Application of the USGS Soil-Water Balance (SWB) Model

Estimation of Groundwater Recharge in Eastern and Western Montana

MBMG
Montana Bureau of Mines and Geology
Ground Water Investigation Program

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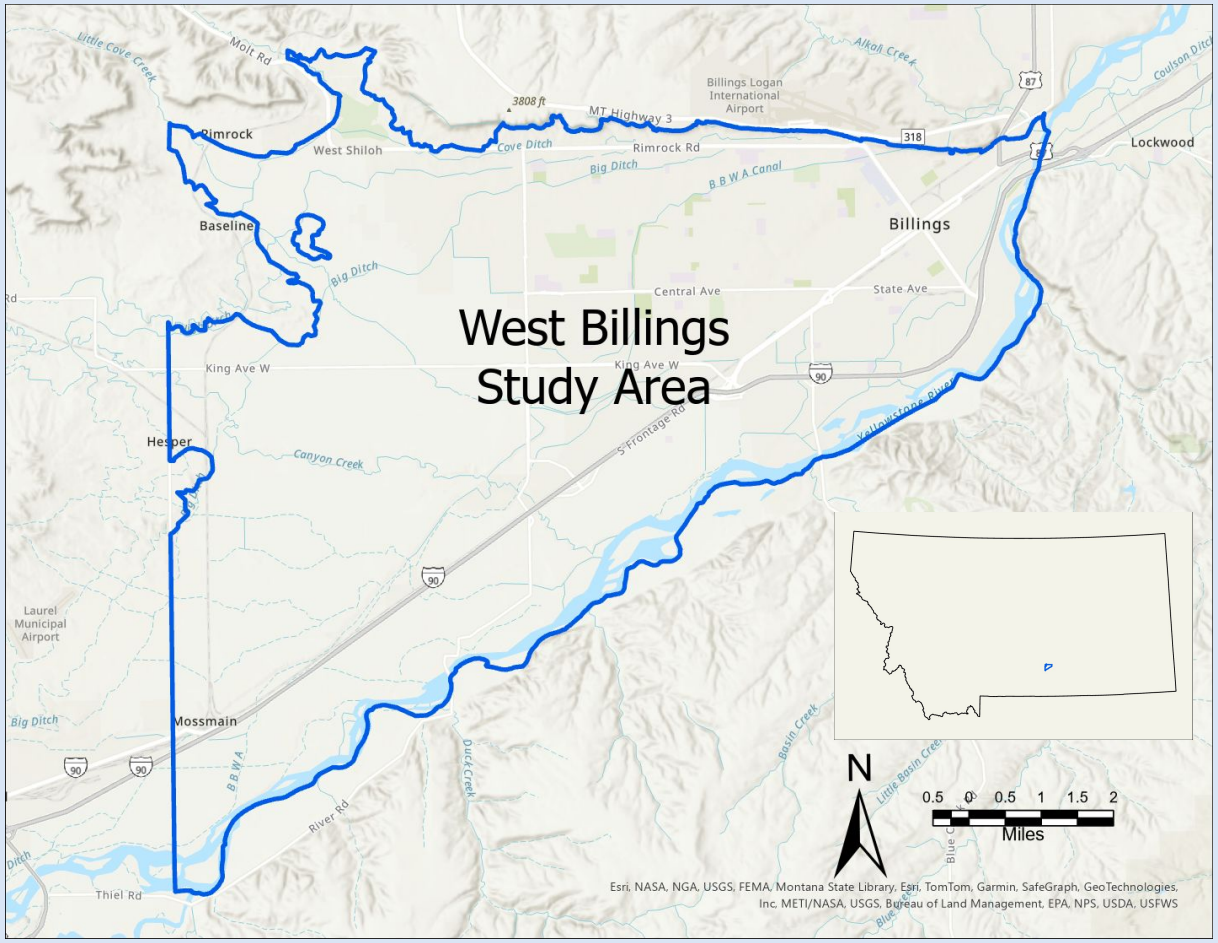
Problem

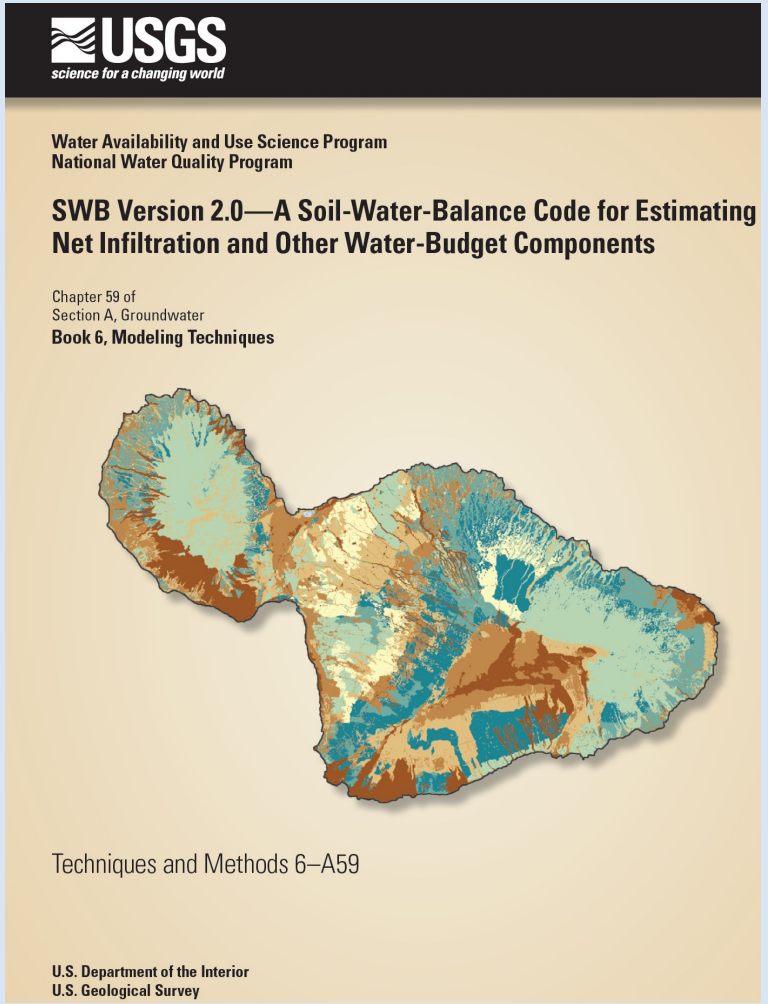
- Estimating groundwater recharge is difficult!
  - Spatially
  - Temporally
  - Multiple mechanisms
- Need recharge estimates for developing water budgets and groundwater models



Study area that needs recharge estimates

Soil-Water Balance (SWB) - A Solution - ?

- Modified Thornthwaite-Mather soil-water-balance accounting approach
- Estimates distribution and timing of ***net infiltration*** downward out of the root zone
- Diffuse areal and focused recharge
- Daily timestepping
- Developing inputs and post-processing outputs is GIS intensive
- Rectangular grid cells

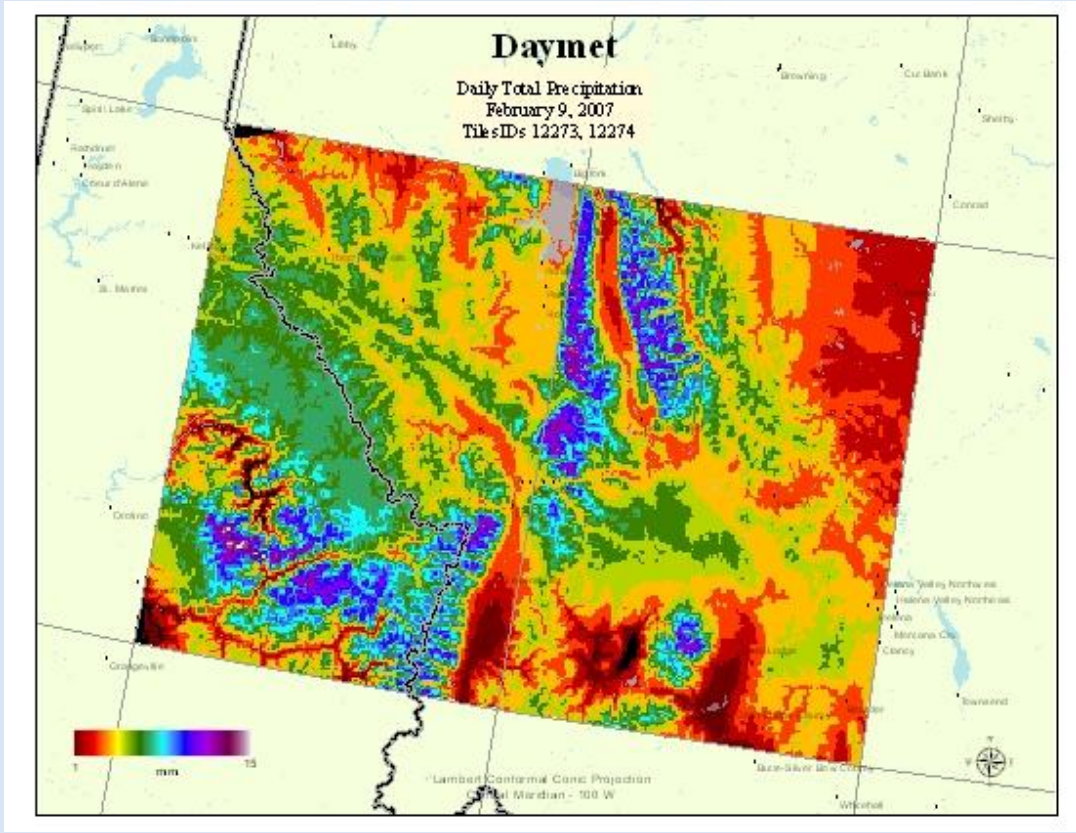


TM6-A59 - SWB2 manual

Previously only tested in humid environments

SWB2 Inputs

- Minimum inputs
  - Climate – precipitation, min/max temp
  - Soils – USDA Hydrologic Soil Group and AWC
  - Land use/land cover
  - Data related to ET/crop water use
  - Land surface flow direction – runoff routing
- Optional inputs
  - Crop irrigation (crop-water demand)
  - Impervious surface
  - Storm drain capture/sewer leakage
  - Fog interception

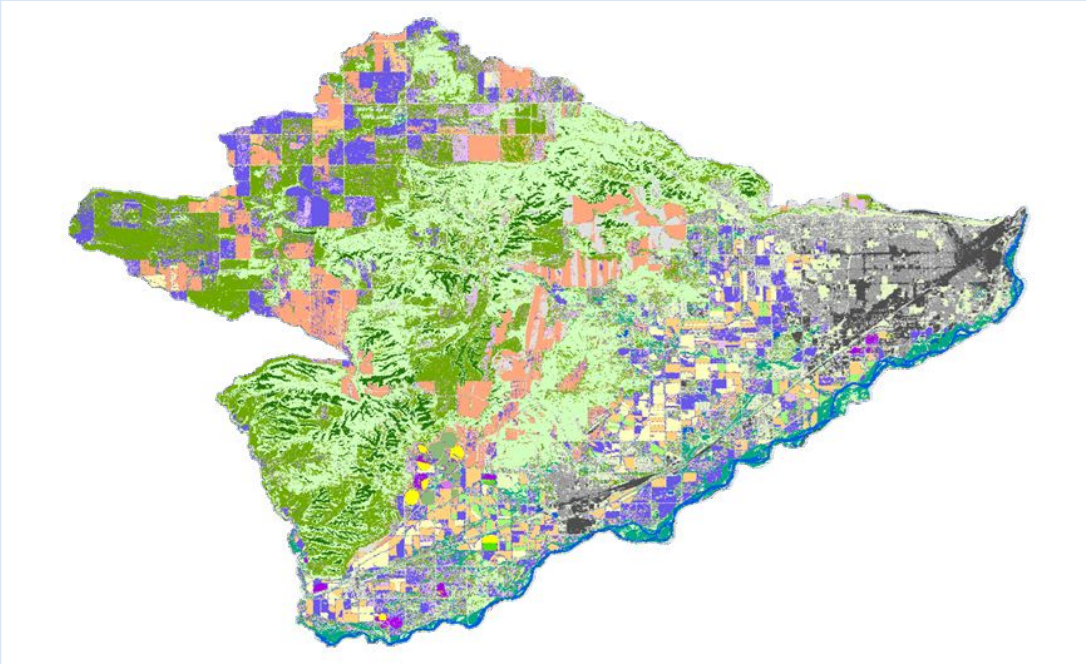


Daymet Daily Total Precipitation snapshot for portion of western MT, Feb 9, 2007

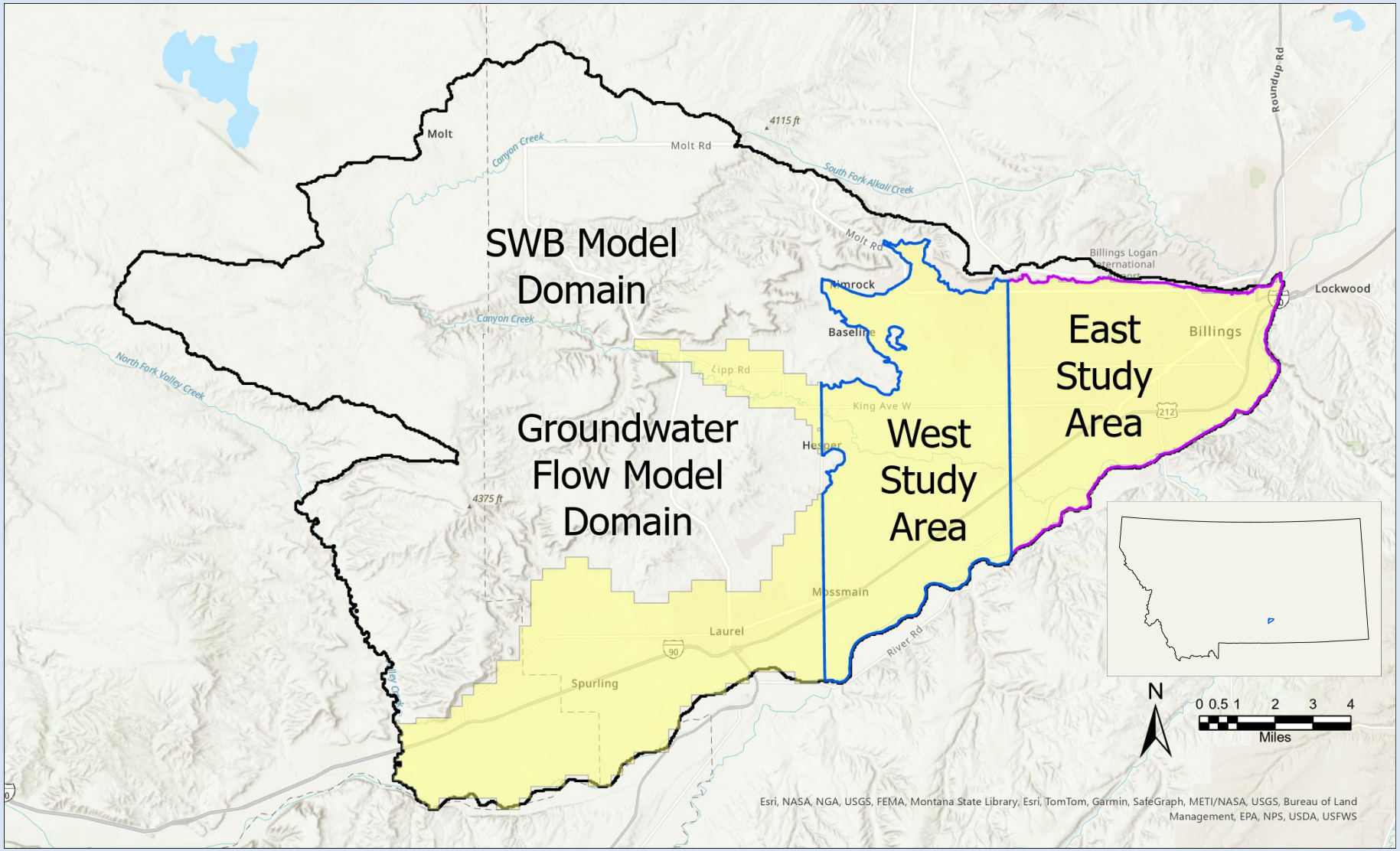
Land Use/Land Cover Elements

- Agriculture
  - FAO-56-based methods to estimate crop-water demands
  - Multiple irrigation application amount/timing methods
  - Can mix irrigated and dryland crops
  - Different irrigation application methods (i.e., flood vs. pivot/sprinkler)
  - Final Land Unit (FLU) Classification datasets for MT

- Urban/suburban effects
  - Impervious cover
  - Septic system effluent
  - Sewer leakage
  - Storm drain capture

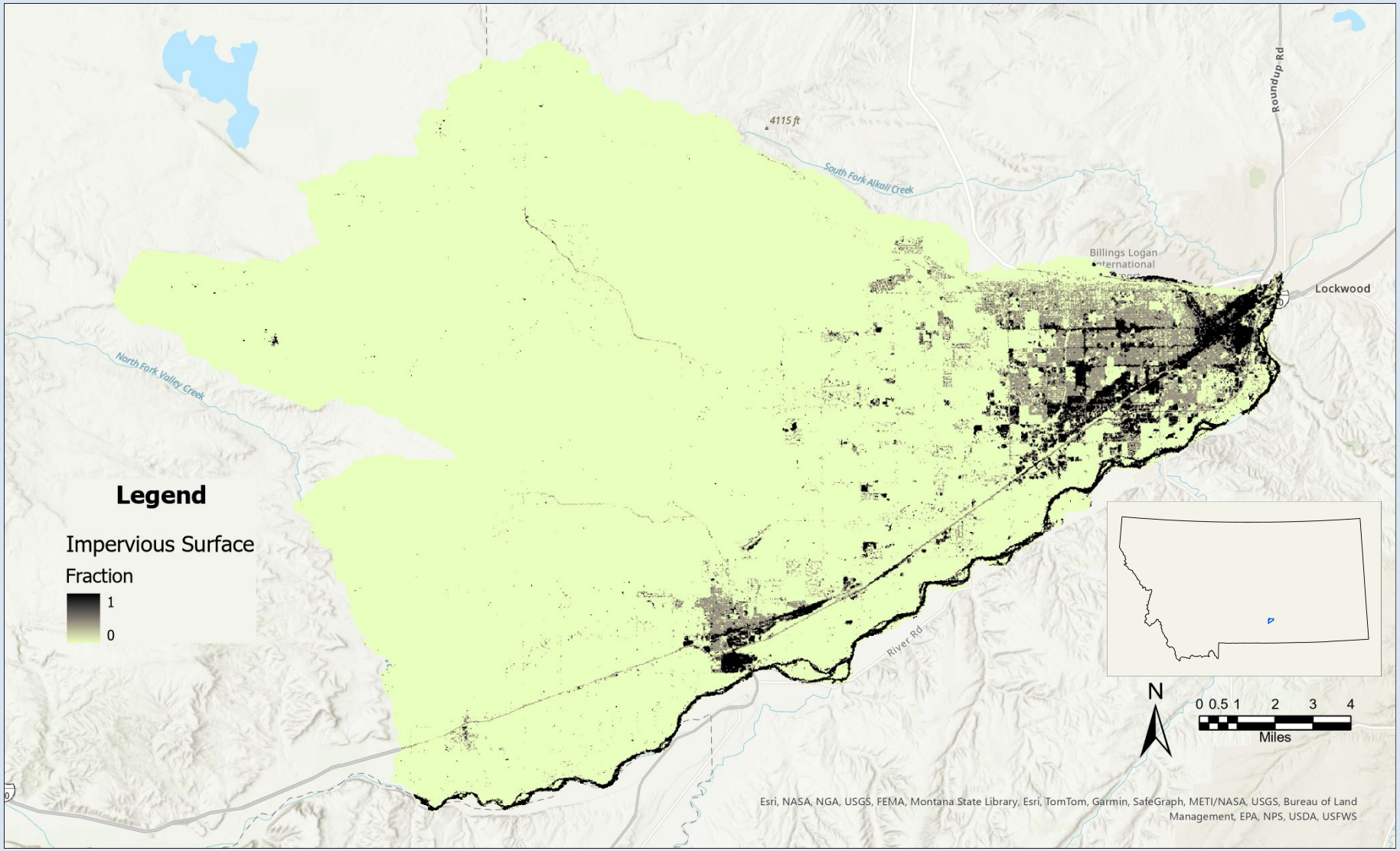


West Billings Example



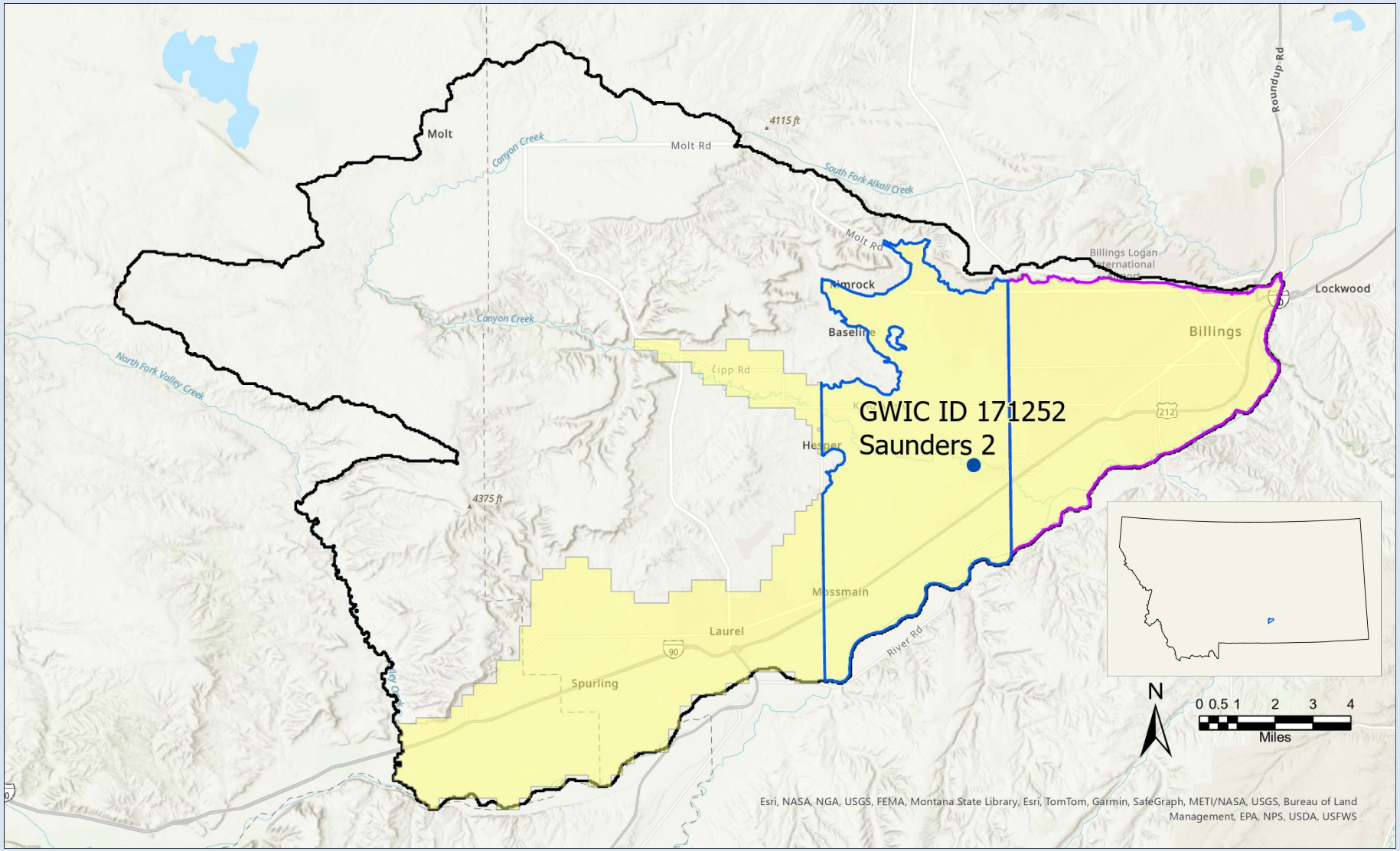
West Billings Study, Groundwater Flow, and SWB Model Areas

West Billings Example



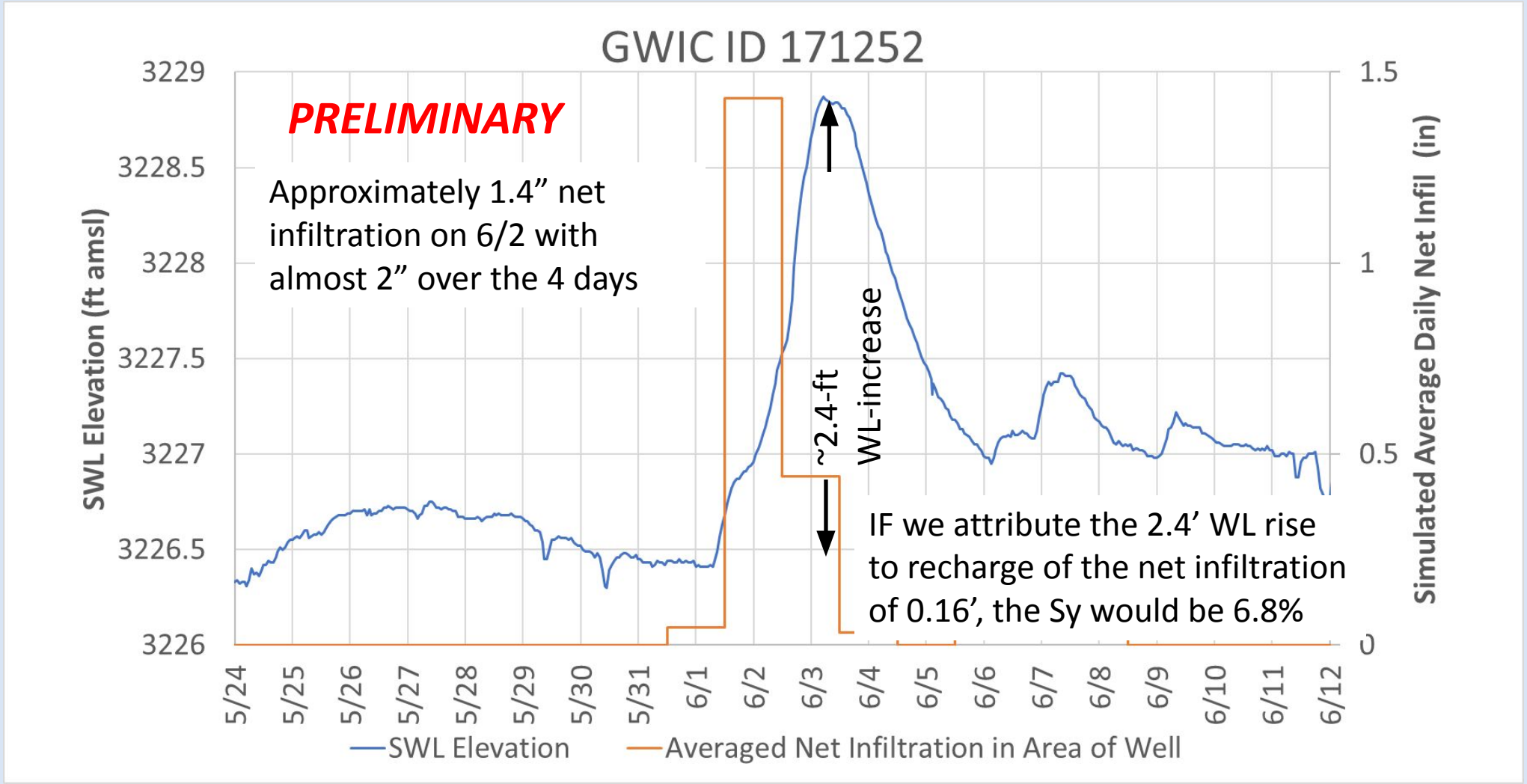
Billings impervious area fractions

West Billings Example



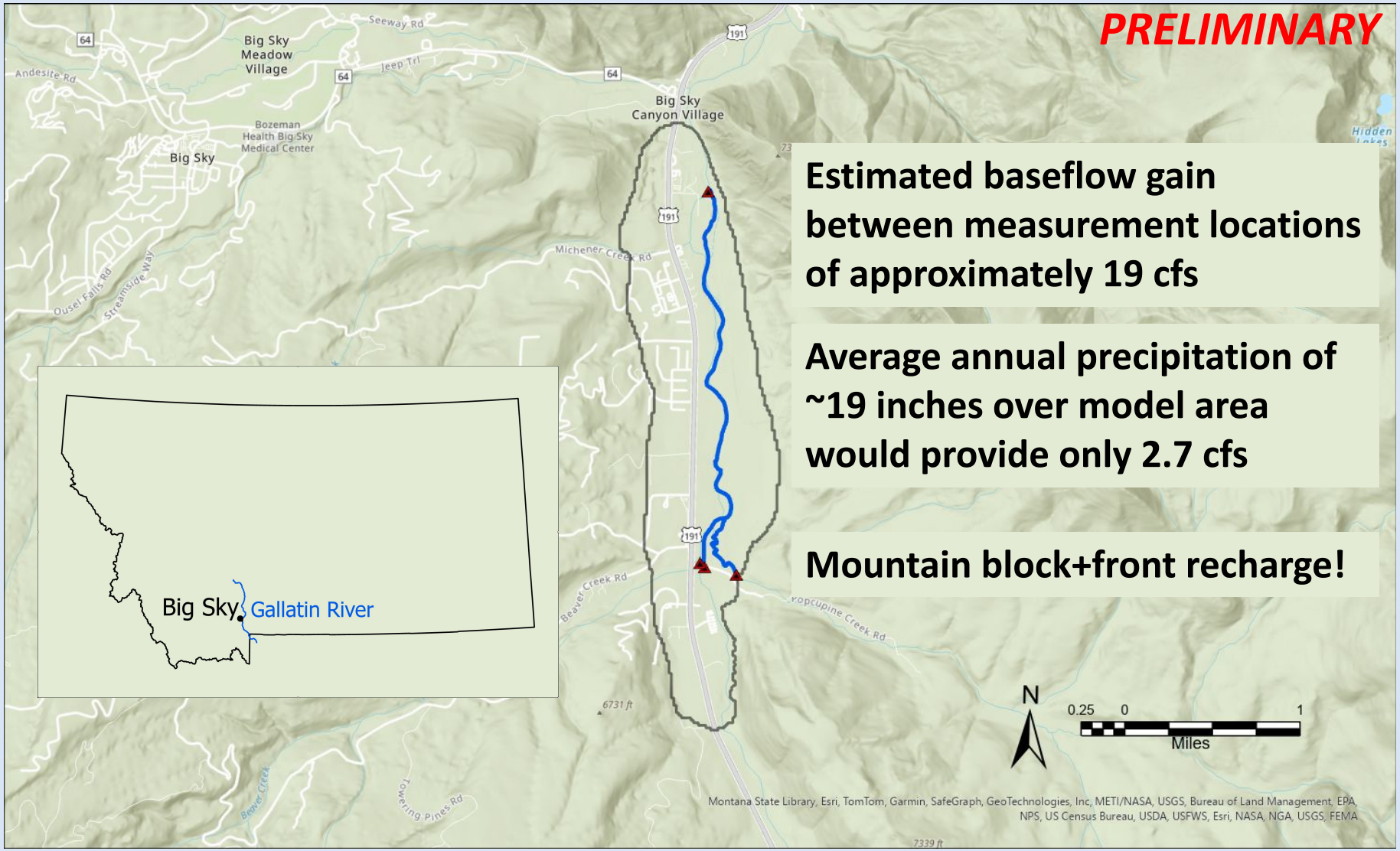
Example well to compare simulated recharge and observed water-level change

West Billings Example



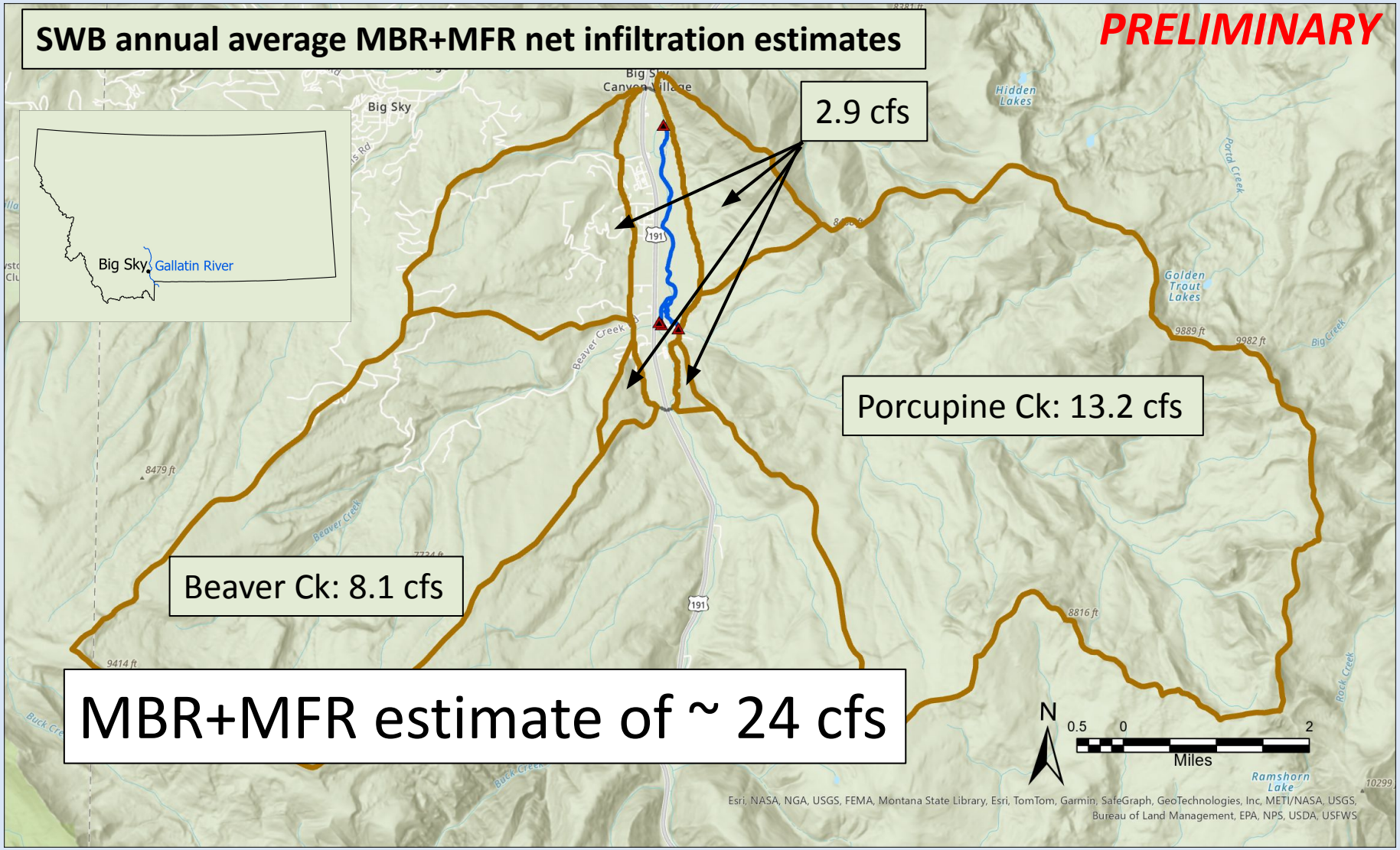
Comparison of simulated net infiltration and observed water-level changes

Upper Gallatin Alluvial Aquifer Example



Upper Gallatin River Groundwater Model Domain and Baseflow Gain Reach

Upper Gallatin Alluvial Aquifer Example



Upper Gallatin River Groundwater Model SWB Simulation Area

Conclusions & Next Steps

- SWB model approach appears useful, but is not necessarily a "plug & chug" exercise
- Another model…another model to calibrate
  - Crop water usage/actual ET estimates
  - Runoff estimates
  - Snow-water equivalent
- Have developed a number of preliminary scripts to automate processing both inputs and outputs
- Need to test results as inputs to groundwater models in MT!