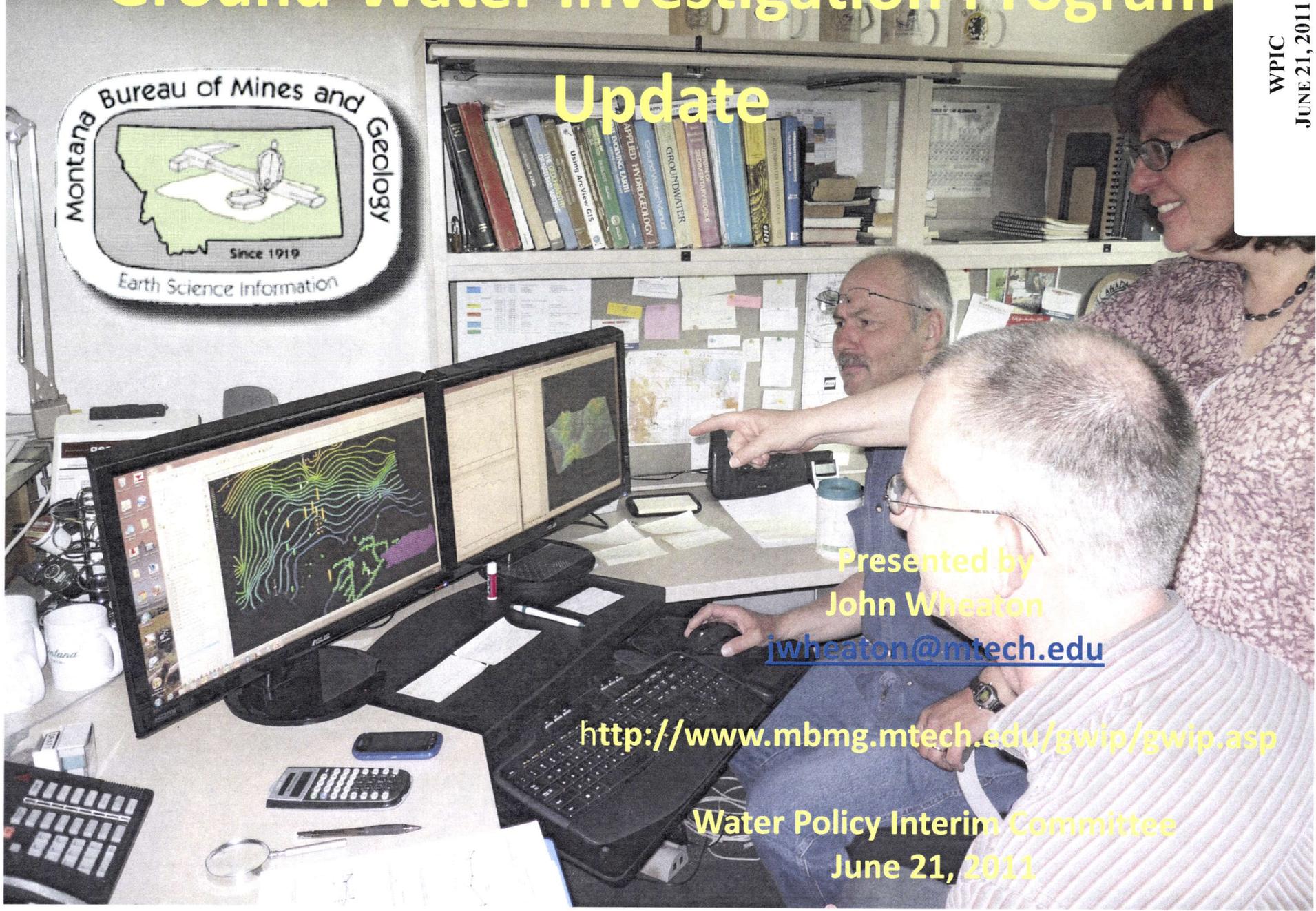


Ground-Water Investigation Program

Update



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<http://www.mbmgs.mtech.edu/gwip/gwip.asp>

Water Policy Interim Committee
June 21, 2011

WPIC
JUNE 21, 2011
EXHIBIT 2

Information from 4 projects:

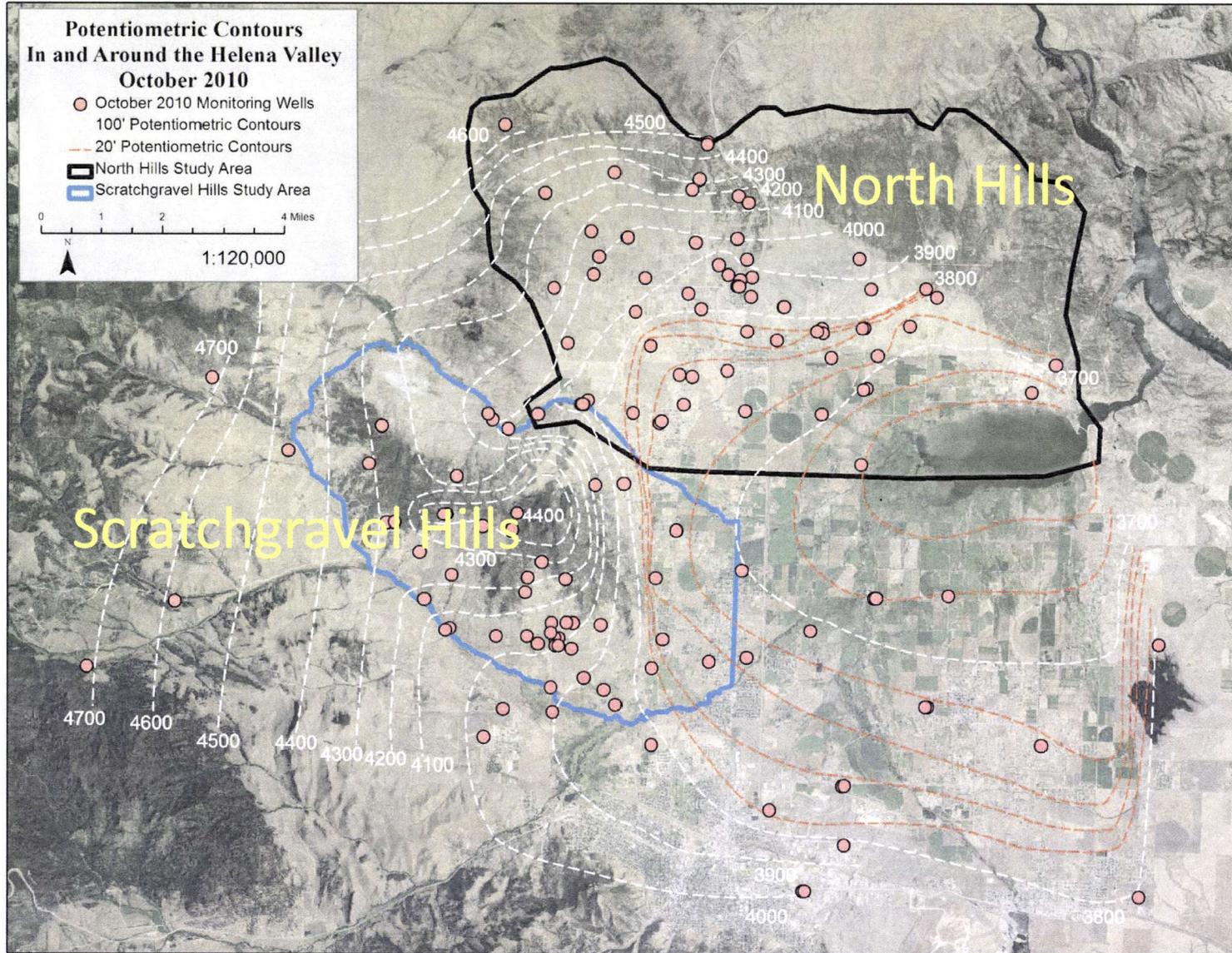
North Hills

Scratchgravel Hills

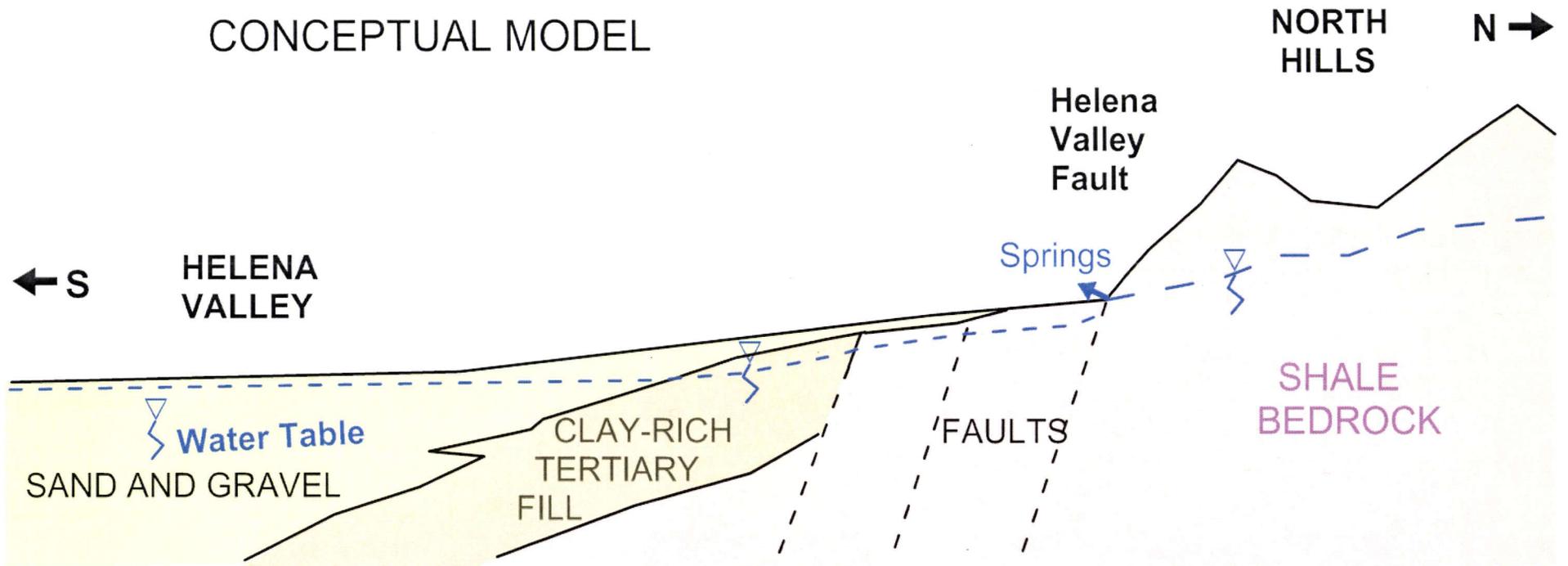
Bozeman (Belgrade and Four Corners)

Dillon

Ground Water Investigation - Helena area projects



CONCEPTUAL MODEL

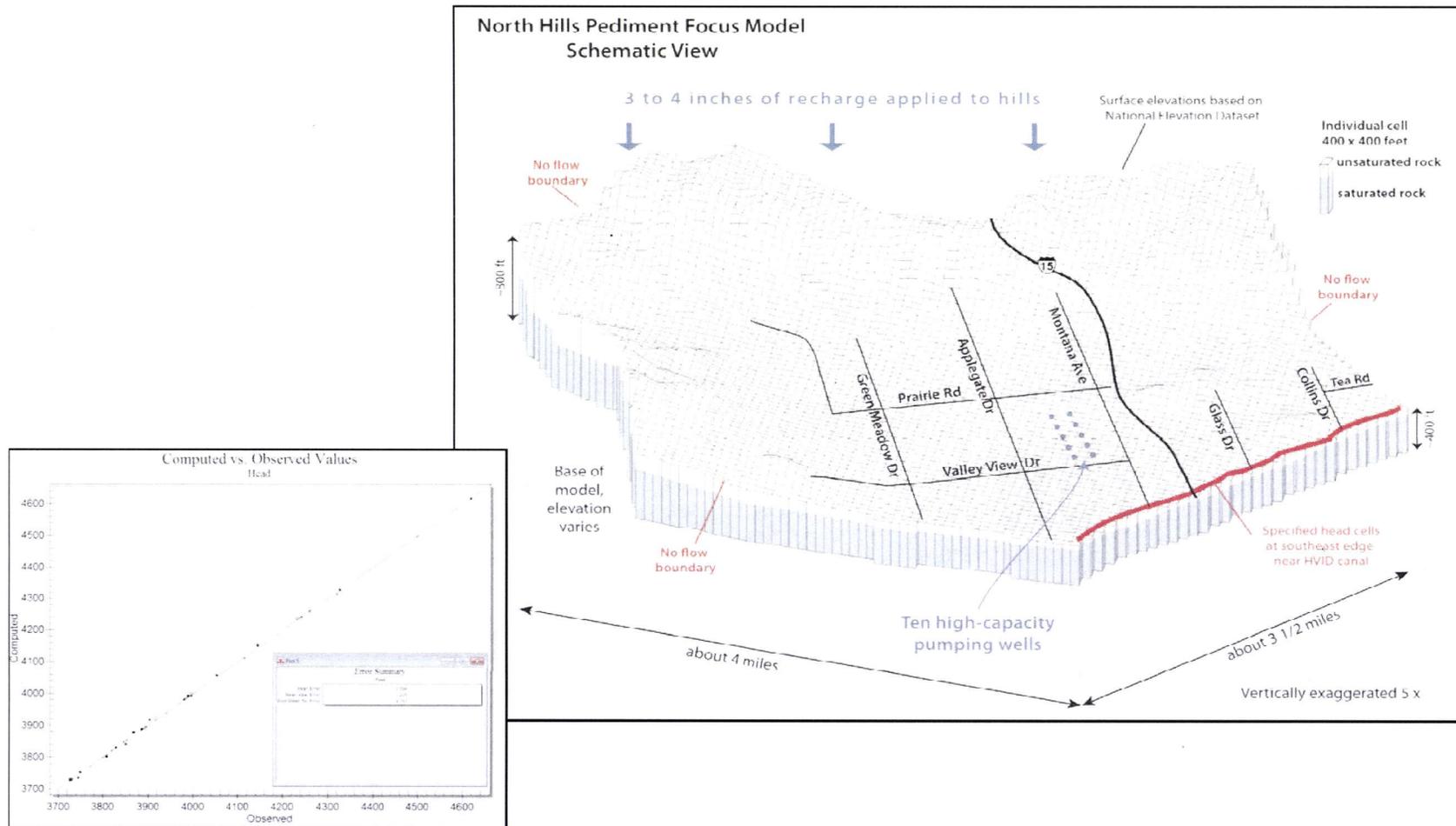


North Hills Groundwater Investigation

- Groundwater flow is from the surrounding Hills to Lake Helena
- Much of the Study Area shows no water level declines
- An area above the Helena Valley Ditch, and immediately west of the Interstate is showing sustained drawdown
- The bedrock aquifers are less productive than Tertiary materials or Quaternary alluvium
- Bedrock faults can form barriers to flow and/or subsurface fractured rock reservoirs
- Groundwater Quality is typically suitable for household use (1 sample exceeded MCL for Nitrate)

North Hills Groundwater Investigation

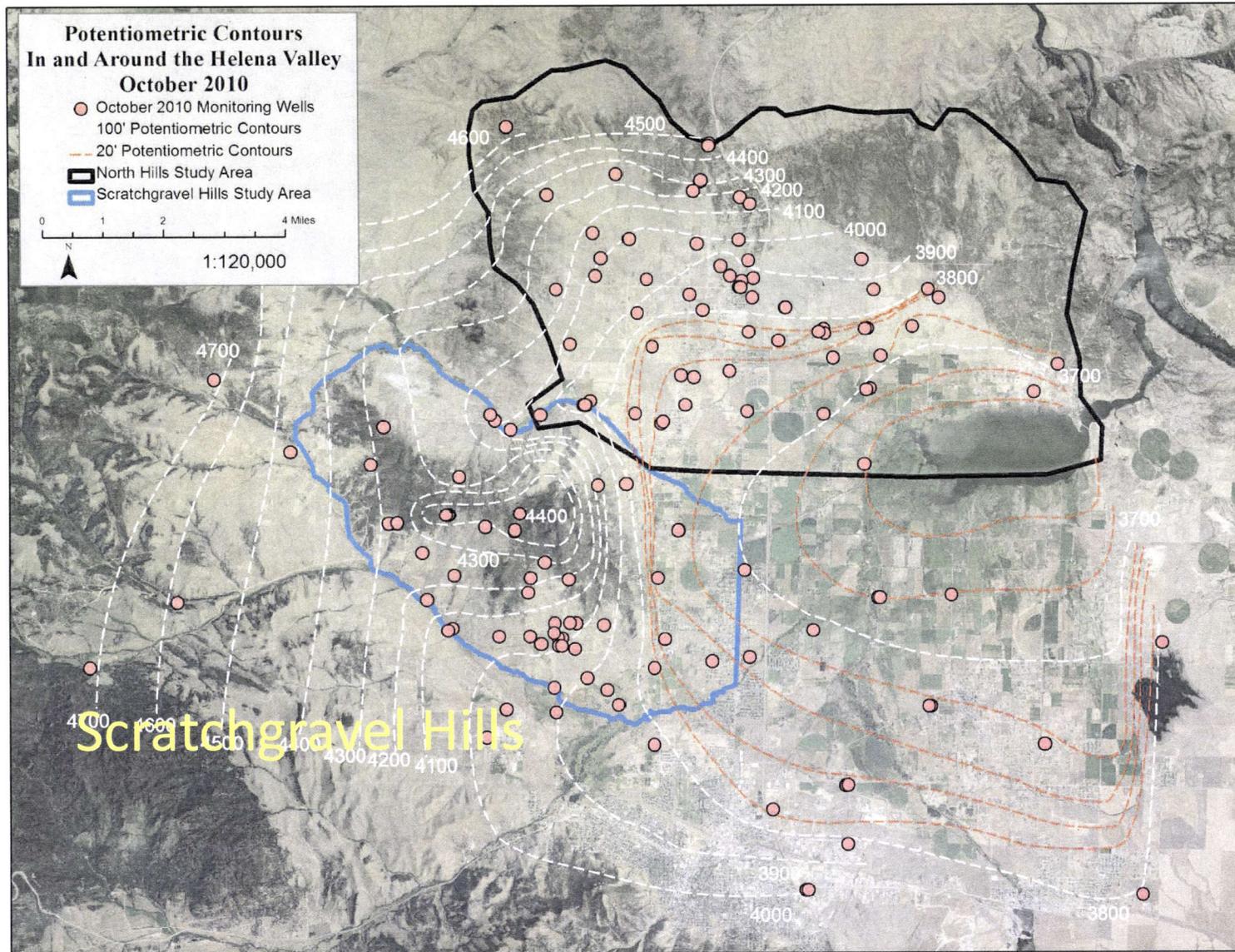
- Groundwater models have been developed for the North Hills



North Hills Groundwater Investigation

- The Groundwater Models Can be Used to:
 - Evaluate the long term effects of existing and proposed development
 - Water availability
 - Size and Magnitude of drawdown cone
 - Impacts to surface water flows (Lake Helena)
 - Contaminate transport
 - Evaluate the potential effects to Groundwater from:
 - Drought
 - Wet periods
 - Changes in Land Use
 - Methods of Irrigation
 - Ditch Management
 - Fields to Houses

Ground Water Investigation - Helena area projects

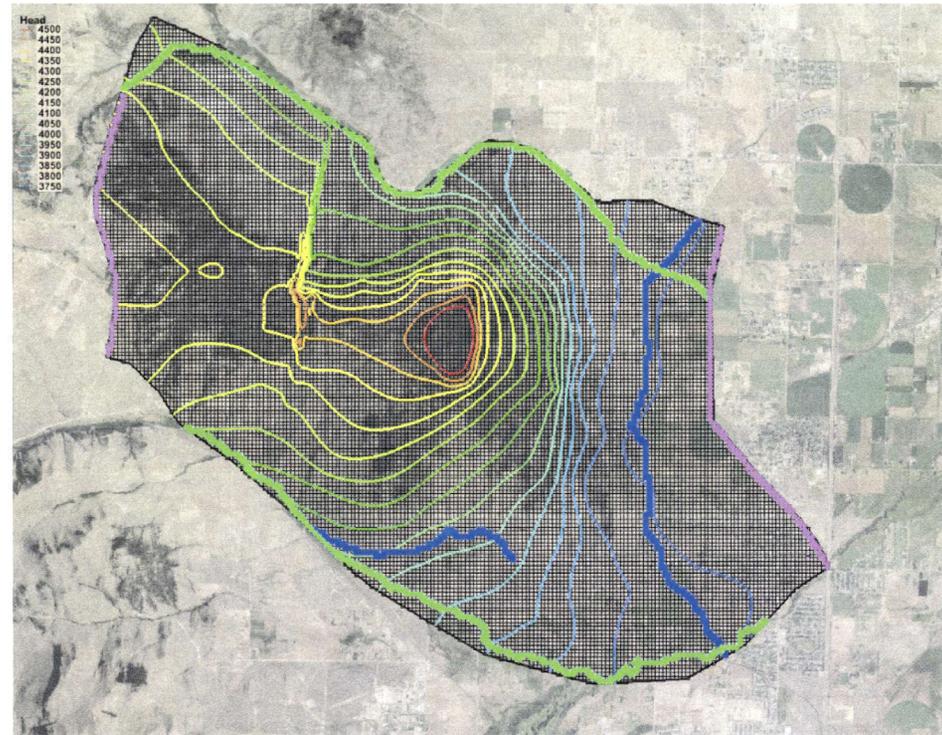


Scratchgravel Hills Groundwater Investigation

- Groundwater recharge for the CGWA is local
- There are not currently areas of water level declines
- Some individual wells have declined; however this appears to be due to poor aquifer conditions and over pumping at each site rather than area wide water level decline.
- The bedrock aquifers are less productive than the Quaternary alluvium. The Helena Formation and the Granite are particularly poor.
- Bedrock faults form barriers to flow
- Groundwater Quality is typically suitable for household use.
 - MCLs exceeded for:
 - Nitrate – Septic (3 sites)
 - Uranium – Alteration near igneous bodies (1 site)
 - Arsenic – Alteration along Bald Butte Fault Zone (1 site)

Scratchgravel Hills Groundwater Investigation

- Groundwater models have been developed for the Scratchgravel Hills
- They show that a high density development in the area of Cornerstone Estates obtaining its water from the bedrock would result in substantial drawdown
- Similar to North Hills, the models will allow for future scenarios to be evaluated.



Belgrade and Four Corners

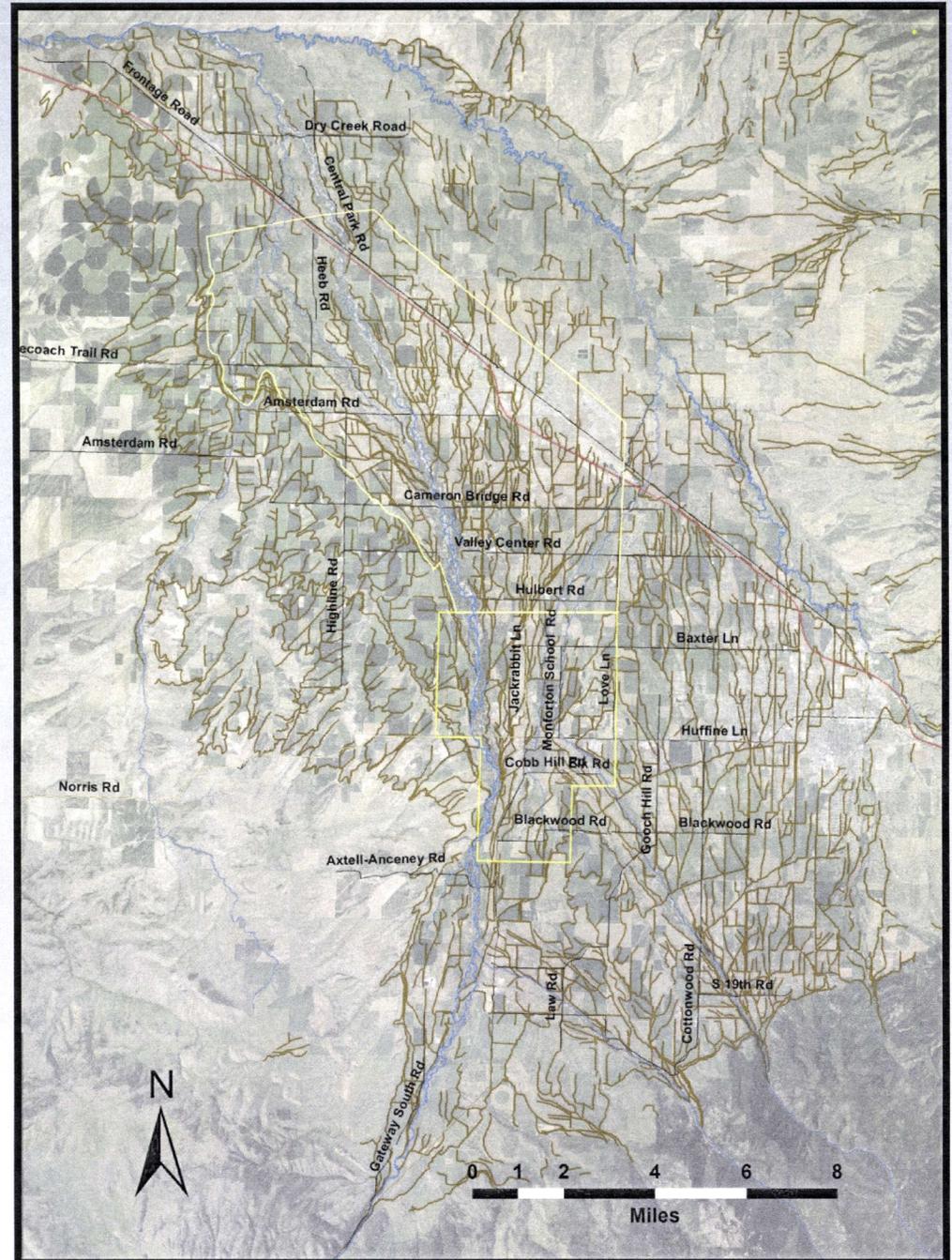
Gallatin Valley Hydrology

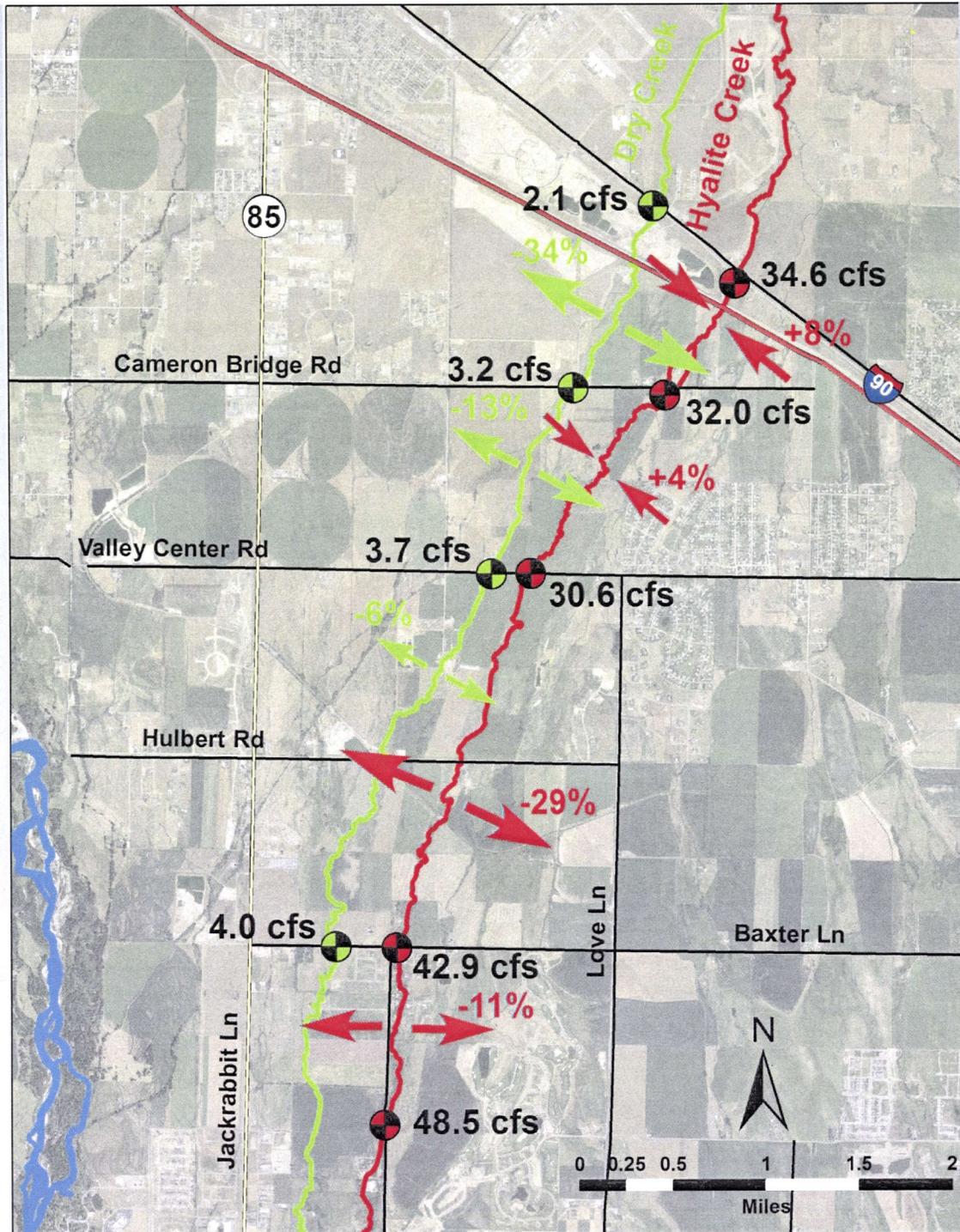
Forty five surface water diversions on the West Gallatin River

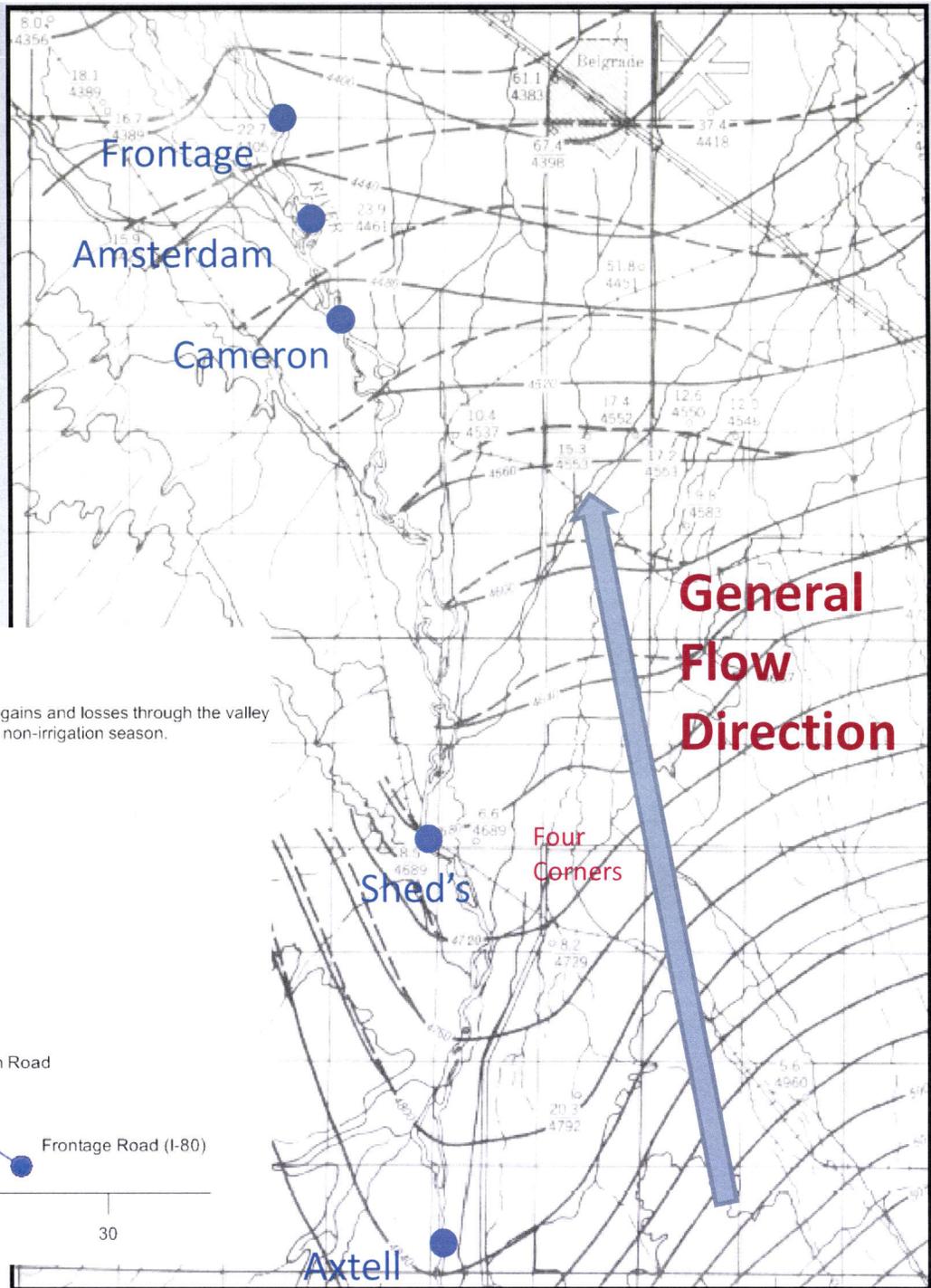
More than **2,000 miles** of canals and ditches were present in the Gallatin Valley during the 1950's

Irrigated land has decreased by **20%** from 2002 -2007, from 101,823 - 81,651 acres.

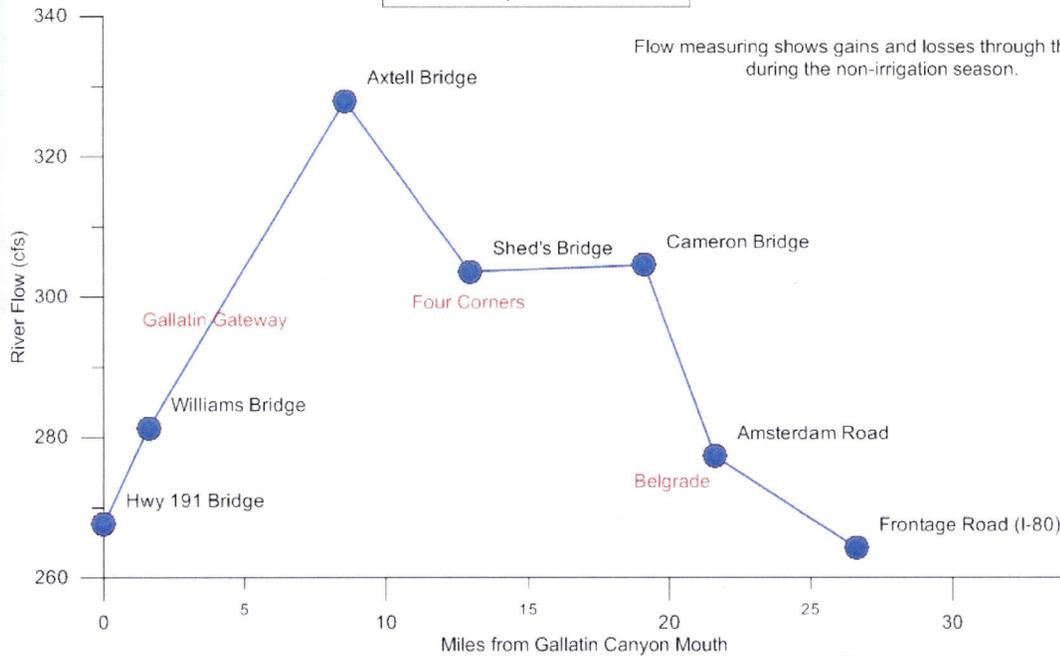
Ground water development from 2002-2007 increased in the Gallatin Valley by **23%**, from 12,064 – 14,865 wells.







Baseline West Gallatin River Flows
April 2010



Flow measuring shows gains and losses through the valley during the non-irrigation season.

Beaverhead River

Dillon to Beaverhead Rock

- Observations of chemistry and water elevation data at two sites along the East Bench and West Side Canals show a connection between groundwater and canal water.
- Volcanic rock on the West Bench is a high yield aquifer. Previous water rights investigations indicate a confined aquifer. However, an aquifer test showed that this aquifer is not confined and it is directly connected to the overlying sediments.
- This aquifer test, performed by pumping a high capacity irrigation well, also showed a connection to surface water down gradient from the pumped well.
- Water isotopes results indicate groundwater upwelling in the Dillon and Beaverhead Rock areas. These are natural 'pinch' points in the topography.

East Bench Canal Influence

Ground-water hydrograph

