

Geology

Groundwater

Groundwater Development

Development Impacts

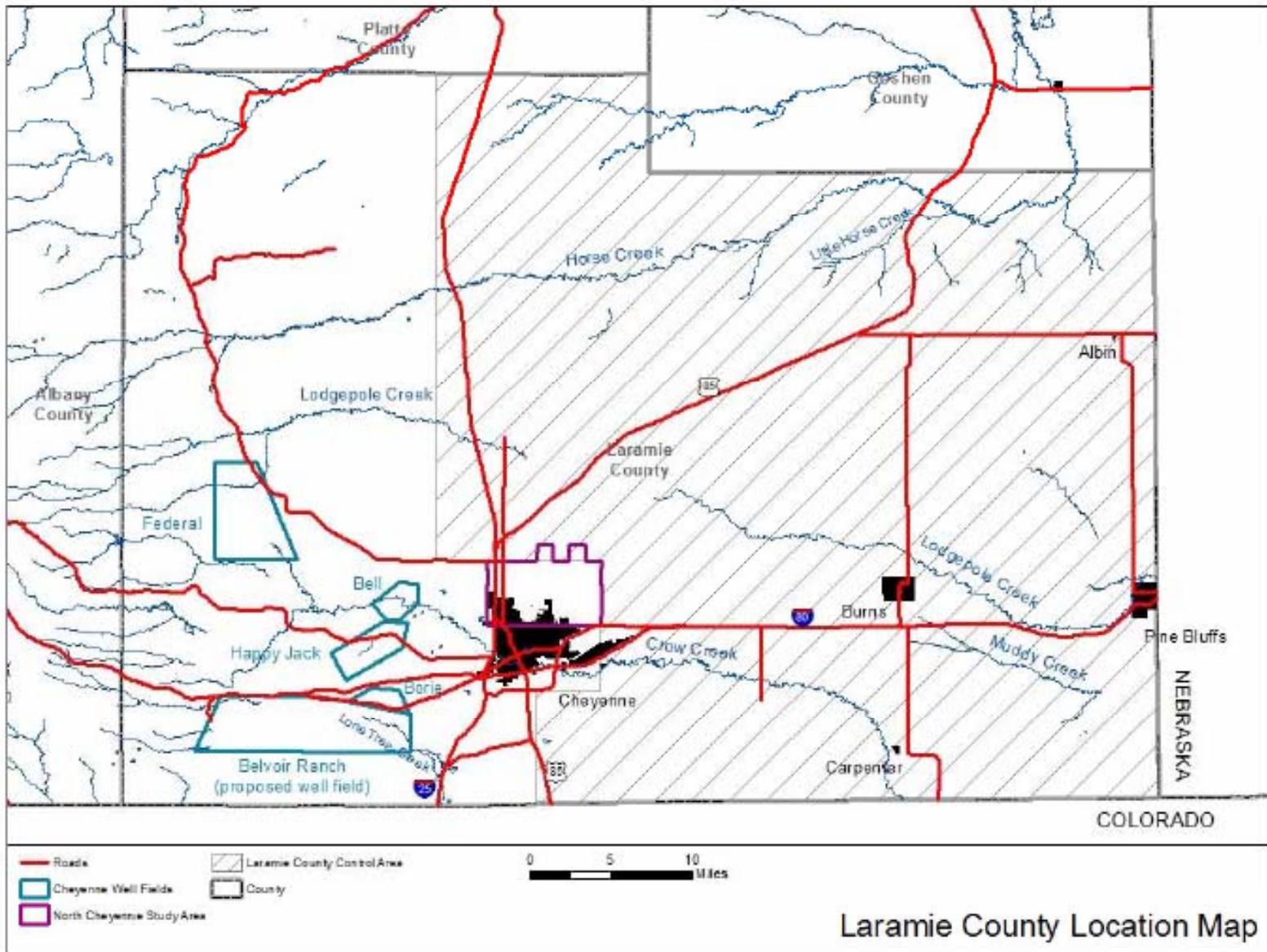
Groundwater Modeling

Development

Results

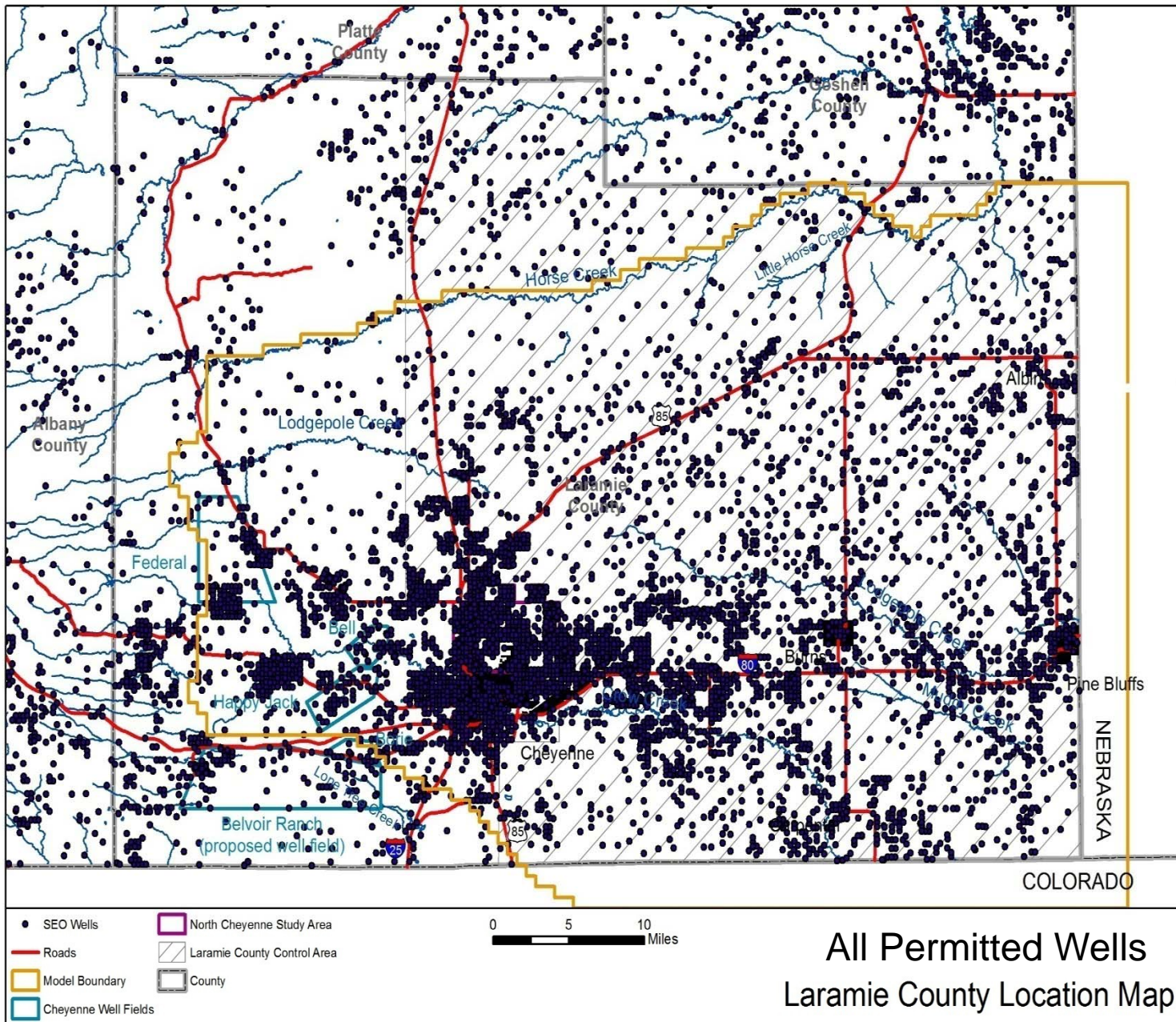
Questions / Comments

see full report on WSEO website



Laramie County Location Map

Figure 1.1 Laramie County Location Map



All Permitted Wells  
Laramie County Location Map

# Project Objectives

- Inform future groundwater management decisions
- Determine status of appropriable water
- Provide sound and defensible science to support any control measures that might be adopted



April 11, 2012

**FROM THE OFFICE OF THE WYOMING STATE ENGINEER**

**TEMPORARY ORDER ADOPTING WELL SPACING REQUIREMENTS WITHIN  
THE LARAMIE COUNTY CONTROL AREA**

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USGS

Dahlgren Consulting

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Lidstone and Associates

JR Engineering

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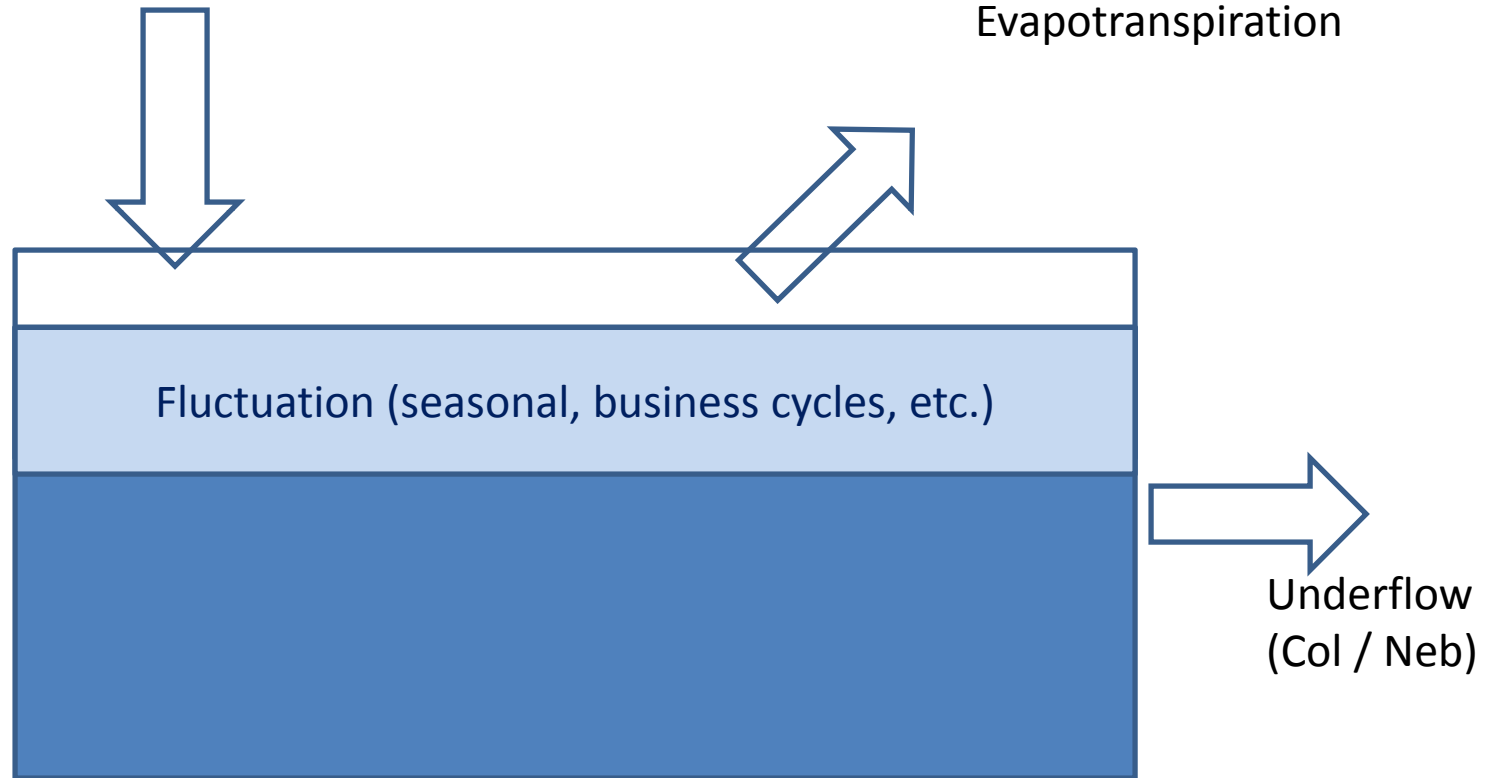
# GROUNDWATER 101 - BANK ACCOUNT

Water In (income):

Stream Infiltration,  
Rainfall / Snowmelt

Water Out (expenses):

Streamflow  
Evapotranspiration



If “income” = “expenses” on average, “balance” remains the same

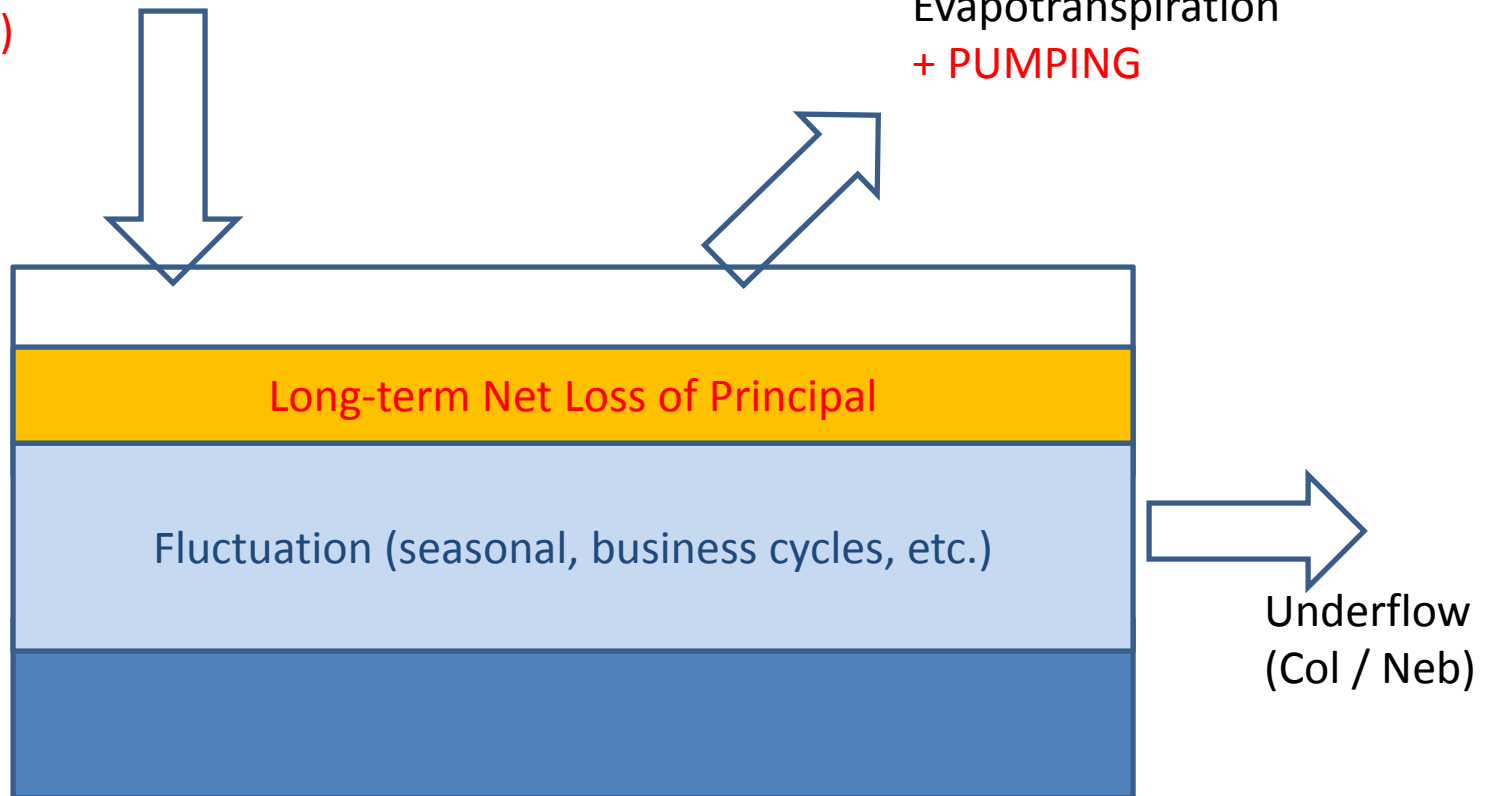
## GROUNDWATER 101 - BANK ACCOUNT

### Water In (income):

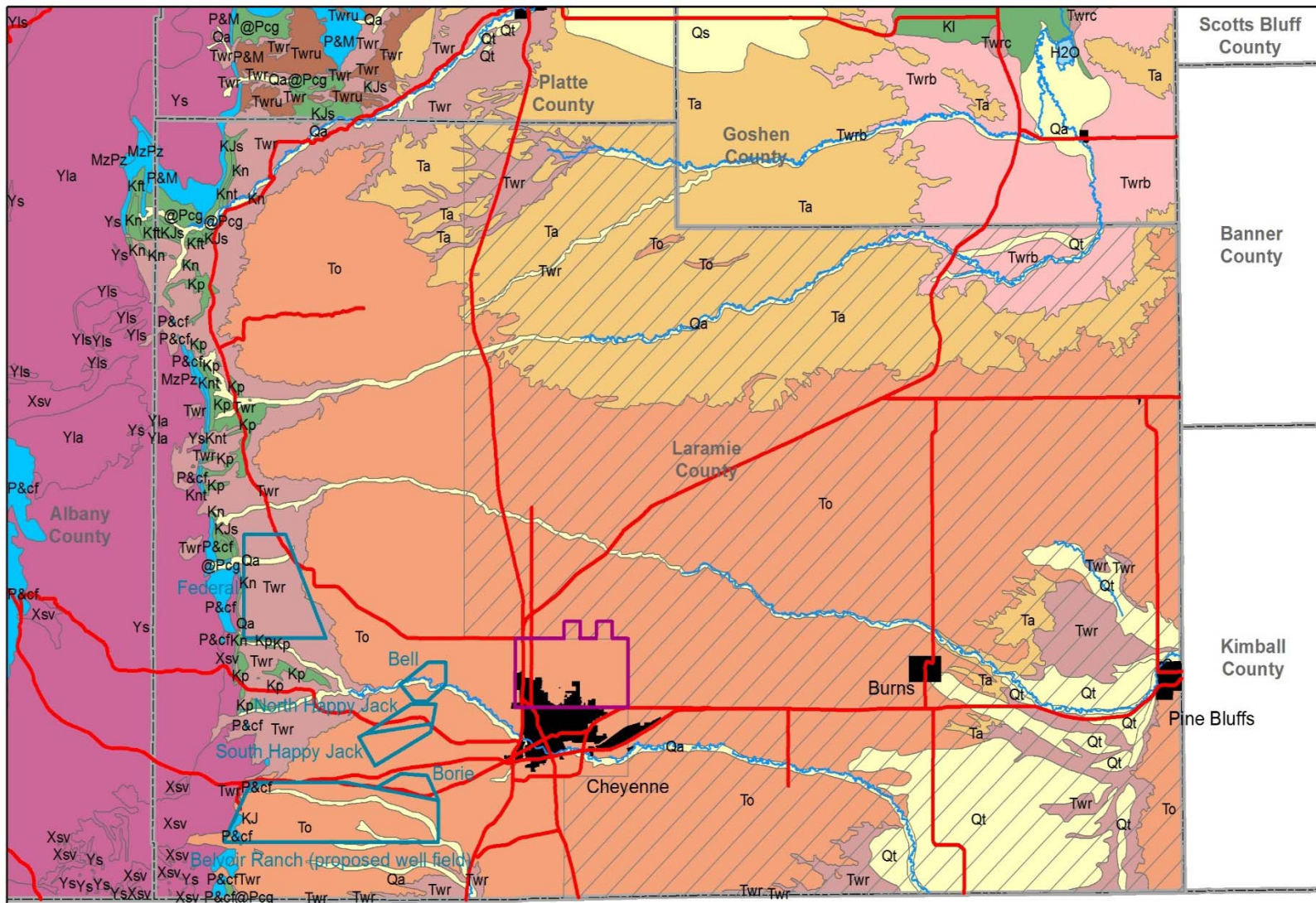
Stream Infiltration,  
Rainfall / Snowmelt  
(+ imports?)

### Water Out (expenses):

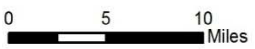
Streamflow,  
Evapotranspiration  
+ PUMPING



If "income" < "expenses" on average, "balance" declines

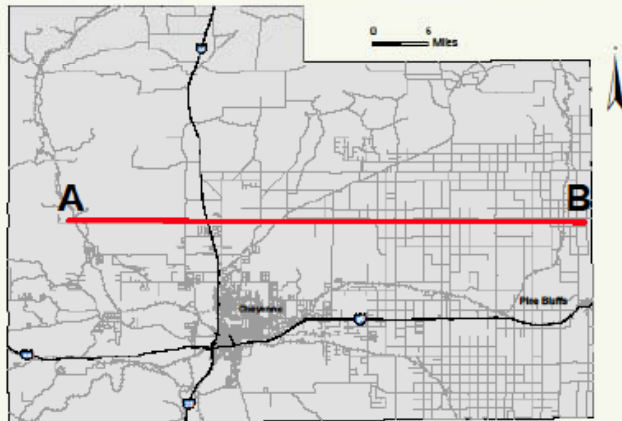


- Cheyenne Well Fields
- North Cheyenne Study Area
- Roads
- Laramie County Control Area



Laramie County Geologic Map and Groundwater Control Area

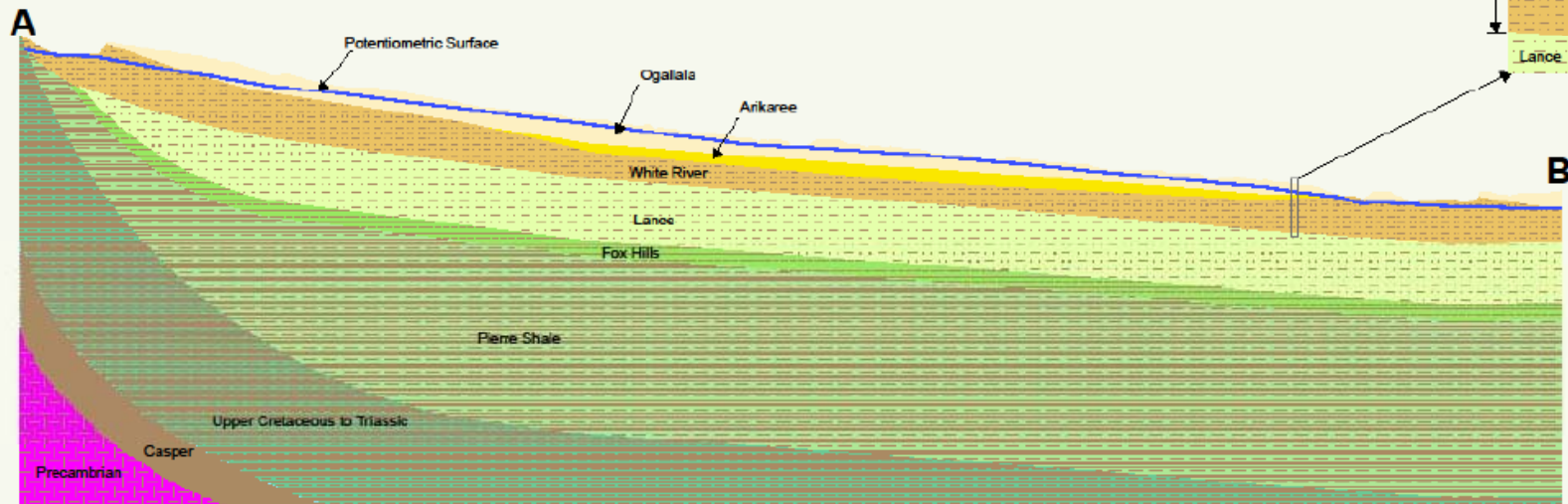
# Aquifer Profile



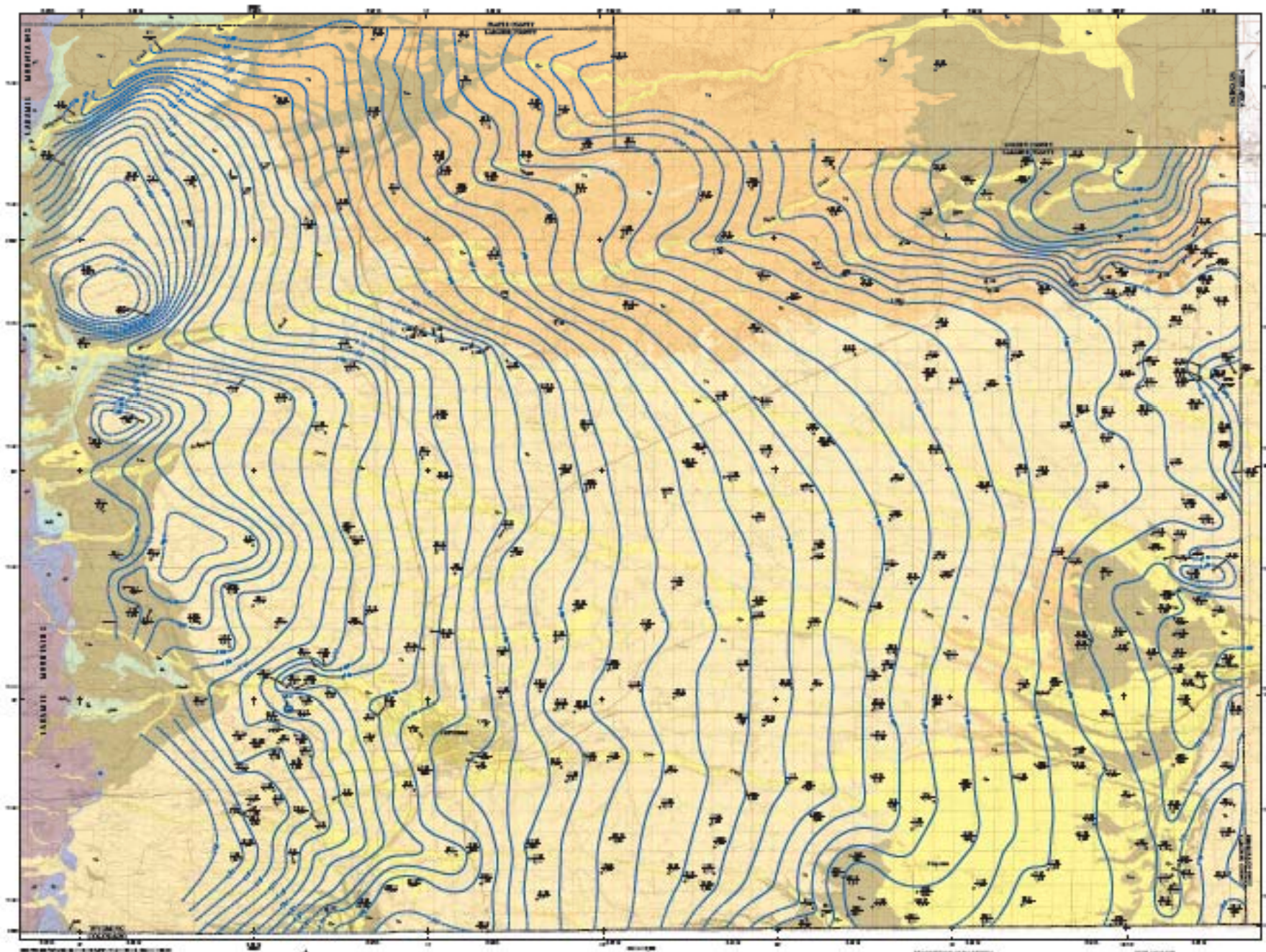
### Aquifer Profile

This West to East cross section represents a generalized profile of the aquifers and stratigraphy in Laramie County. There are faults and other geologic details not shown, so this does not necessarily represent conditions at any specific location.

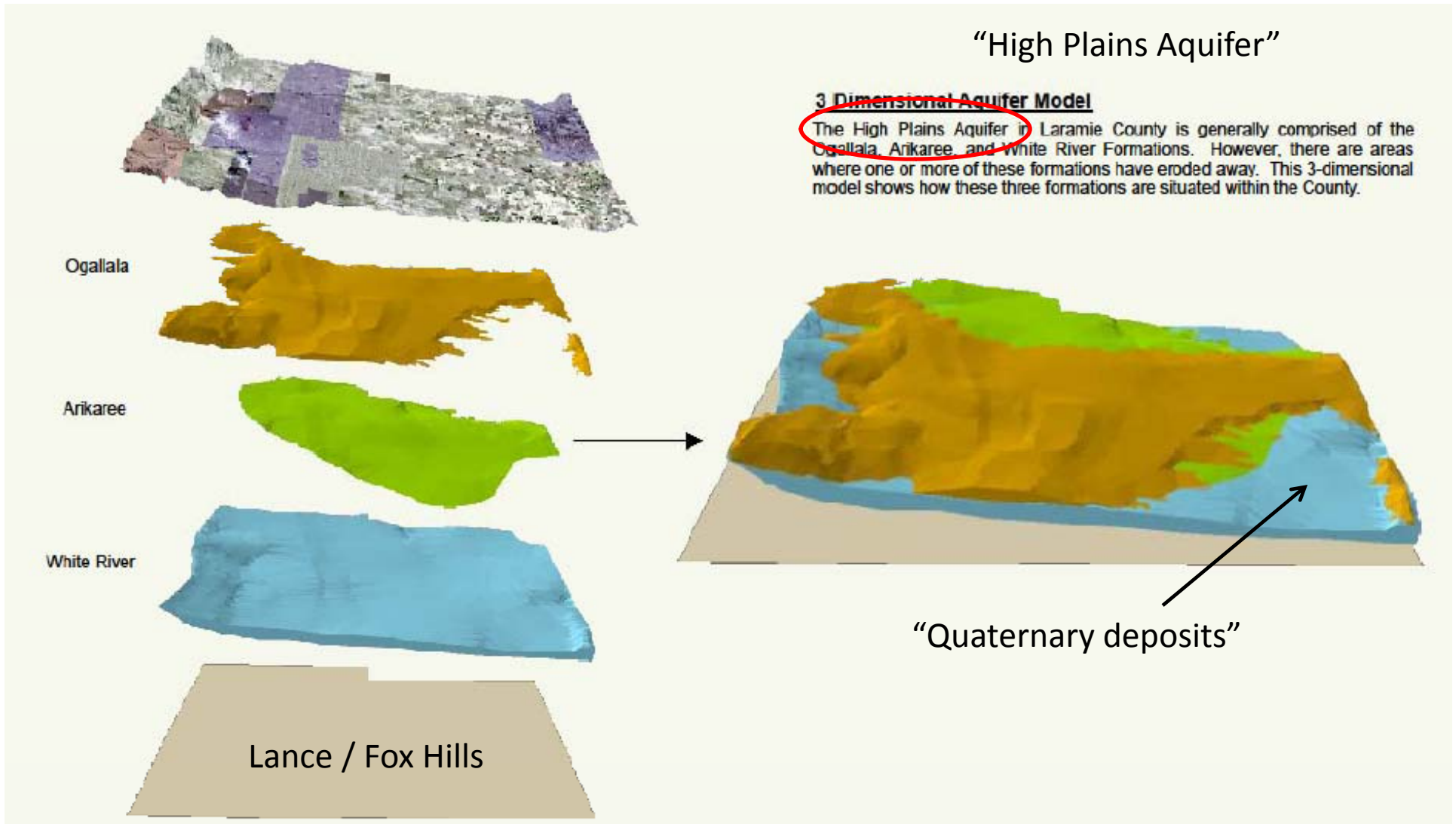
The Saturated Thickness maps in this Atlas indicate that there are areas in Laramie County that appear to have relatively high saturated thickness. It should be kept in mind that potential water production varies significantly in different formations. The White River Formation is a part of the High Plains Aquifer and is the thickest member. However, it typically has lower hydraulic conductivity than the overlying Ogallala and Anikaree. As the water level drops in the High Plains Aquifer, the higher producing Ogallala and Anikaree are depleted first, leaving a saturated but often poorly producing White River Formation.

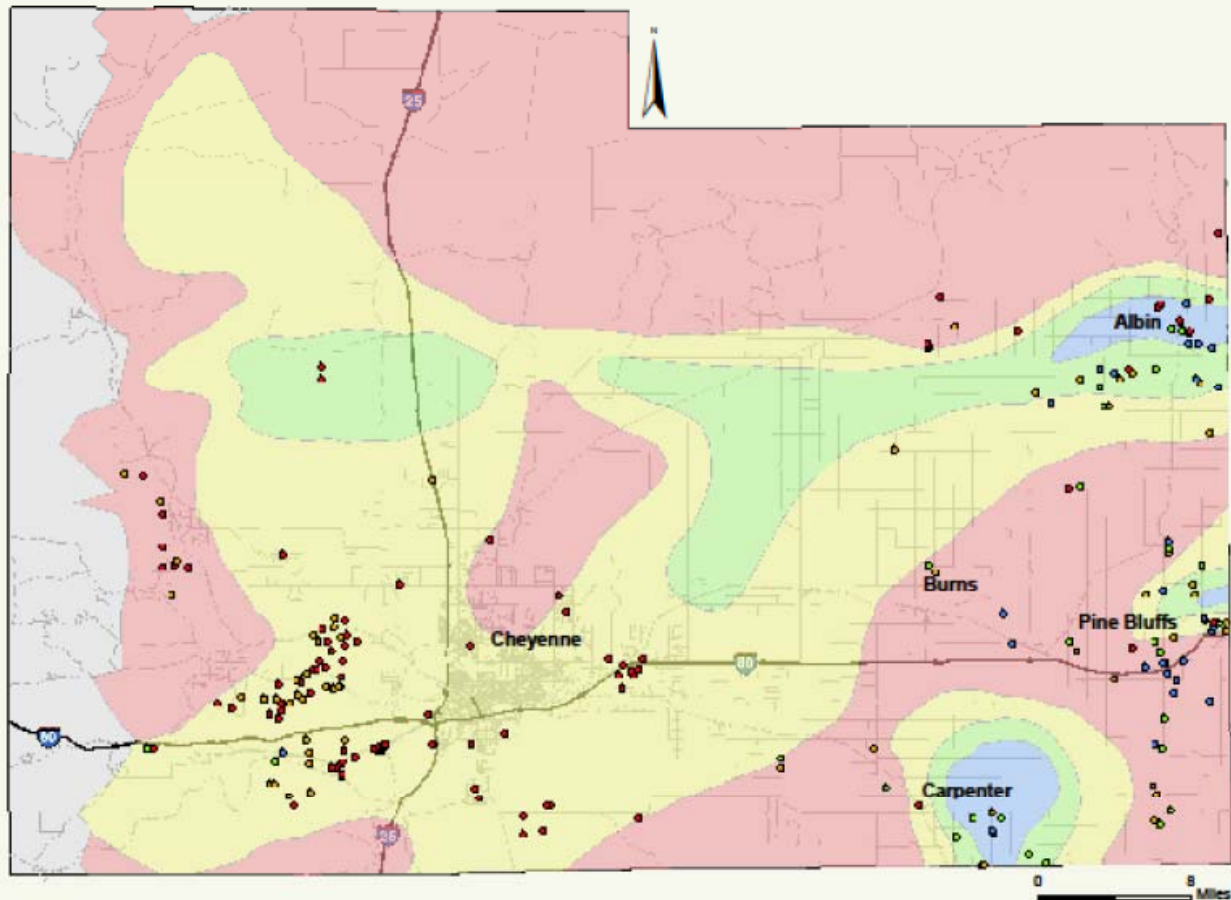


Vertical scale has been greatly exaggerated for clarity



# 3-D Aquifer Schematic





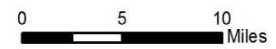
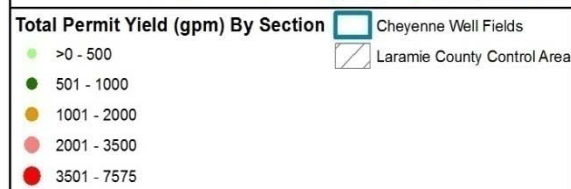
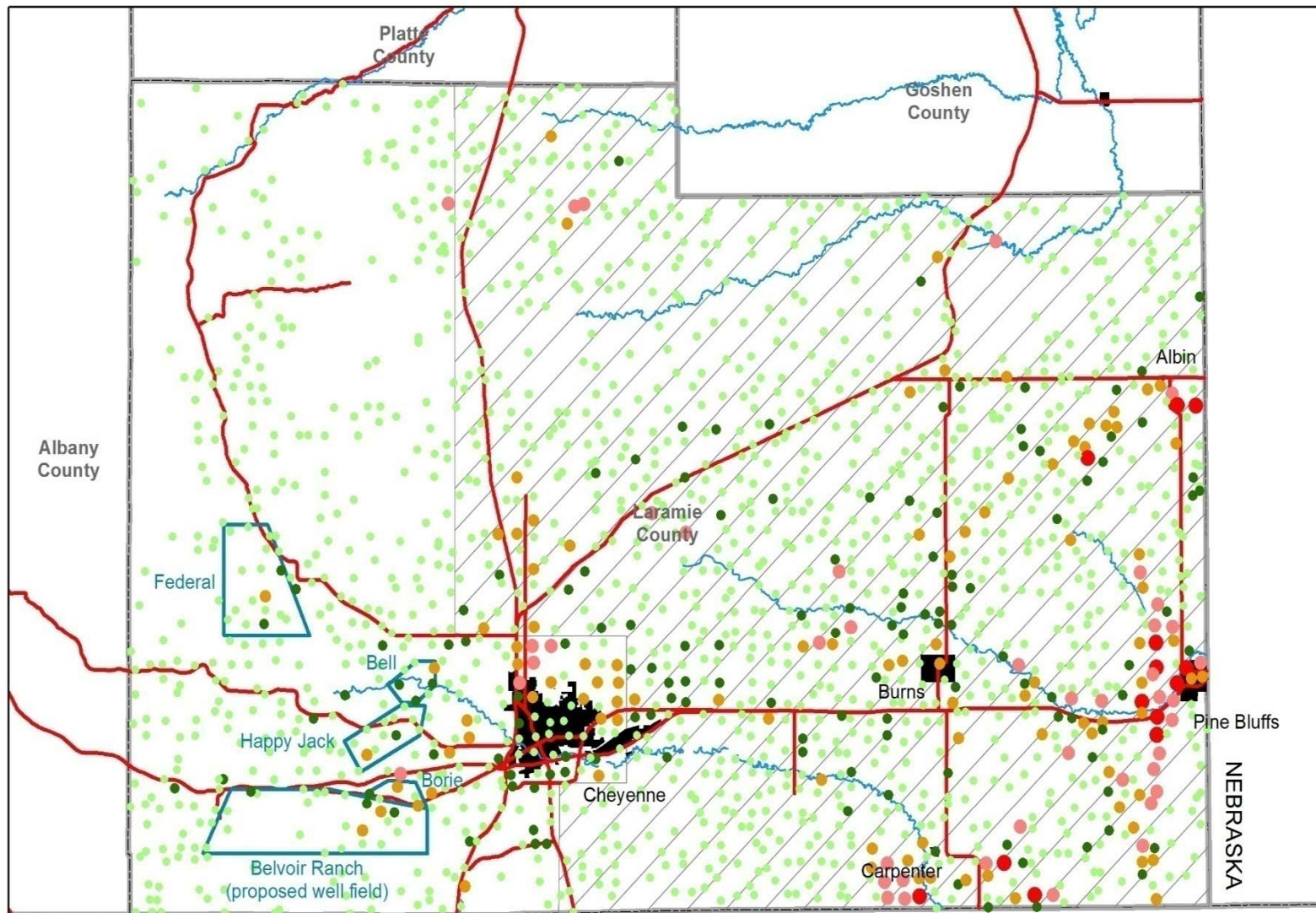
**Legend**

Transmissivity (GPD/FT)	Hydraulic Conductivity (GPD/SQ FT)
• < 10,000	RANGE
• 10,000 - 50,000	□ No Data
• 50,000 - 100,000	□ 0 - 25
• > 100,000	□ 25 - 50
	□ 50 - 100
	□ 100 - 200

Map compiled: 3/2013; intended for planning purposes only  
 Data Sources: Laramie County Groundwater Atlas, 2008; Gutentag and others, 1984;

**Figure 3. General Distribution of Hydraulic Conductivity**



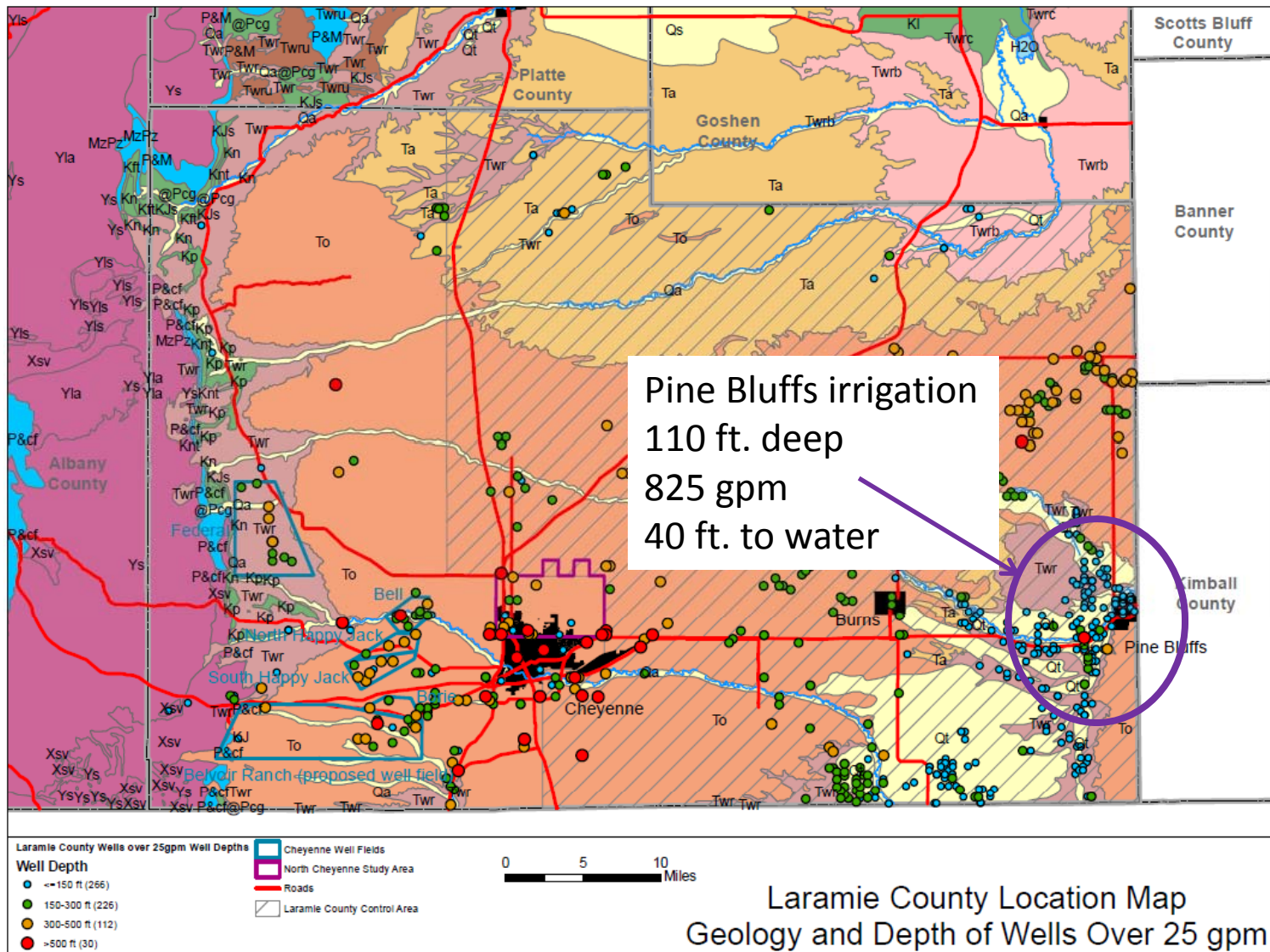


Laramie County Total Permit Yield by Section

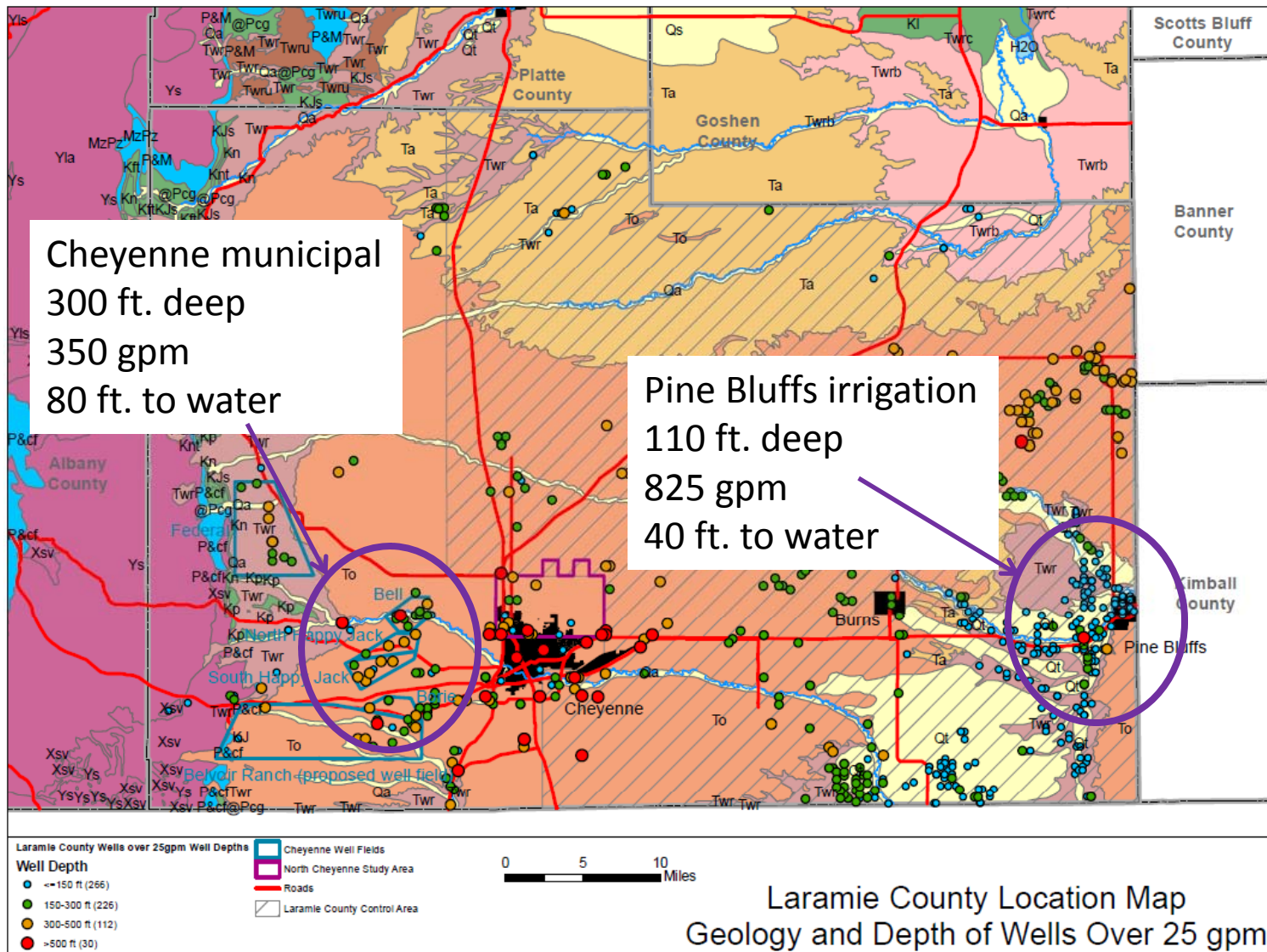




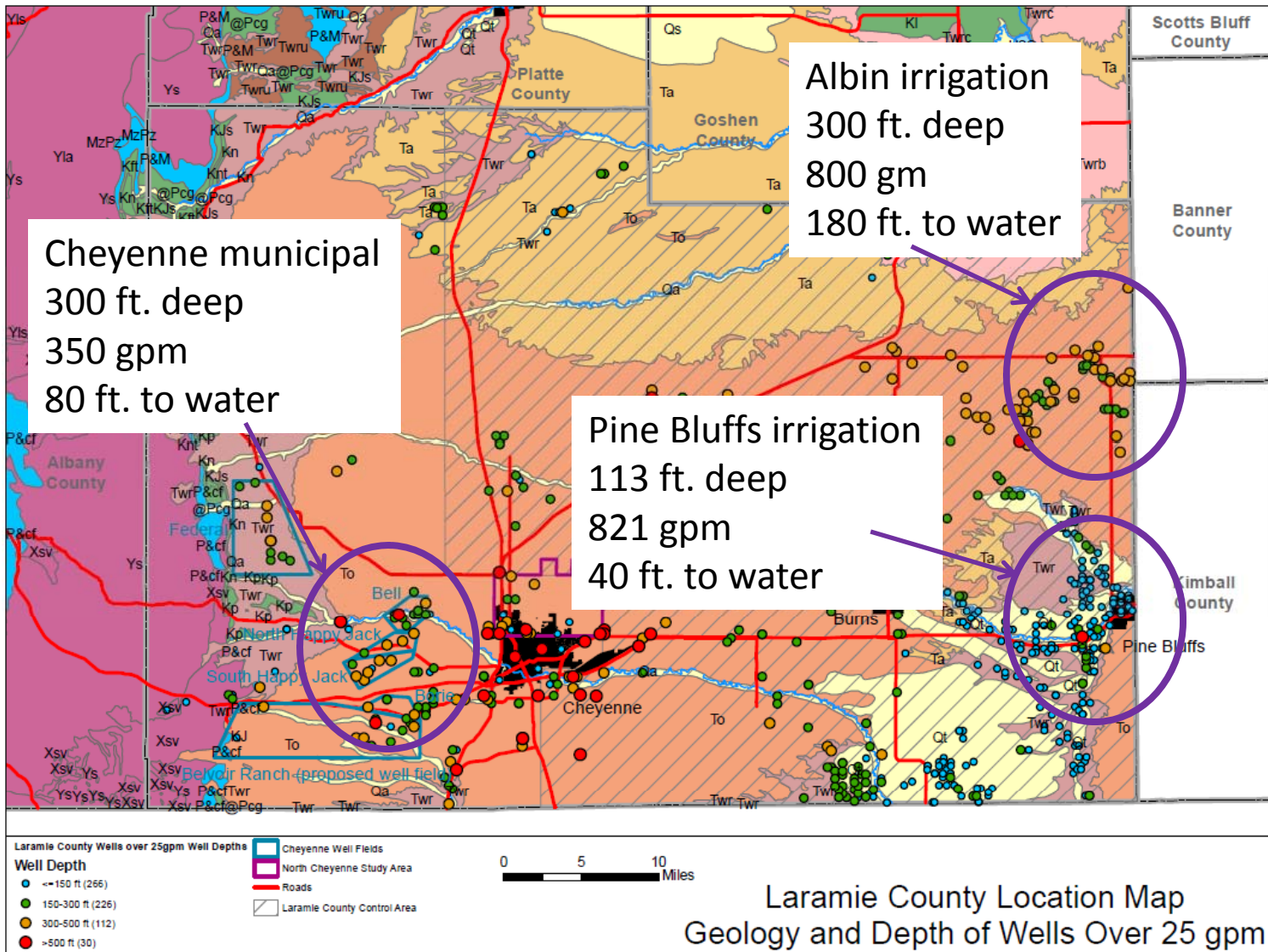
# Laramie Co. Water Resources



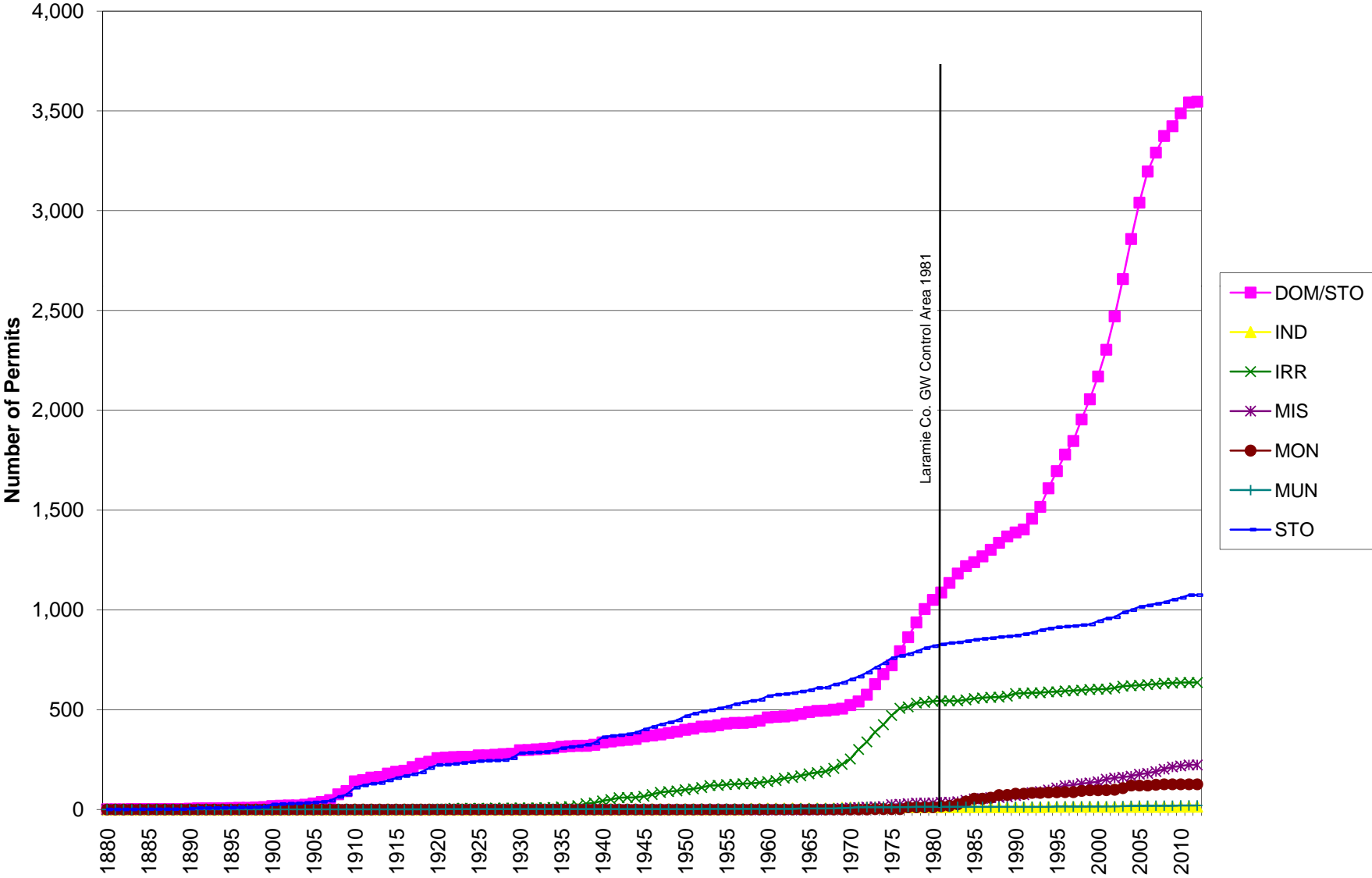
# Laramie Co. Water Resources



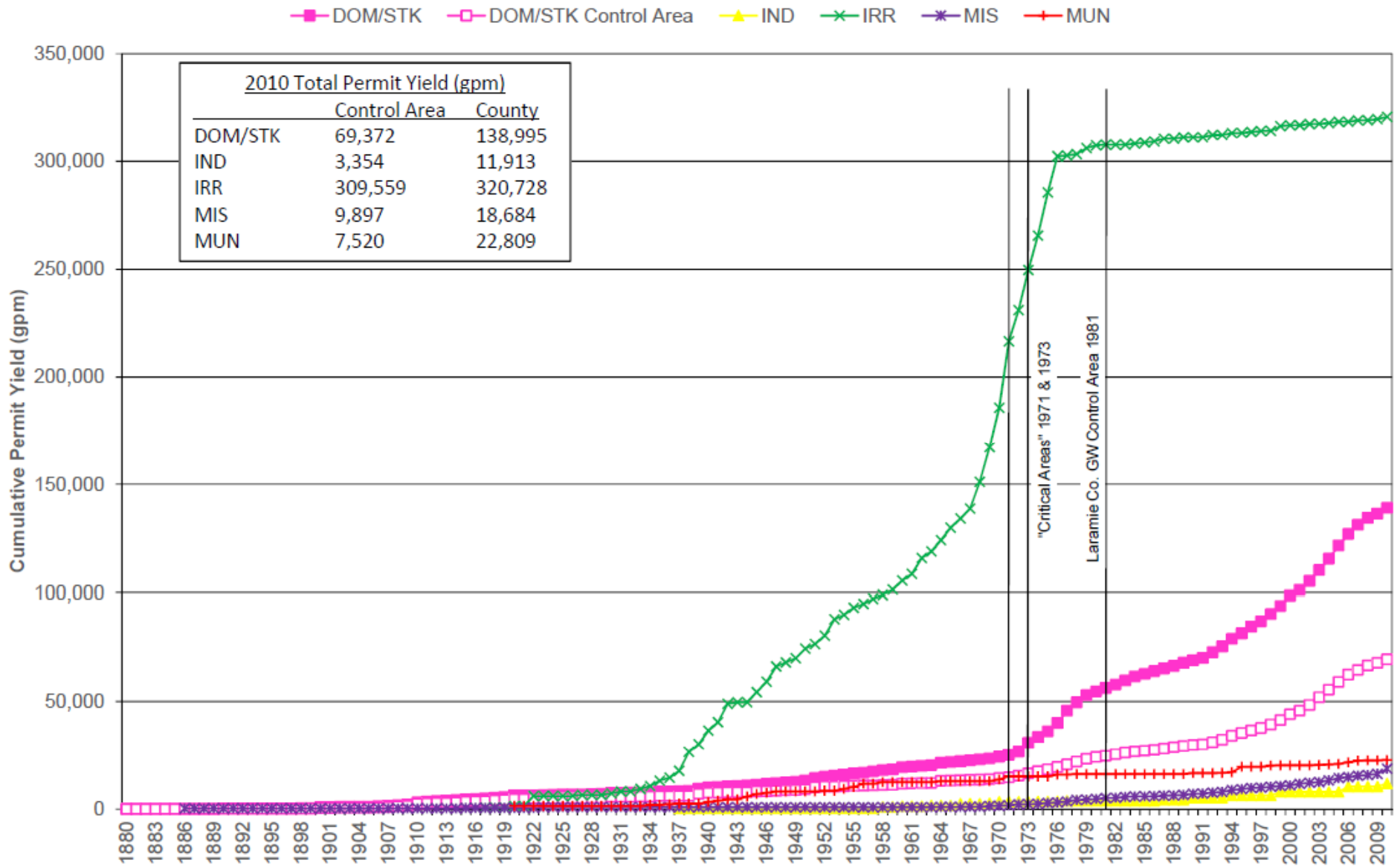
# Laramie Co. Water Resources



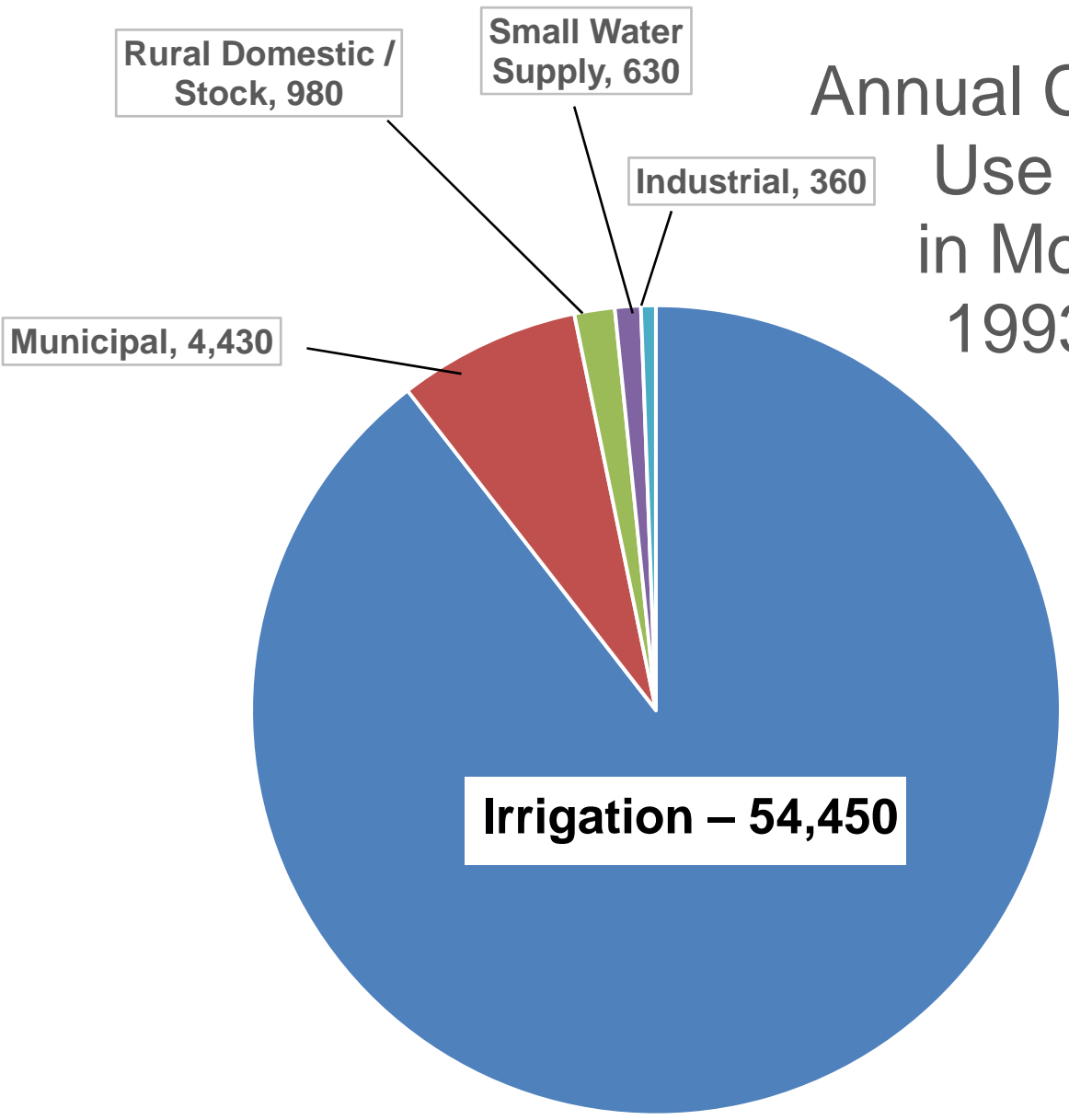
# Laramie County Cumulative Permit Count by Use

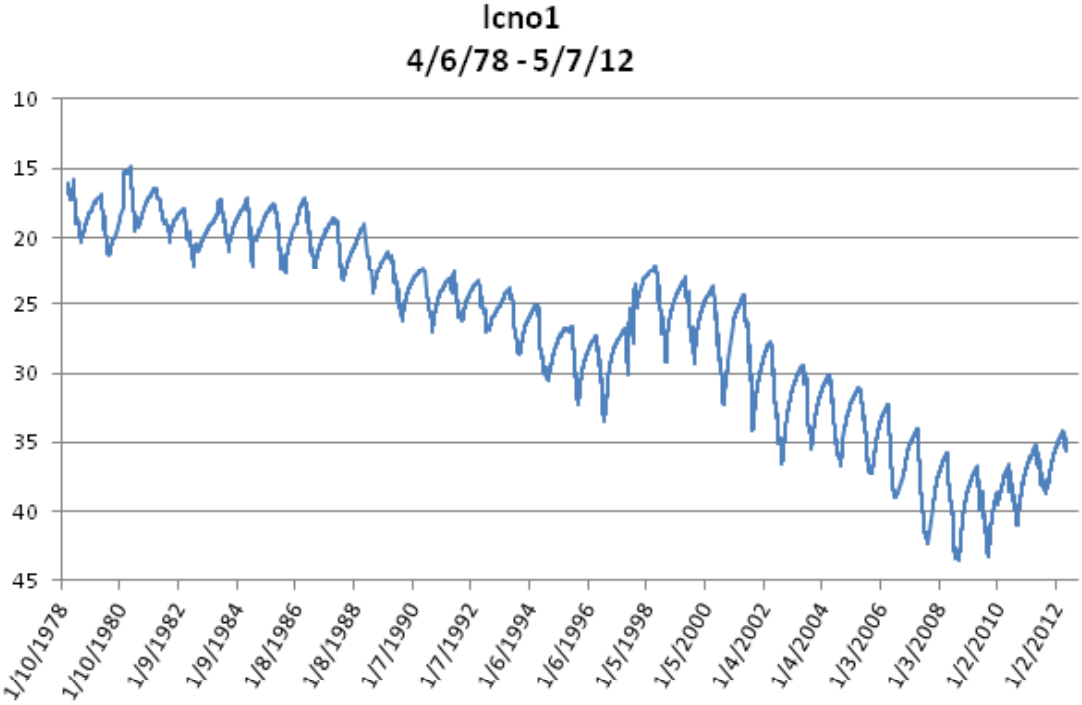
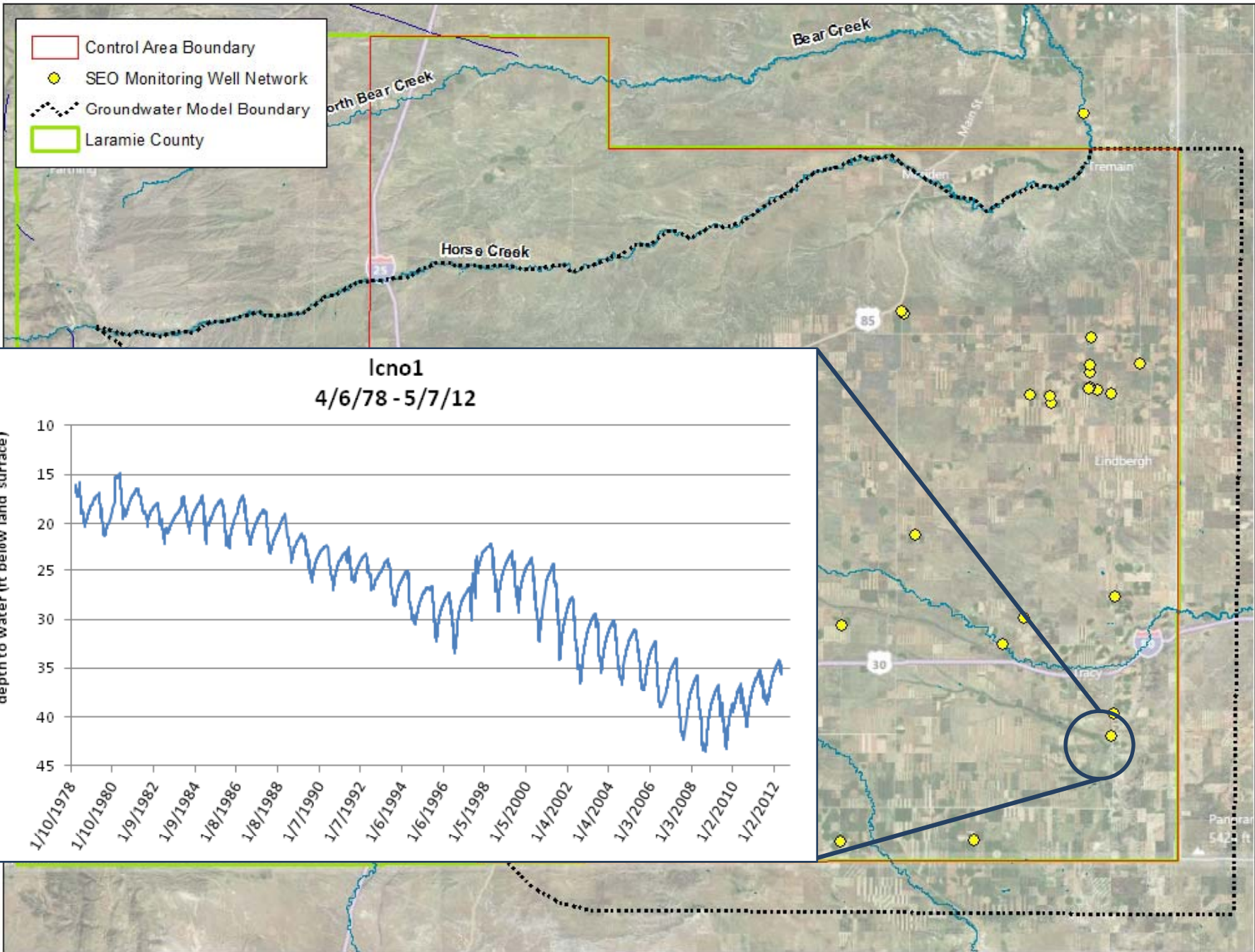


# Laramie County Cumulative Permit Yield by Use



Annual Consumptive  
Use (Acre-ft)  
in Model Area  
1993 - 2010

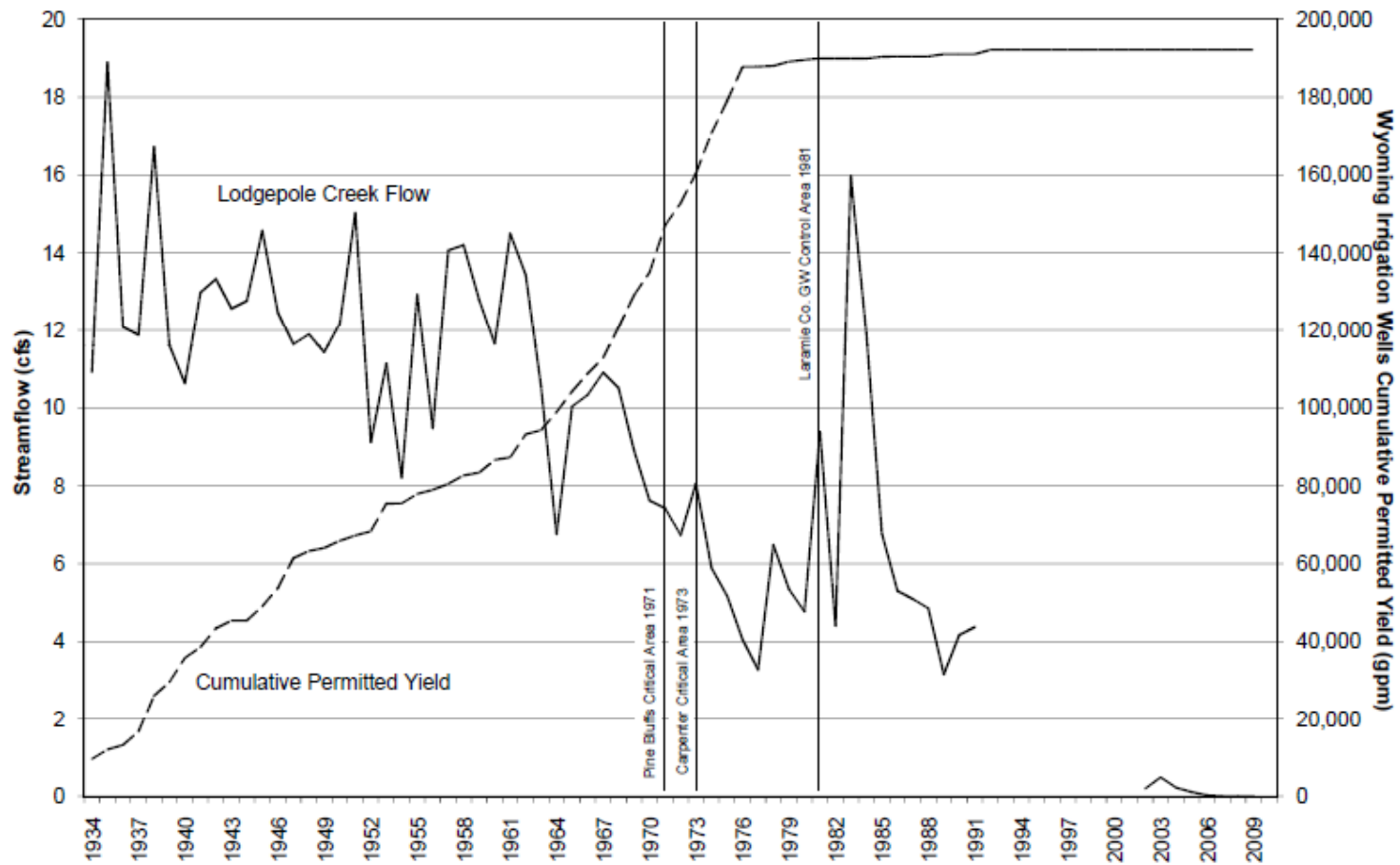






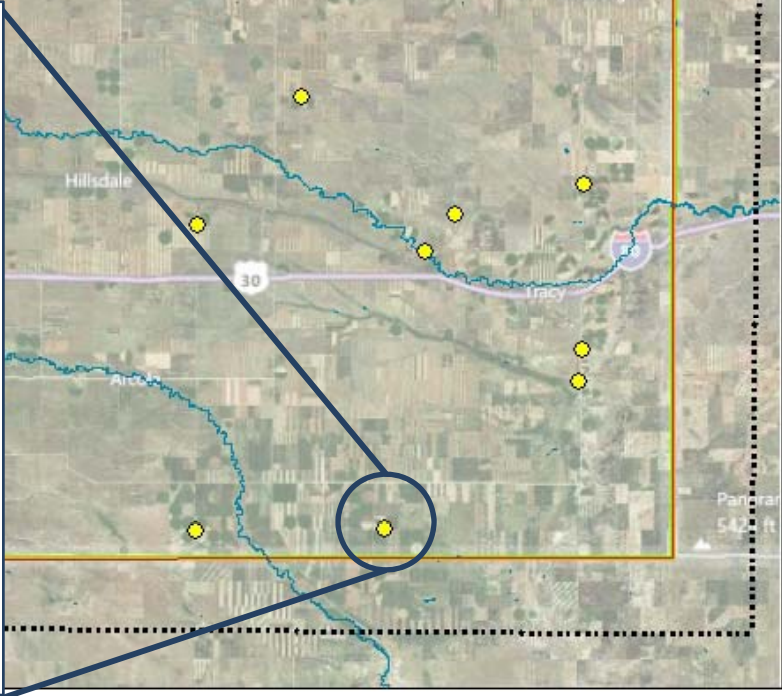
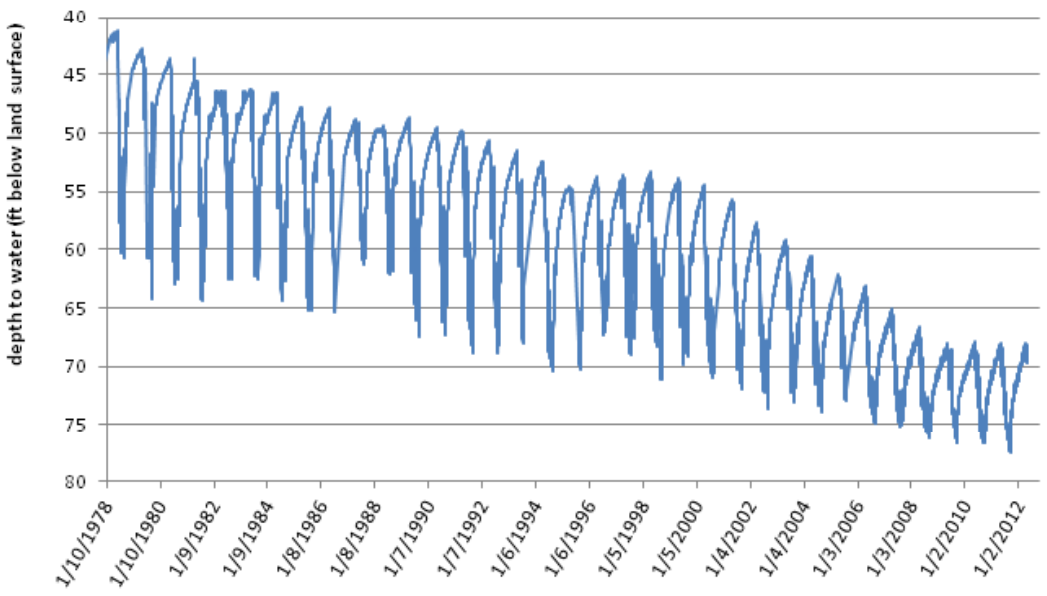
# Streamflow Depletion

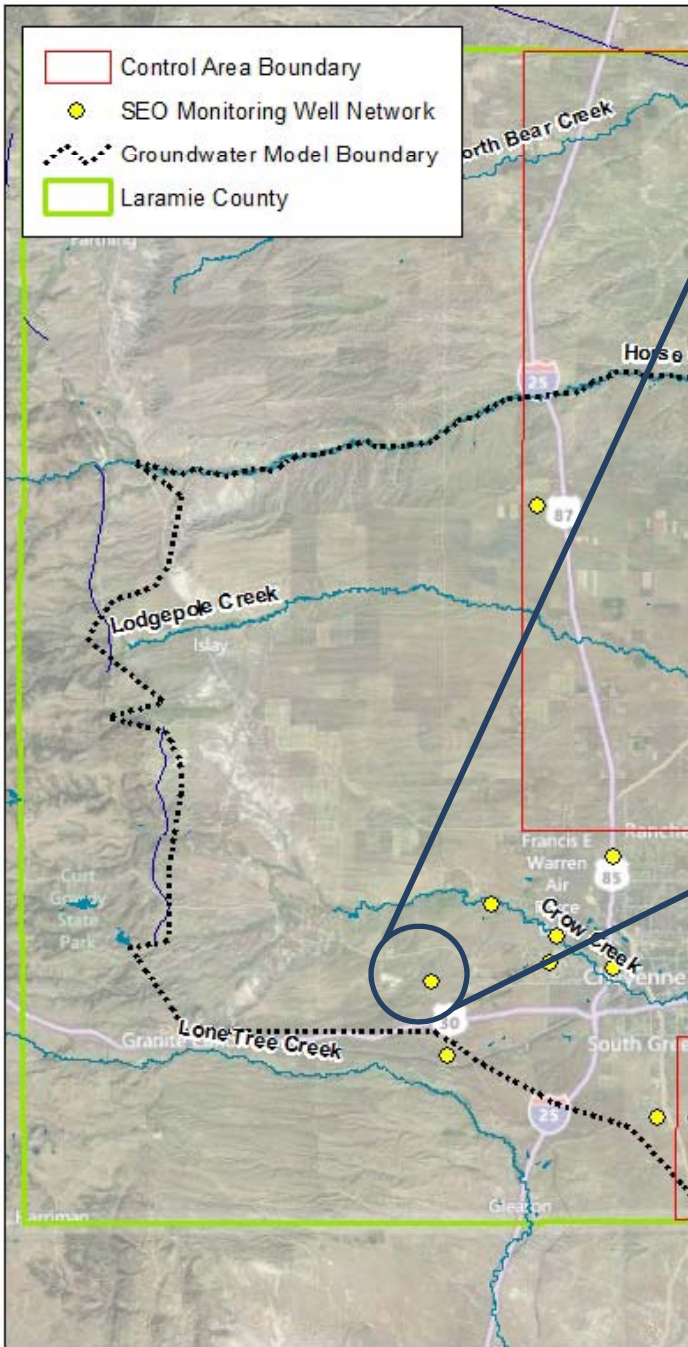
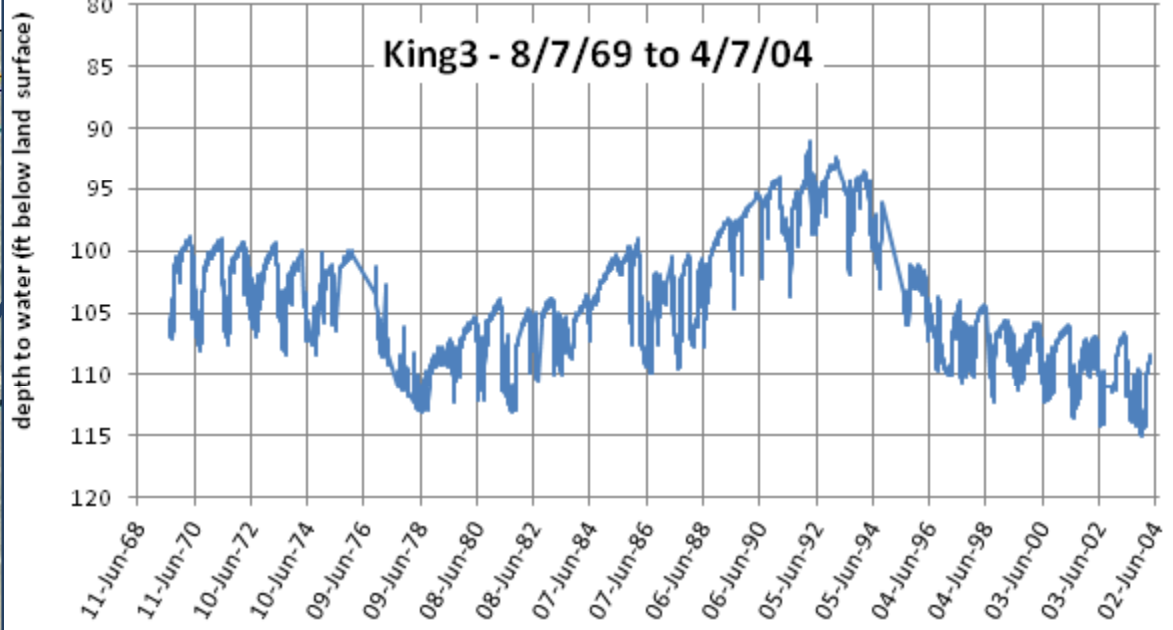
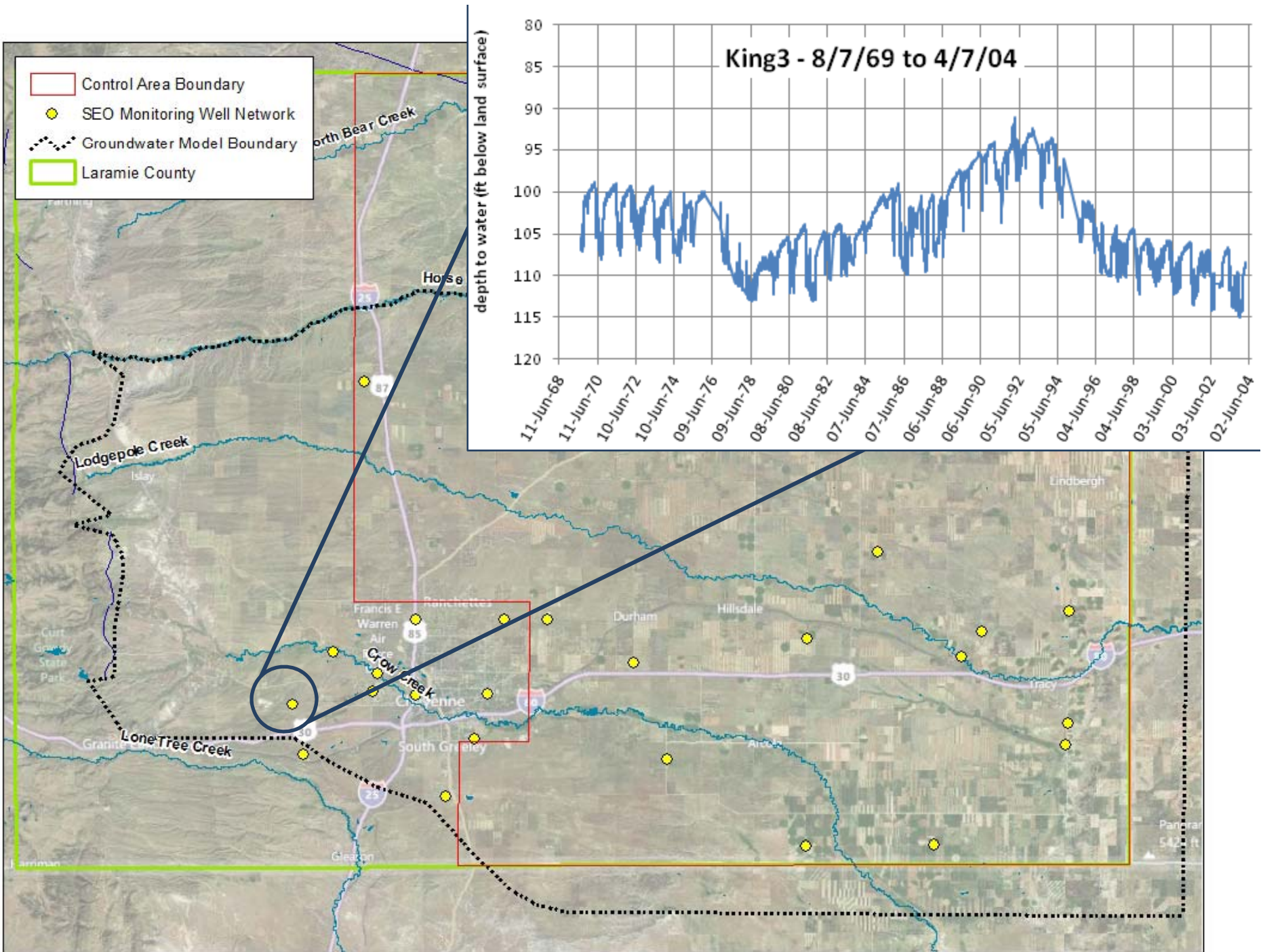
Streamflow and Irrigation Well History in Lodgepole Creek Basin, Wyoming



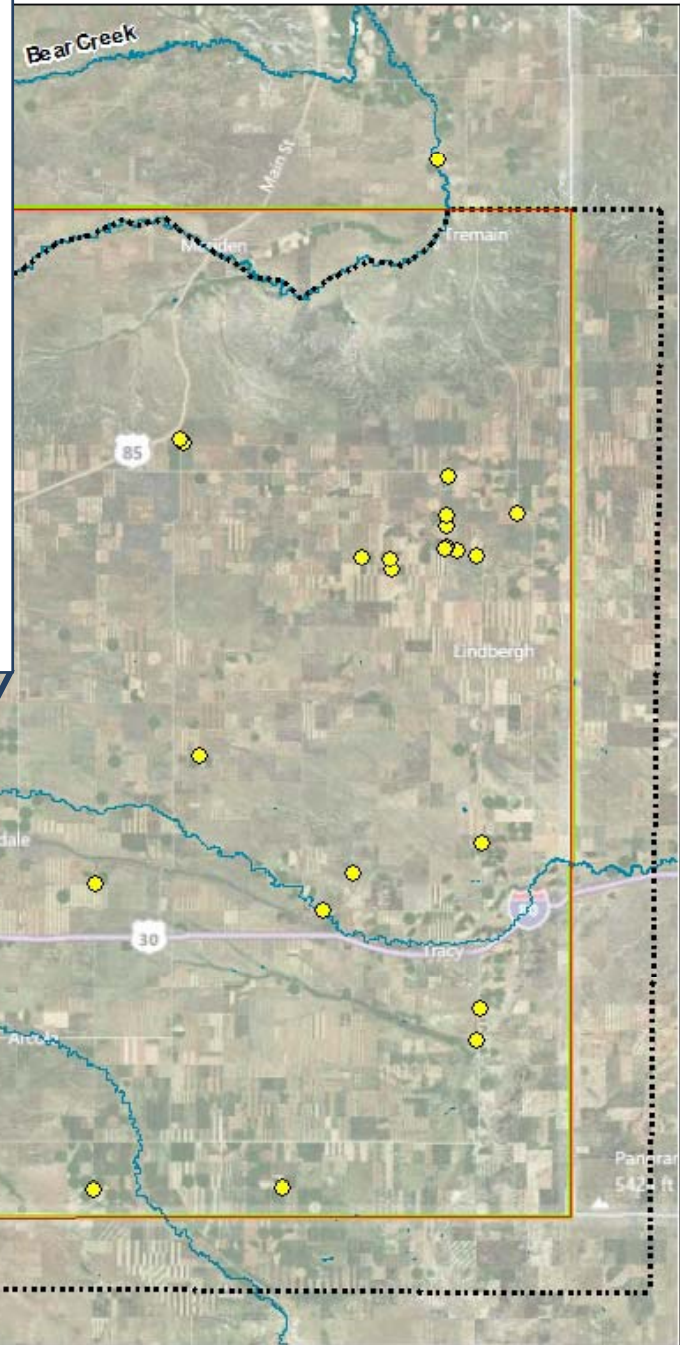
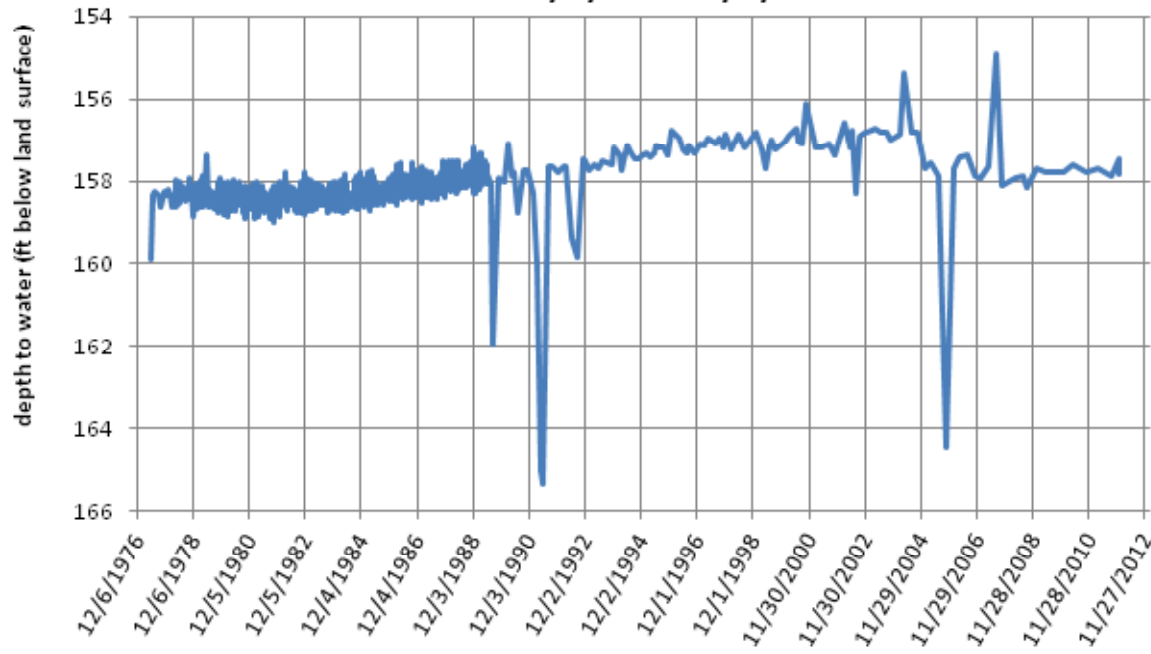


**SE Carp  
9/22/75 - 5/7/12**





lcno9 - 6/7/77 to 1/9/12



# Groundwater Model

- Why use a numerical model?
- What does it look like?
- What will it do?

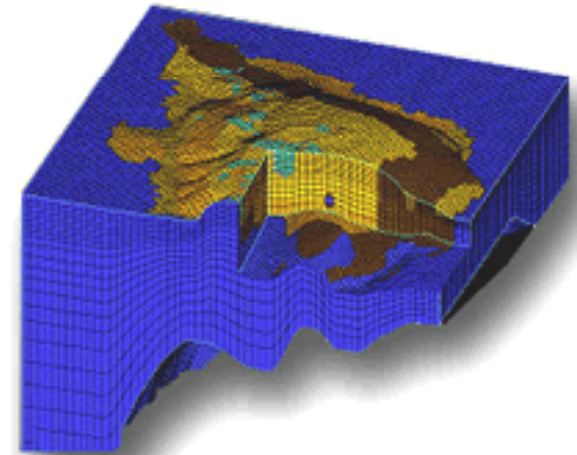
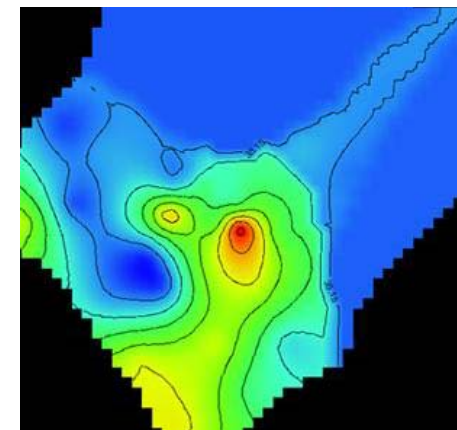
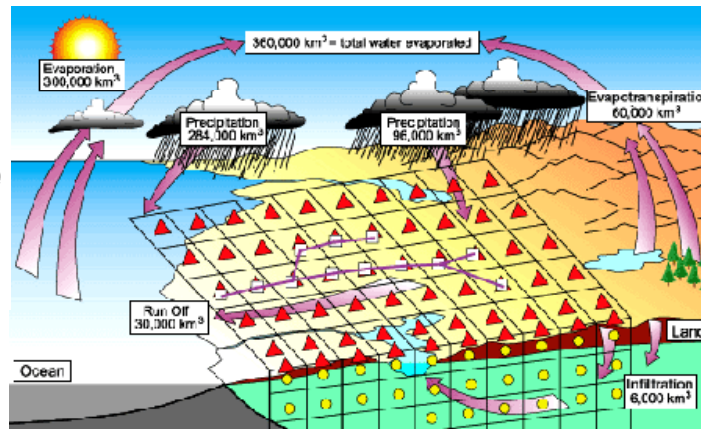
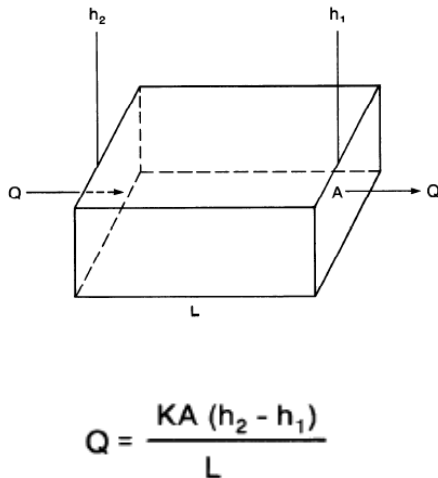
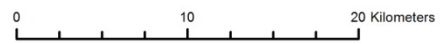
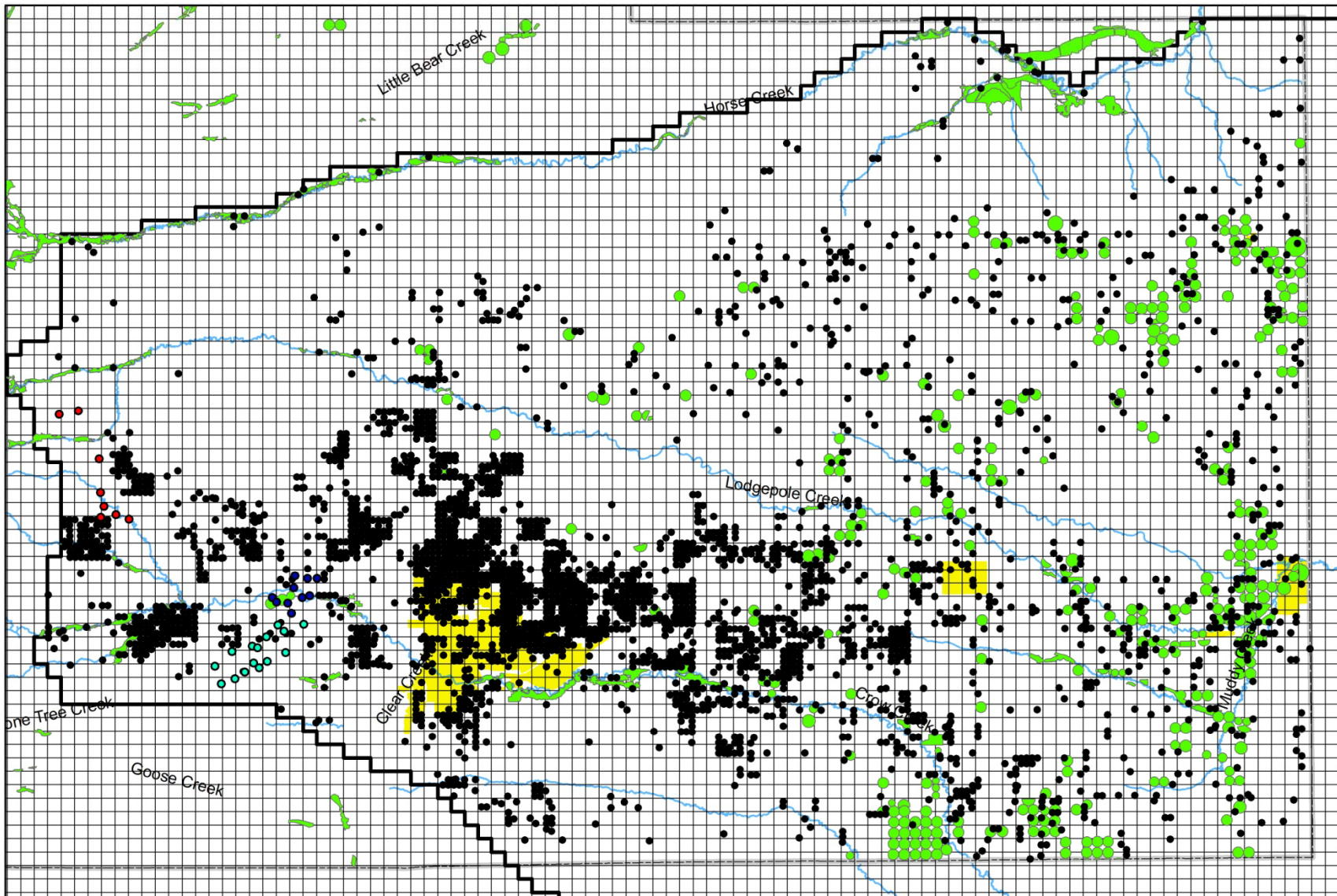


Image courtesy of HydroGeologic, Inc.

$$\frac{\partial}{\partial x} \left( K_{xx} \frac{\partial h}{\partial x} \right) + \frac{\partial}{\partial y} \left( K_{yy} \frac{\partial h}{\partial y} \right) + \frac{\partial}{\partial z} \left( K_{zz} \frac{\partial h}{\partial z} \right) - W = S_s \frac{\partial h}{\partial t}$$



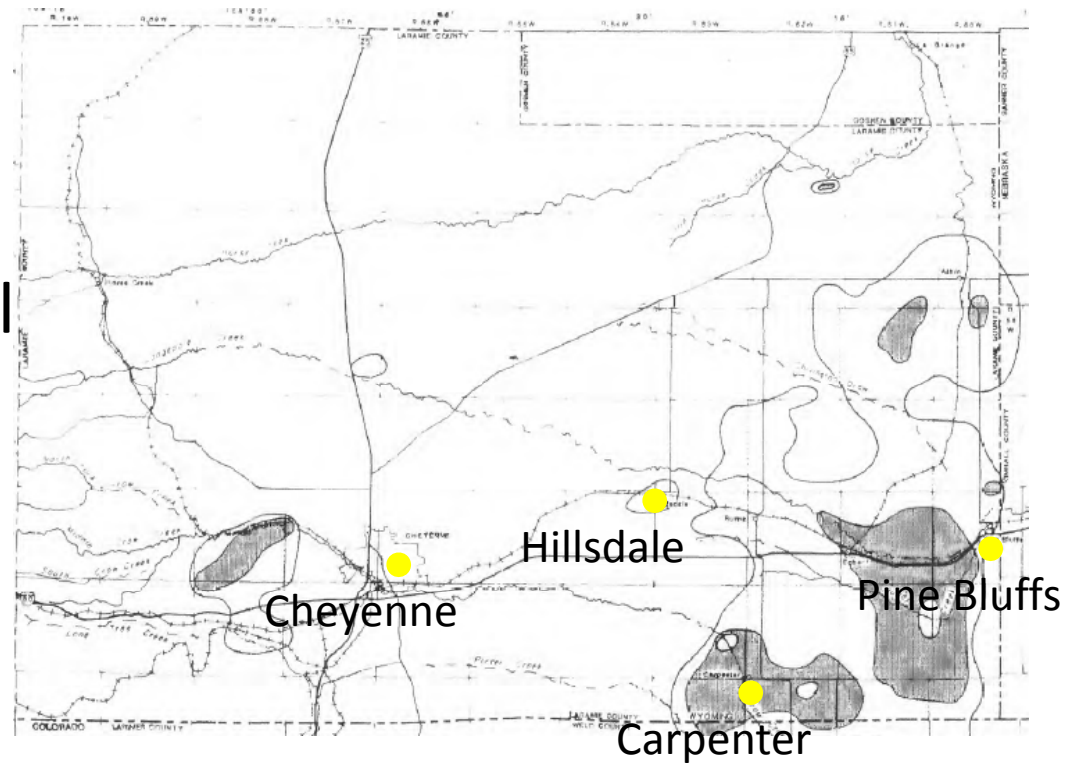


- BOPU\_Bell\_Wellfield
- BOPU\_Federal\_Wellfield
- BOPU\_HappyJack\_Wellfield
- Domestic Permits
- Irrigated Agriculture
- Groundwater Model Grid
- Groundwater Model Boundary
- Laramie County
- streams

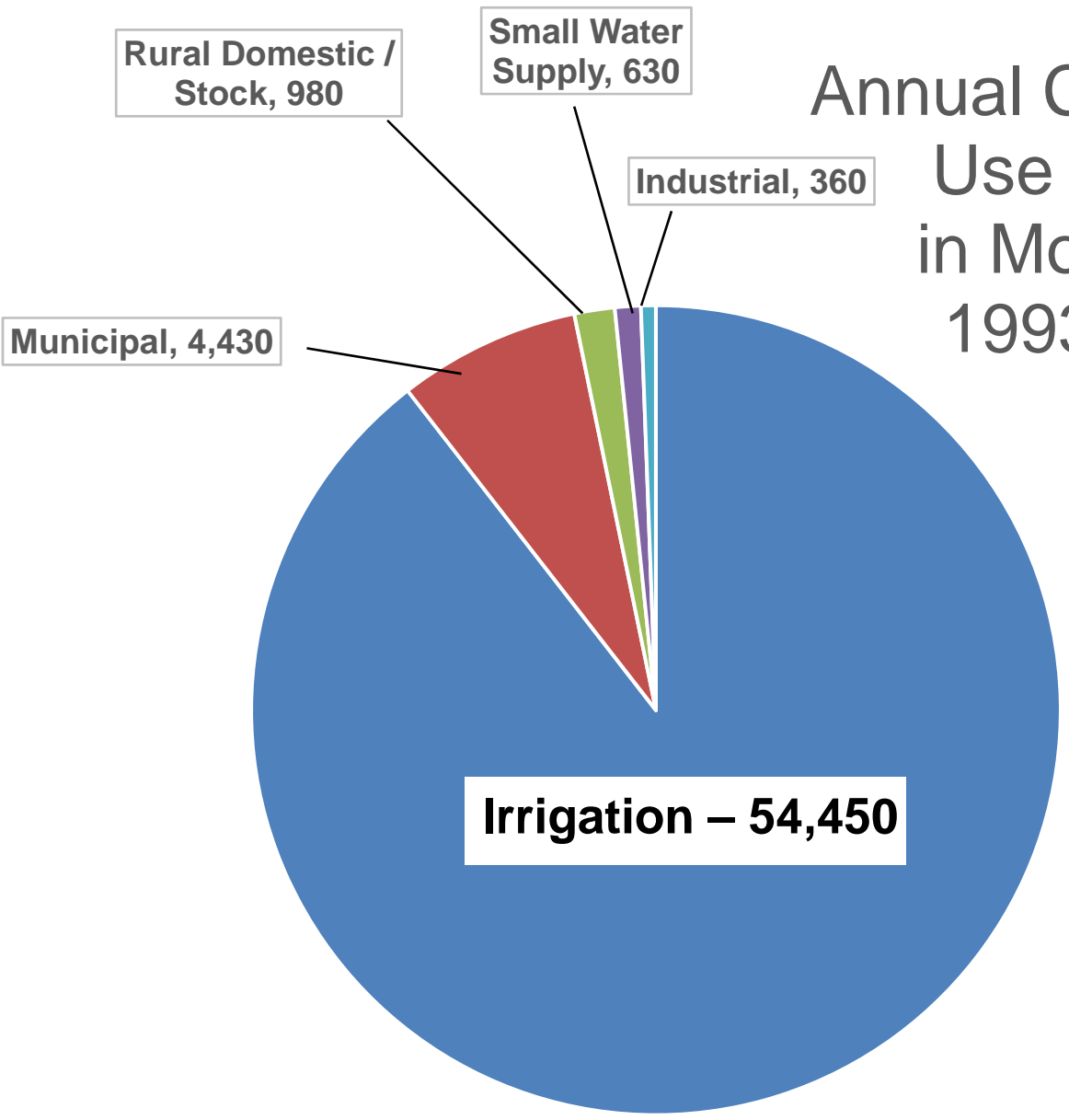


# Previous Studies

- Crist, 1980 – early groundwater model
- Calculated 20-30 ft declines in water level (shaded areas) from 1920-1987 at 1977 levels of pumping

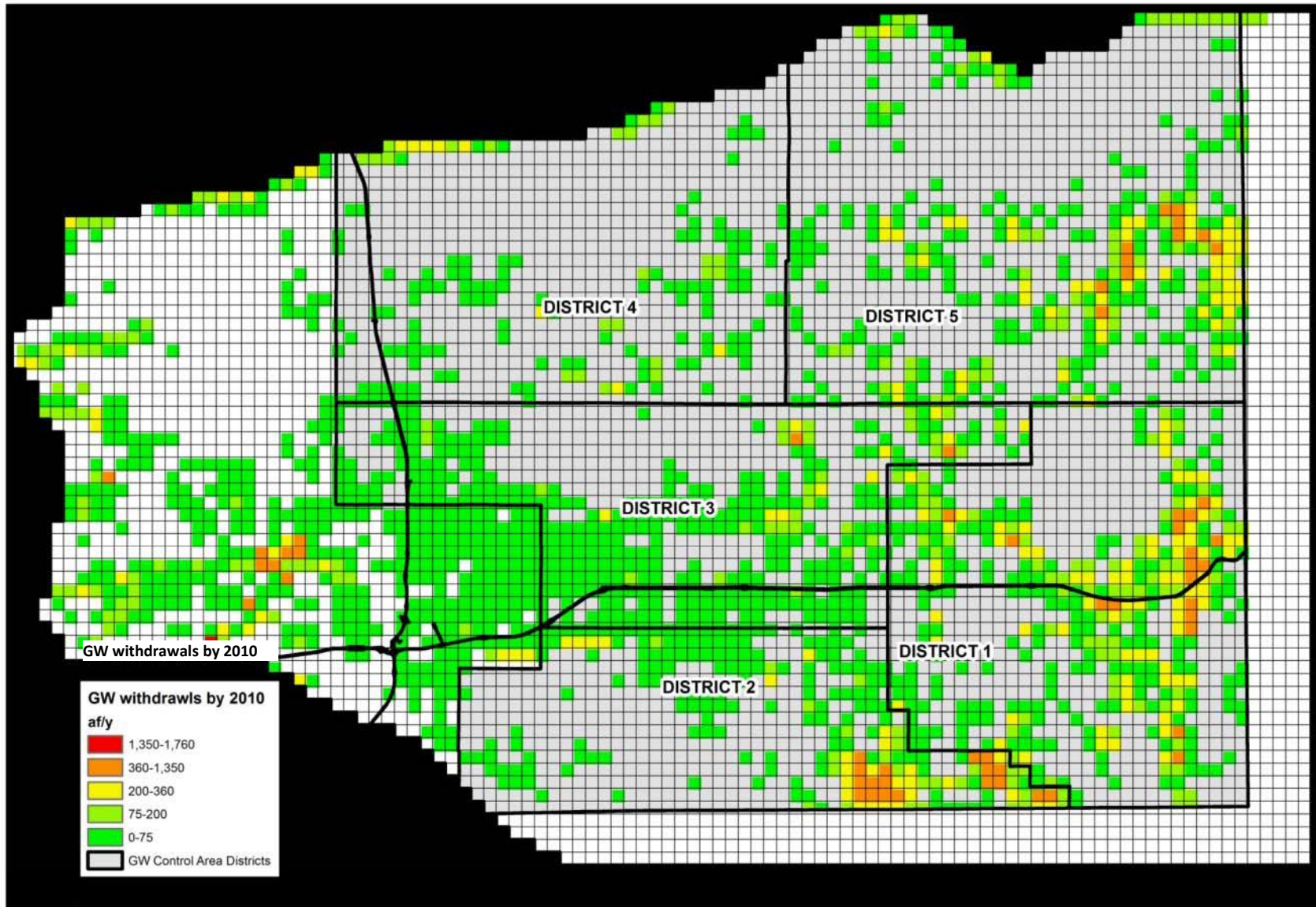


Annual Consumptive  
Use (Acre-ft)  
in Model Area  
1993 - 2010

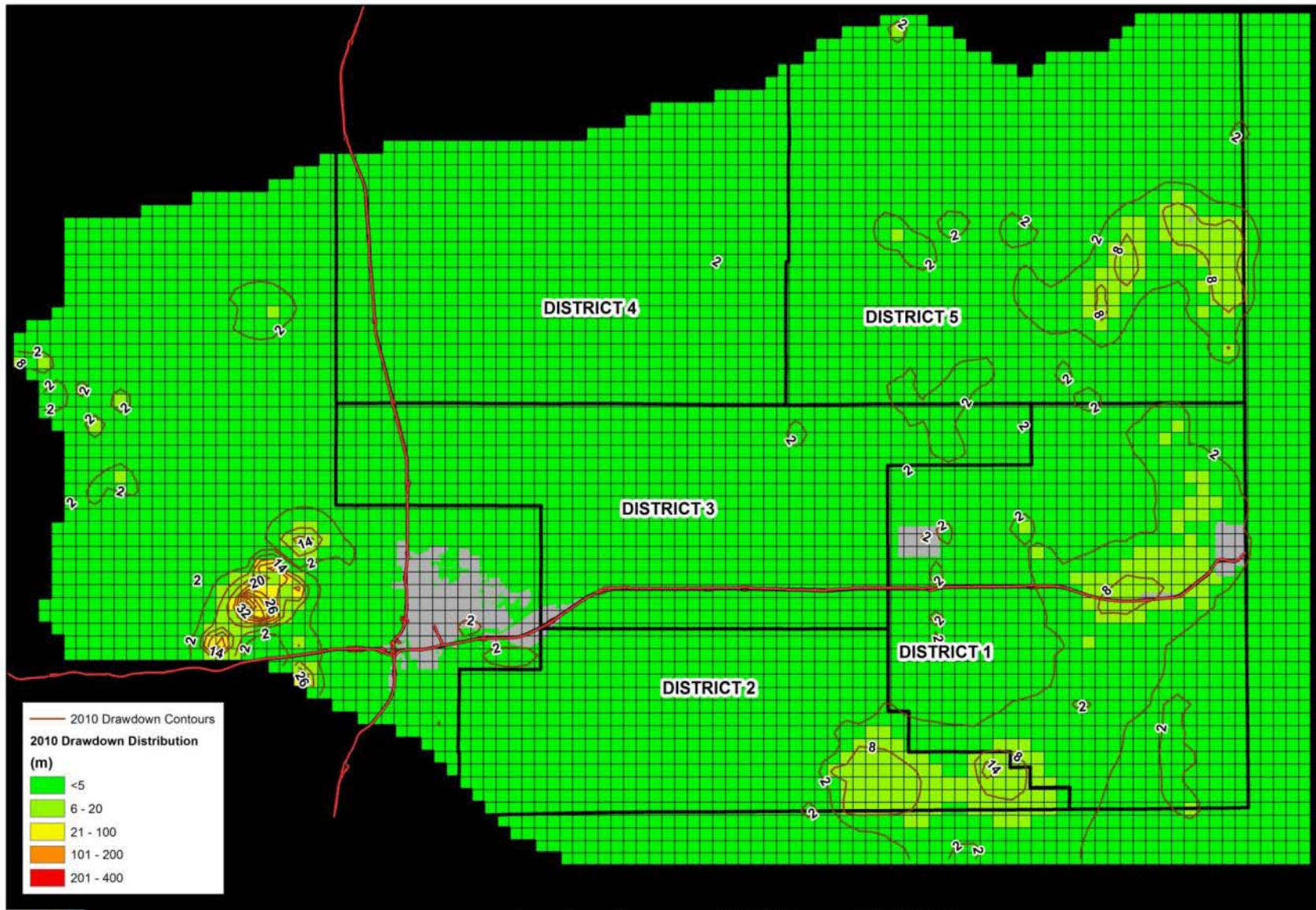




# Groundwater Withdrawals by 2010



# Drawdown in 2010



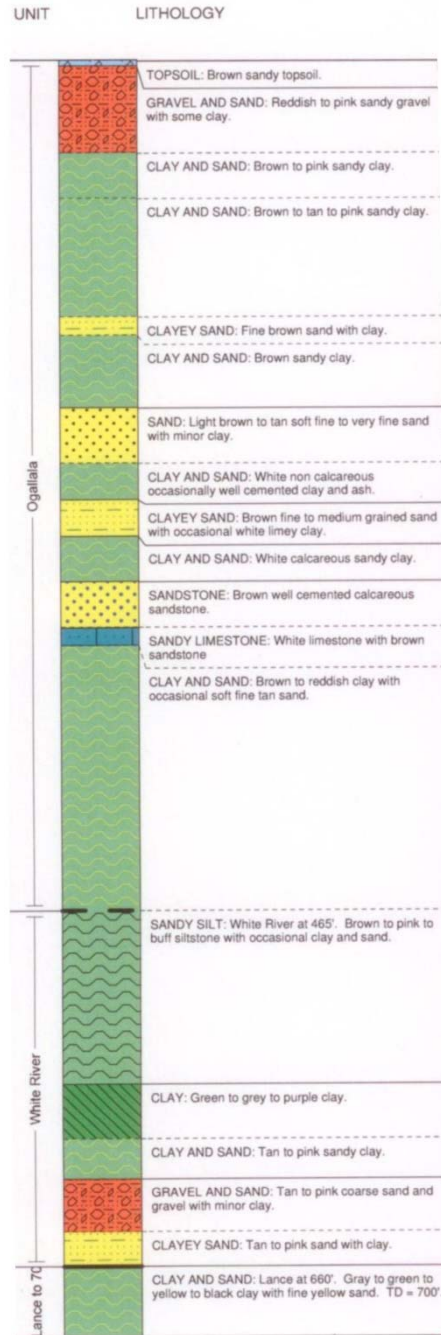
amec

0 4 8 16 Kilometers

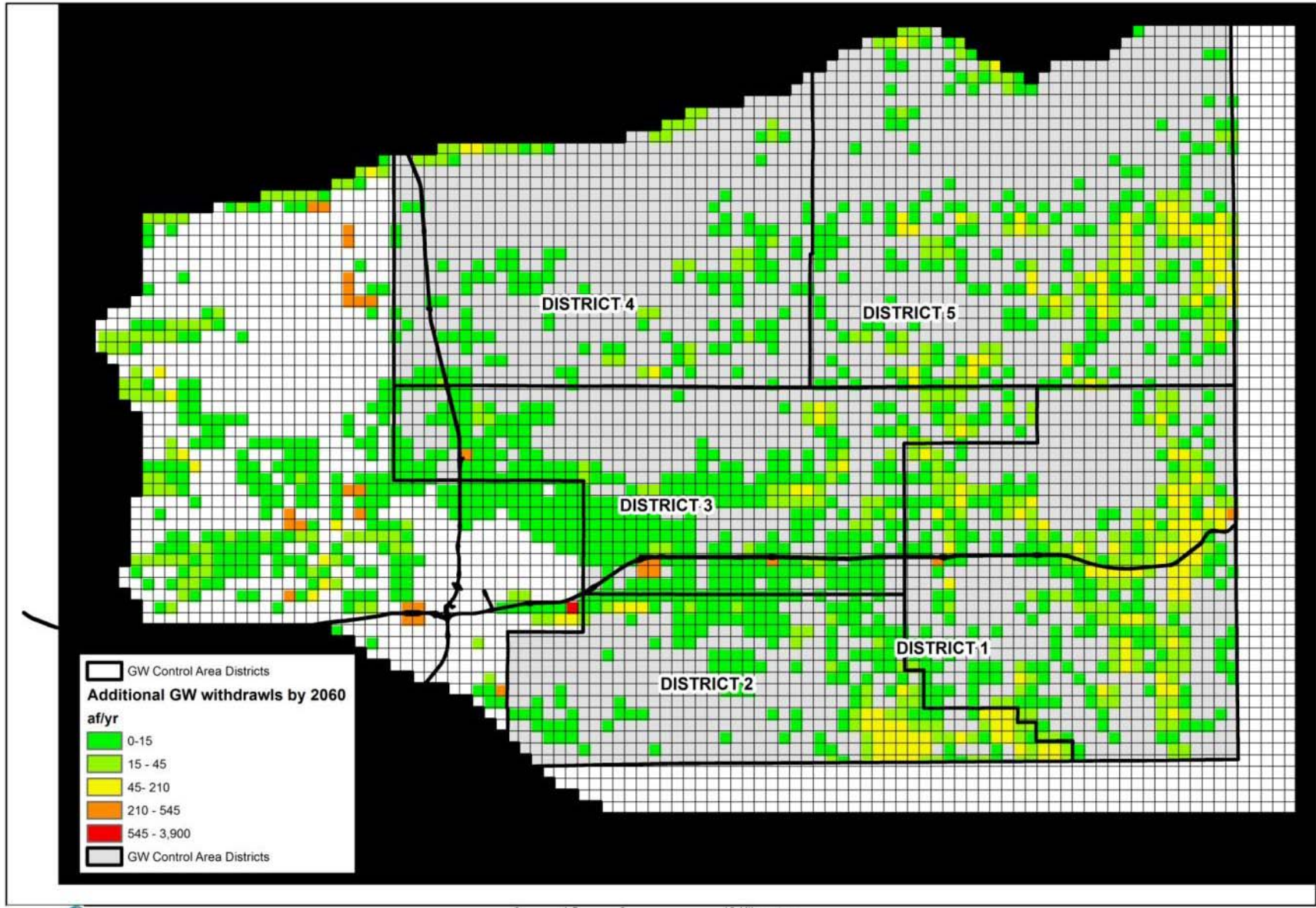
Cities and Towns  
 ALBIN  
 BURNS  
 CHEYENNE  
 PINE BLUFFS  
 Interstate



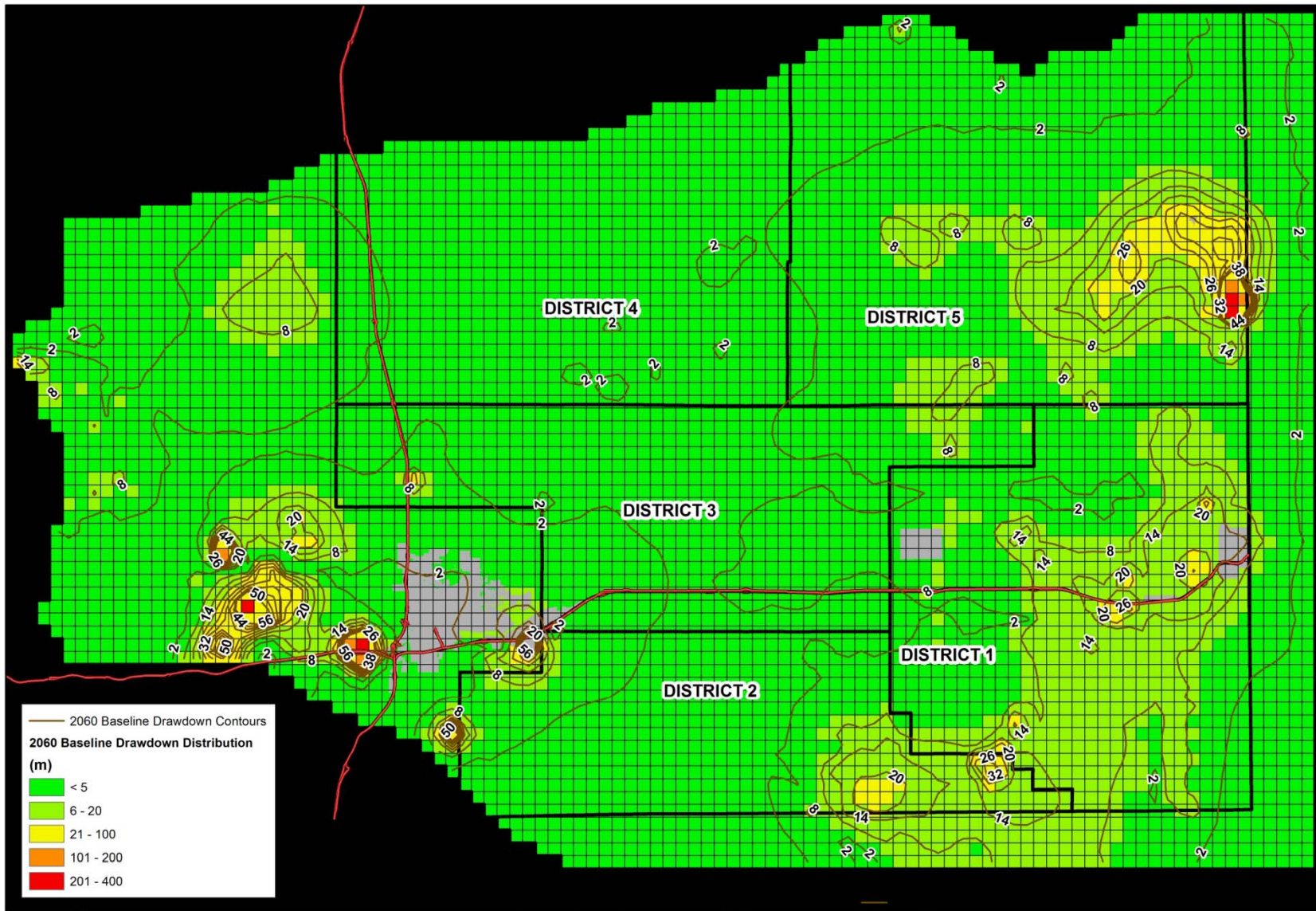
# Aquifer Lithology



# Additional Groundwater Withdrawals by 2060



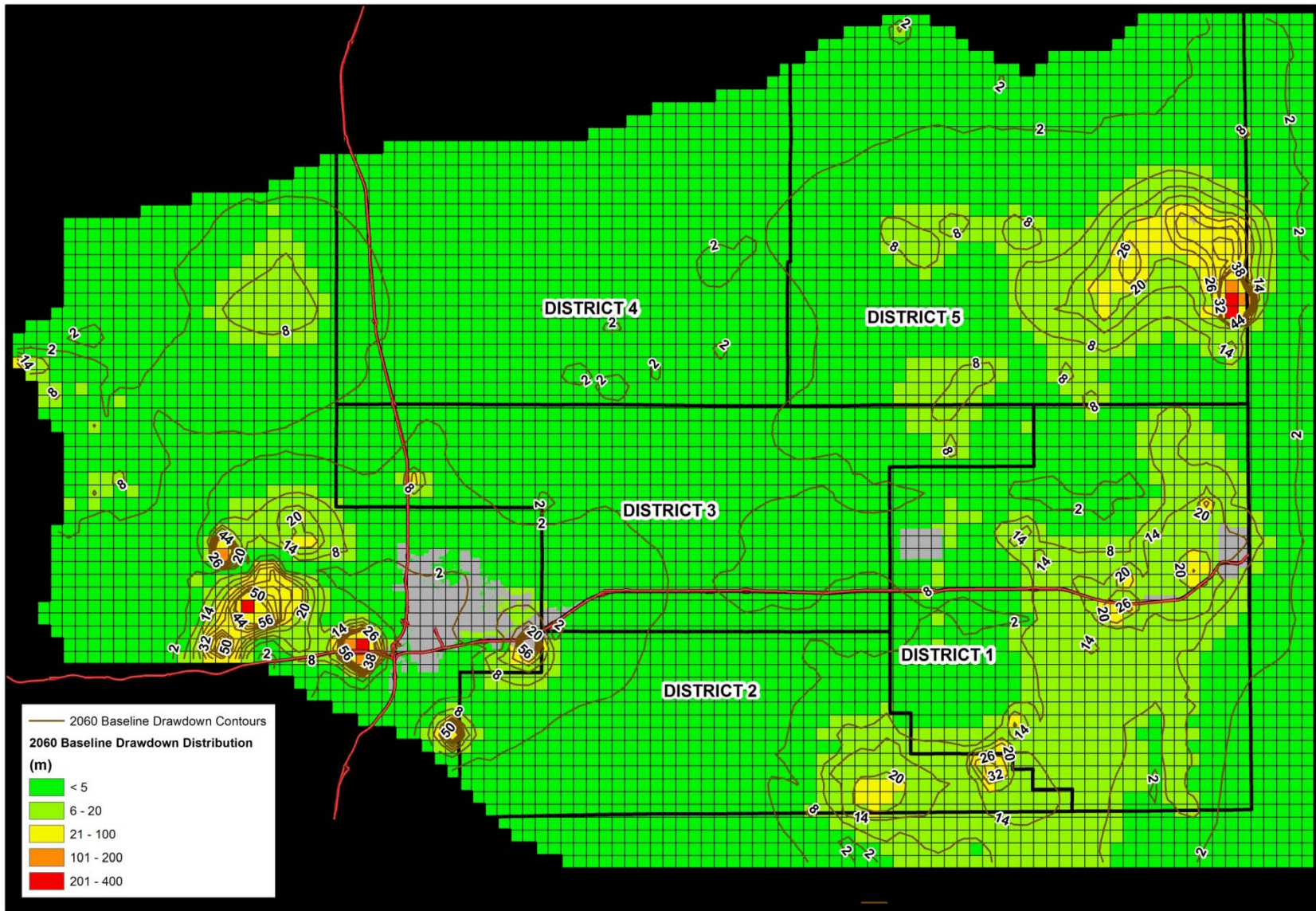
# Drawdown in 2060



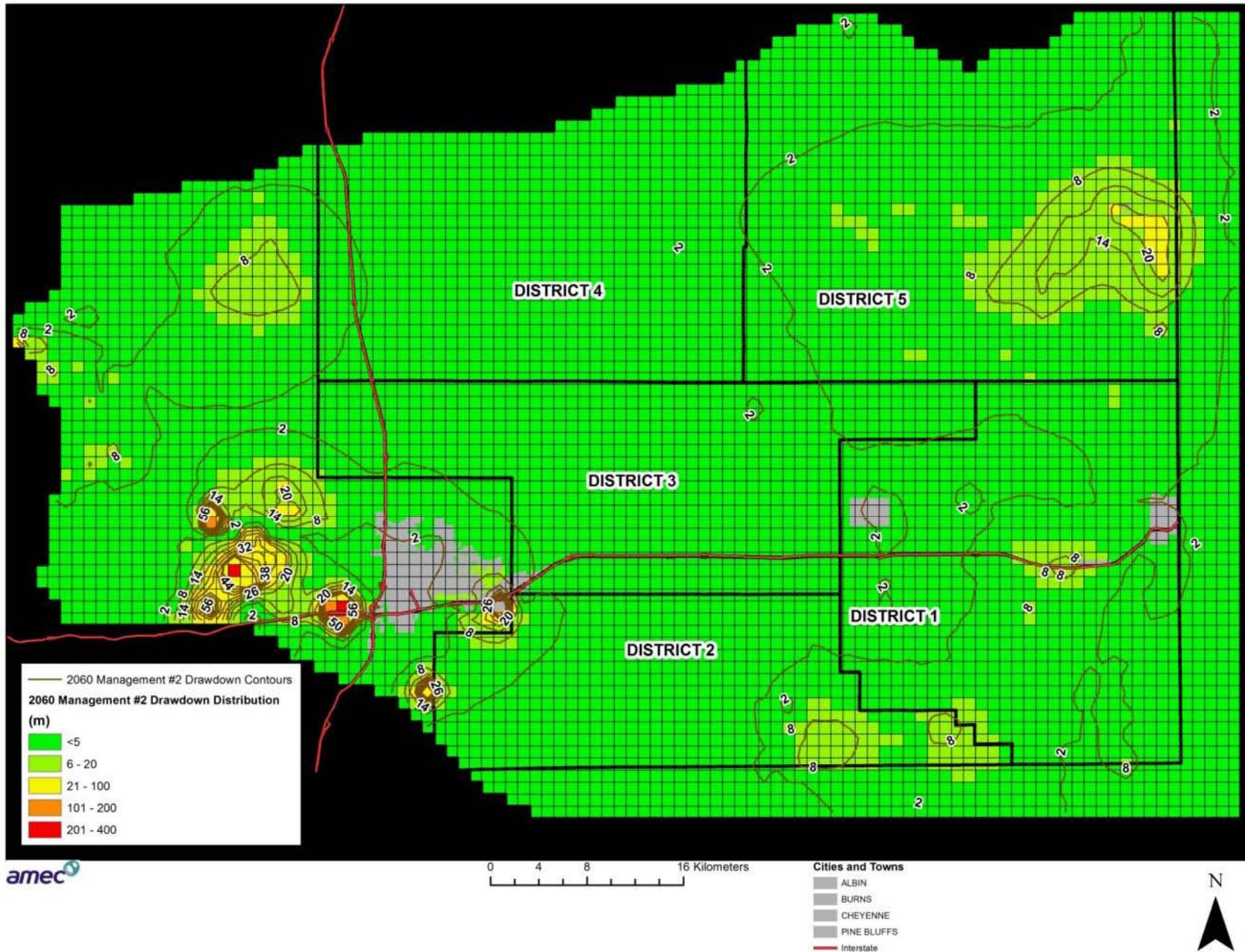
## “What If” #2 – Reduce Irrigation

- Reduction in irrigation pumping to achieve stabilization/recovery of water levels
- All areas inside the Control Area reduced the same amount – 50% from 2010 levels
- No reductions outside the Control Area
- Industrial growth allowed outside the Control Area, but no growth inside

# Drawdown in 2060



# Management #2 Drawdown in 2060

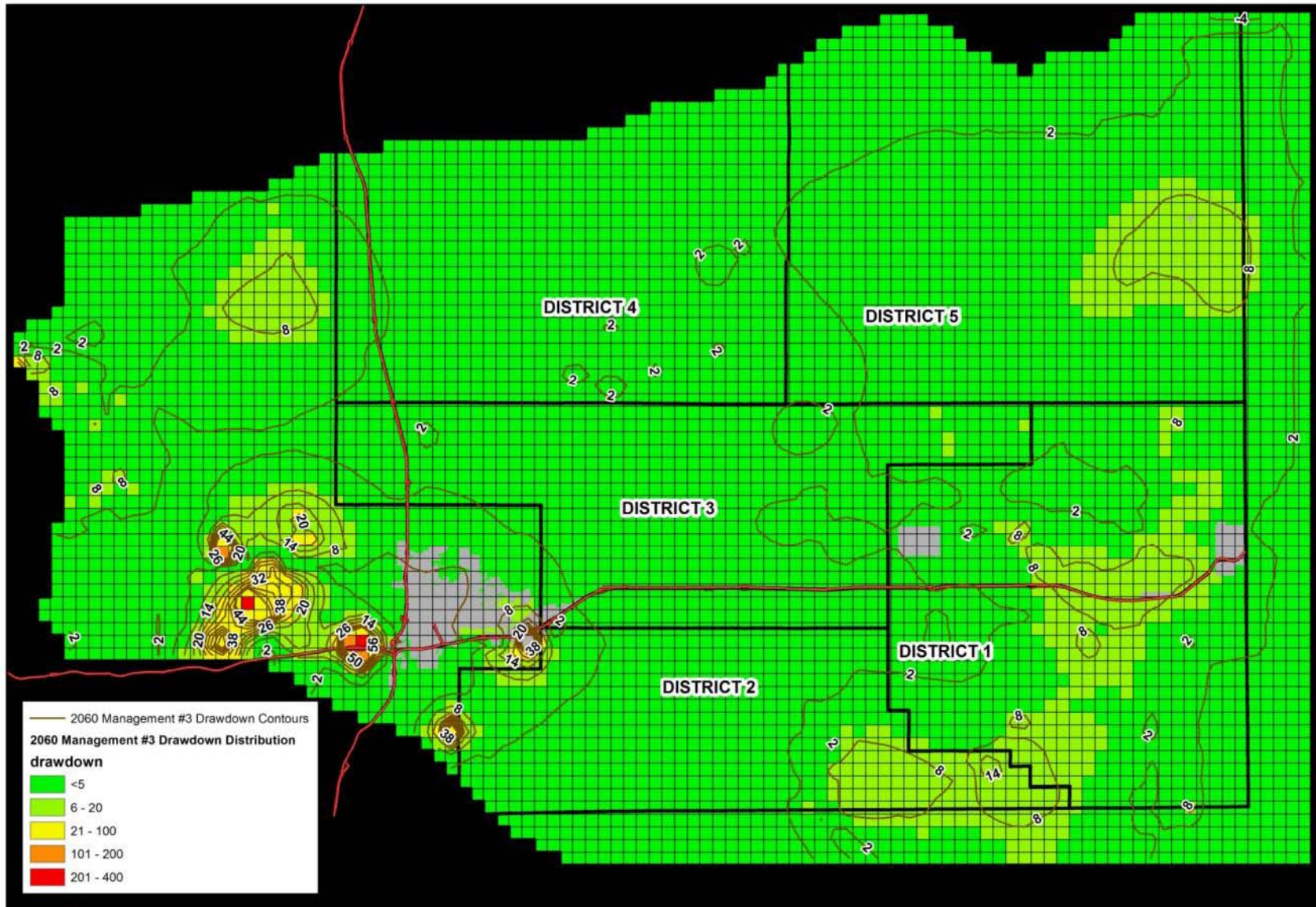




## “What If” #3 – Reduce Irrigation (2)

- Like Management Option #2, but pumping is reduced differently depending on which district the well is in
- District 1 reduced 30%
- District 2 reduced 35%
- Districts 3 & 4 no reduction
- District 5 reduced 90%
- Goal was to stabilize water levels, not present a realistic vision of the future or make a recommendation

# Management #3 Drawdown in 2060



amec

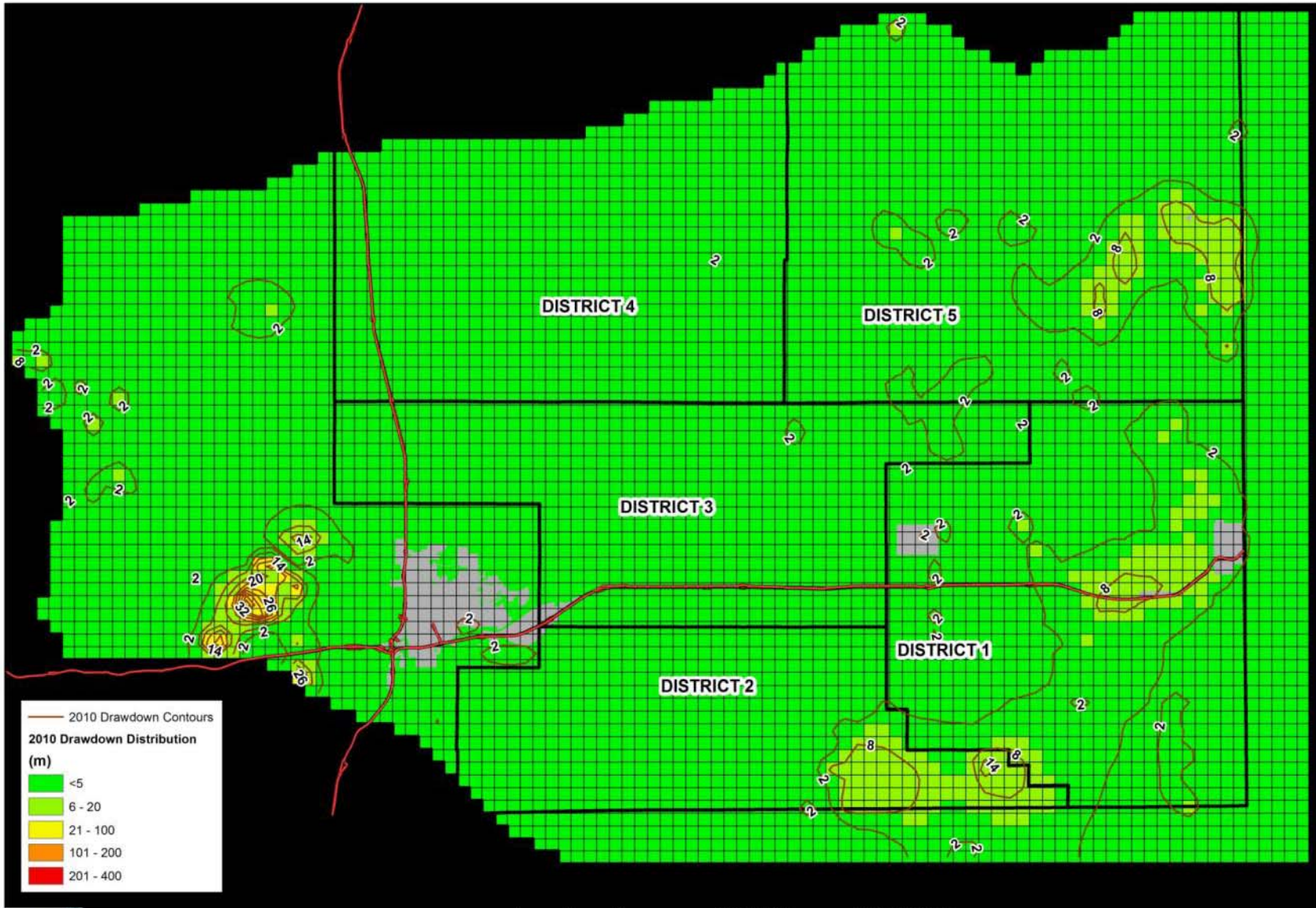
0 4 8 16 Kilometers

Cities and Towns

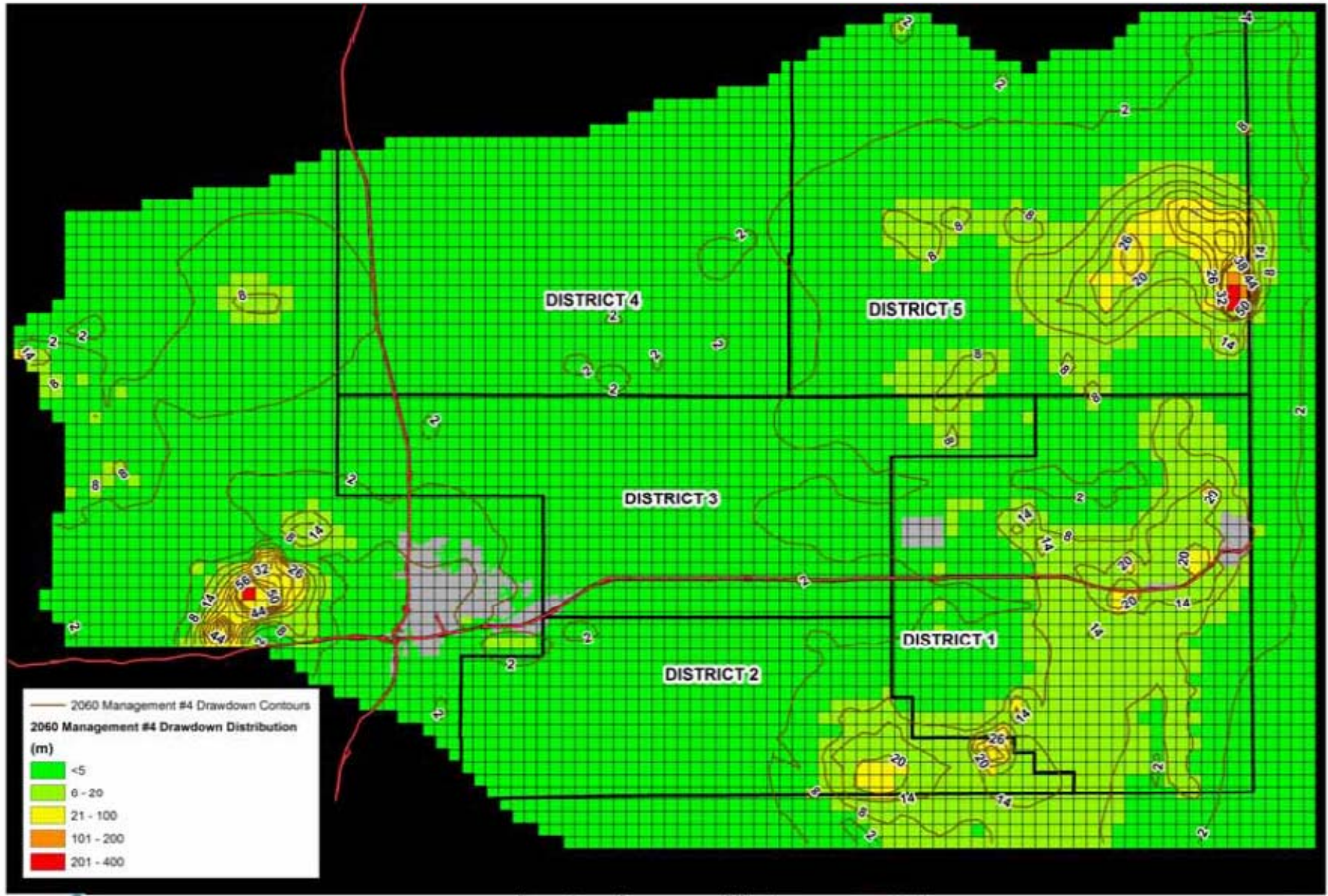
- ALBIN
- BURNS
- CHEYENNE
- PINE BLUFFS
- Interstate



# Drawdown in 2010



# Management #4 - Moratorium to 2060



# Conclusions from Modeling

- If groundwater withdrawals continue to increase, expect there to be areas in the county where wells go dry (self regulating?)
- Pumping that is already in place, without adding any more, will lower the water table going into the future

# Conclusions from Modeling (cont.)

- Variable conditions around the county
  - In some areas the only way to recover is to reduce use
  - Some areas have minimal withdrawals and substantial saturated thickness
- The effects of pumping don't propagate very far over the 40-year model period
  - Supports the targeting specific areas



*Laramie County Control Area  
Hydrogeologic Study*

Cheyenne, Wyoming

December 2, 2014

**Open for Discussion/Questions**