

# Deep Aquifer Hydrogeology The Flathead (Kalispell) Valley

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**Ground Water Investigation Program**  
Montana Bureau of Mines and Geology

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Sponsored by  
The Flathead River Commission



Answering complex, locally identified hydrologic  
questions across Montana

# The Flathead Valley, Deep Aquifer Project Ground Water Investigations Program

## Purpose

- ✓ Does the overlying confining unit separate the deep aquifer from surface water resources?
- ✓ Does the deep aquifer discharge to Flathead Lake?
- ✓ Is the aquifer being depleted?



# Tonight's Discussion

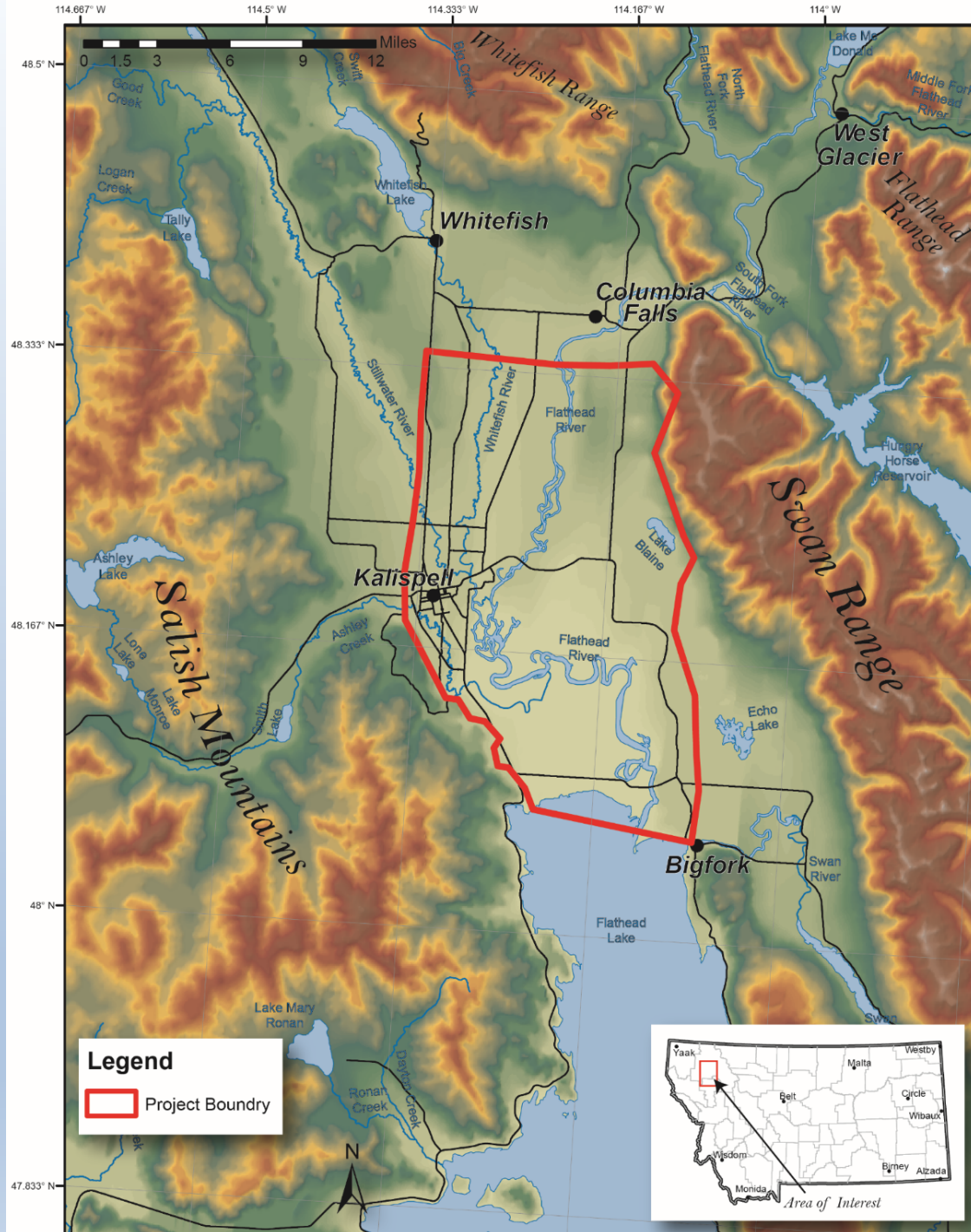
- ✓ **History of groundwater use in the valley**
- ✓ **How the aquifer functions**
- ✓ **Possible stresses identified in the aquifer**
- ✓ **Some examples of impacts or lack of impacts**



# Study area

Red polygon north of Flathead Lake is focus area

But, we'll look around the valley also.

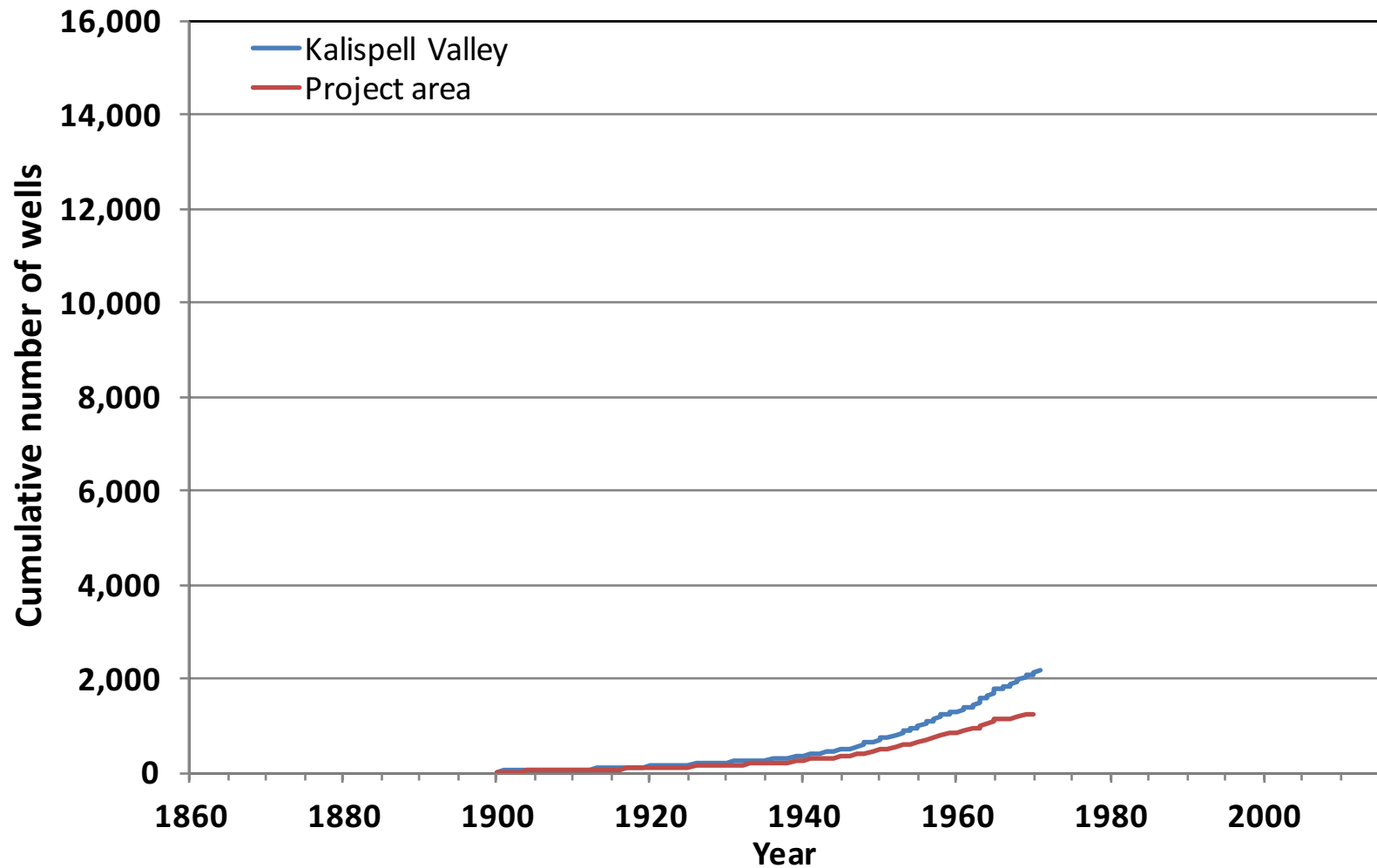




# Well count

Kalispell Valley

1860-1970





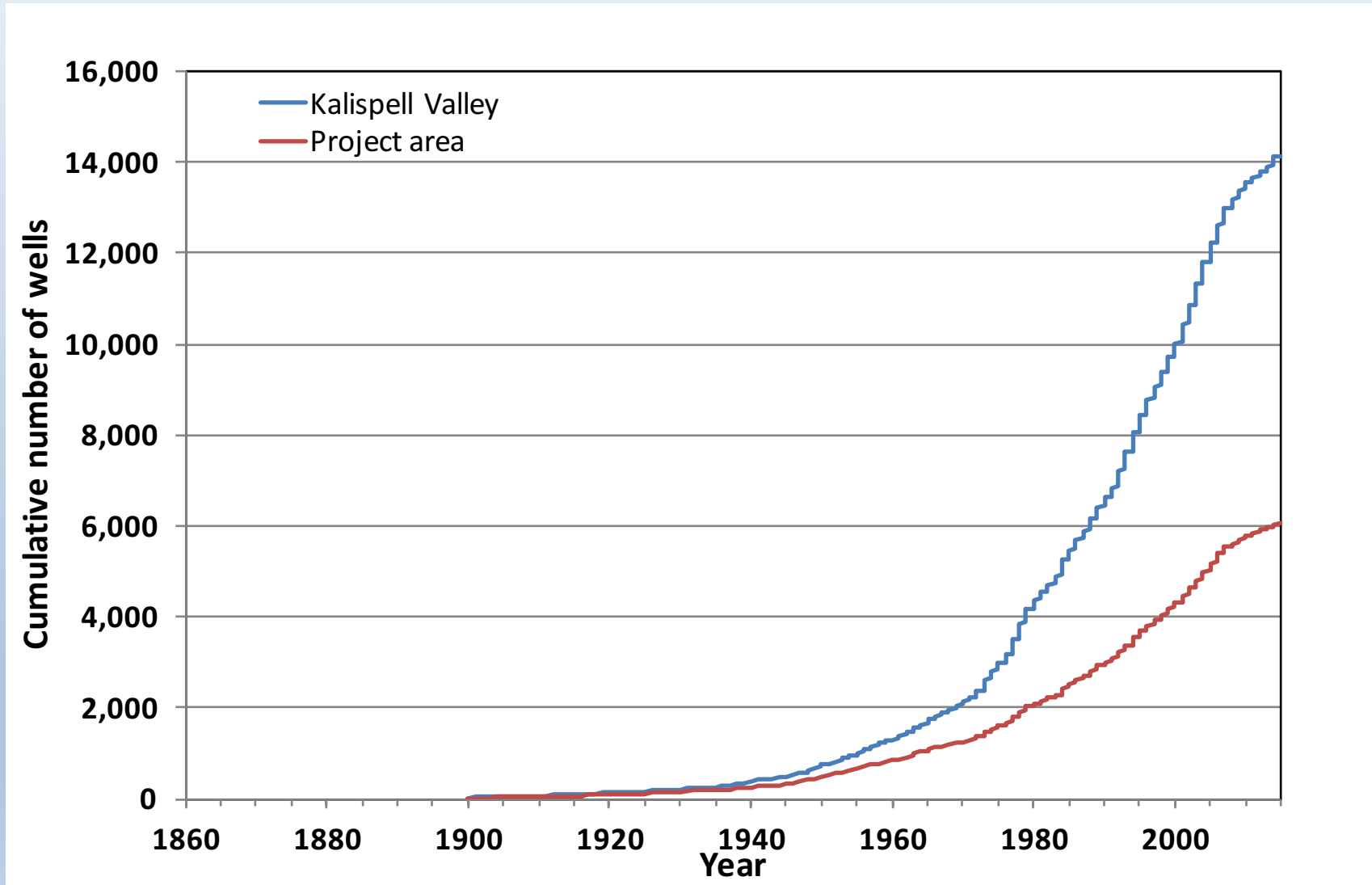




# Well count

Kalispell Valley

1860-2004





# The Deep Aquifer

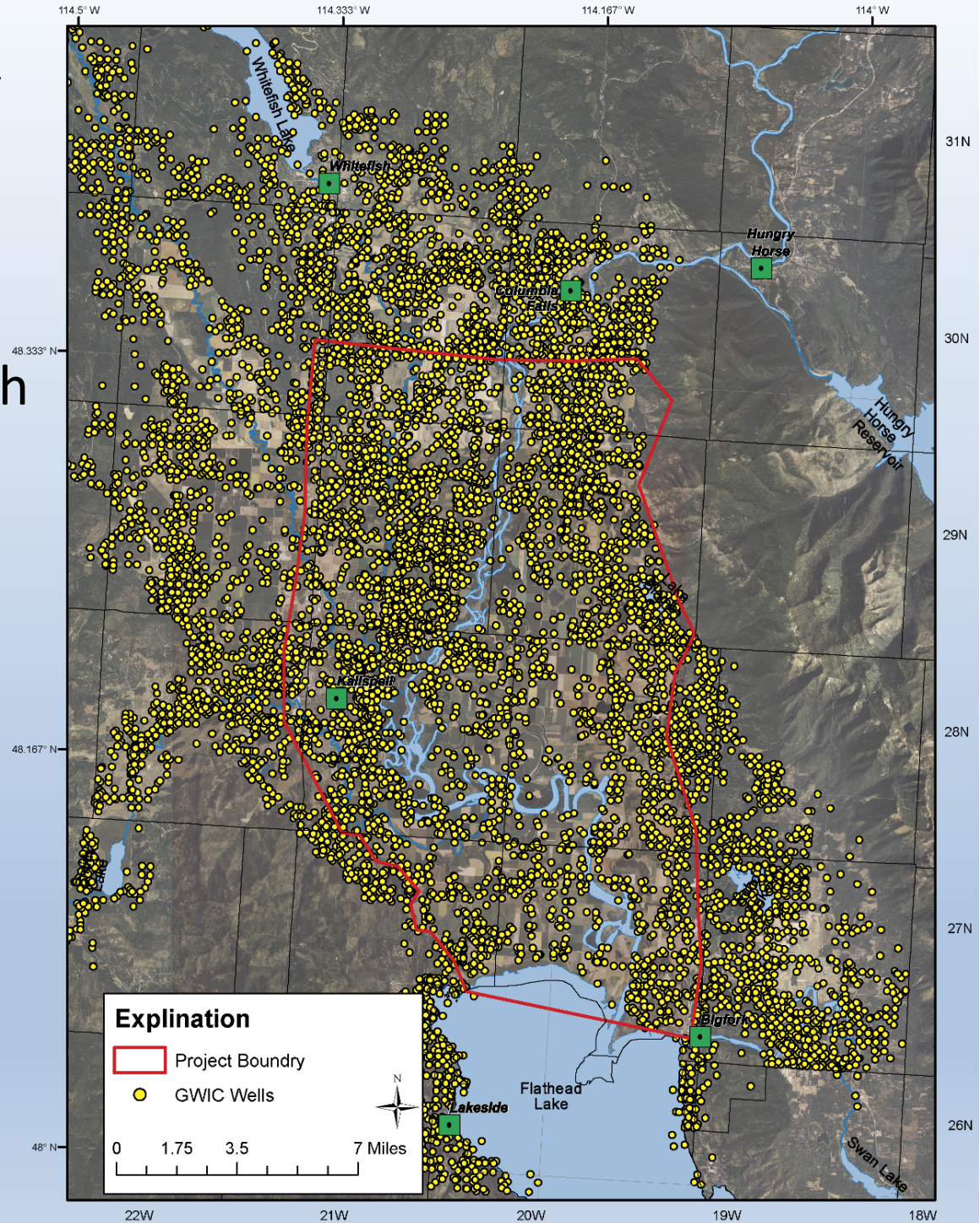
2,570 wells in the study area

200 ft average, 810 max depth

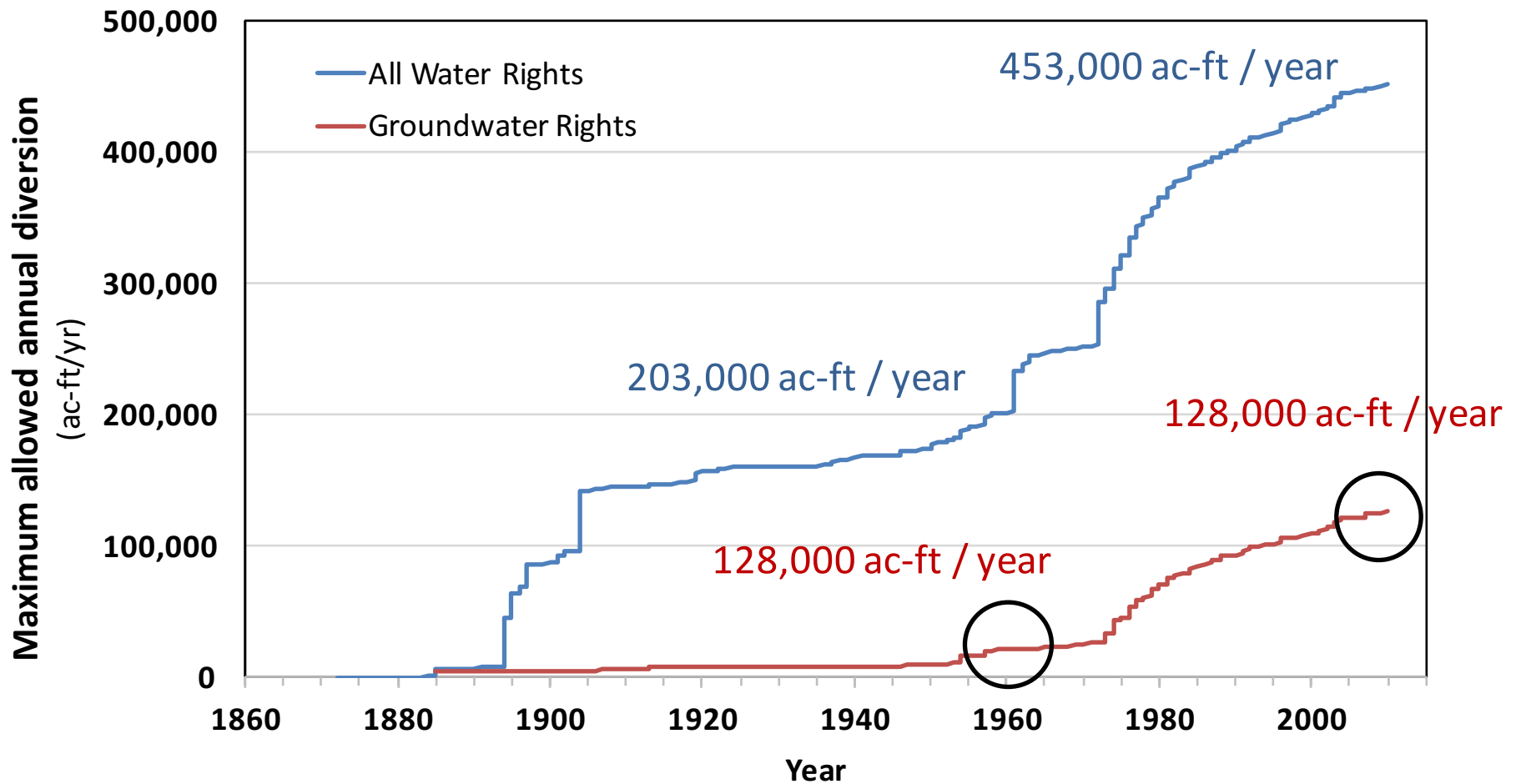
60 gpm to 3,500 gpm yields



All wells

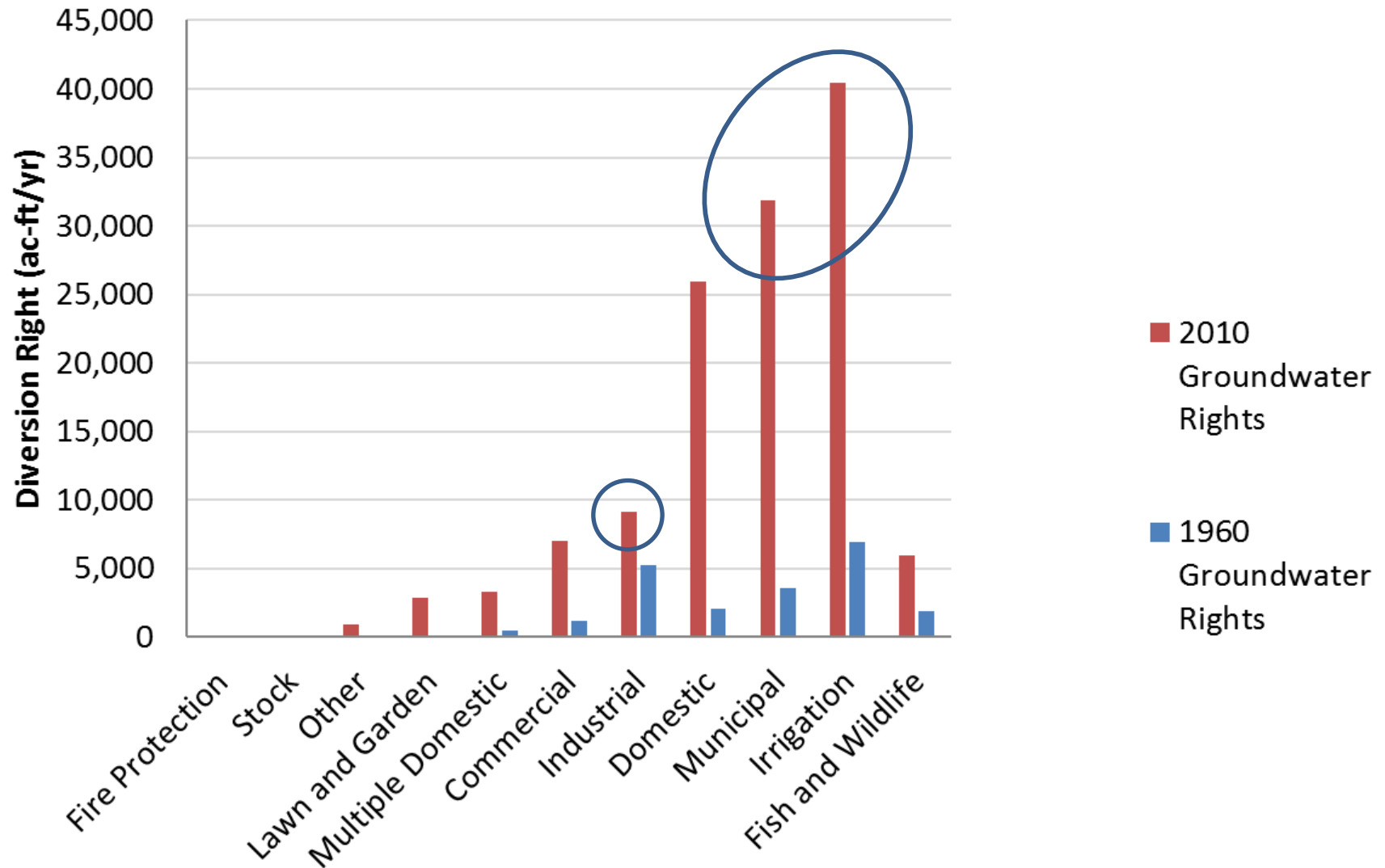


# Water Rights Kalispell Valley 1860-2015

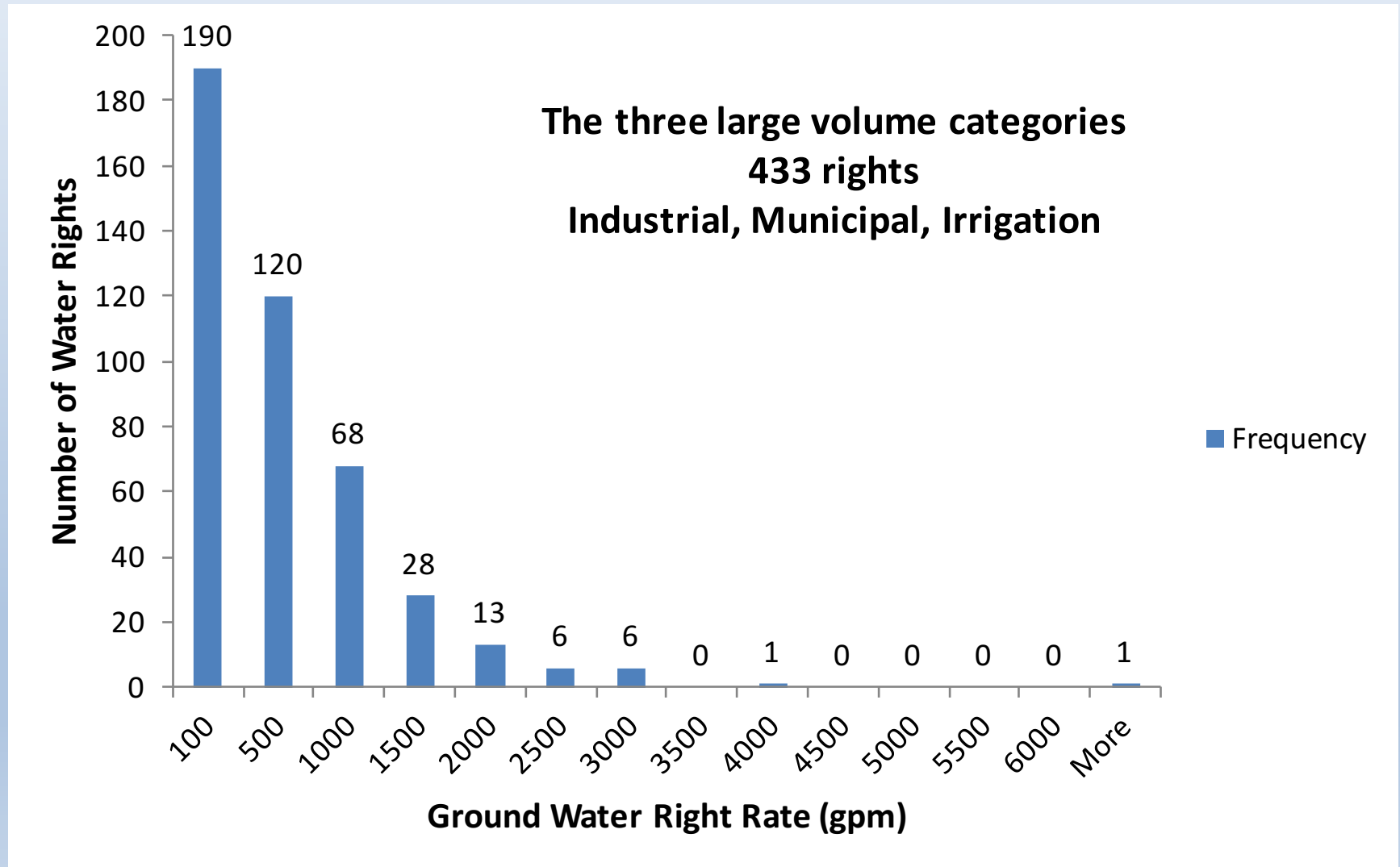




# Diversion Right and Water Use

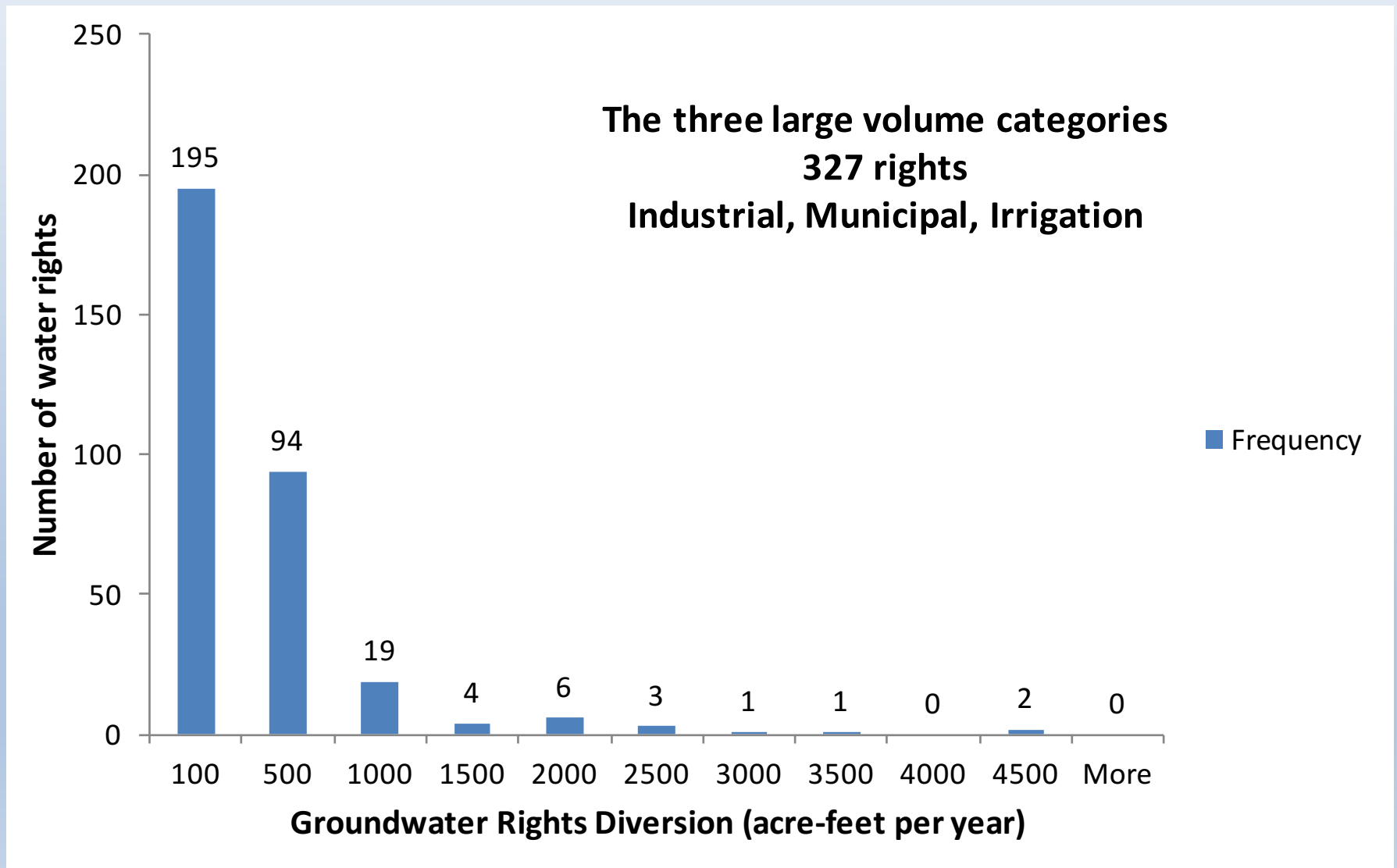


# Groundwater Rights and Pumping Rates



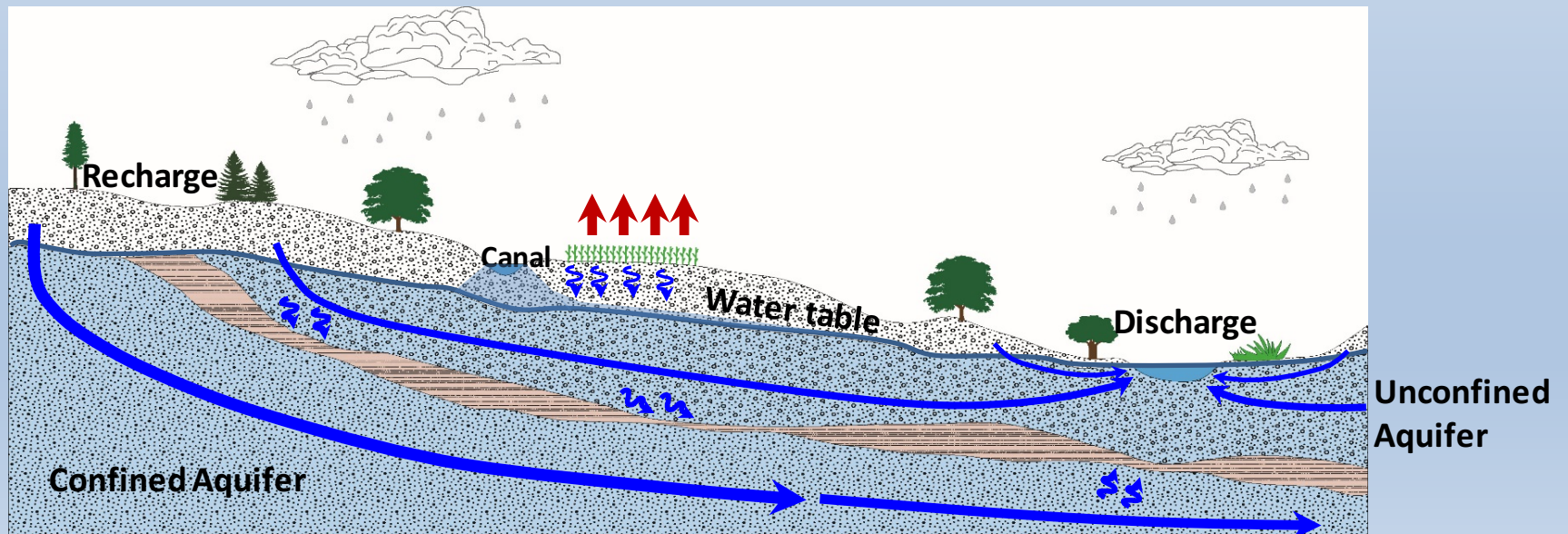


# Groundwater Rights and Number of Water Rights



# Terminology

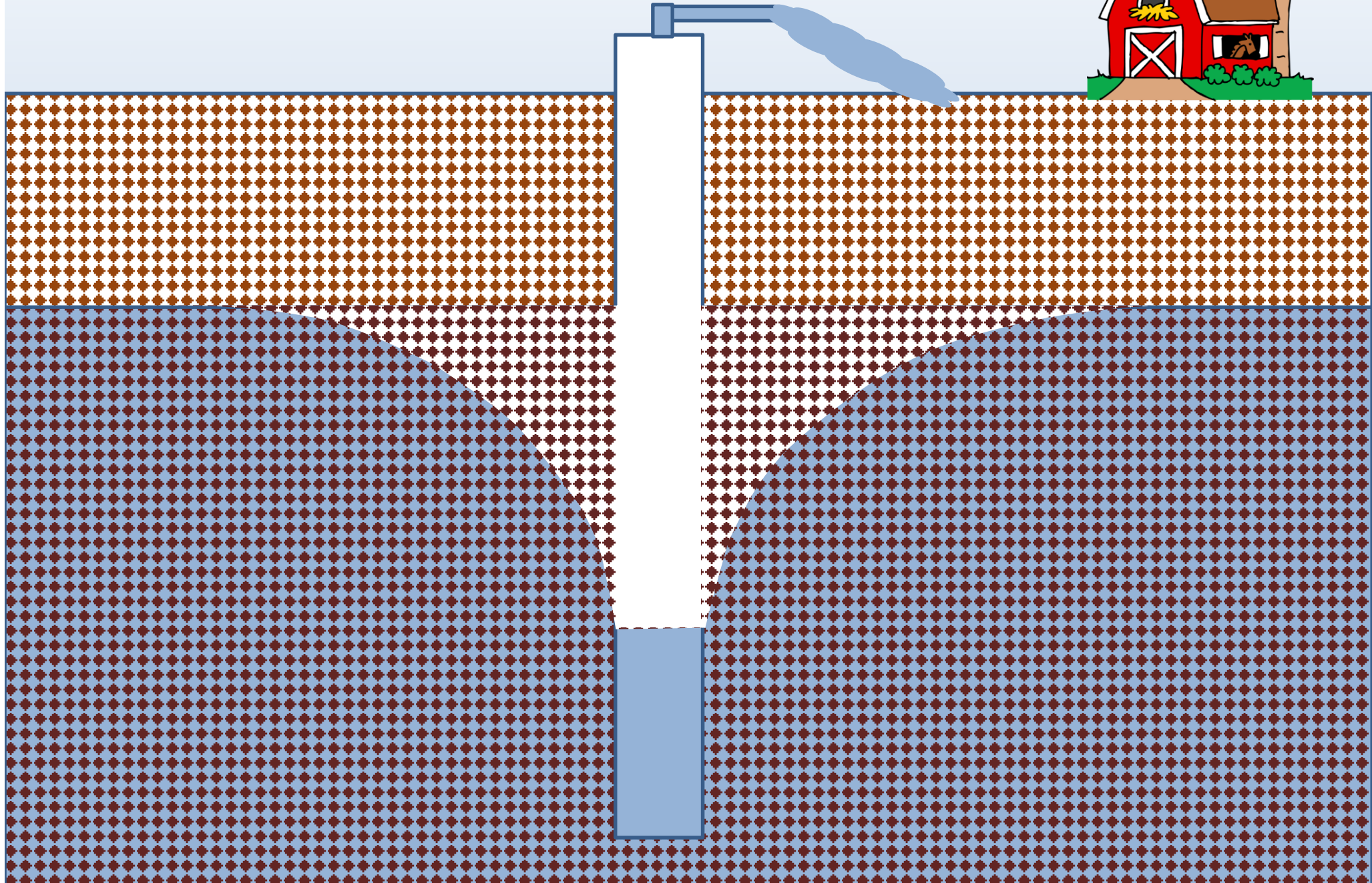
- ✓ Water Table or Unconfined Aquifer  
Shallow
- ✓ Confined Aquifer or Artesian  
Deeper  
Beneath a confining layer
- ✓ Flowing wells are special cases





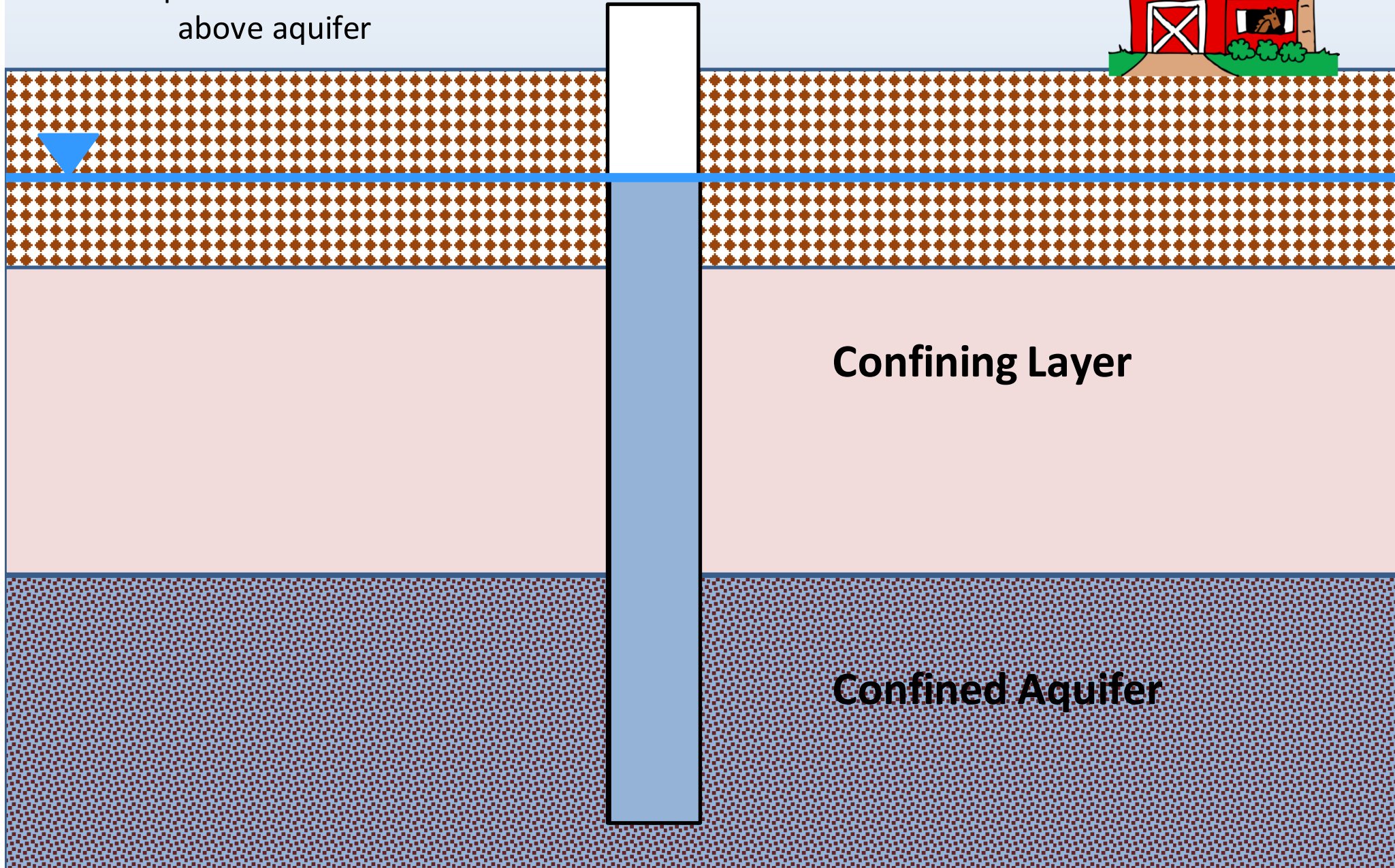
# Unconfined Aquifer (water table)

Water is drained from pores between sand and gravel cobbles



# Confined Aquifer (artesian)

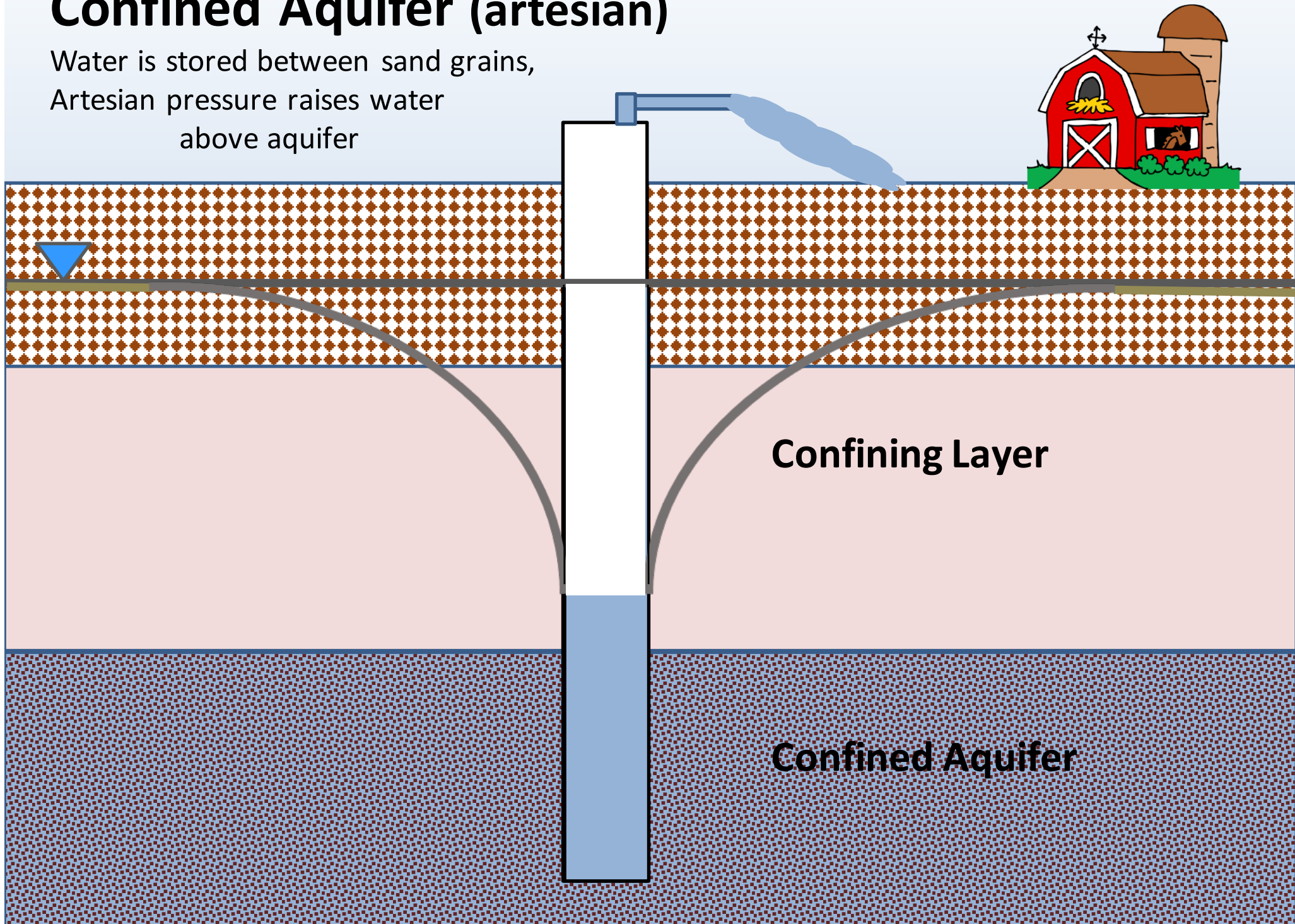
Water is stored between sand grains,  
Artesian pressure raises water  
above aquifer





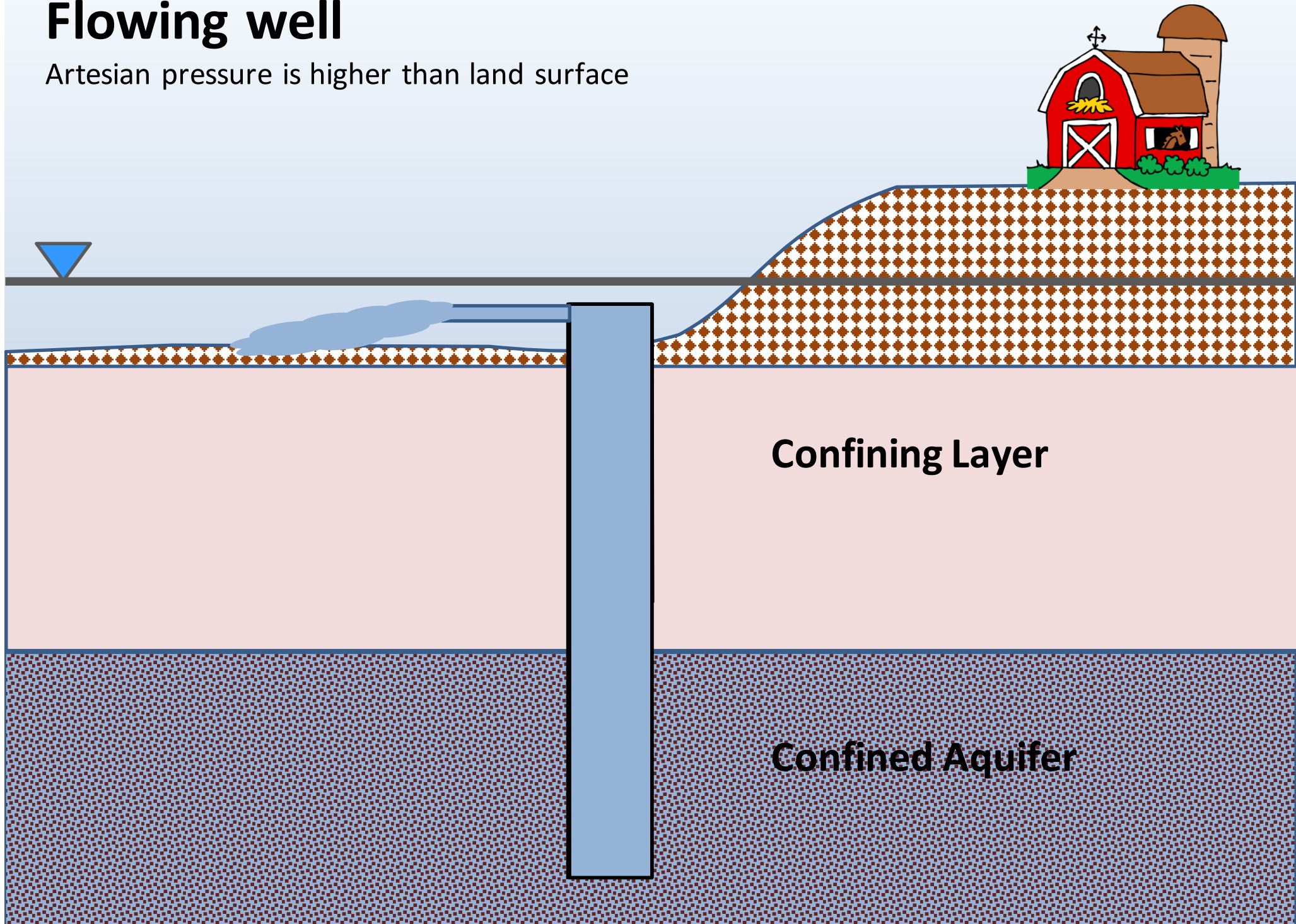
# Confined Aquifer (artesian)

Water is stored between sand grains,  
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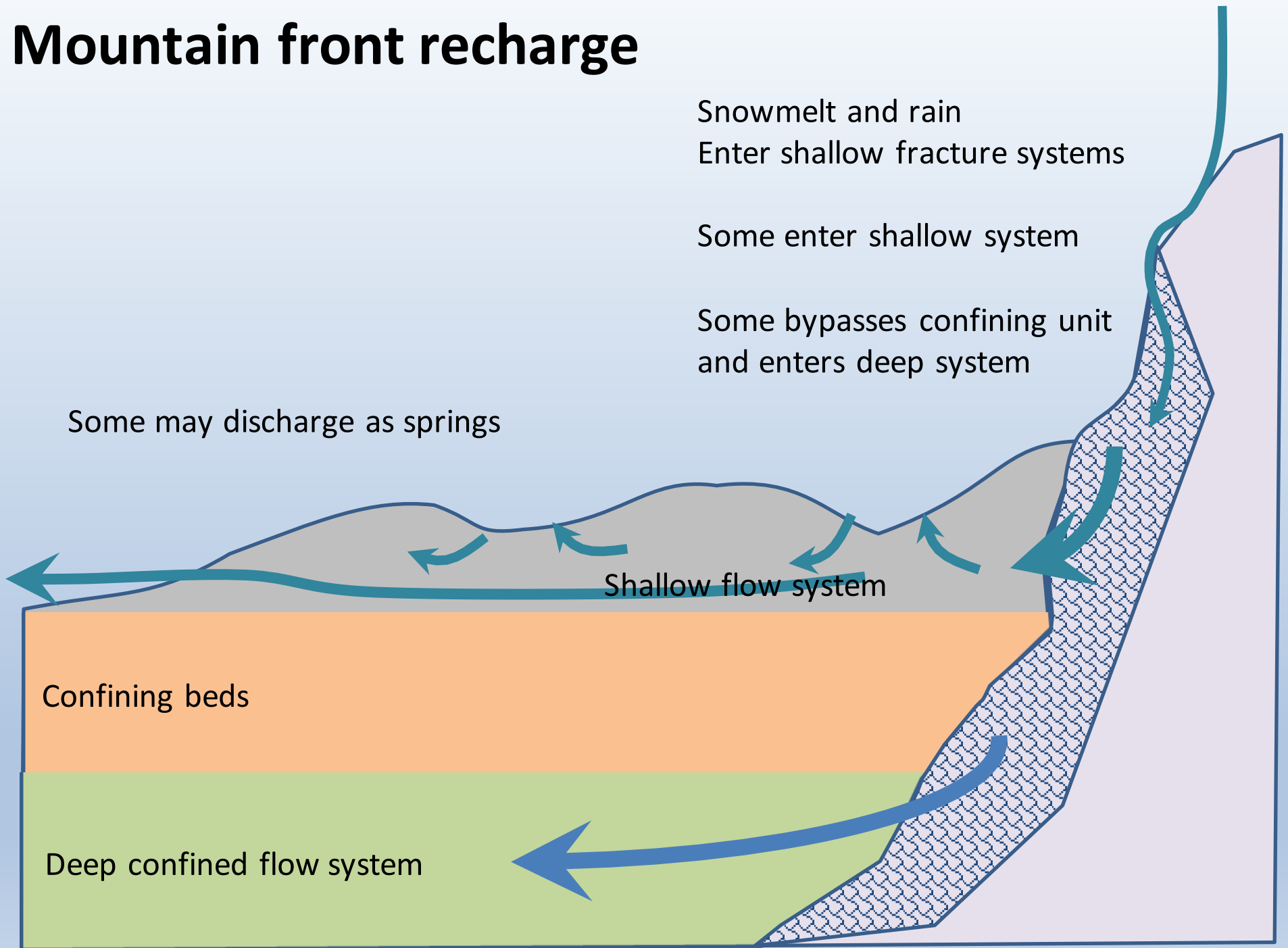
# Flowing well

Artesian pressure is higher than land surface





# Mountain front recharge



# GWIP Research

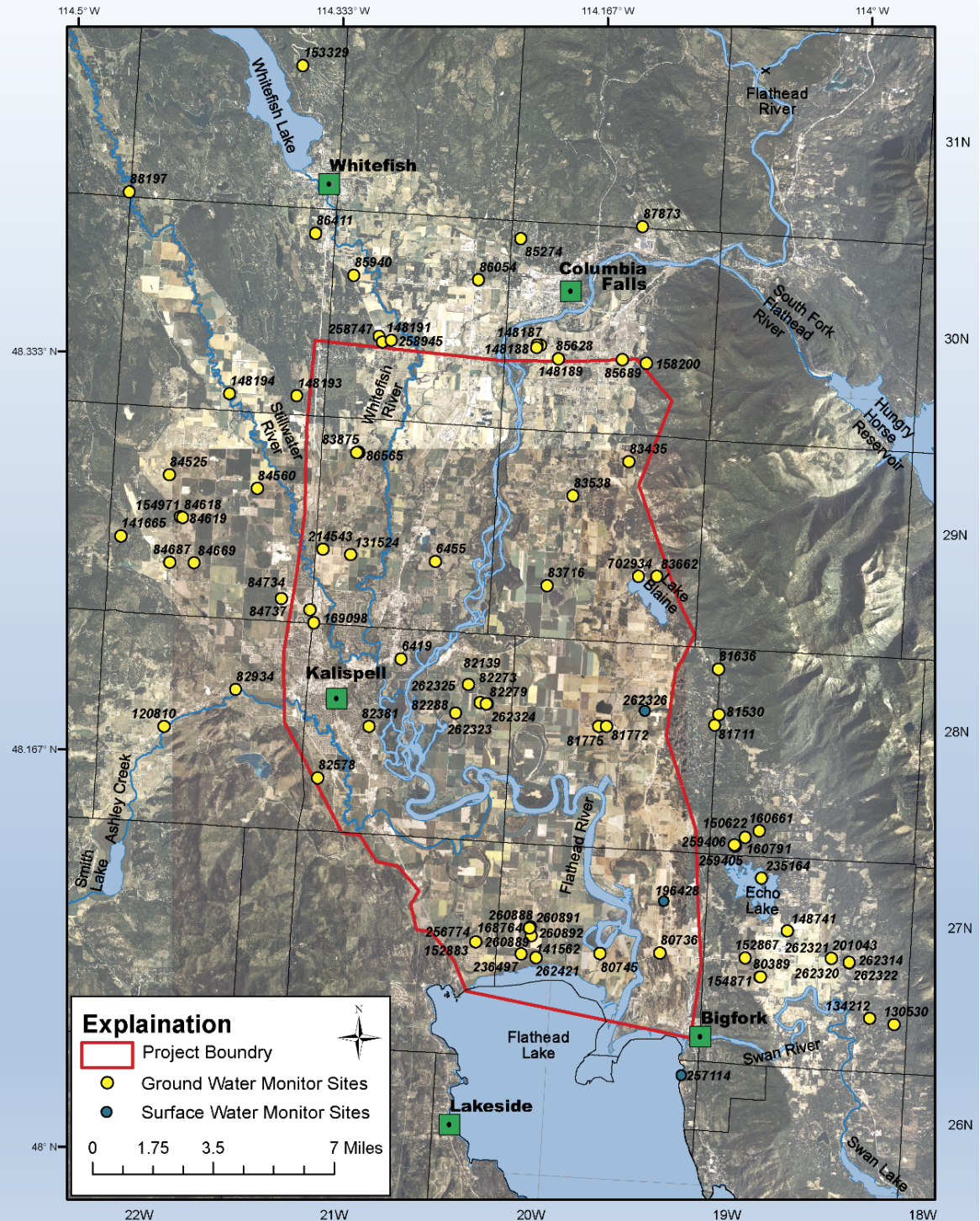
## Purpose:

To provide a better understanding of the deep aquifer, in order to facilitate water management decisions.

## The aquifer:

About 90 monitoring wells around the valley.

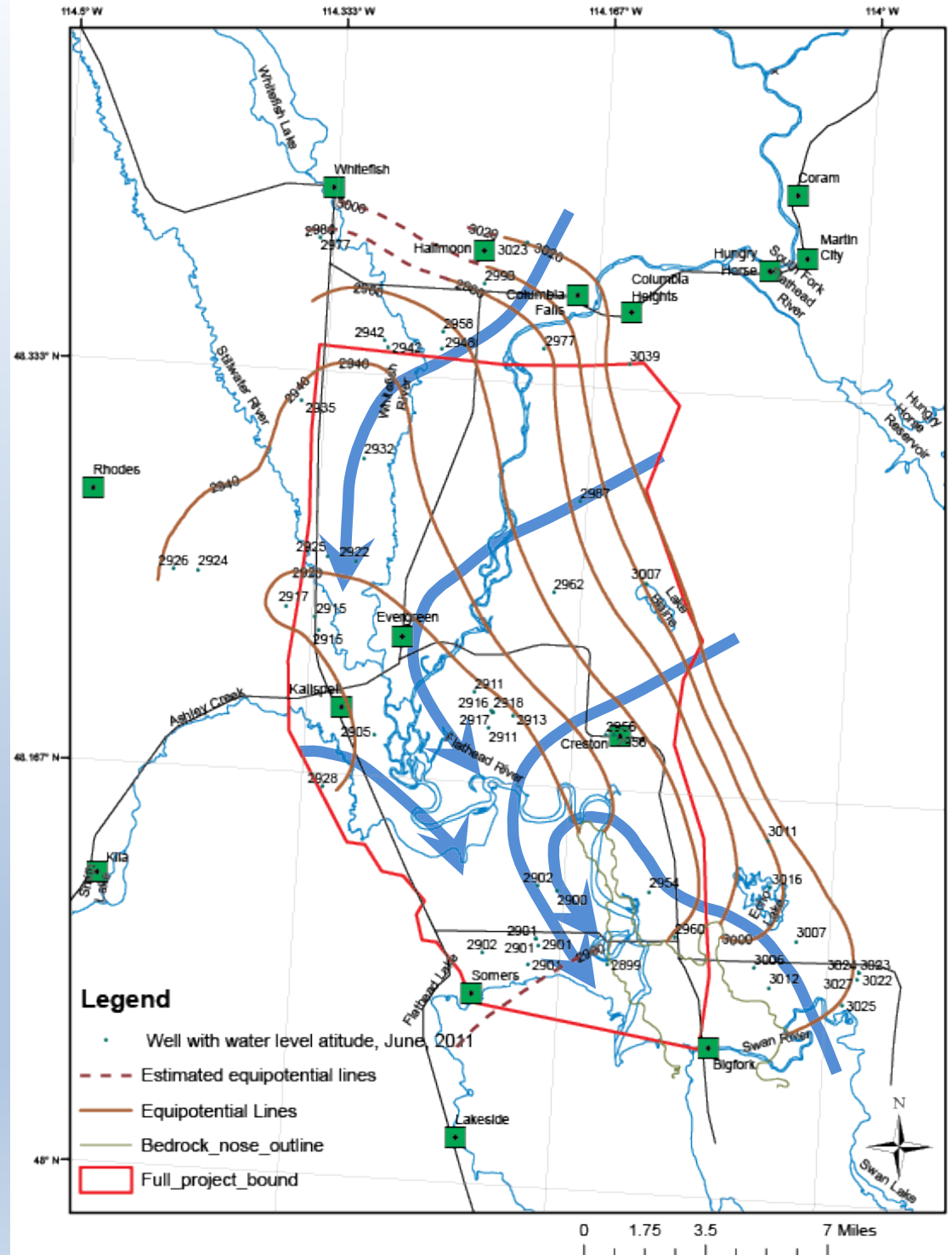
Start with the physical character



# Potentiometric map Deep aquifer

Indicates groundwater:  
flow directions  
recharge areas  
discharge direction

(NOTE TO READER: The equipotential lines on this map have been updated since the presentation on April 6, 2016 to better represent the deep aquifer data.)



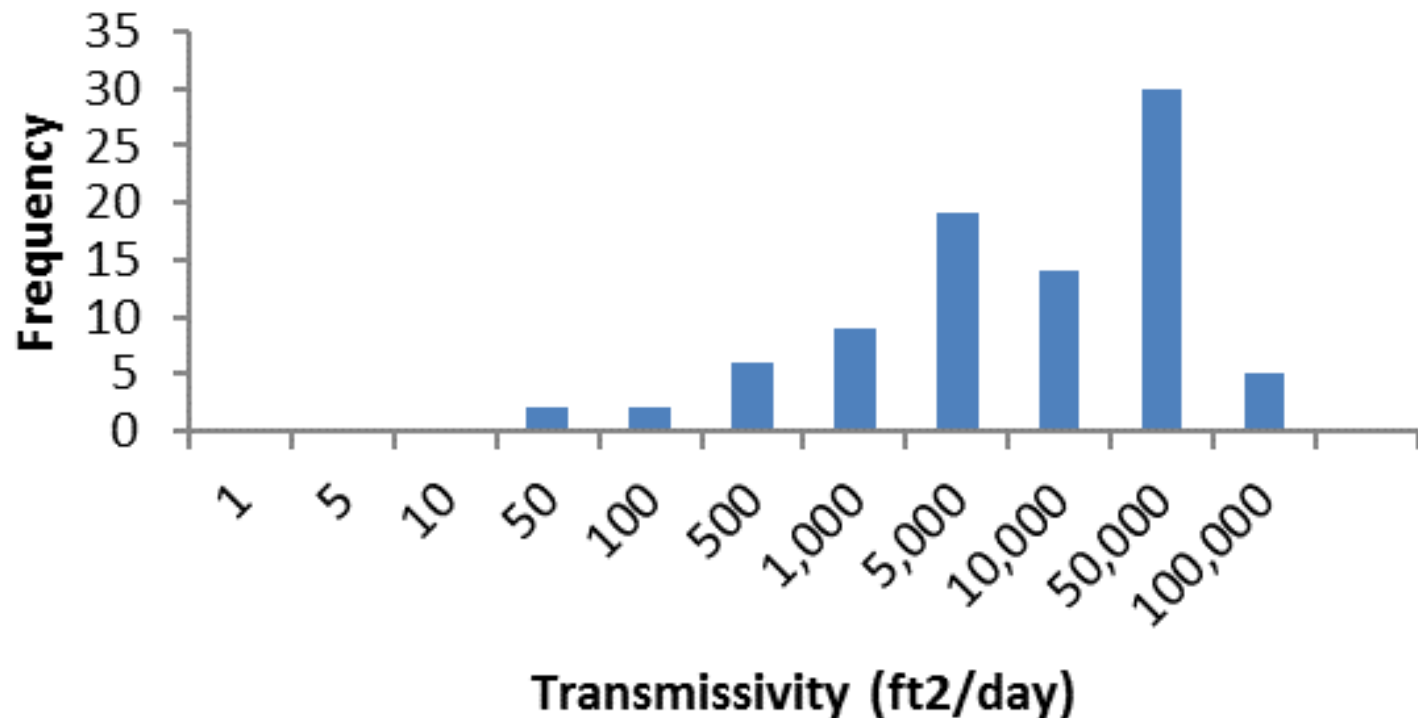


# Deep Aquifer

- ✓ Not uniform
- ✓ Transmissivity

The ability for water to move in an aquifer

Generally - Very, Very High but  
also very, very variable



# How much water is there?

**Consider a lake:**

**Water stored below low-pool level – never used or accessed**

**Flow into and out of -- that includes**

**Increase and decrease from full-pool to low-pool**

**Flow that spills**

**during normal operation and**

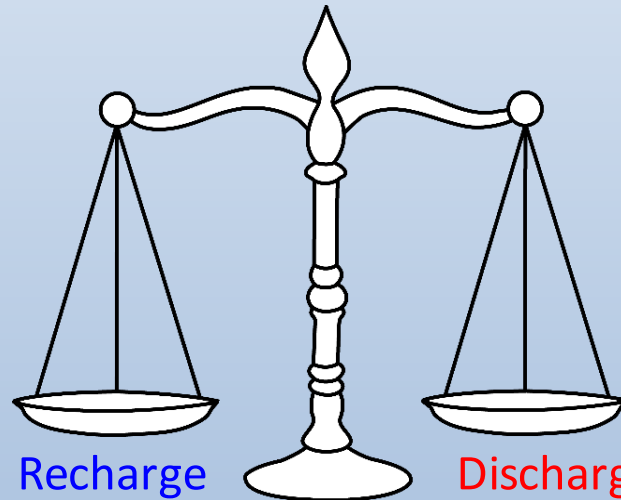
**during full-pool**

# Deep Aquifer Groundwater Budget 2011

(The deep aquifer is not a lake)

Intentional management requires an idea of how much there is.

**Inflow = Outflow**



Recharge

Precipitation

=

Discharge

Pumping withdrawals + Groundwater Outflow

Assume no change in stored water

**Statistical Approach – remember the variability of Transmissivity**



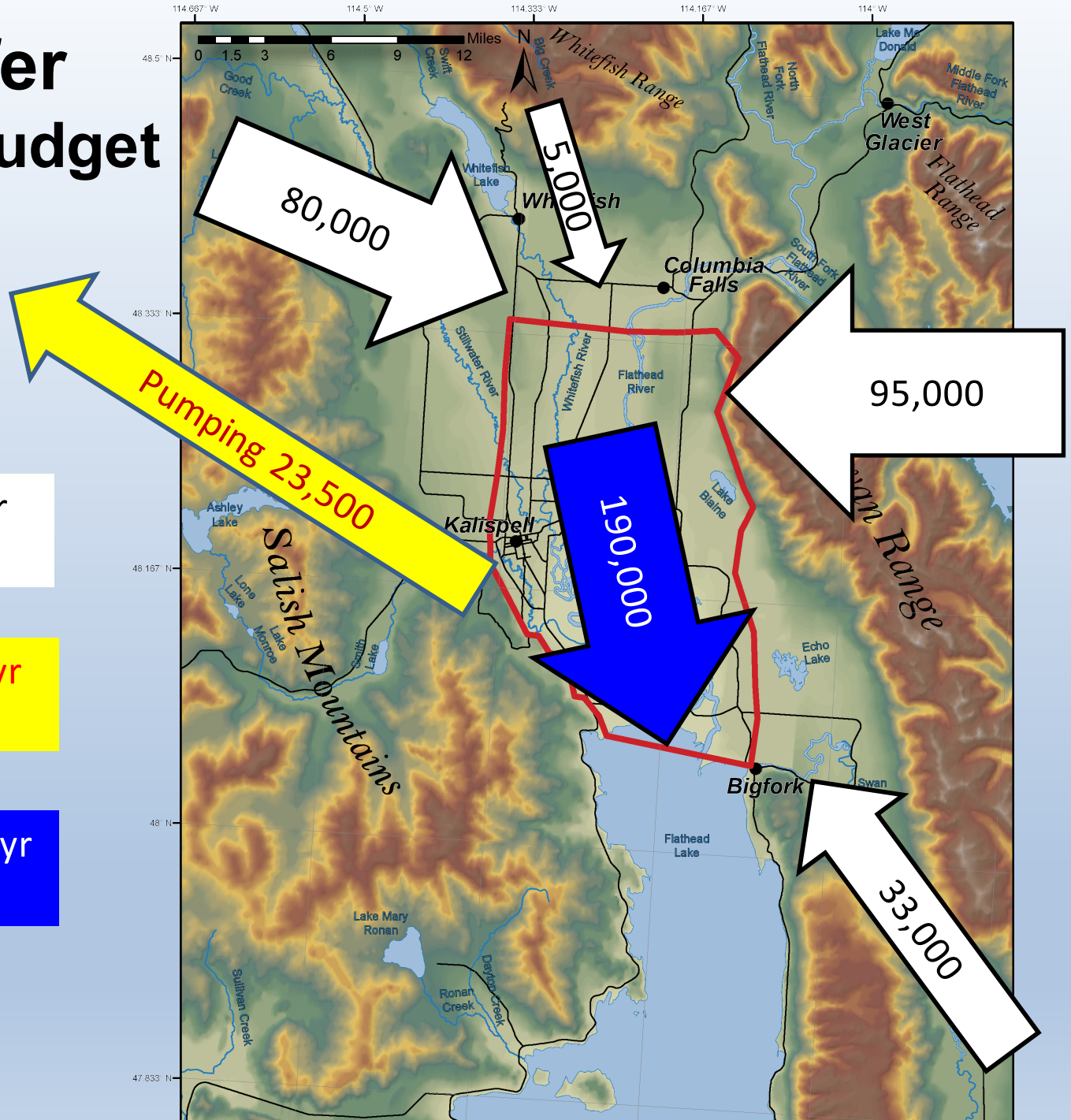
# Deep Aquifer Groundwater Budget (2011)

Values are approximate  
Based on statistical mean

**Inflow** = 213,000 acre-ft/yr  
300 cfs

**Pumping** = 23,500 acre-ft/yr  
32 cfs

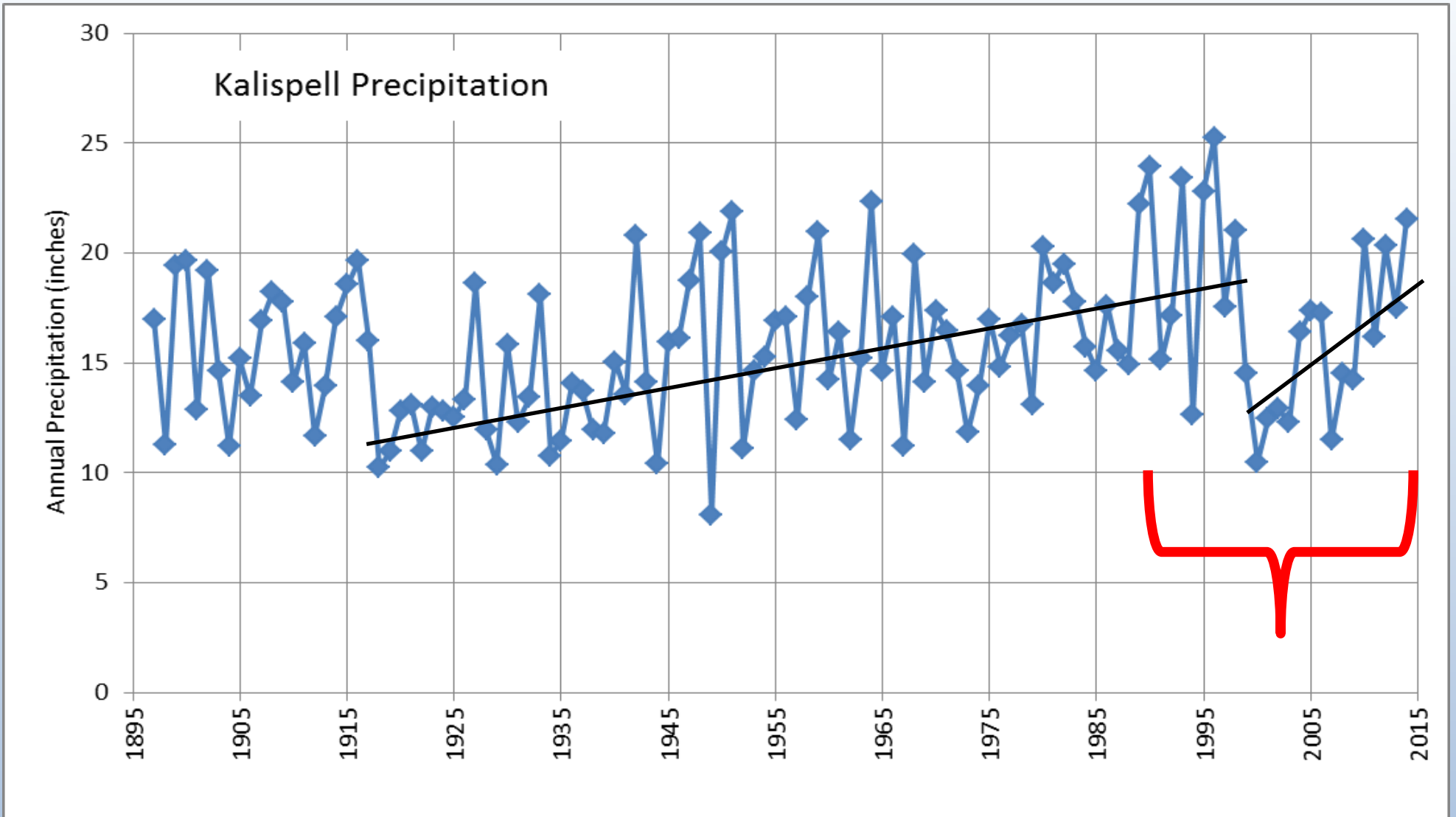
**Outflow** = 190,000 acre-ft/yr  
260 cfs



# Water Level Trends

- ✓ To better understand the groundwater systems, we try to understand what causes the water levels to fluctuate.
- ✓ Fluctuations occur on Decadal, Annual, Seasonal and Daily cycles.
- ✓ Long-term trends help demonstrate aquifer health.
- ✓ Short-term trends help understand how the system works.
- ✓ Following are examples.



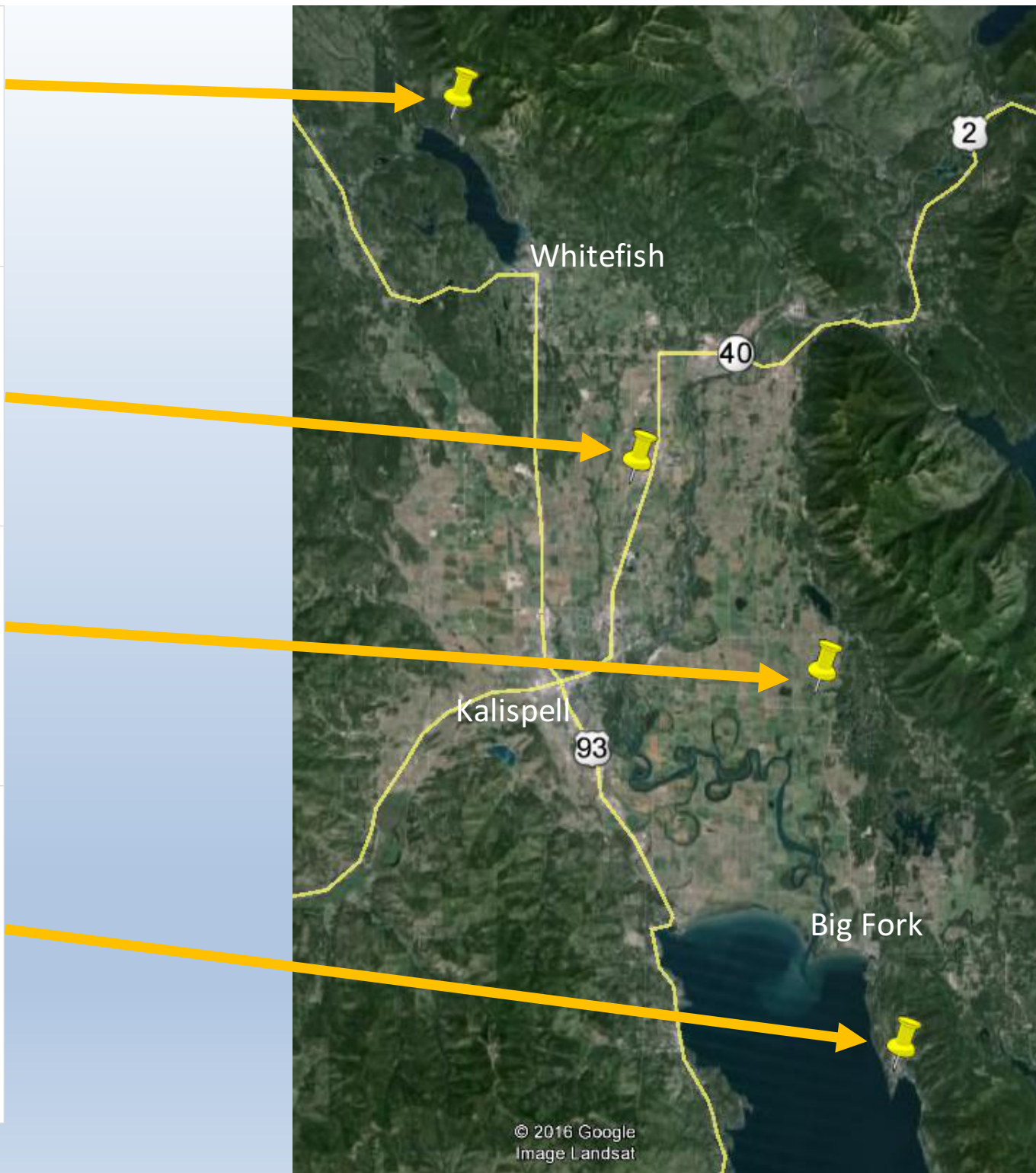
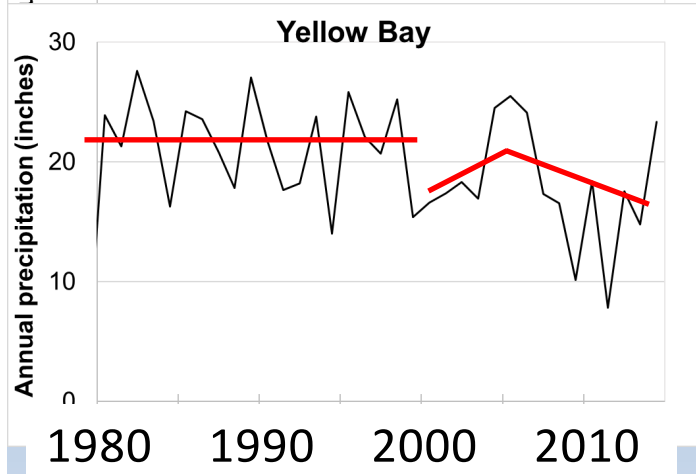
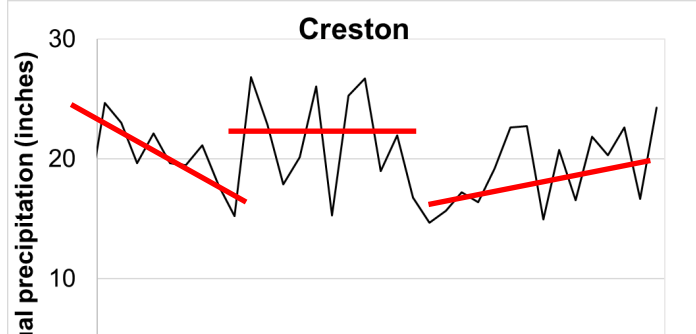
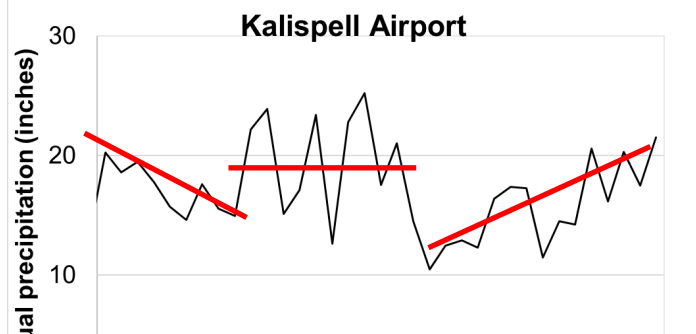
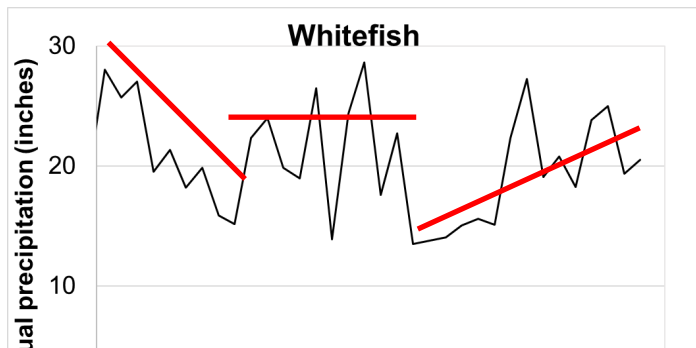


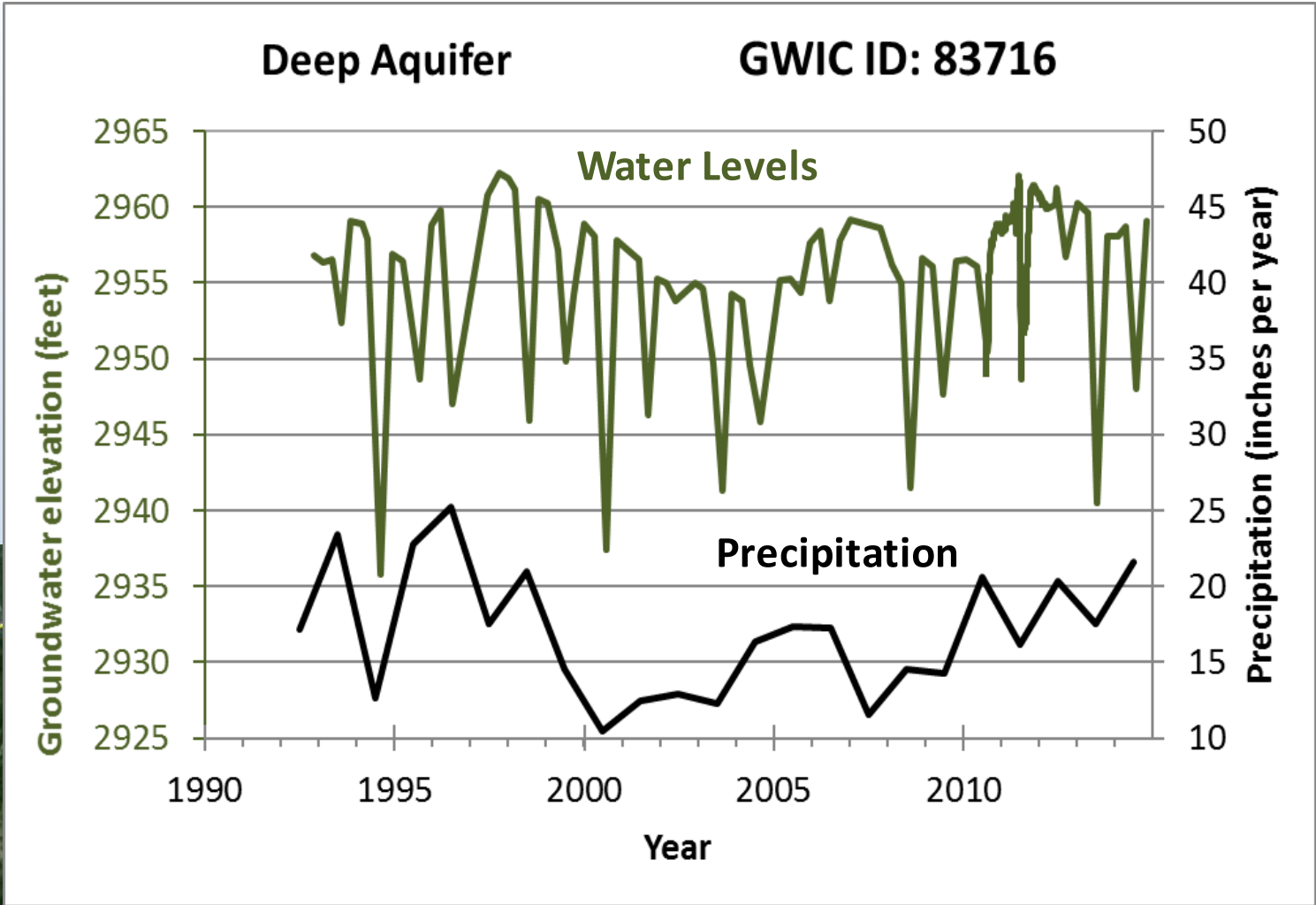
**It's all driven by precipitation.**

There are two long-term increasing trends.

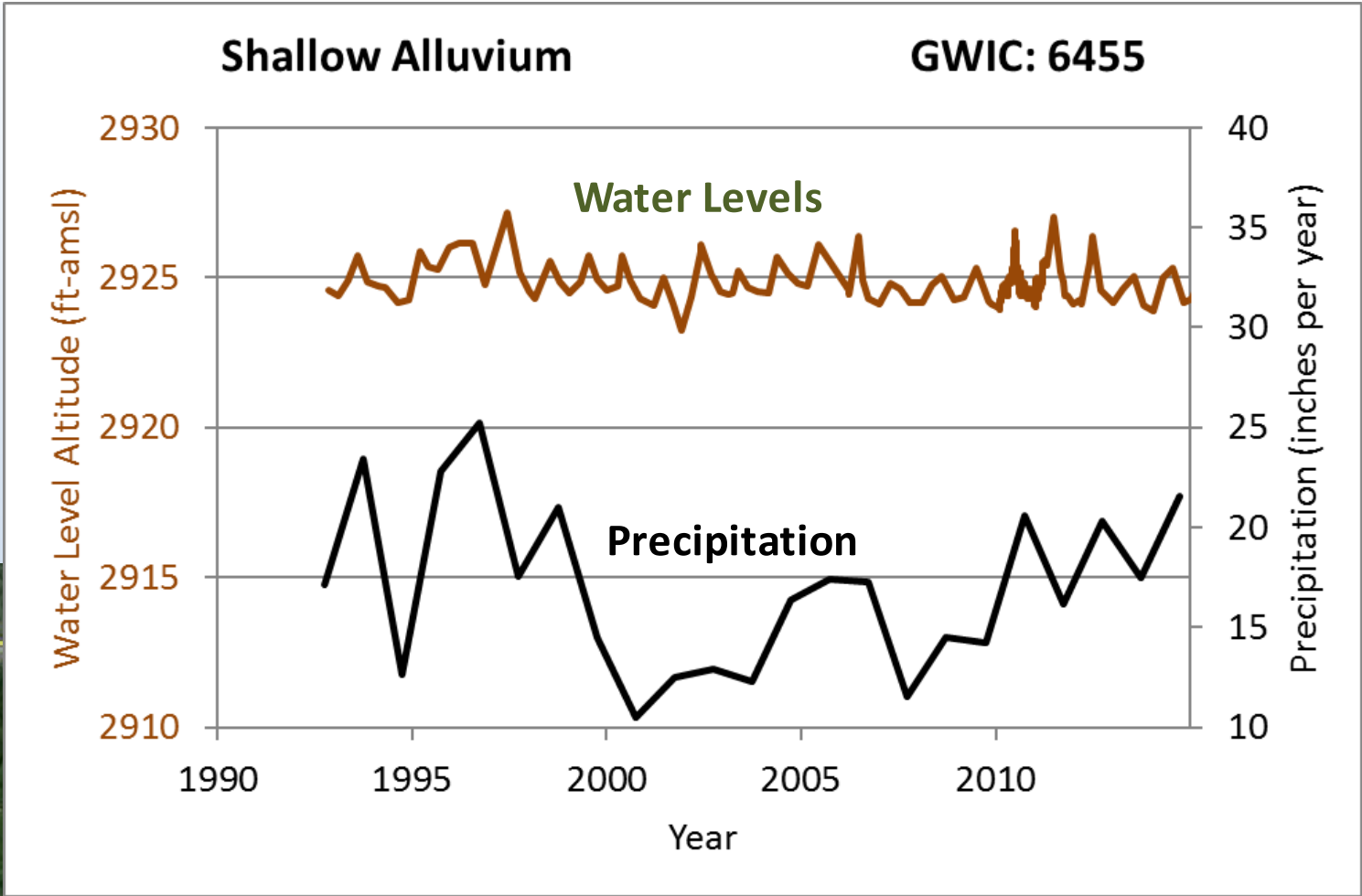
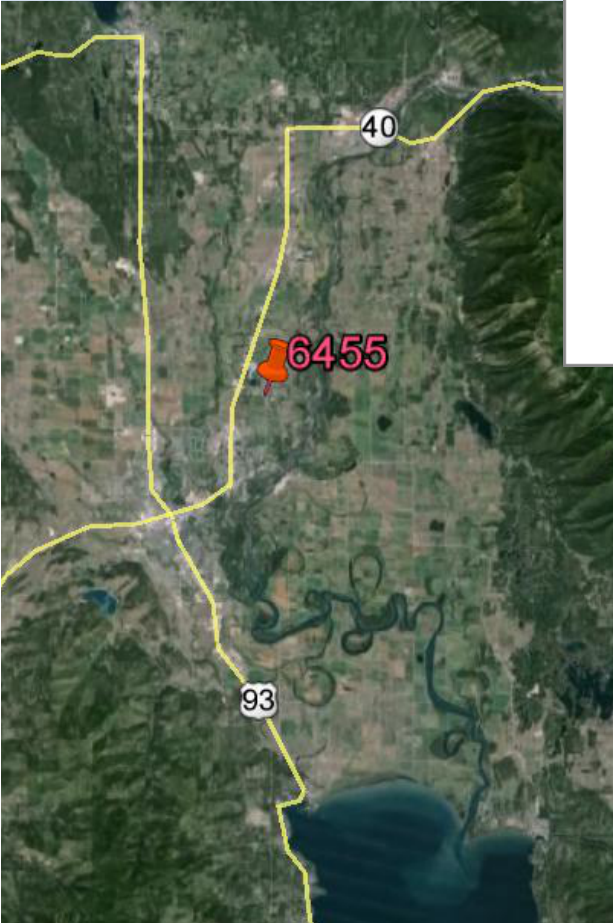
Interesting.



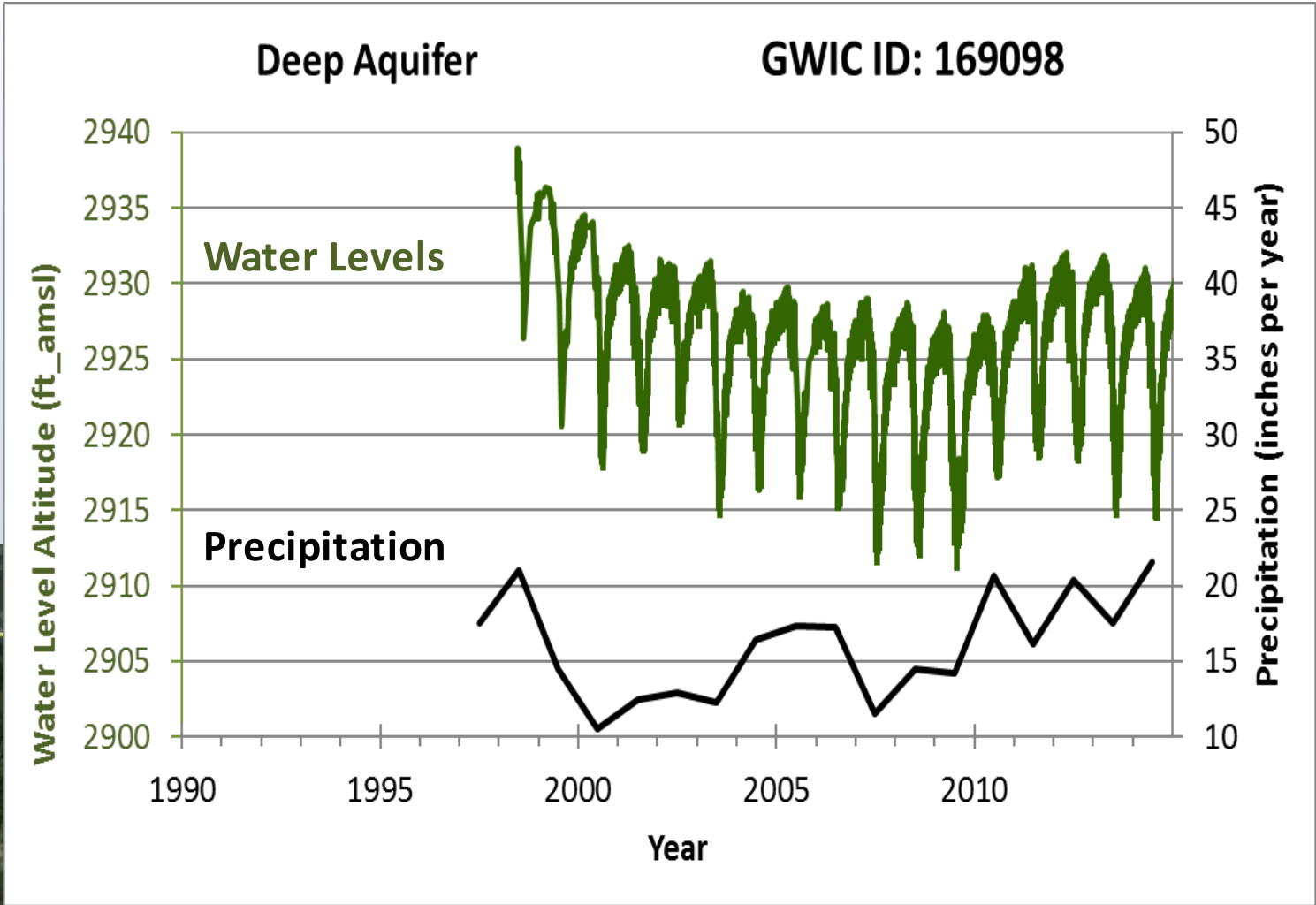


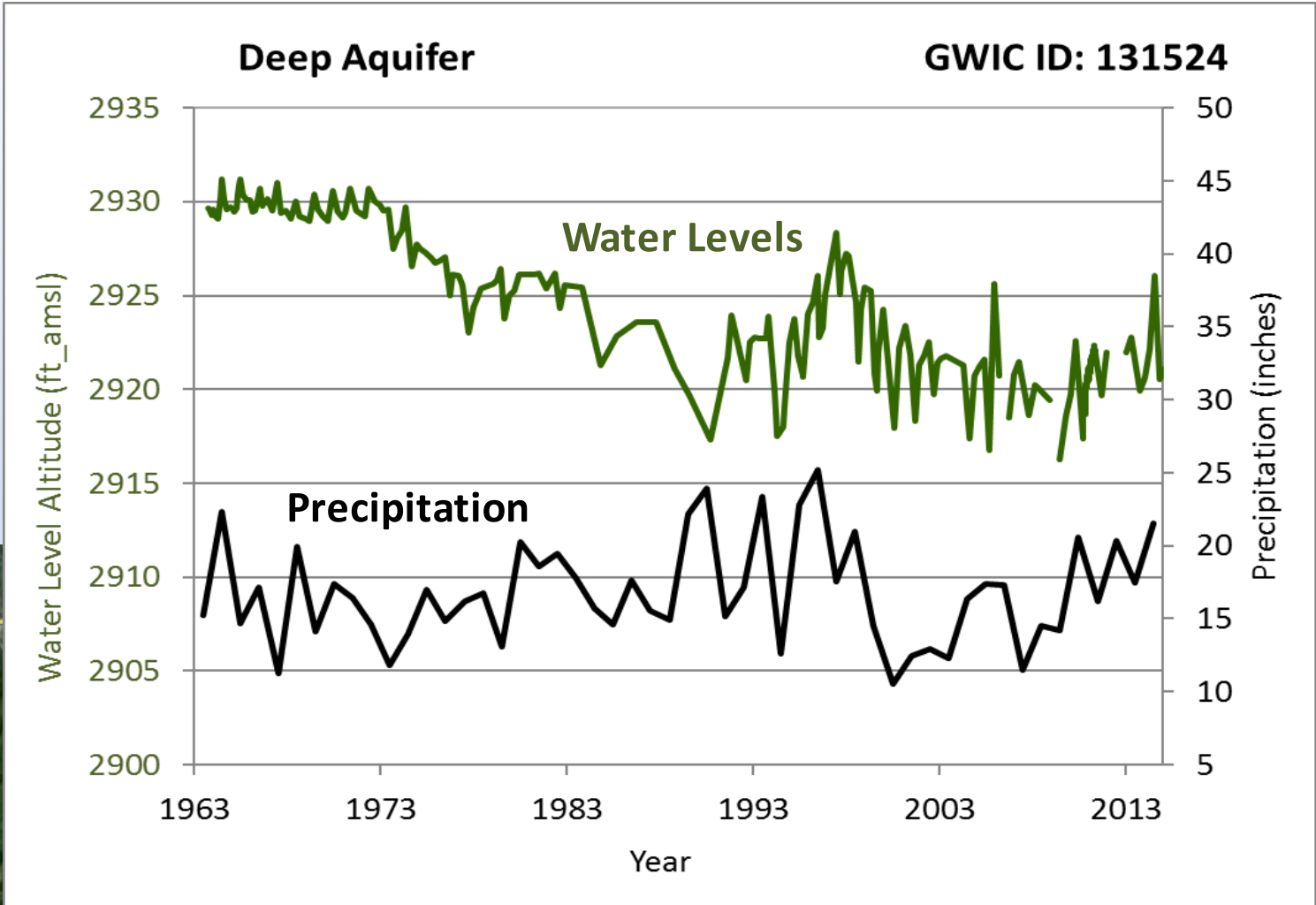


Near valley center



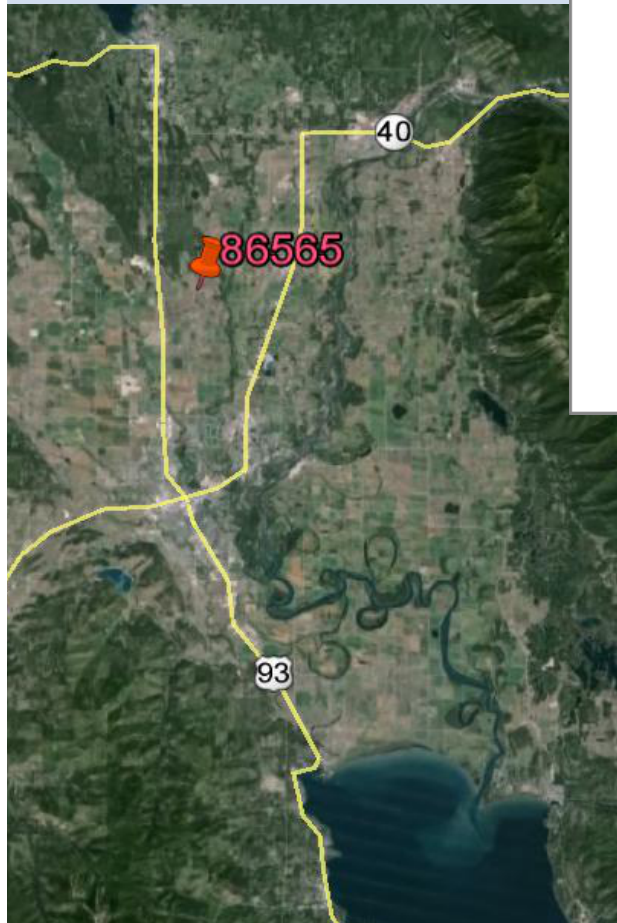
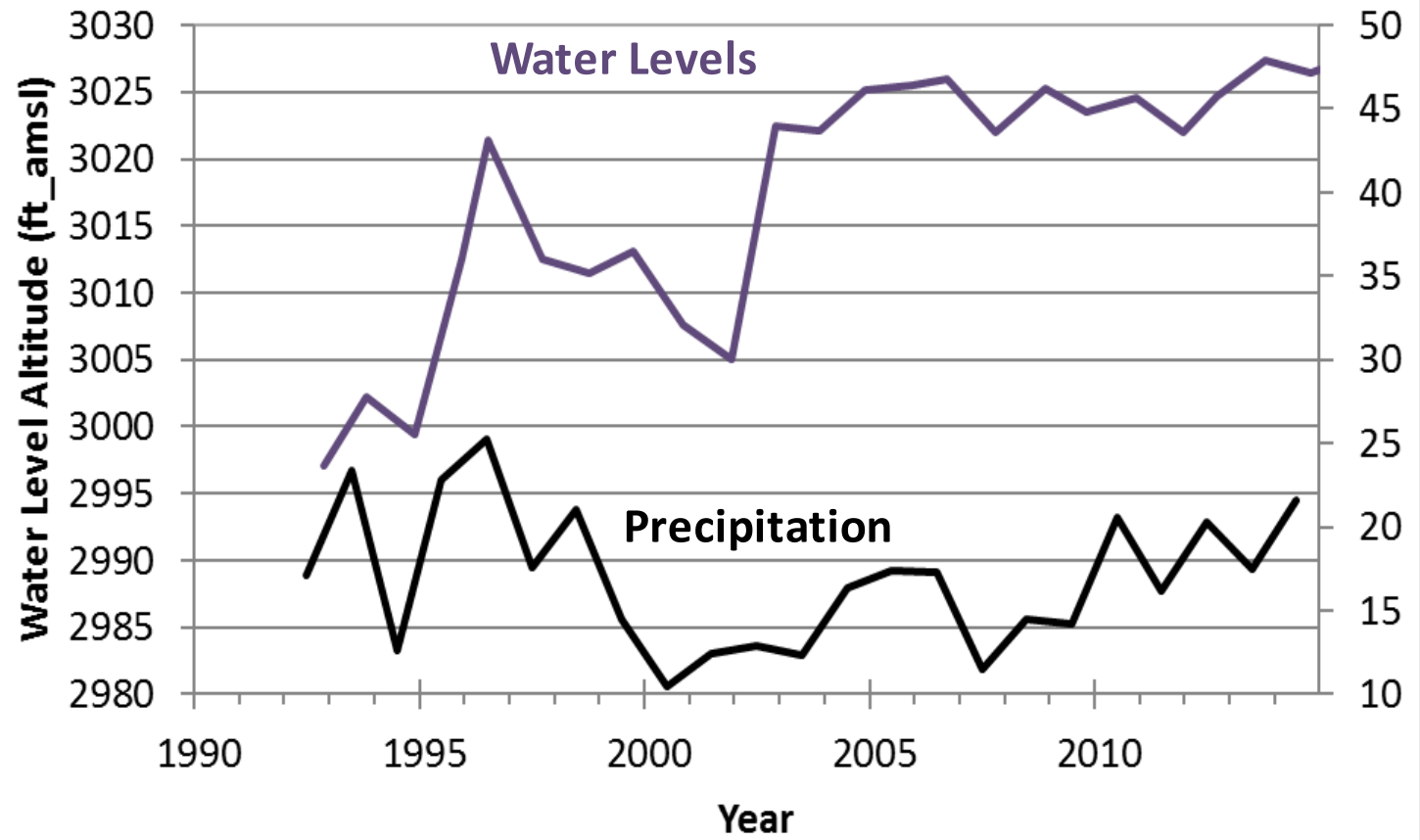






# Bedrock Aquifer

GWIC ID: 86565







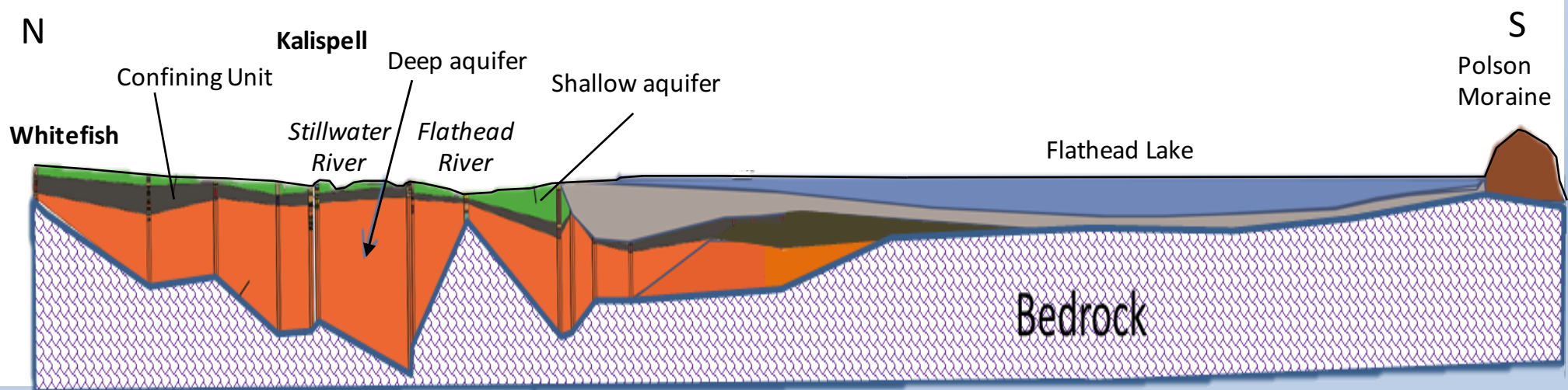
# Groundwater generally flows south toward Flathead Lake

But we have not yet documented a direct connection



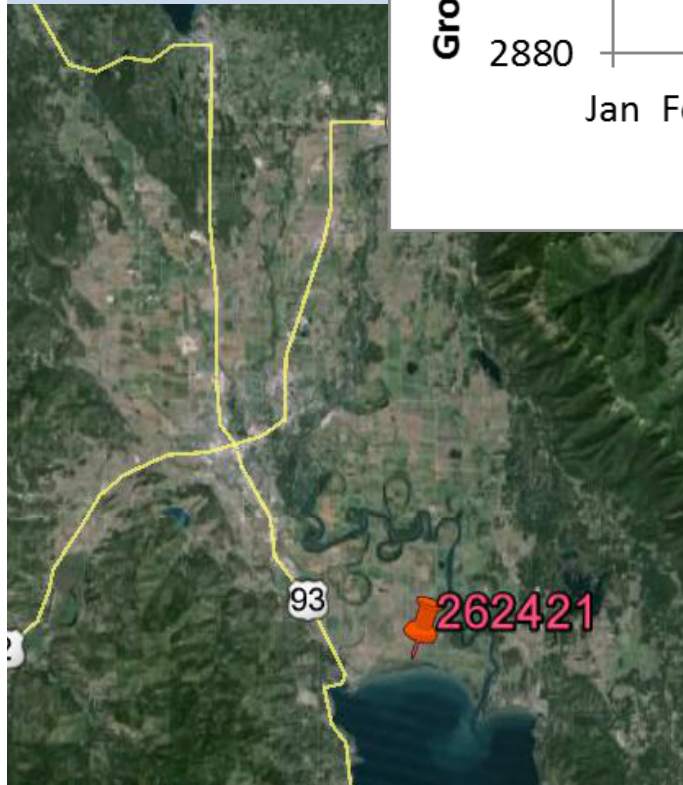
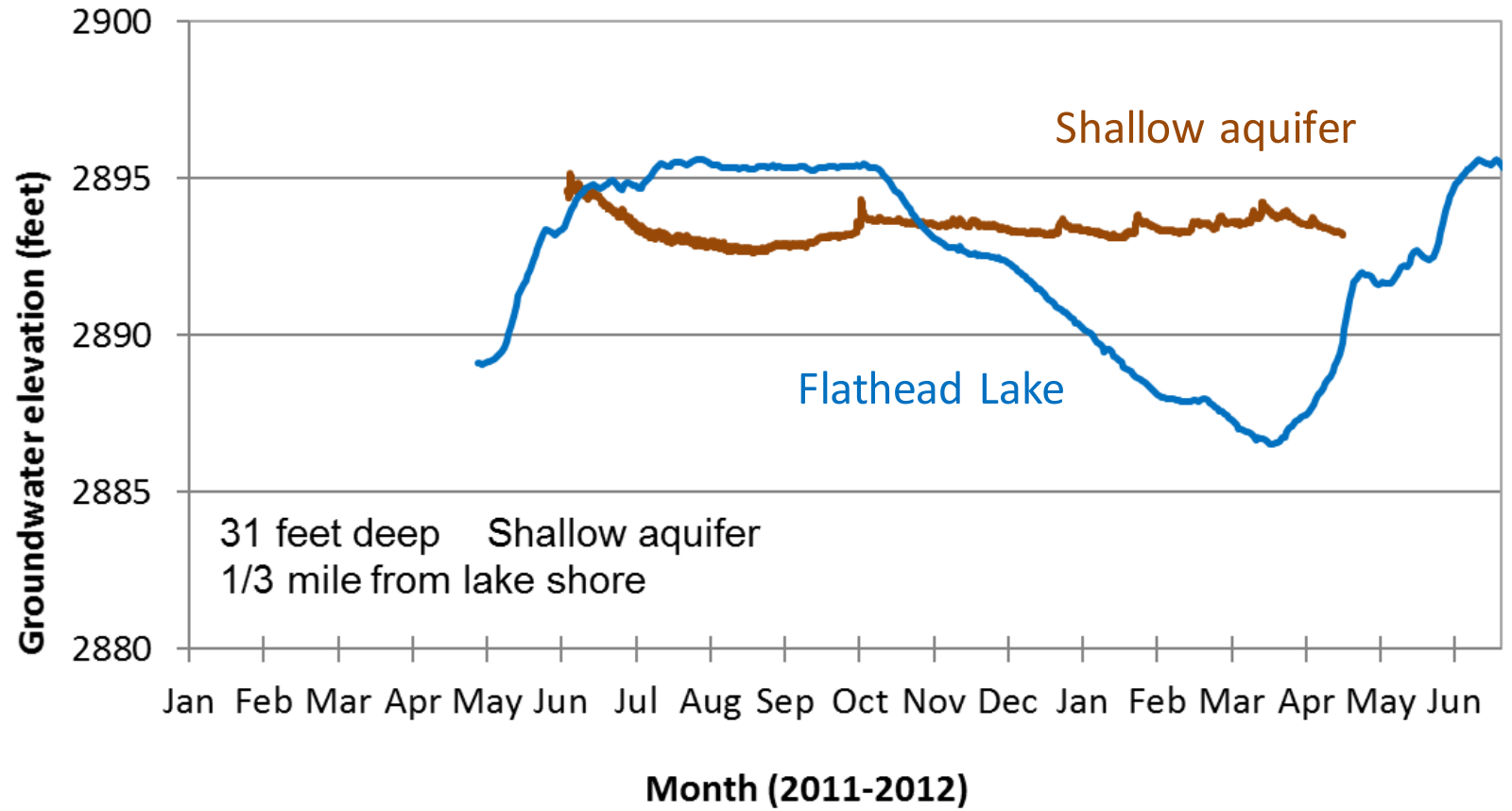
# Interaction between deep aquifer and Flathead River and Flathead Lake

North to South, the big picture.



# Shallow Aquifer

GWIC ID: 262421



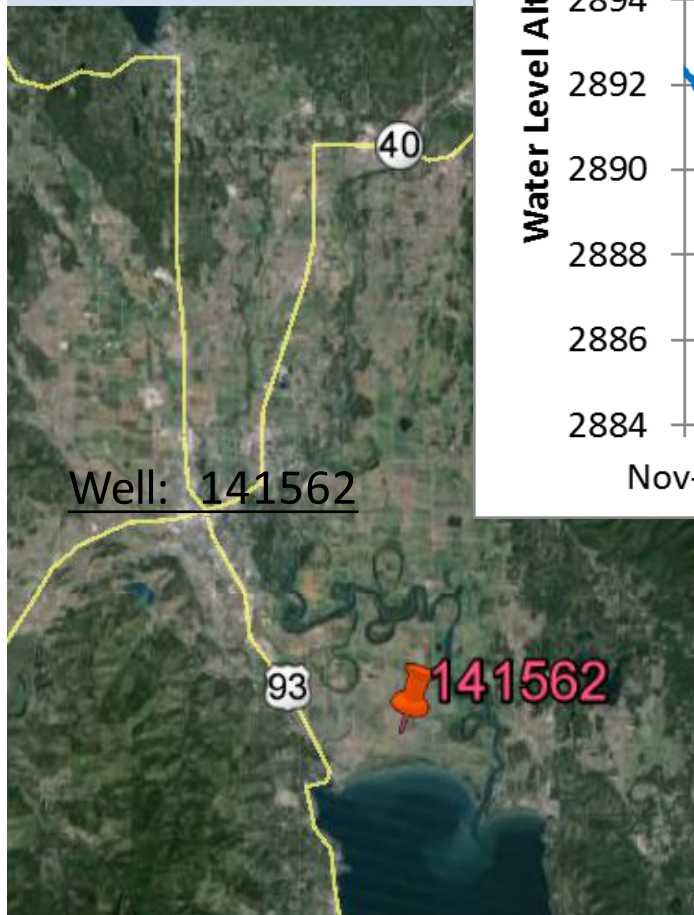
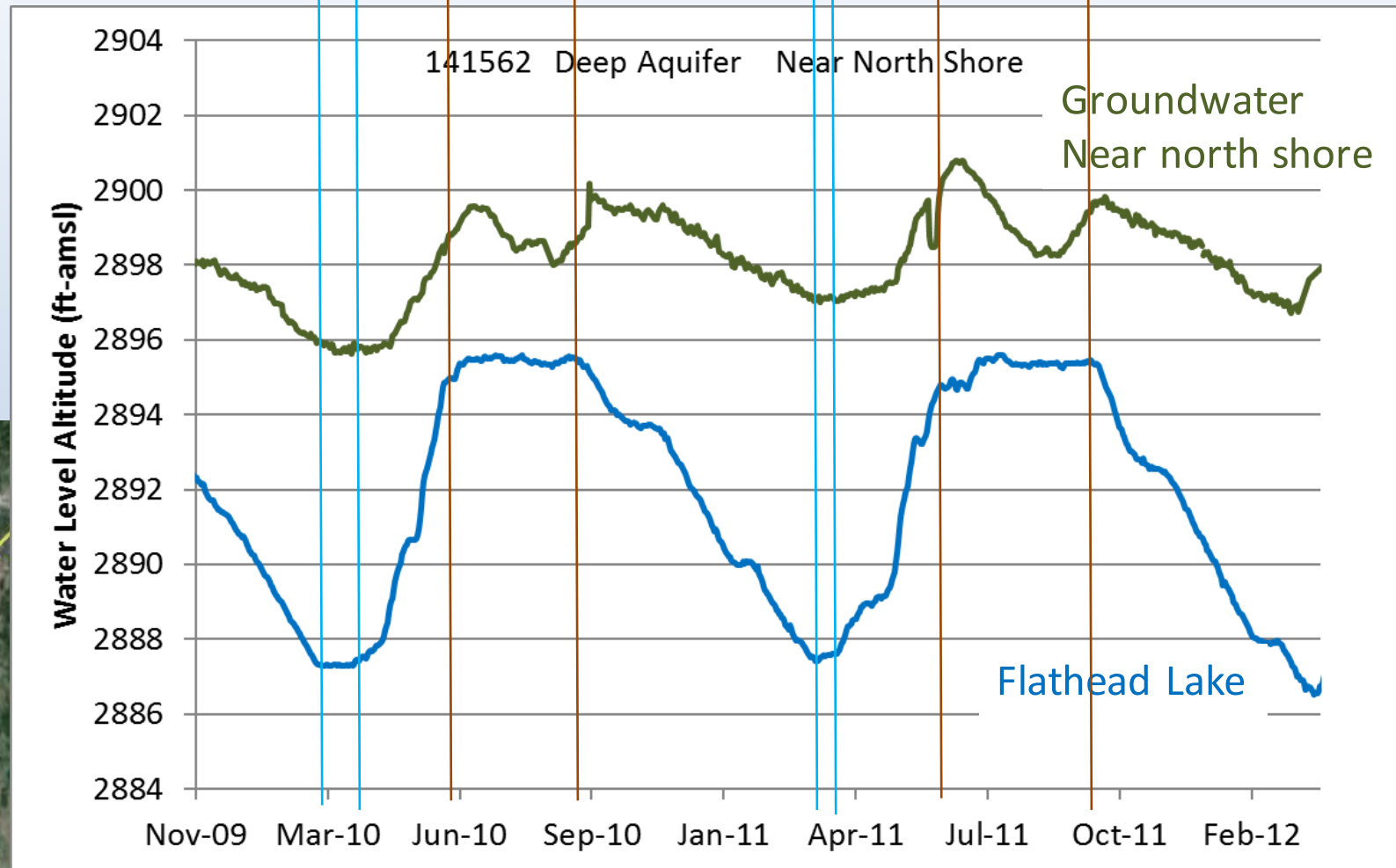


Lake Level - Trough

Peak

Trough

Peak



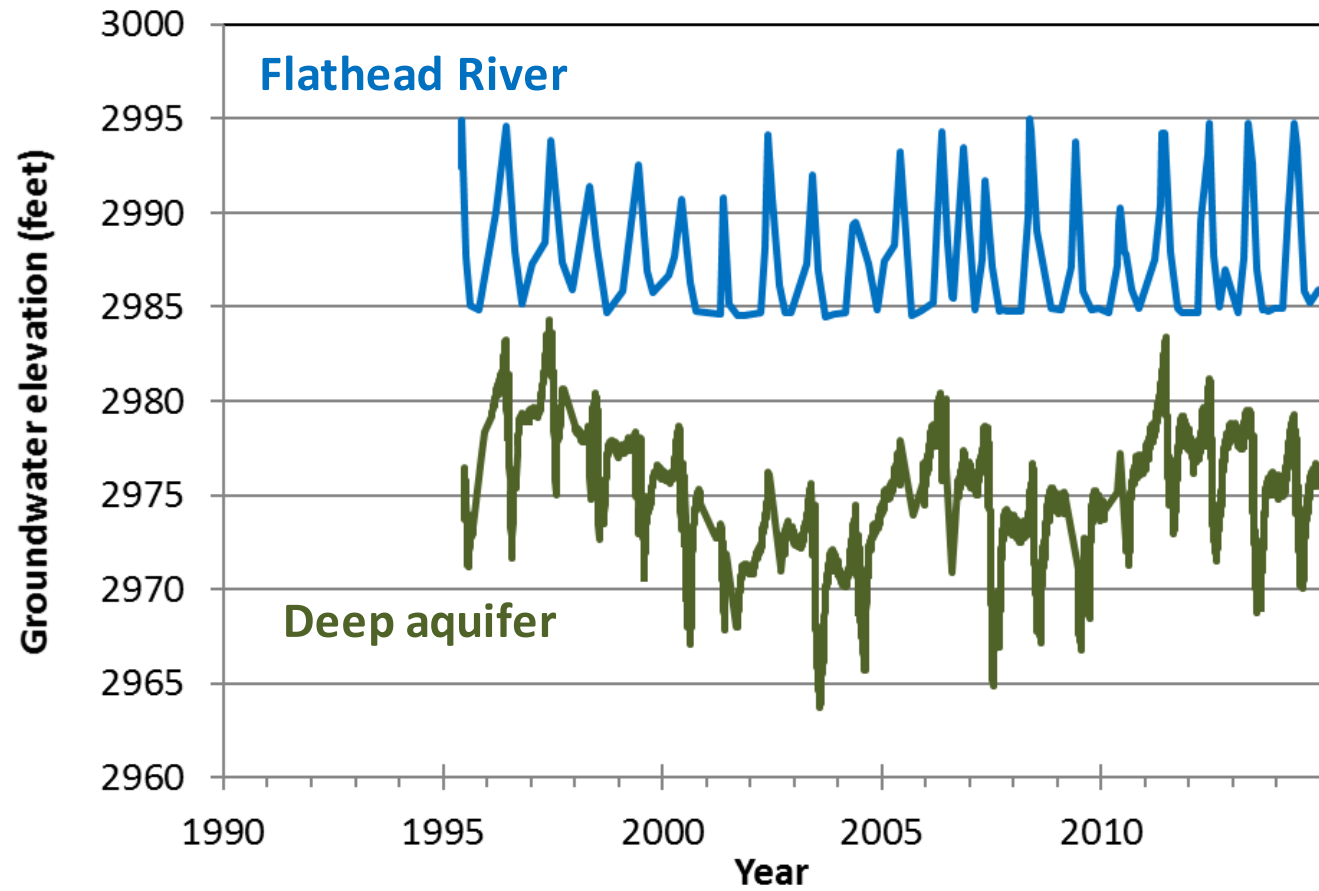
**Deep aquifer  
and  
Flathead Lake**





**Deep Aquifer**

**GWIC ID: 148187**

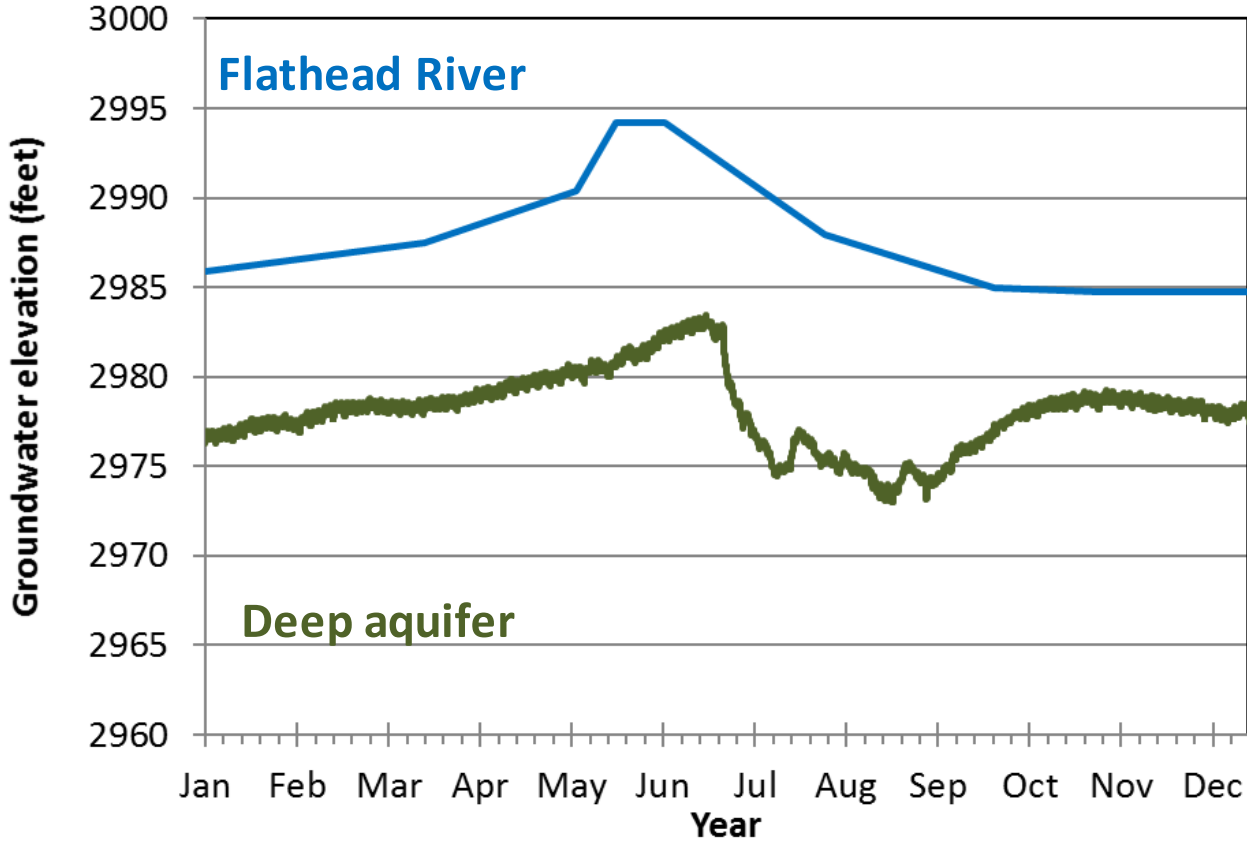


**Deep aquifer  
and  
Flathead River**



Deep Aquifer

GWIC ID: 148187



**Deep aquifer  
and  
Flathead River**

## **Applying some of this information:**

Impacts to Flathead Lake

The impact of pumping a single well, as an example.

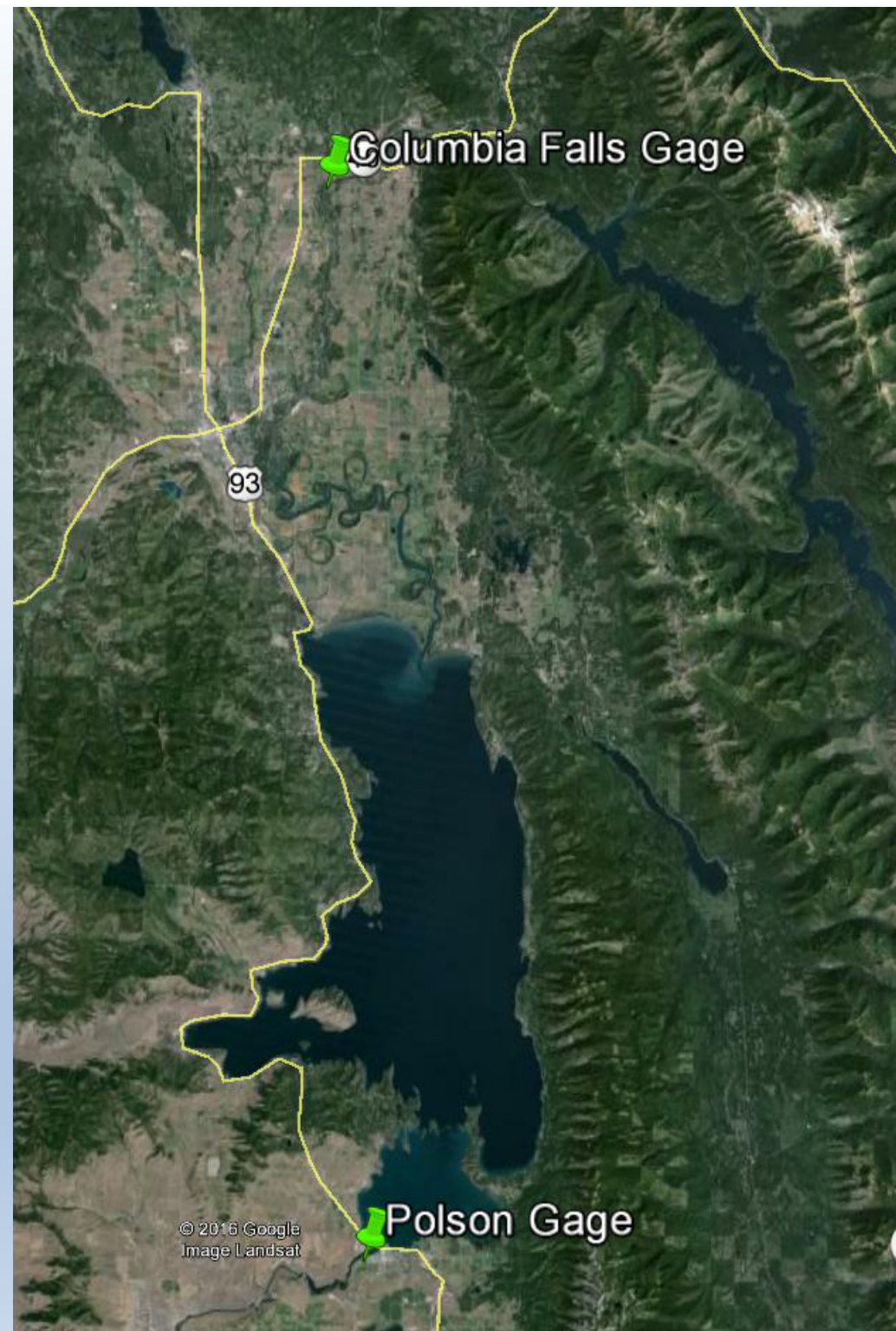
# Can we see pumping impacting discharge from Flathead Lake?

## Flathead River Flow (2010)

Columbia Falls  
5.9 million ac-ft

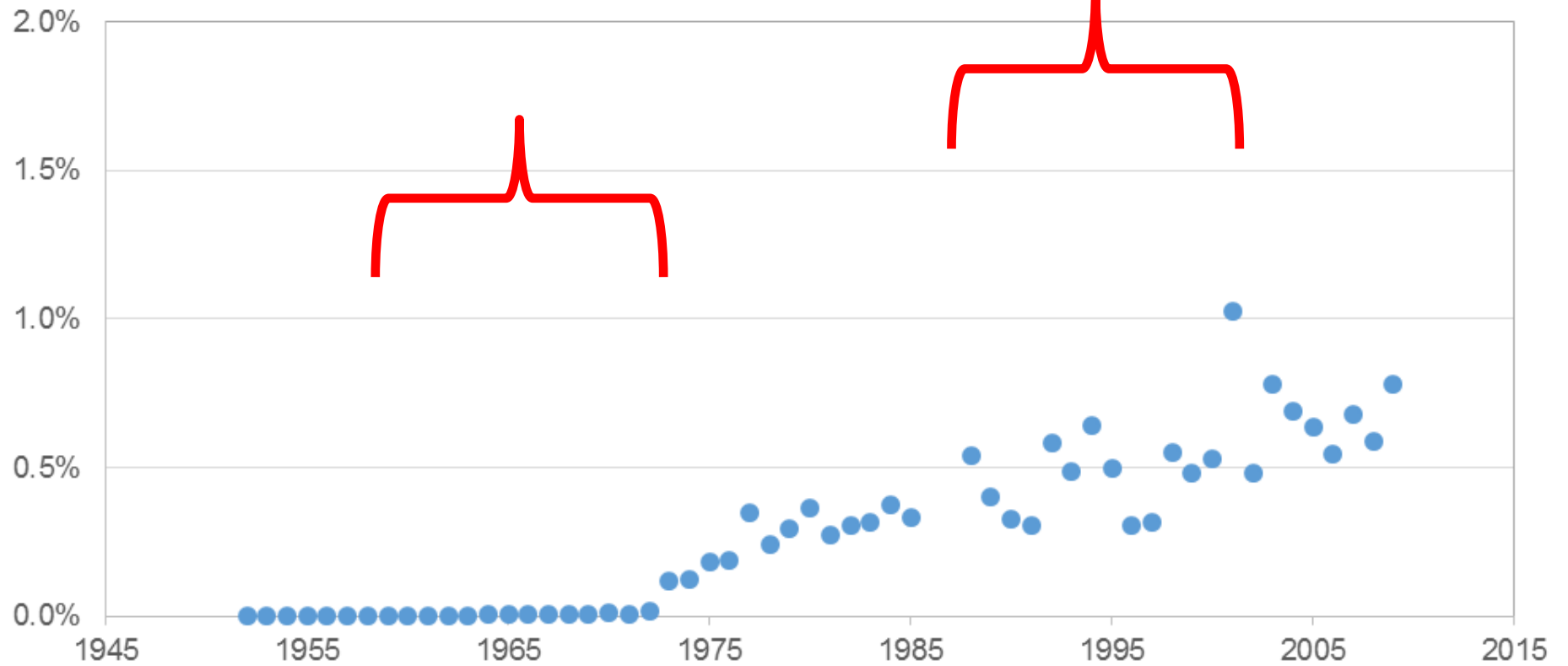
Polson  
7.6 million ac-ft

Deep Aquifer pumping  
0.19 million ac-ft

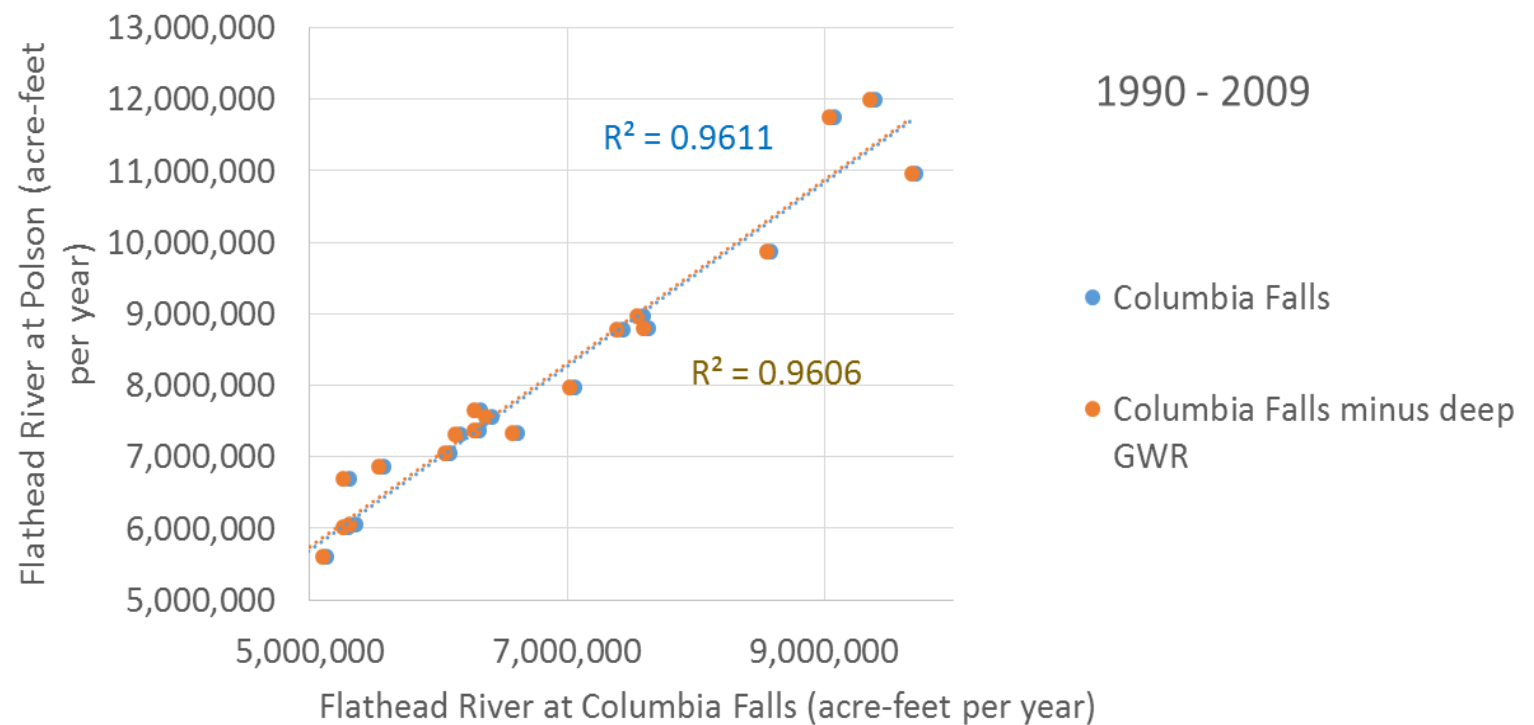
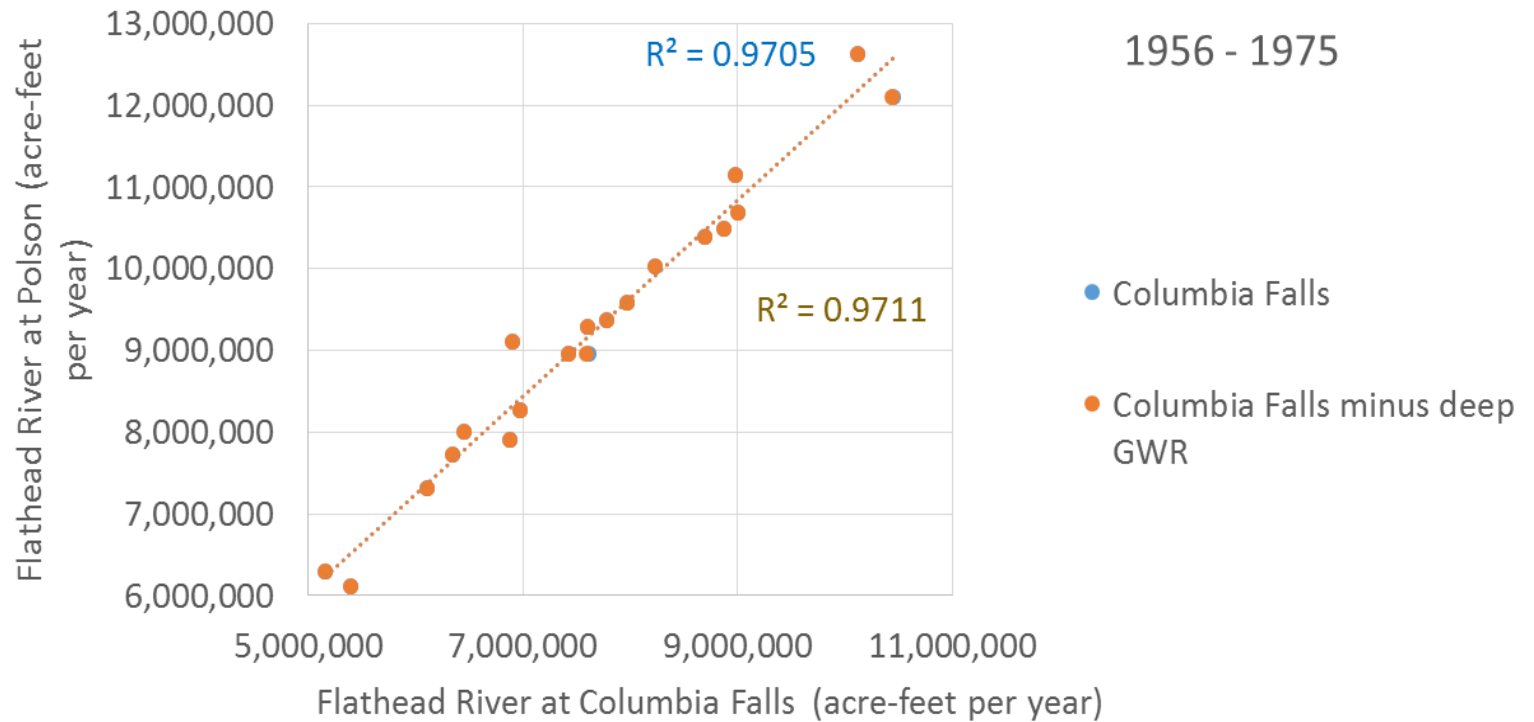




# Deep aquifer groundwater rights as a percentage of Flathead River flow at Polson



Any impact to water entering Flathead Lake that may be occurring at this time is not statistically identifiable.



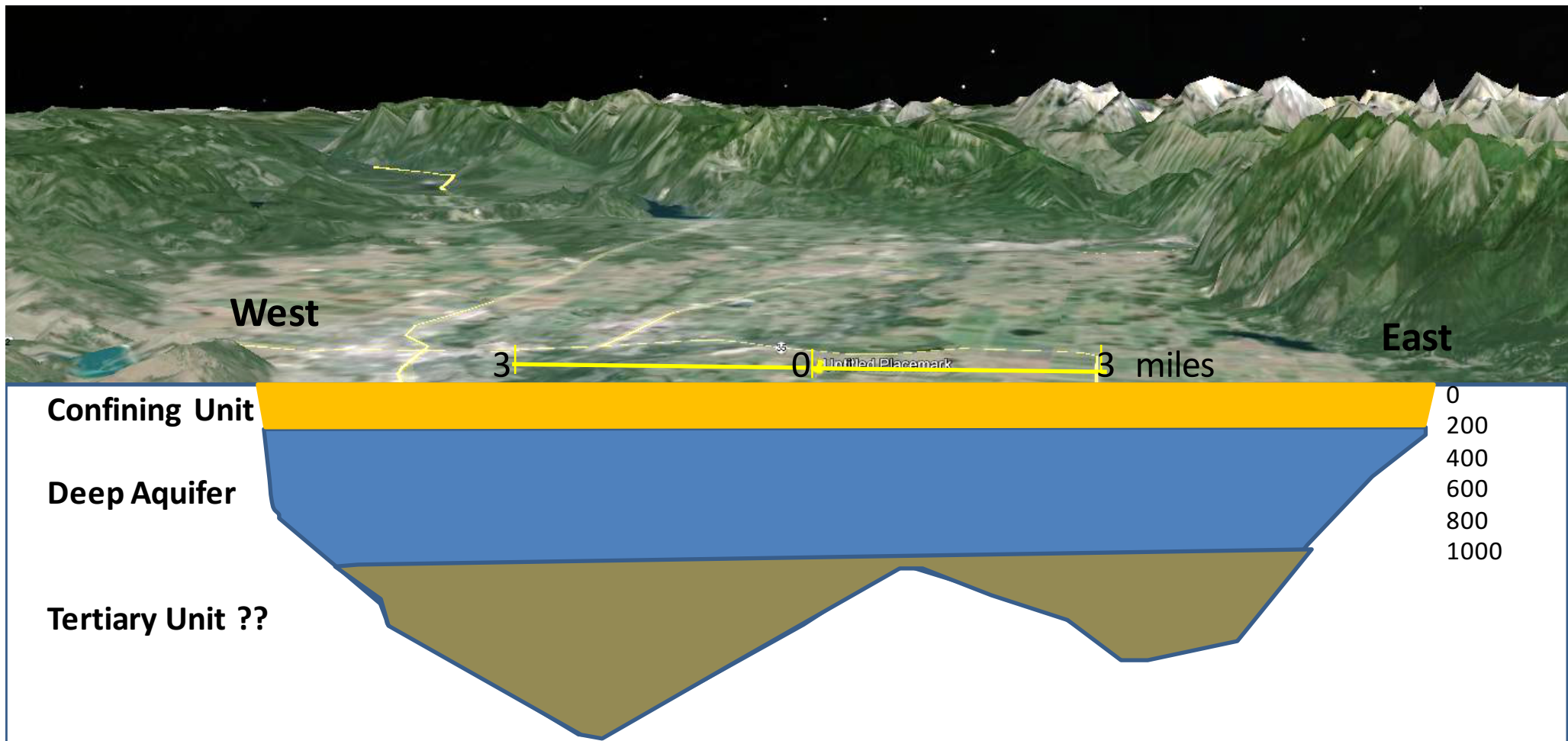
Hypothetical well, mid-valley

Untitled Placemark

93

82



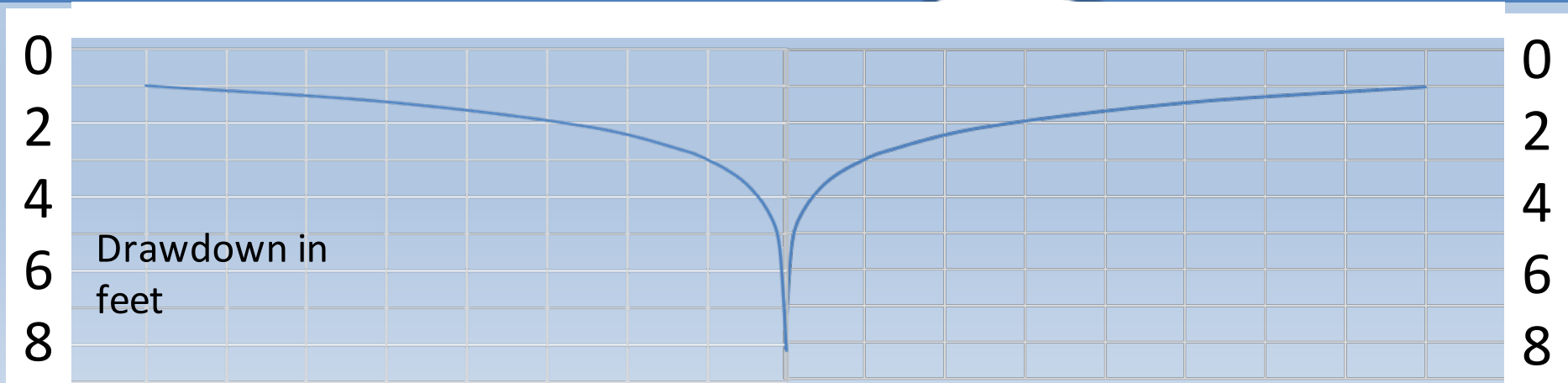
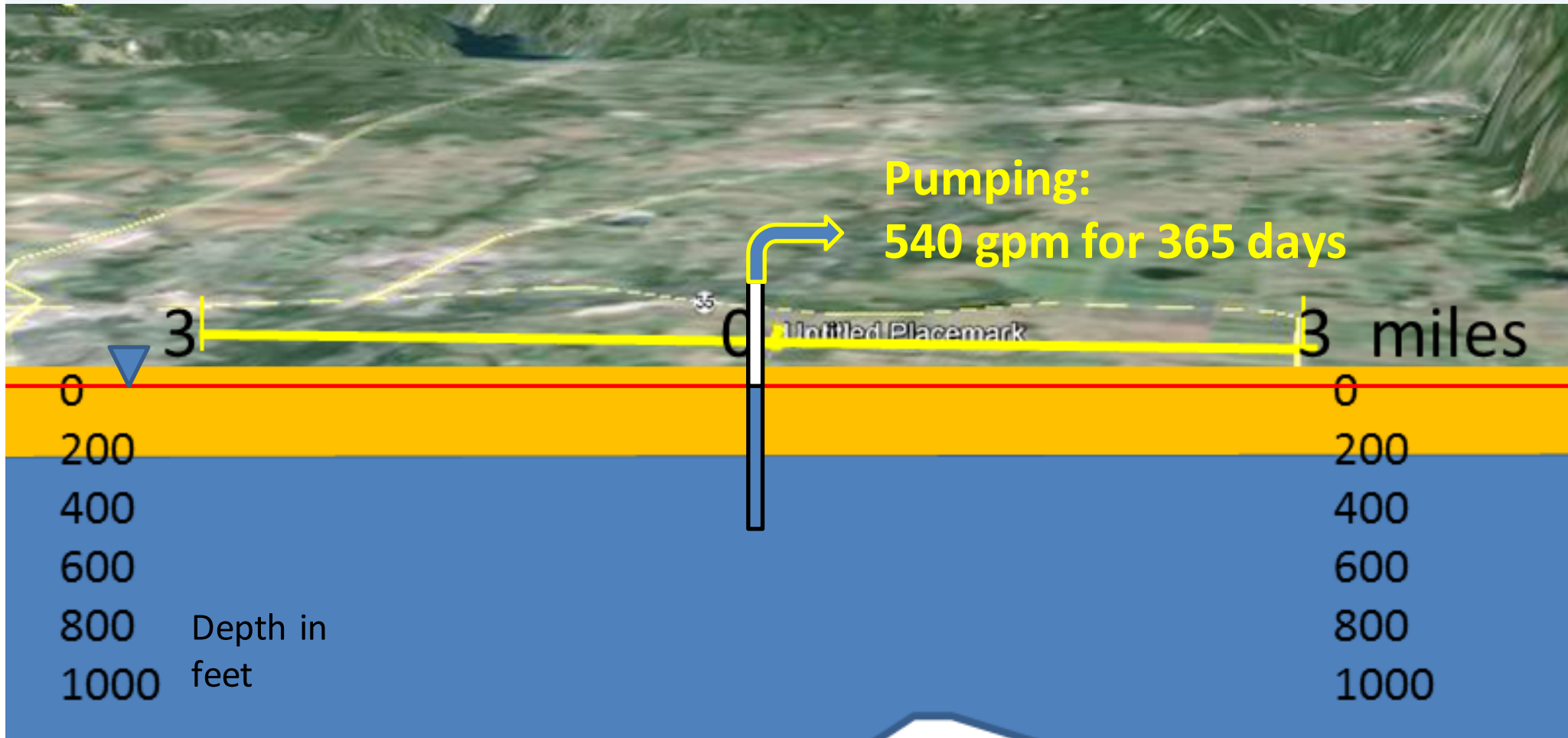


## Schematic Geologic cross section

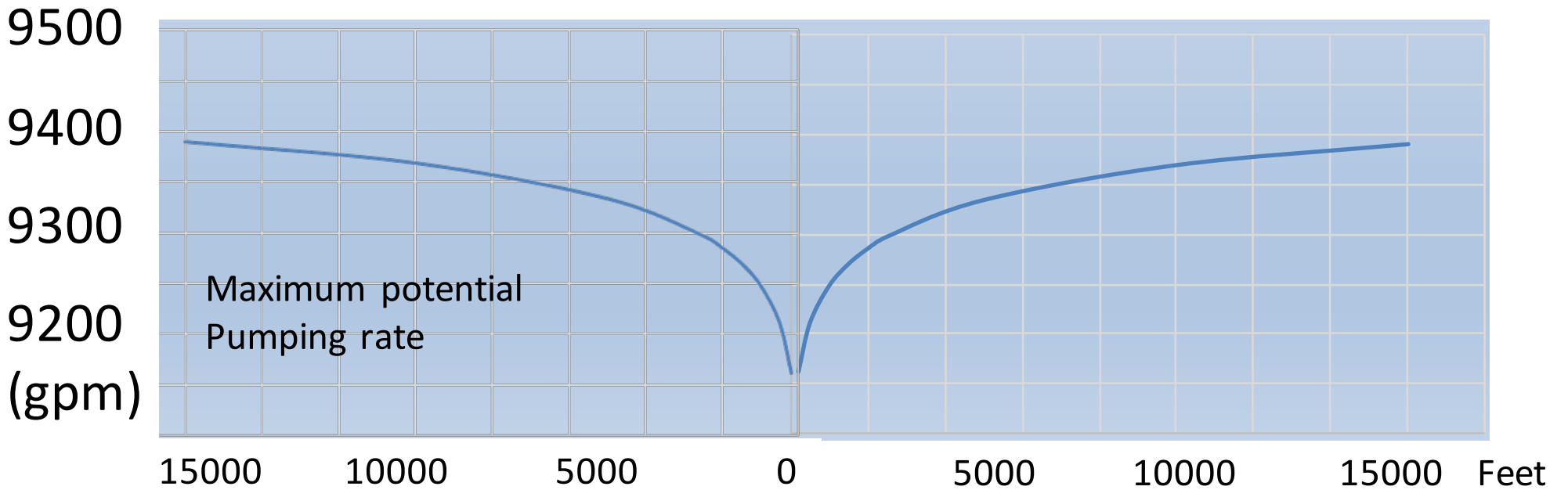
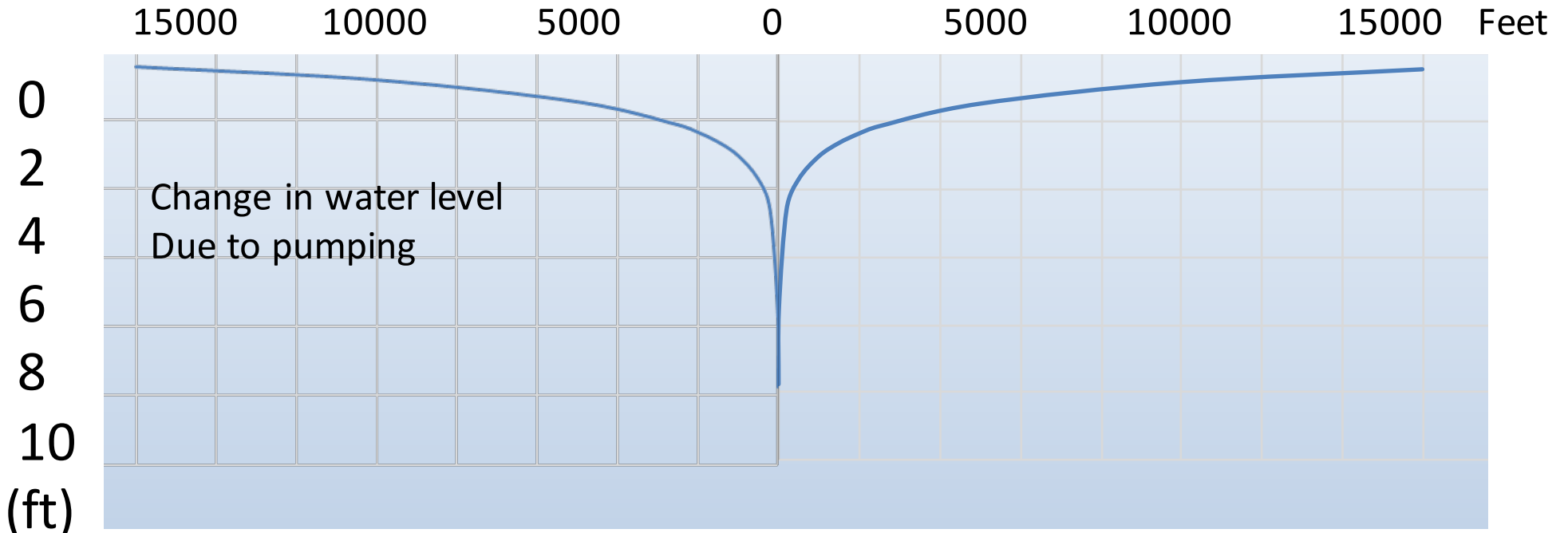
Vertical exaggeration greatly exceeds horizontal.  
Blue color represents the deep aquifer.



# How far does a pumping well influence the aquifer?



# Change in possible production at 100 days from wells within the cone-of-depression of a hypothetical well pumping for 1-year



# Summary

## Groundwater Discharge to Flathead Lake:

- ✓ No direct discharge to the lake has been documented  
But no alternate destination is apparent,  
so slow seepage to the lake is inferred
- ✓ Groundwater withdrawals from the deep aquifer have increased to less than 2 percent of the River discharge from Flathead lake

# Summary

## Water Balance:

- ✓ Recharge occurs primarily along the mountain fronts surrounding the valley
- ✓ Snowmelt and rainfall are the sources of recharge
- ✓ Annual flow through the deep aquifer is about 200,000 acre-feet per year
- ✓ Annual withdrawal by pumping is about 25,000
- ✓ Annual Outflow is estimated to be about 190,000 toward Flathead Lake



# Summary

## Aquifer Depletion:

- ✓ Water levels are not declining in response to pumping over long periods of time, except in isolated areas
- ✓ Due to the number of wells in the valley, and the pumping rate of many, influences overlap and create broad, seasonal declines.
- ✓ Drawdown from wells will change water levels for up to several miles from production wells
- ✓ However, due to the capacity of the aquifer, decreased water levels will only minimally impact production potential

# Recommendations

Maintain long-term GWAP monitoring program for perpetuity

Consider establishing focused local monitoring

Establish or clarify roles of a local water management organization

The deep aquifer is a phenomenal resource, that can both be used and conserved

(Addition from comment made during presentation:  
Properly plug and abandon wells that are no longer in use to reduce path of contamination and loss of water.)



What's coming next?

