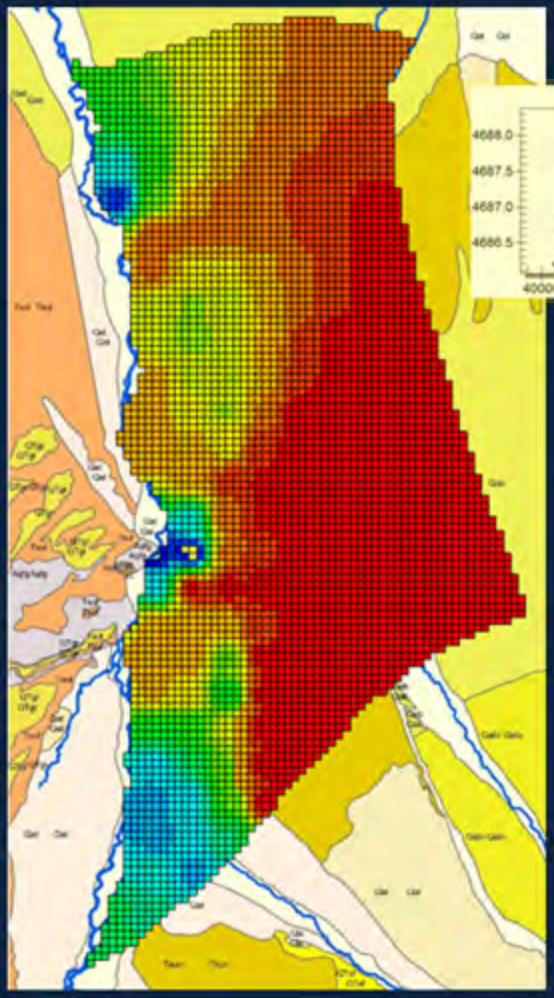
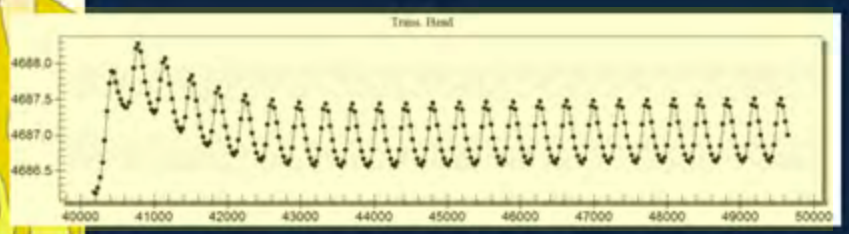
Gallatin Valley
Four Corners Investigation Area

Presented to the Groundwater Steering Committee
September 26, 2012





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Team Leader:
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Ground Water Investigation Program

MBMG

Gallatin County

- ✓Fastest growing county in the state; 32% increase in last census
- ✓10,000 more housing units
- ✓40% increase in water wells
- ✓Irrigated acres decreased by 20% from 2002 to 2007
- ✓Flood irrigation changing to sprinkler and pivot

GWIP Questions:

What are the effects of these rapid changes?

Can we manage future changes through hydrologic science?

Four Corners Ground Water Investigation Project

Objectives / *Results*

- Determine the extent of alteration to the groundwater system in the Four Corners Area over the last 60 years.

  Small water elevation changes, large flux decrease

- Correlate groundwater changes to land use conversion.

  Reduction of irrigated acres has decreased recharge
  Subdivision use has a minimal effect

- Document the effects of irrigation and canal leakage on groundwater recharge.

  Typical canal leakage is 1.1 cfs per mile

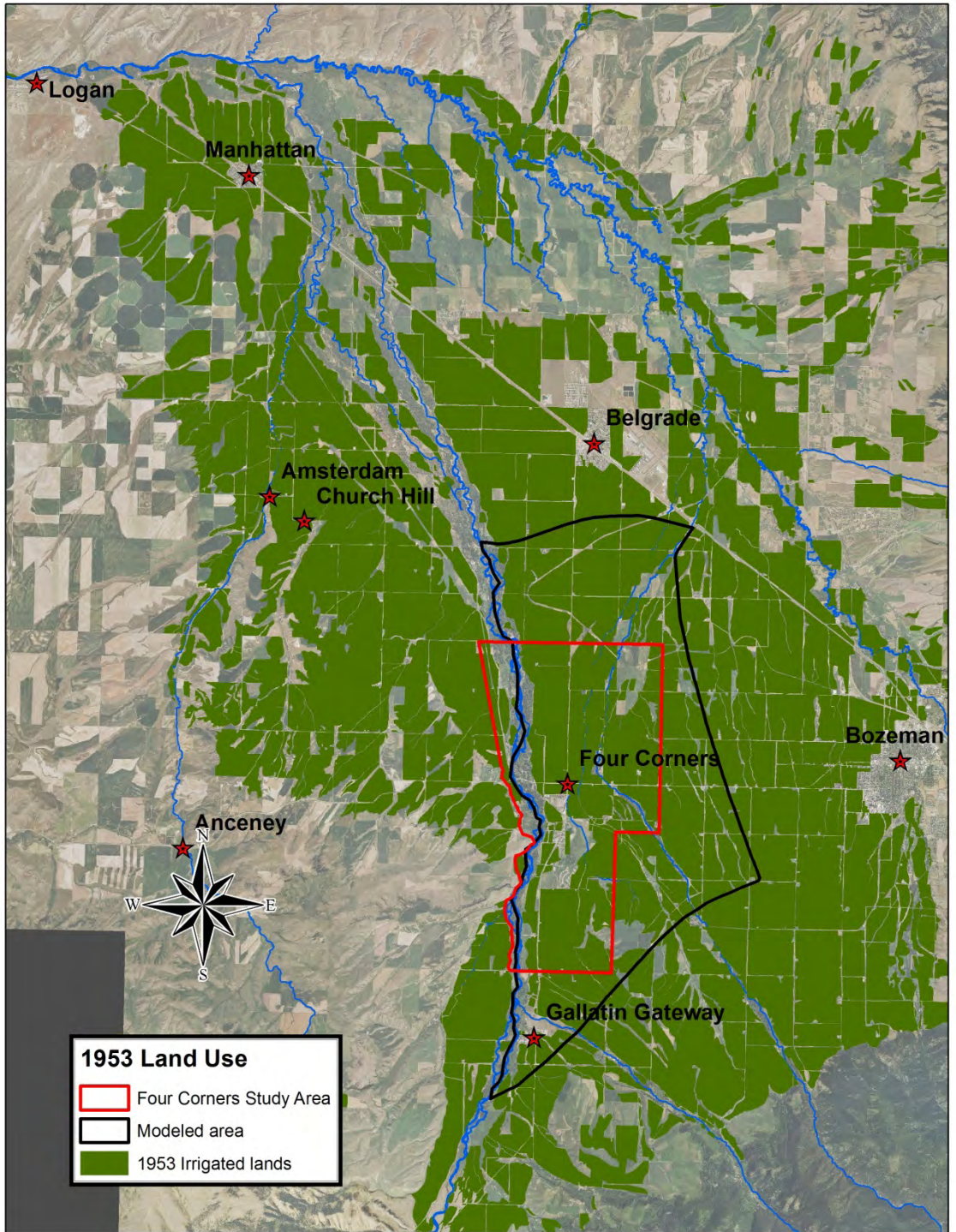
- Evaluate likely effects of future changes and development.

  At past growth rates, future development will lower the water table about 2.5 feet

Irrigated Land

(1953)

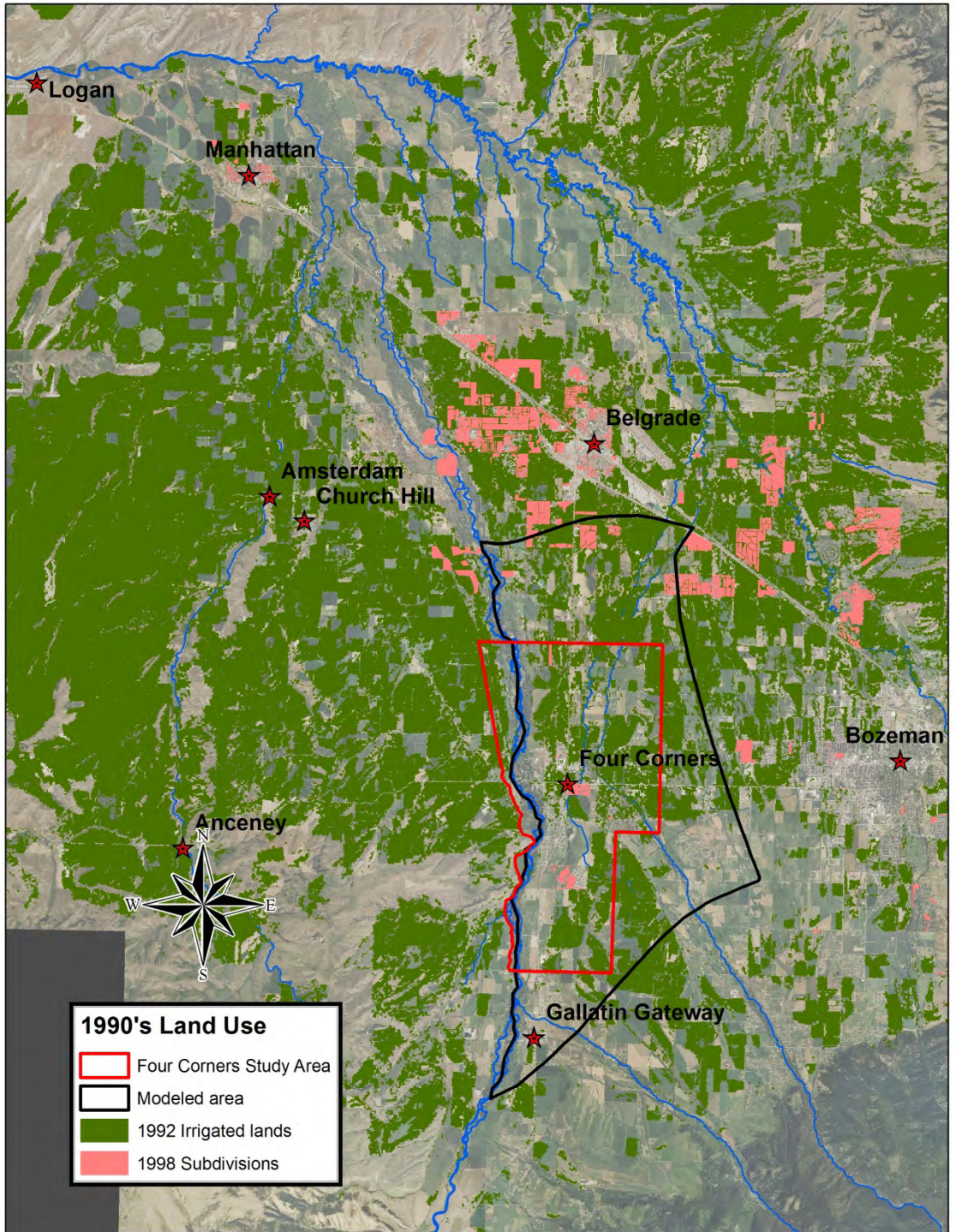
All flood irrigation



Irrigated Land
(1990's)

Irrigated lands decreased

Suburban development

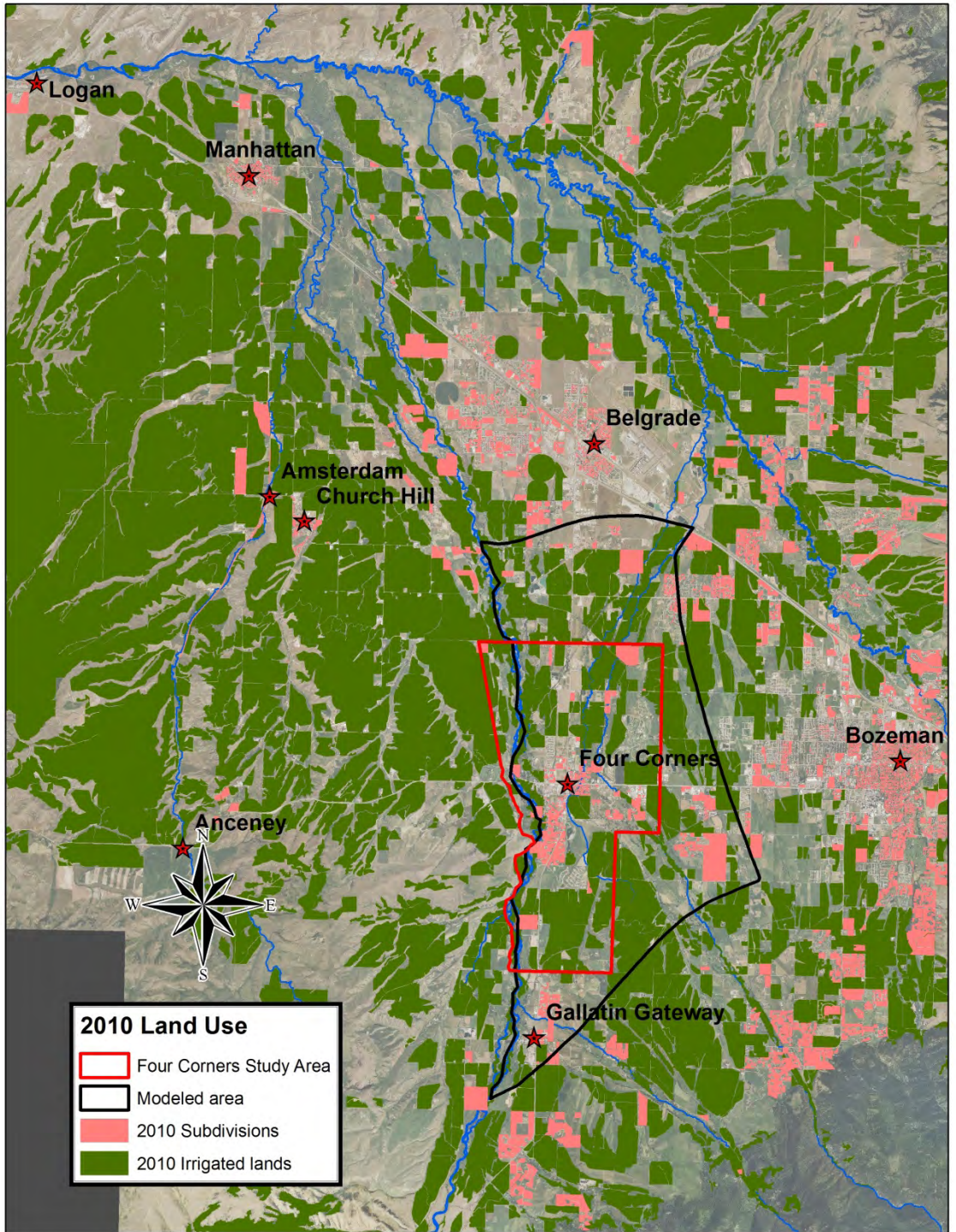


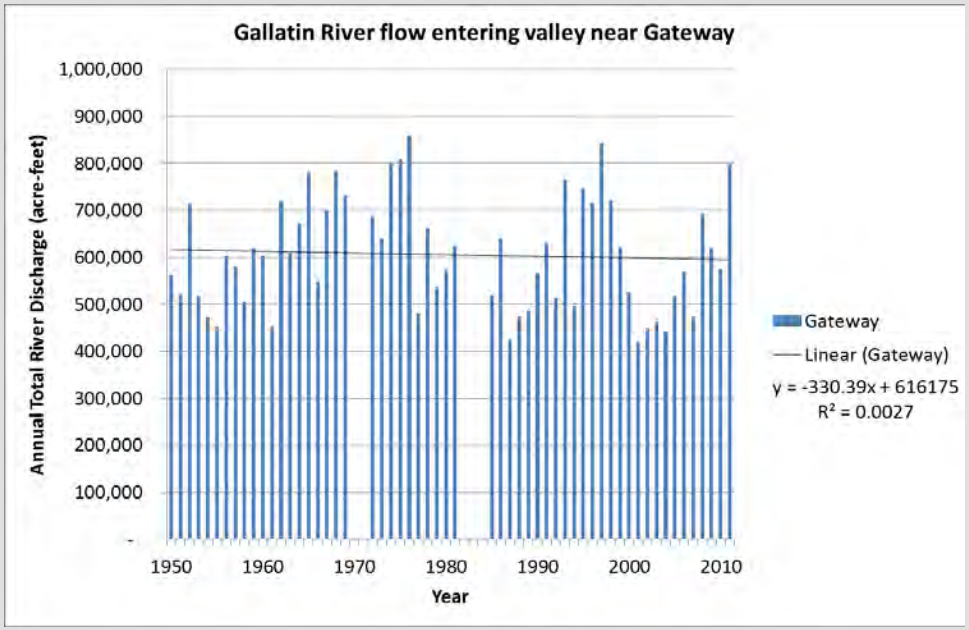
Irrigated Land

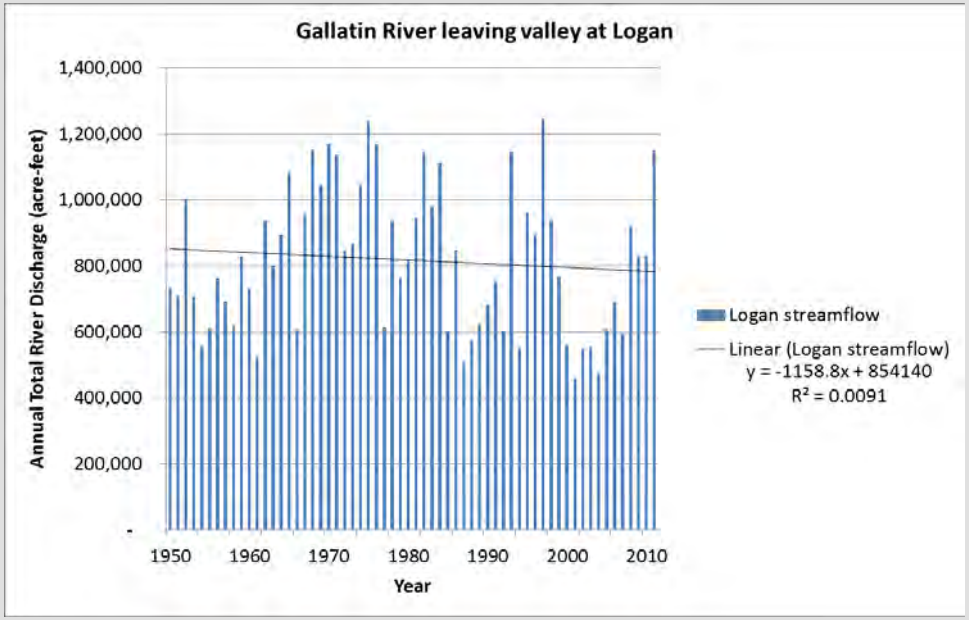
(2010)

Irrigated lands decreased at an average rate of 628 acres per year since 1992

Suburban development increasing at an average rate of 535 acres per year since 1998





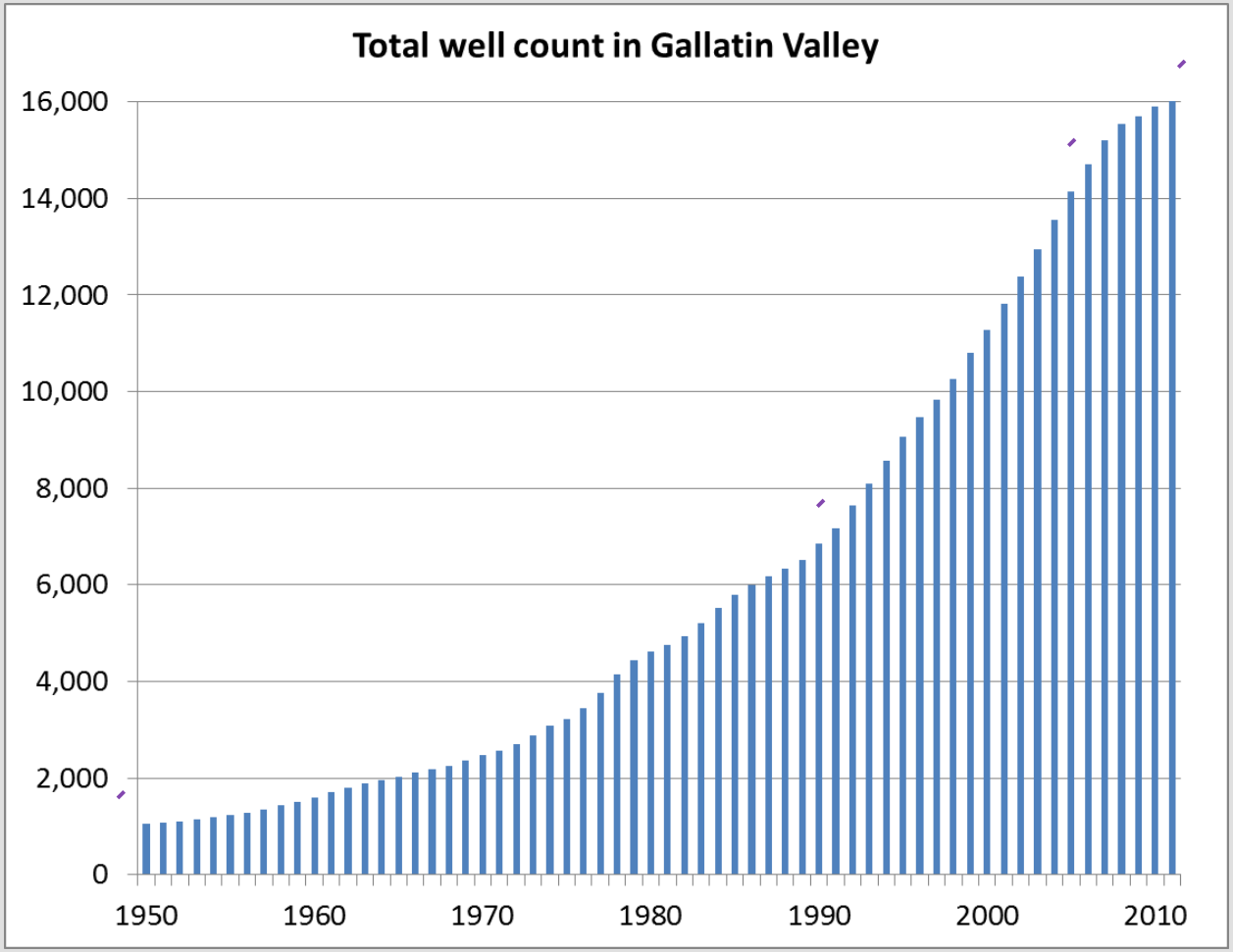


Since 1950:

River flow entering valley has decreased an average of about 330 ac-ft per year.

River flow leaving the valley has decreased an average of about 1,160 ac-ft per year.

Consumptive uses within the valley have increased and recharge from irrigation has decreased during that timeframe.



Since 1950:

The total number of wells in the valley increased slowly until mid-1970's,

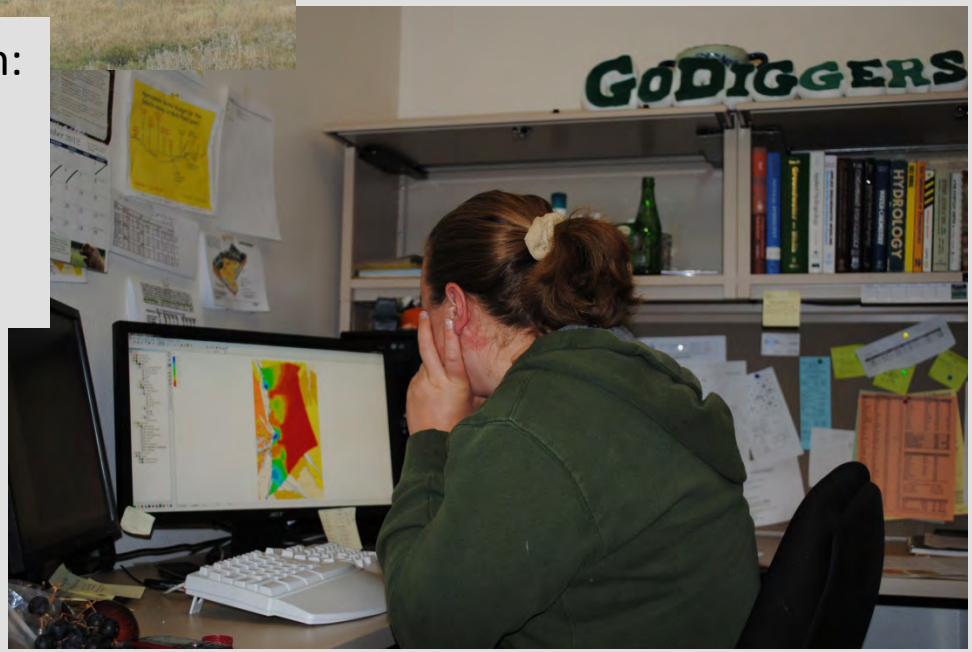
Then increased more rapidly until the mid-1980's

And then increased at an even faster rate for about 20 years.

The rate of new well installations has slowed since about 2004.

How we approached the problem:

Monitoring
Modeling
Interpretation



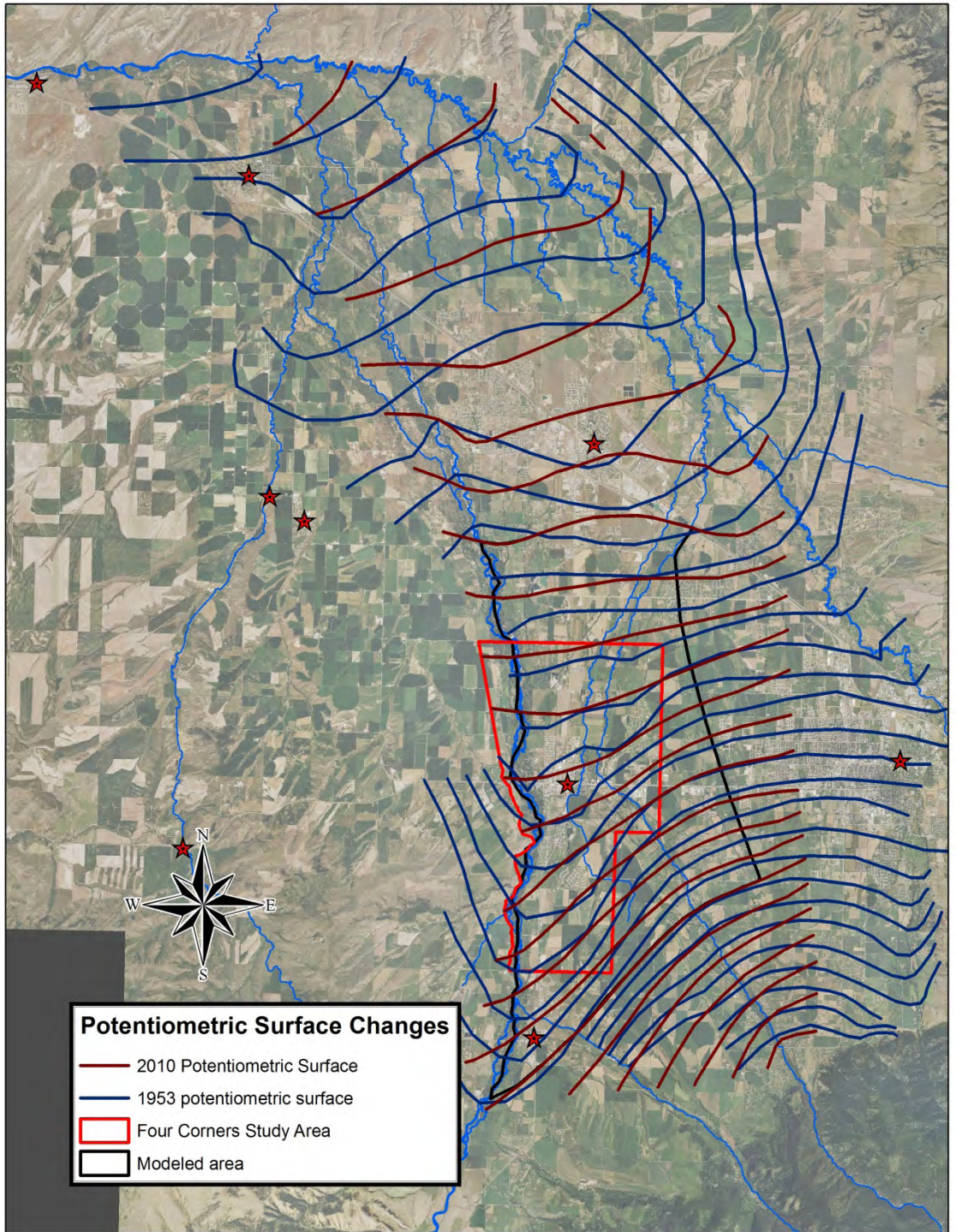
Potentiometric Surface

April 1953

April 2010

Few significant changes

Water table elevations very similar to present

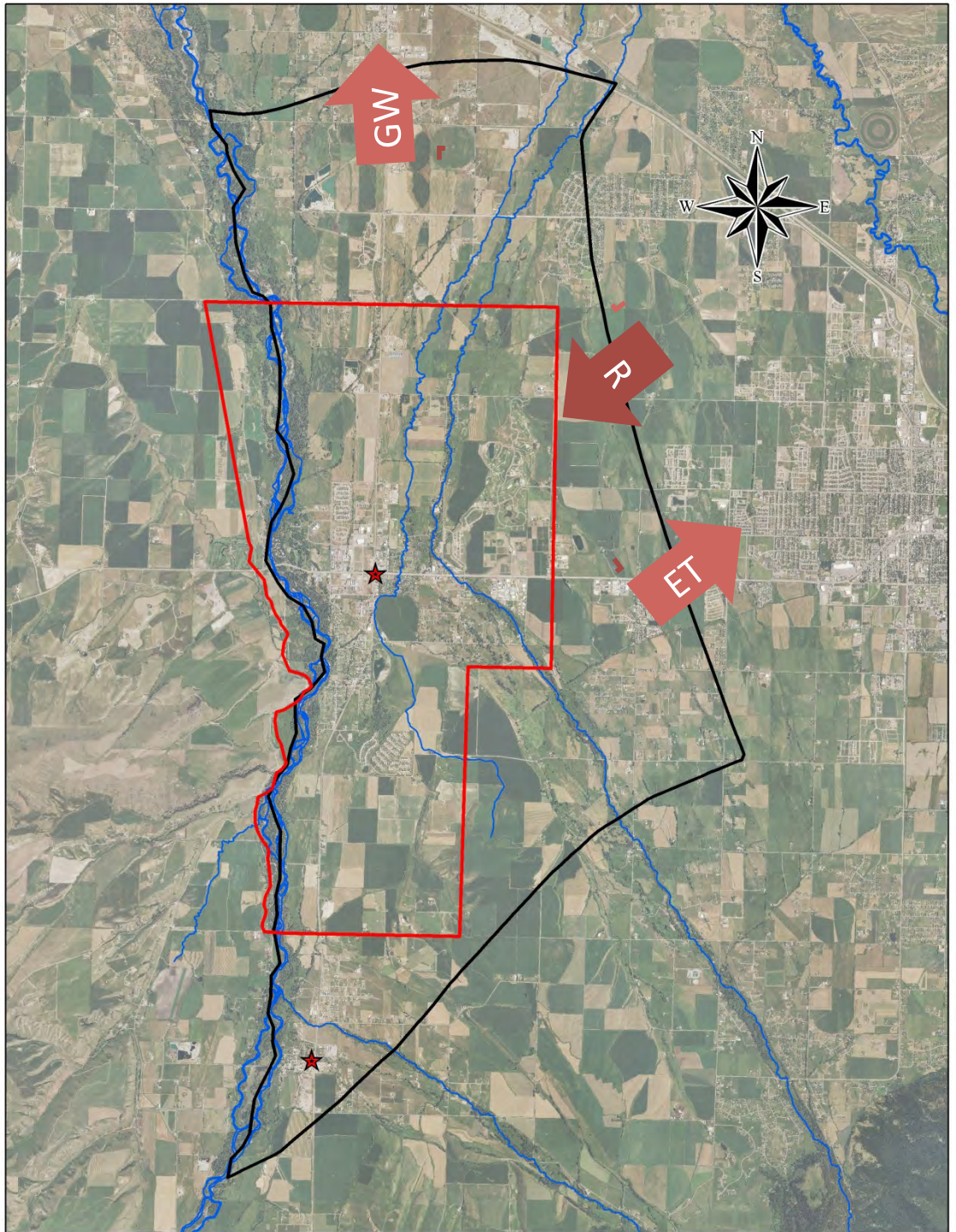


Groundwater flow components:

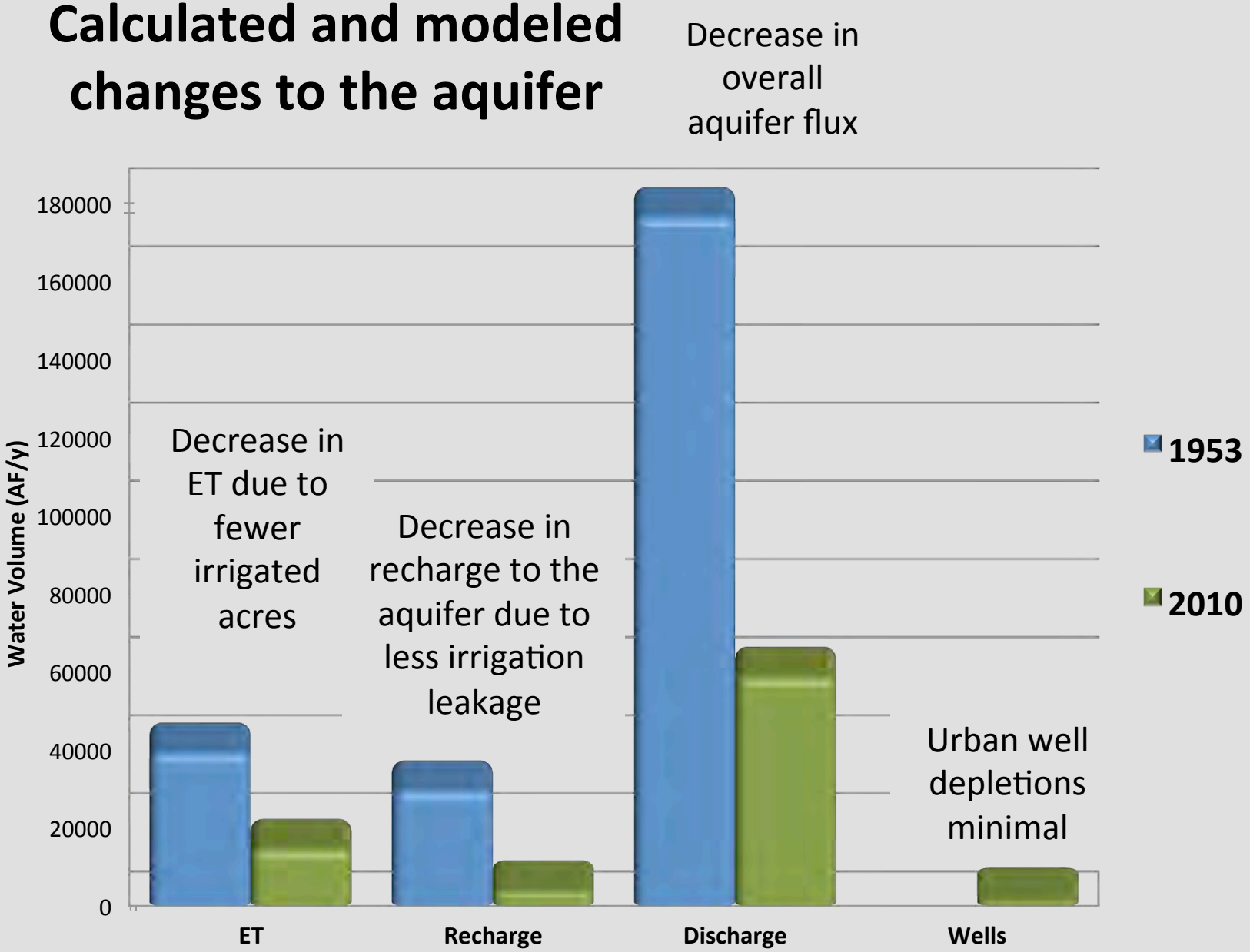
Groundwater (GW) flow out of the area

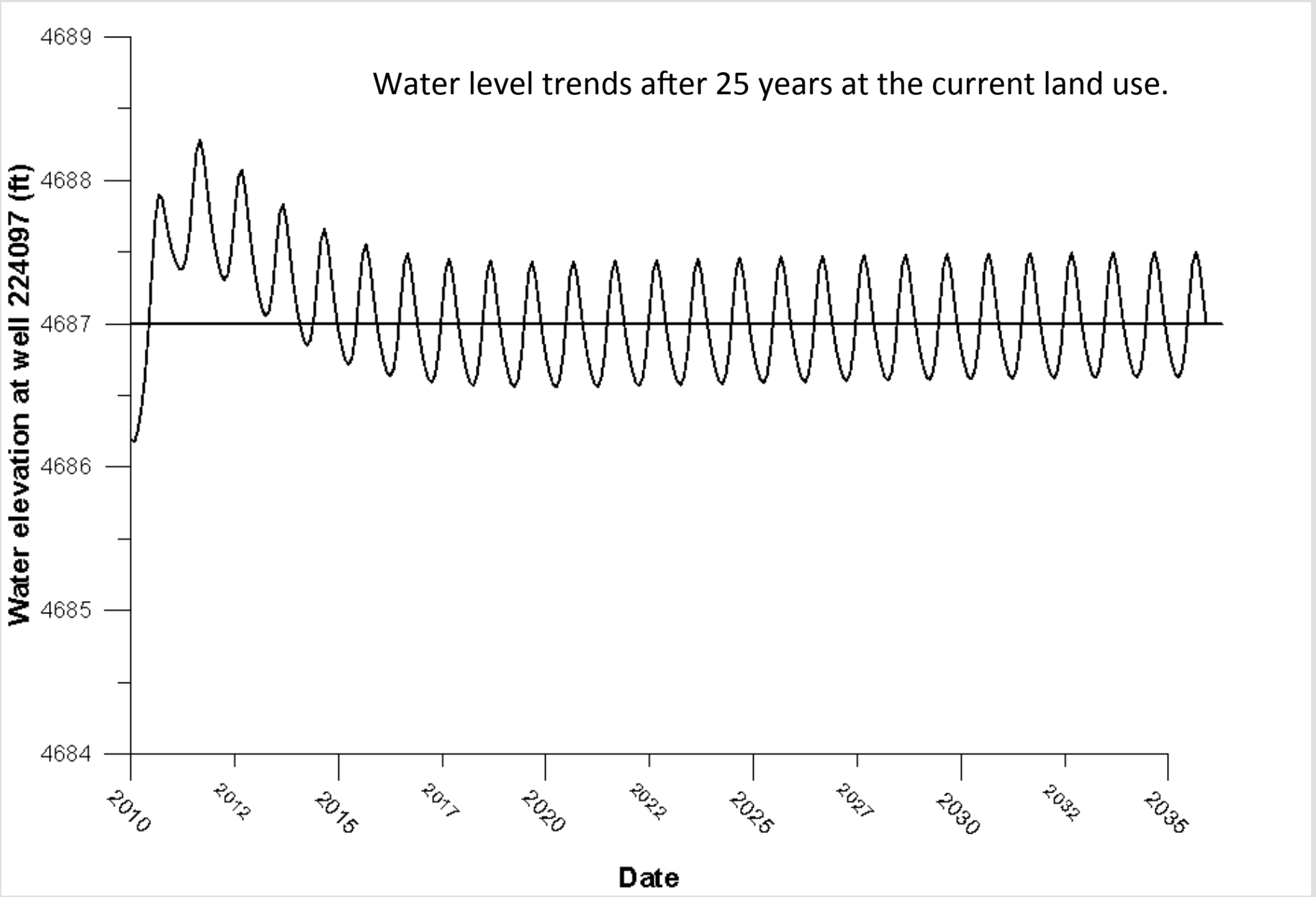
Recharge (R) from irrigation seepage

Evapotranspiration (ET) from crops and lawns

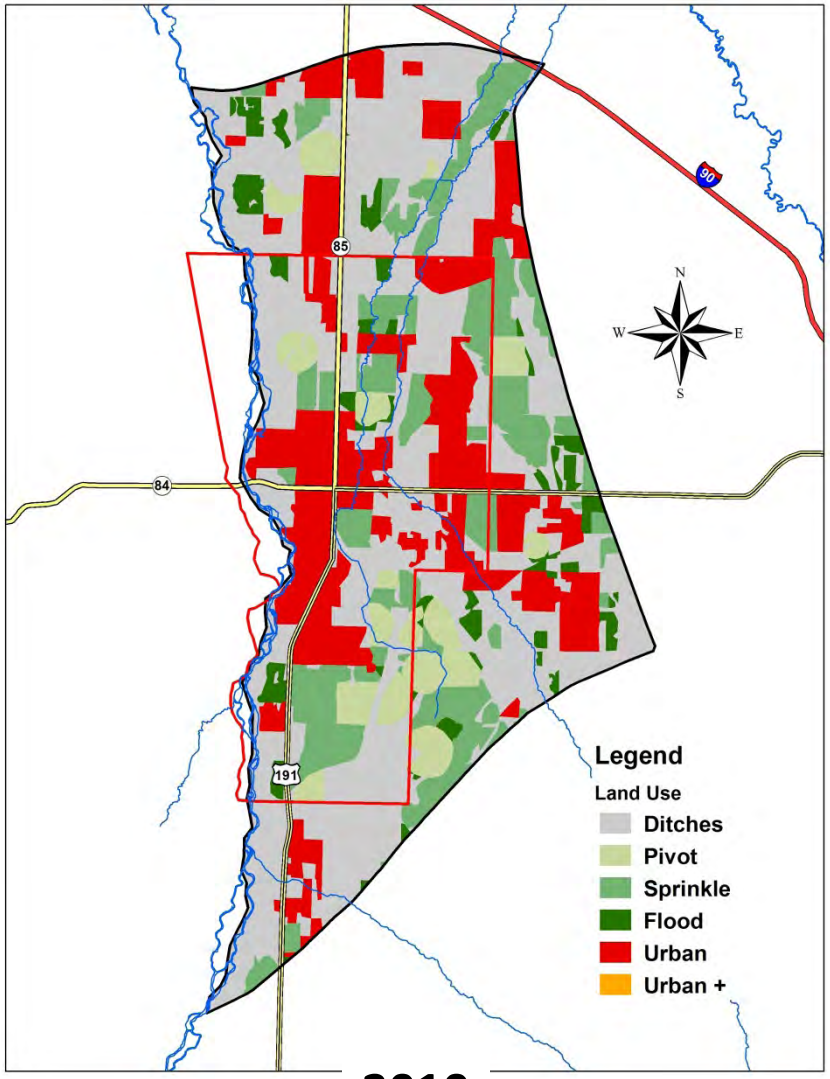


Calculated and modeled changes to the aquifer



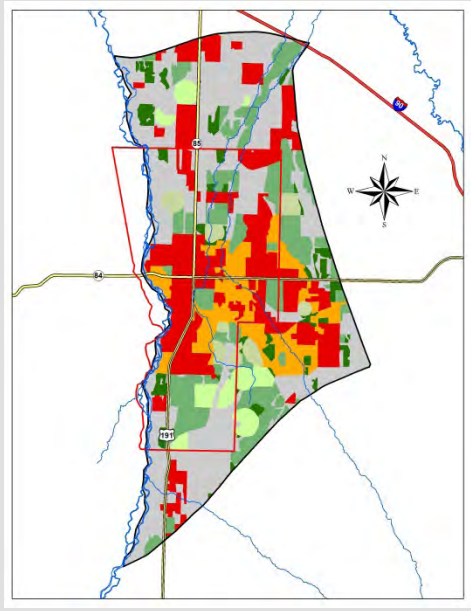

Water level trends after 25 years at the current land use.
Water elevation at well 224097 (ft)
4689
4688
4687
4686
4685
4684
2010
2012
2015
2017
2020
2022
2025
2027
2030
2032
2035
Date

Modeled Urbanization Prediction

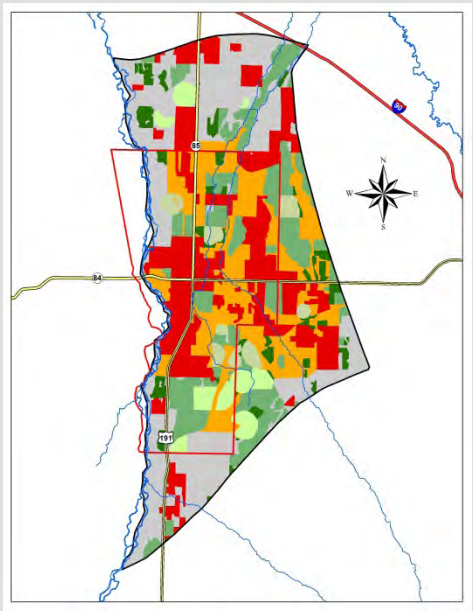


2010

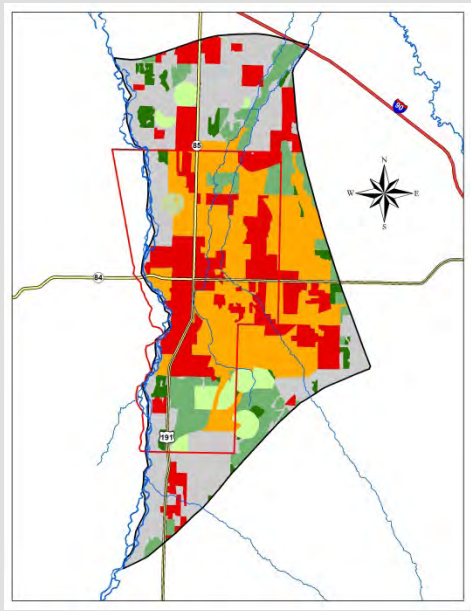
Current conditions and projected urban expansion at a rate of 500 acres/year



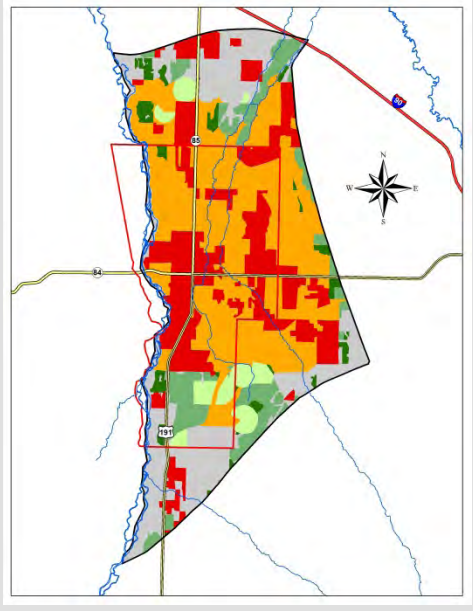
5 years



10 years

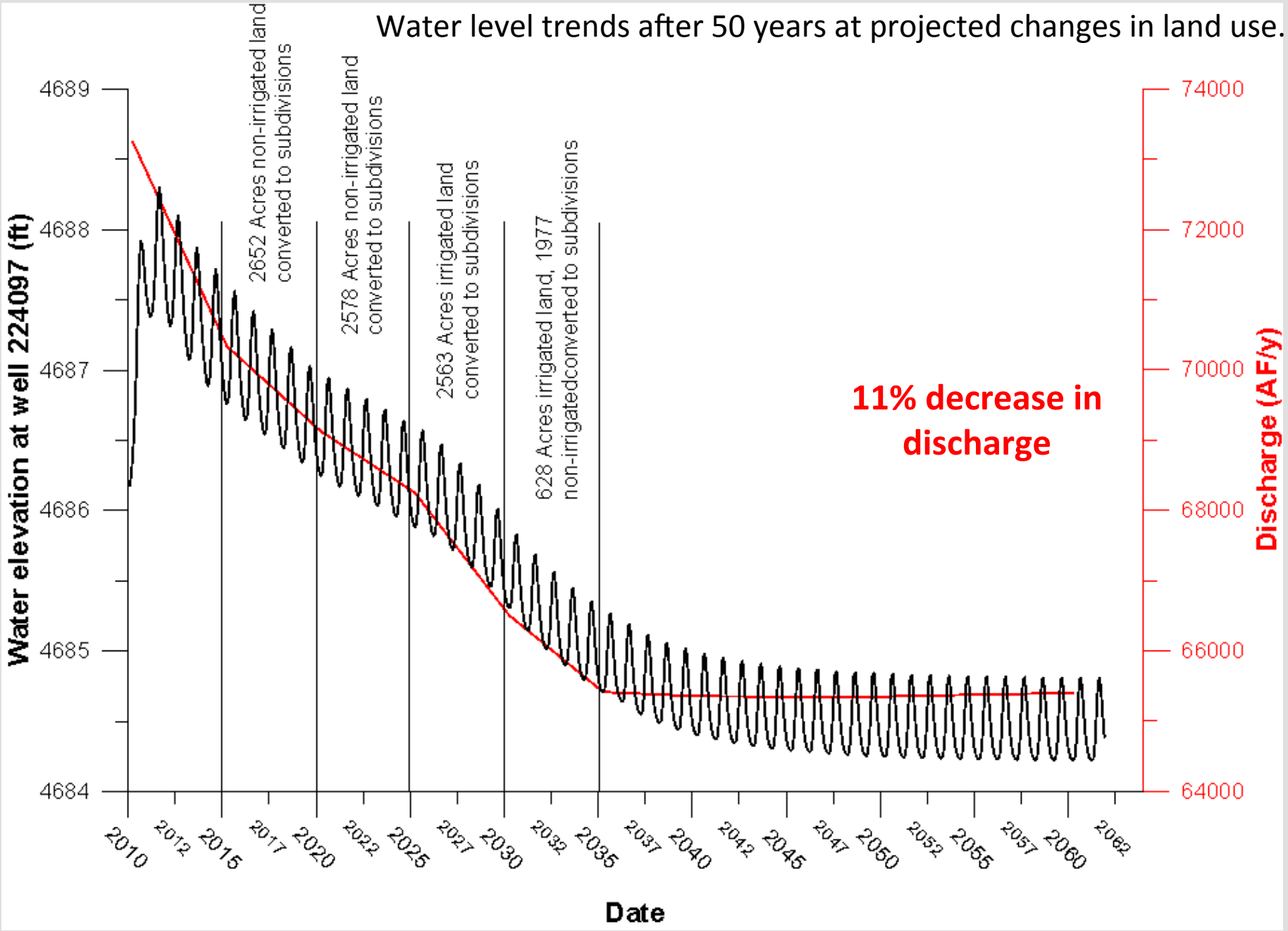


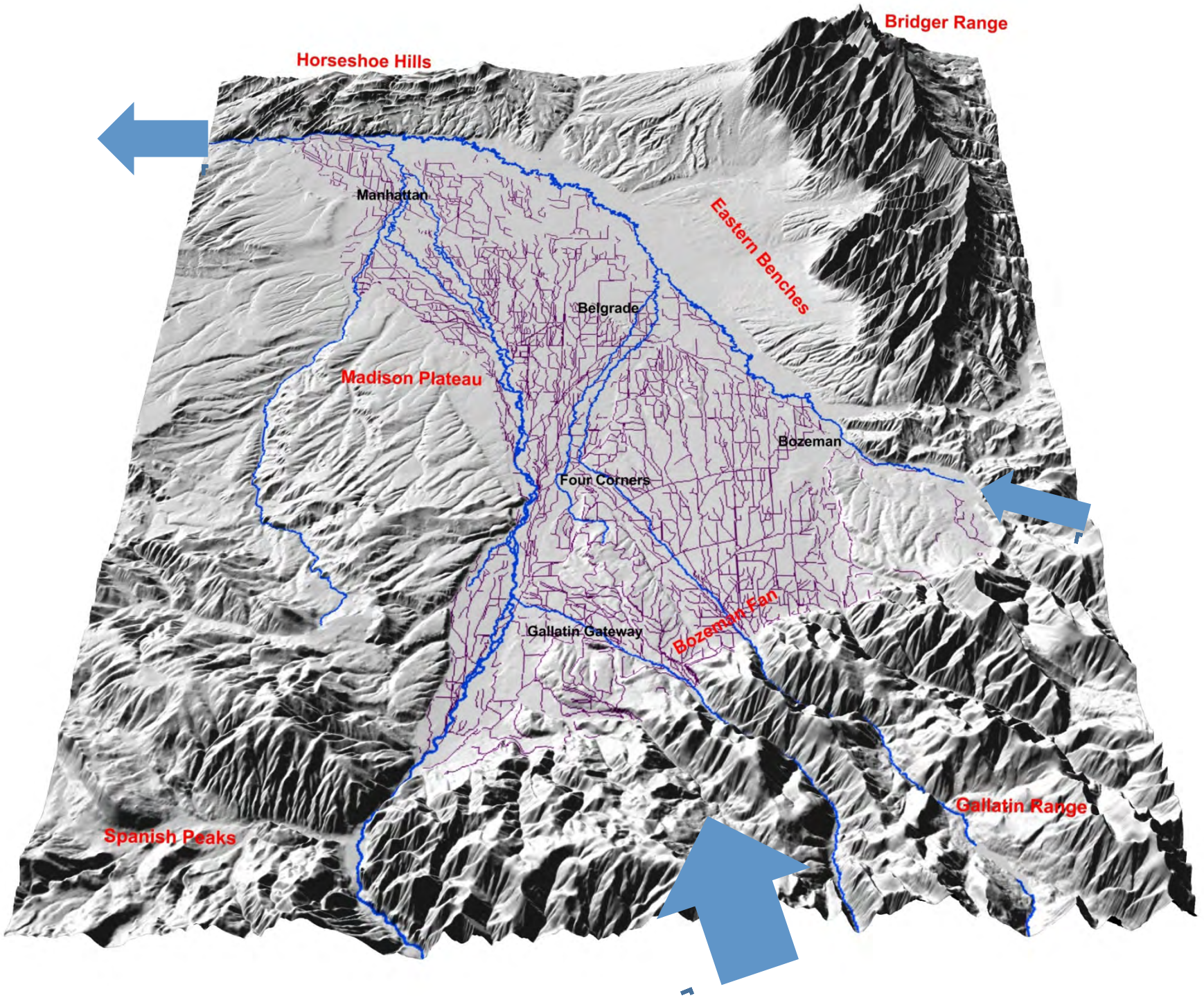
15 years



20 years

Water level trends after 50 years at projected changes in land use.




Bridger Range
Horseshoe Hills
Manhattan
Eastern Benches
Belgrade
Madison Plateau
Bozeman
Four Corners
Gallatin Gateway
Bozeman Fan
Gallatin Range
Spanish Peaks

Conclusions:

- *Use and recovery due to "bathtub effect"*
- *Water levels artificially elevated from irrigation*
- *Land use changes have decreased flow volume*
- *Water level decrease of approximately 1 foot predicted from current land use changes*
- *Projected future land use changes could decrease the water level approximately 2.5 feet*
- *Groundwater flux is considerably more sensitive to land use changes than water levels*
- *The effect of reducing irrigated acres is significantly greater than increasing suburban acreage*