Development of Hydrologic Model of Modesto Region

A cooperative effort between USGS and the Stanislaus-Tuolumne Rivers Groundwater Basin Association

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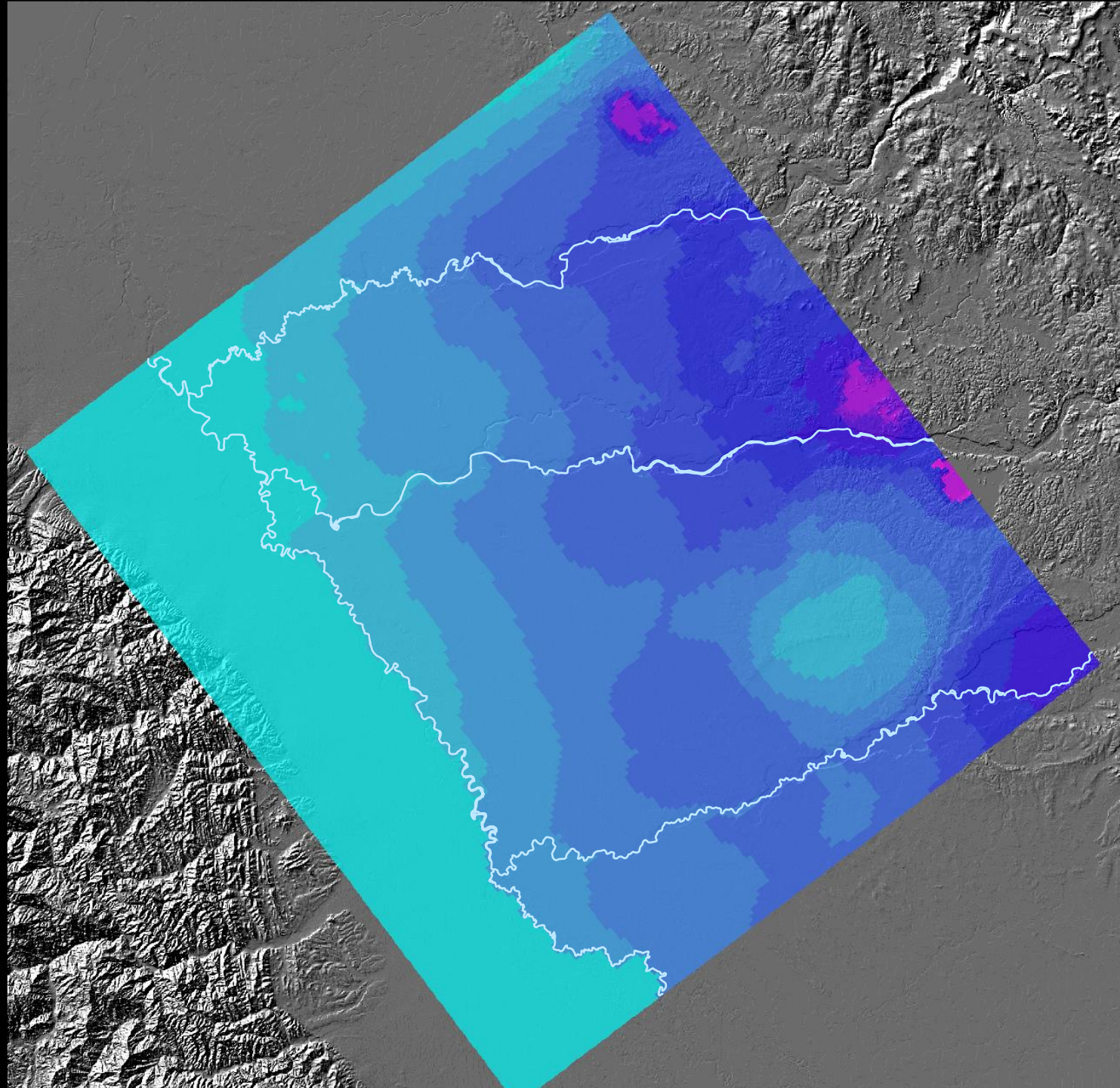
Simulated water levels, 5m (~15 ft) interval, year 2000



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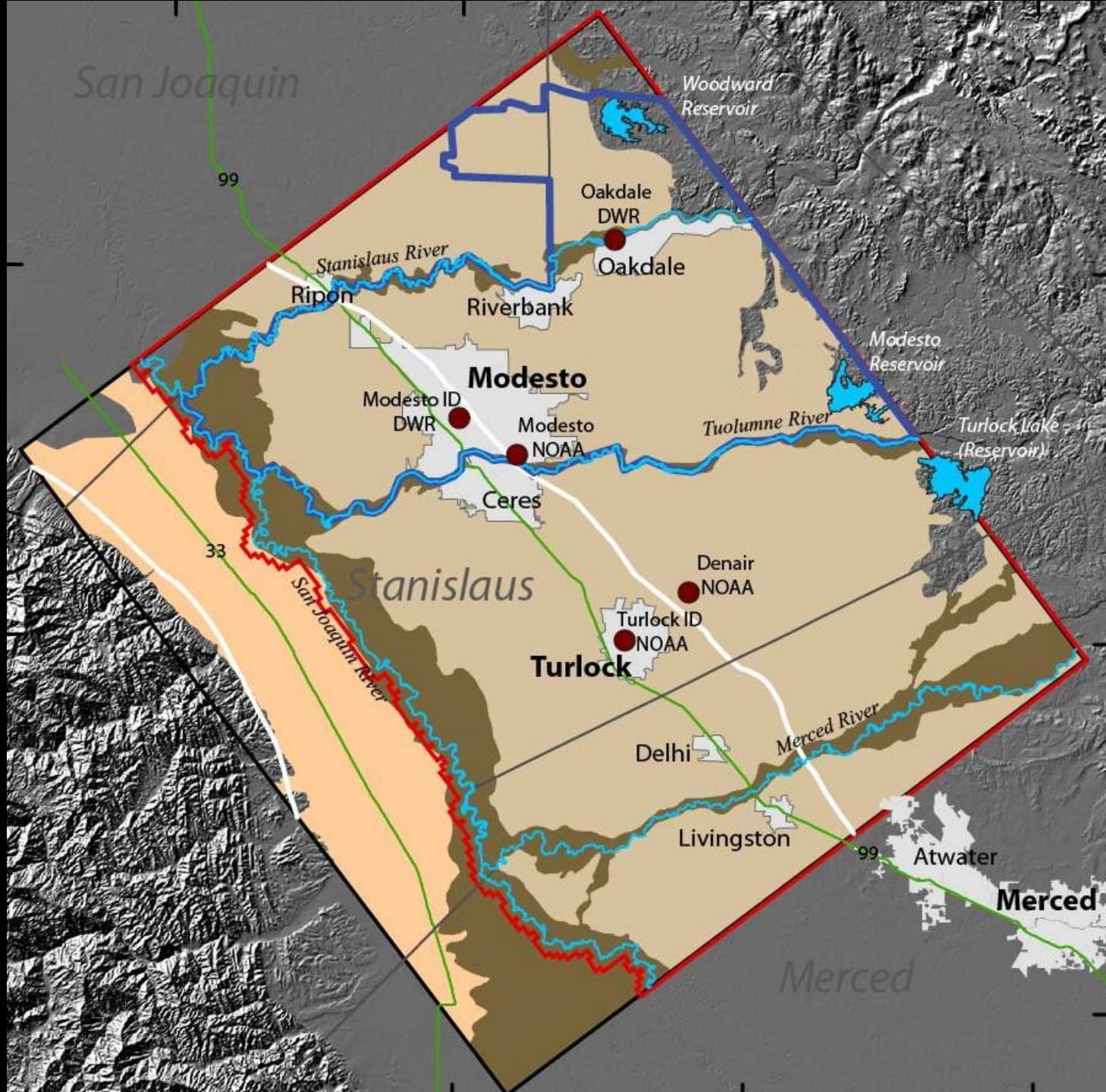
History of Model Development

- 2002-3, basin characterization, incl. borehole data – STRGBA/USGS
- 2004-05 developed WY2000 groundwater model – USGS, NAWQA
- Present: transient 1960-2004 model – STRGBA/USGS

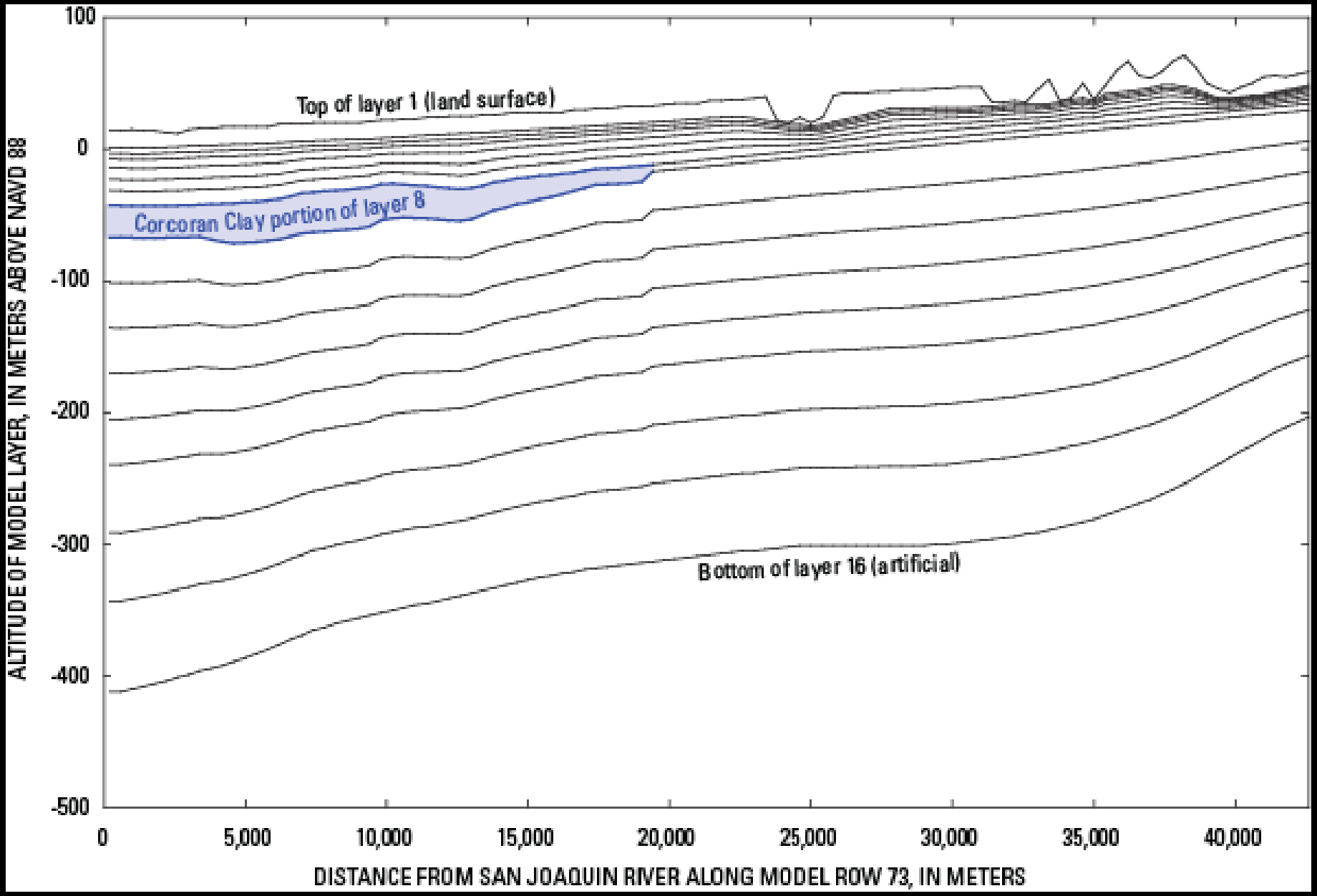
Model Area

¼-mile grid spacing

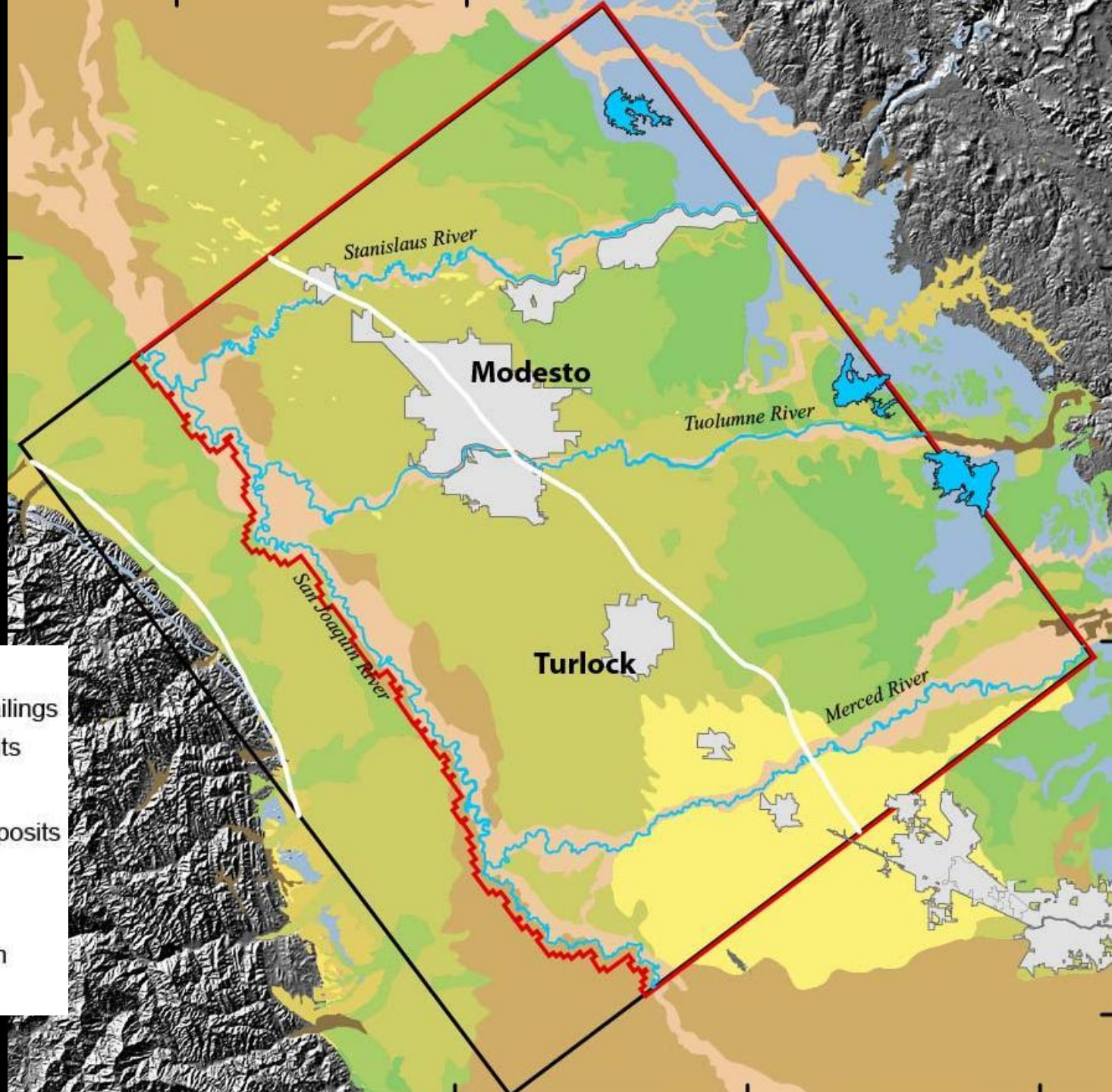
16 layers



Model Layers



Local Geology



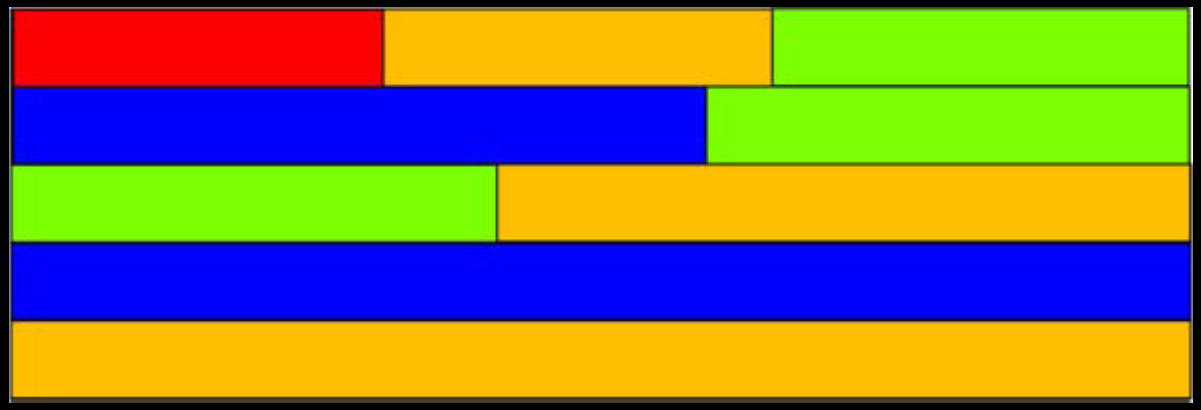
- Dunes
- Alluvium and dredge tailings
- Stream channel deposits
- Flood-basin deposits
- Non-marine terrace deposits
- Modesto Formation
- Riverbank Formation
- Turlock Lake Formation
- Mehrten Formation

Incorporation of Geology into the Model

- Used sediment texture data from over 3,500 boreholes
- Estimated hydraulic conductivity for every model cell on basis of sediment texture

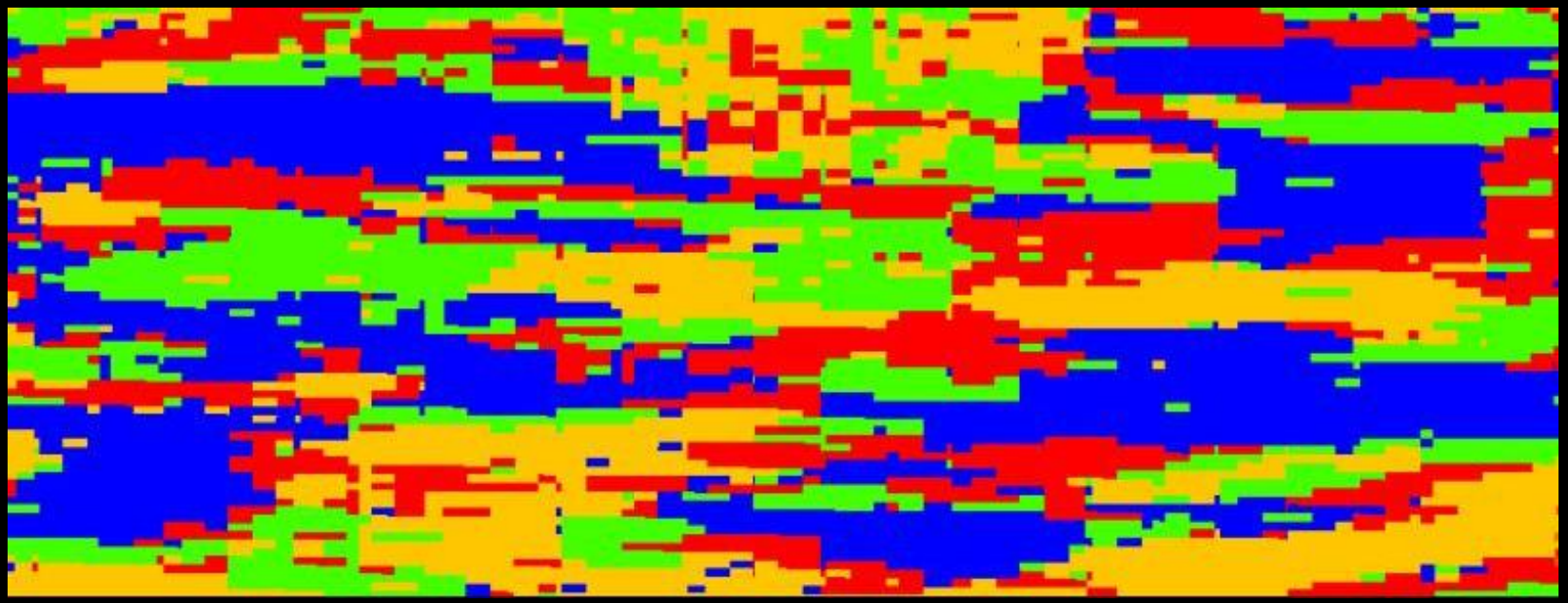
Accounting for the Influence of Geology on Ground-Water Flow

Typical “layer-cake” model construction



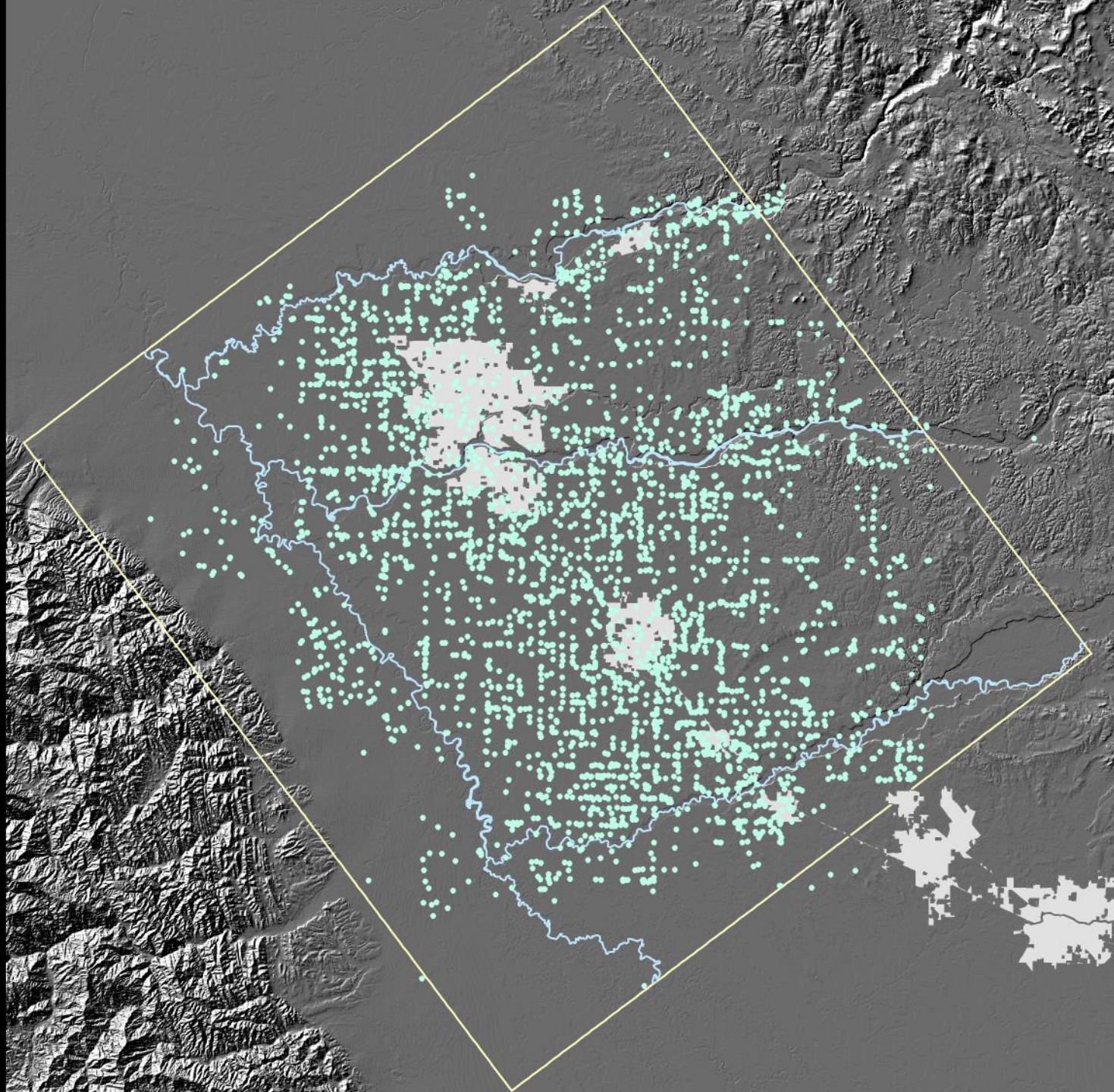
- Flow is strongly controlled by modeler’s layering scheme
- Solute transport highly dependent on assigned dispersion

More realistic model construction

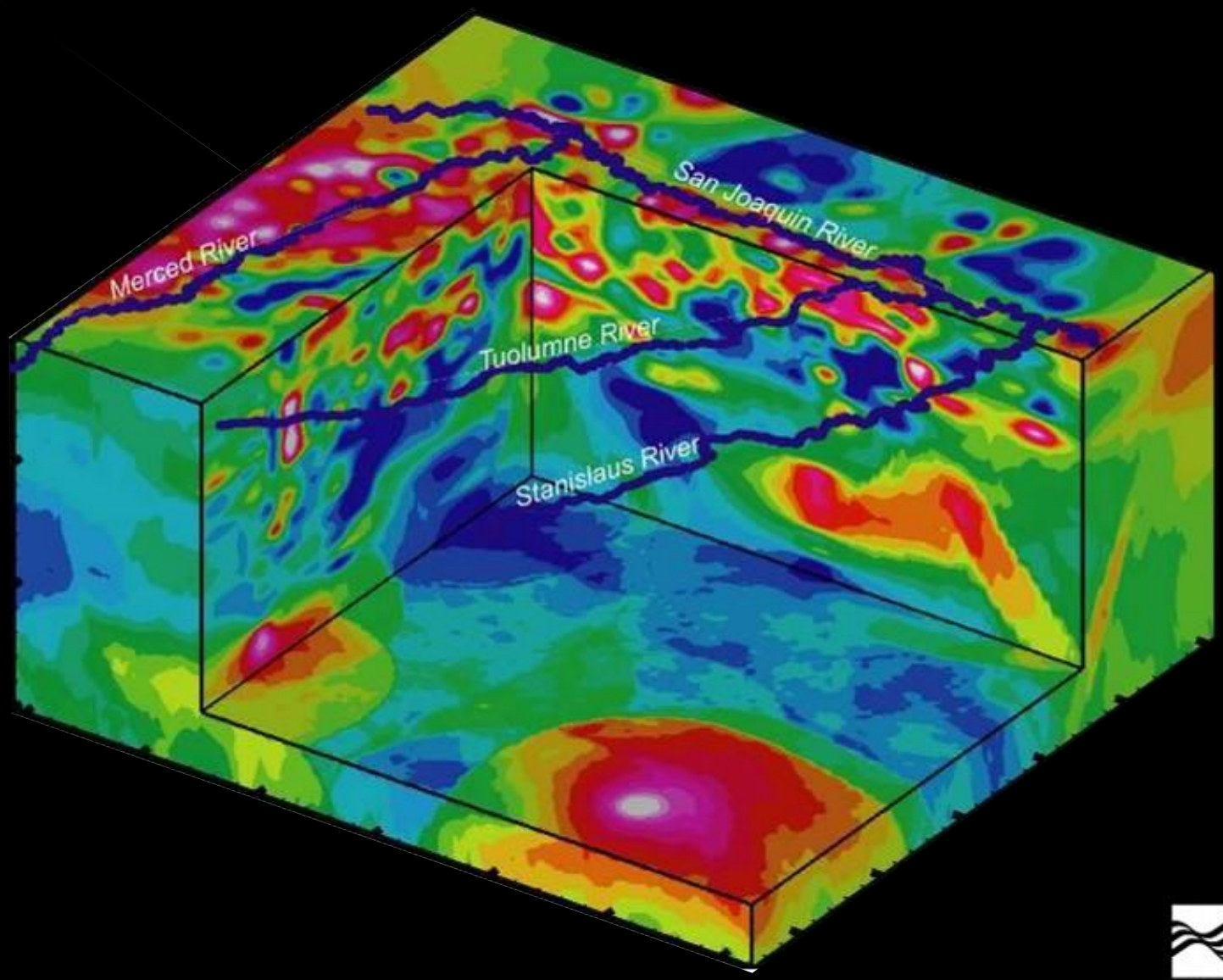


- Flow is not strongly controlled by modeler's decisions
- Solute transport not as dependent on assigned dispersion

Locations of 3,500 drillers' logs



3-Dimensional Realization of Sediment Texture



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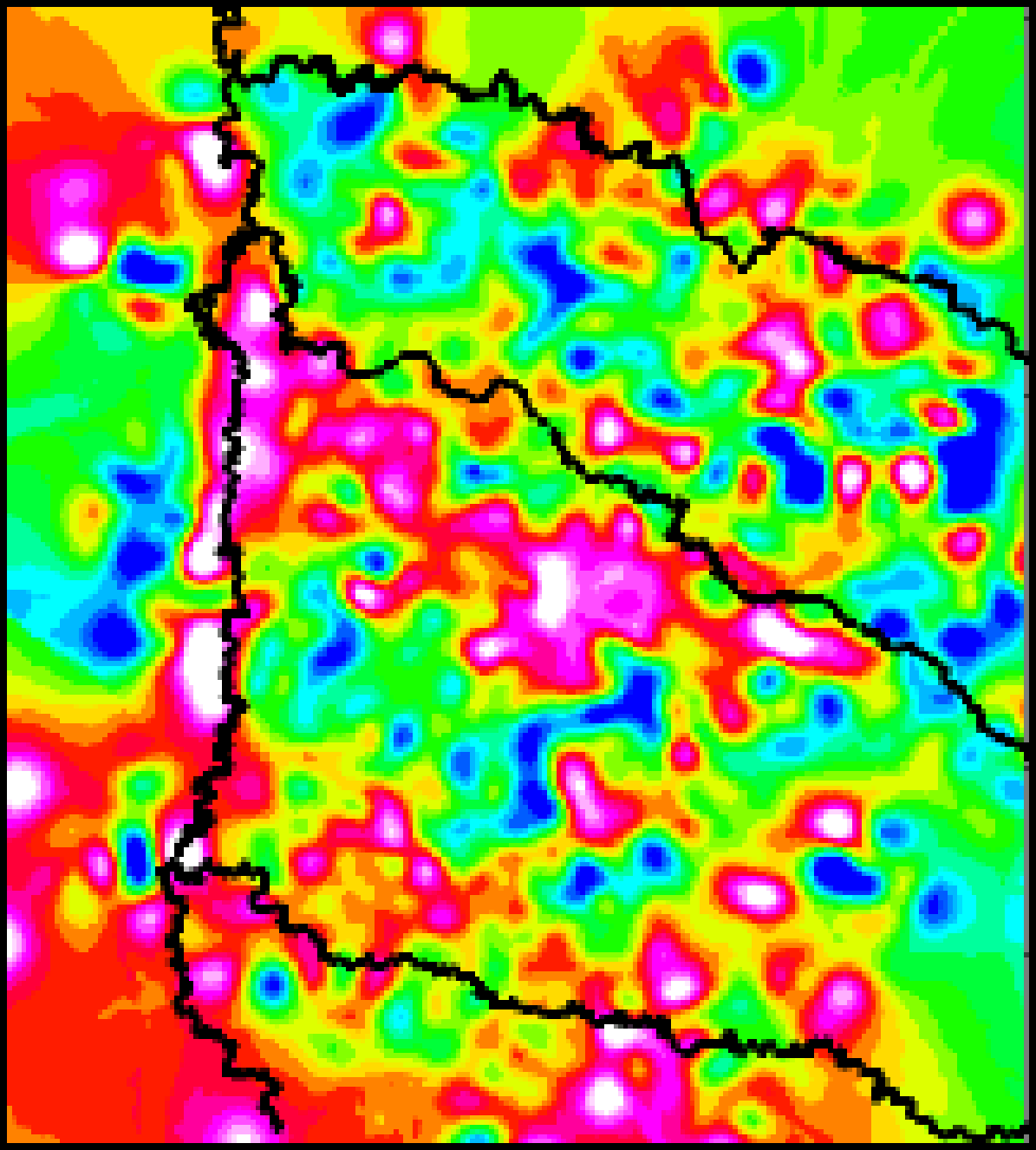
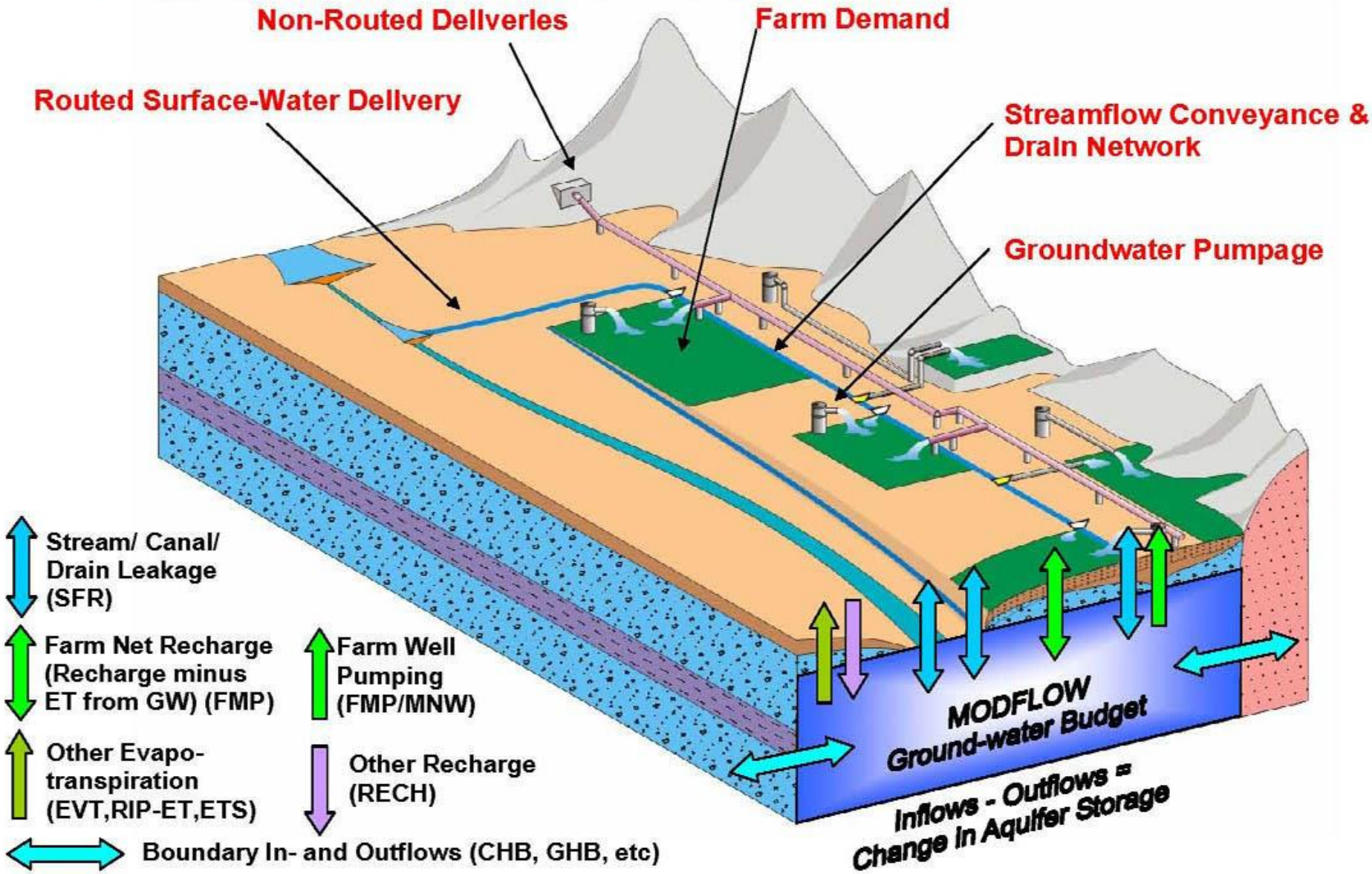
Sediment texture at 25 meter (~80 ft) depth



The water budget is dominated by agricultural use → using the Farm Process in MODFLOW

Current Features of FMP

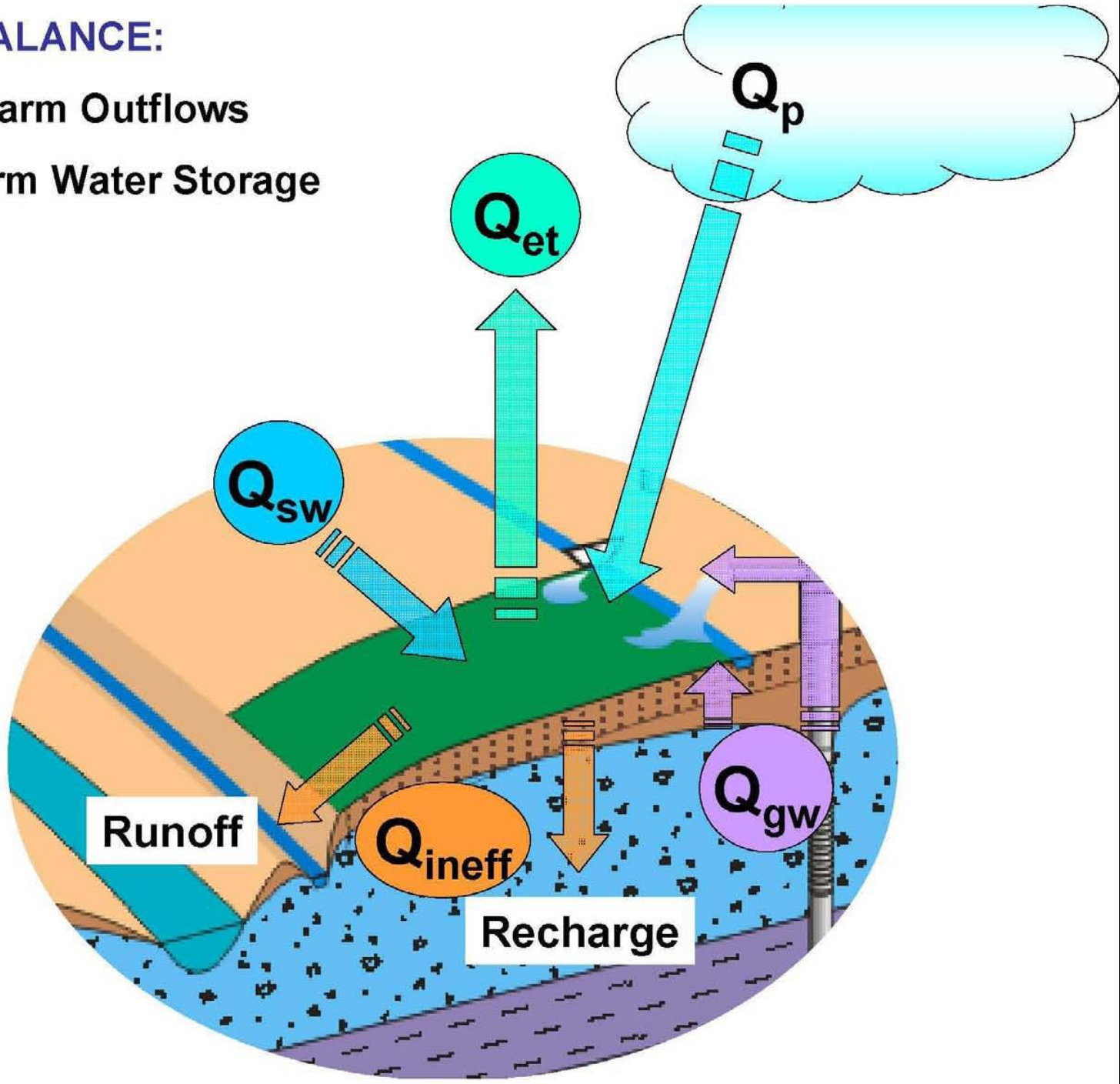
Demand & Supply and Mass Balances



FARM MASS BALANCE:

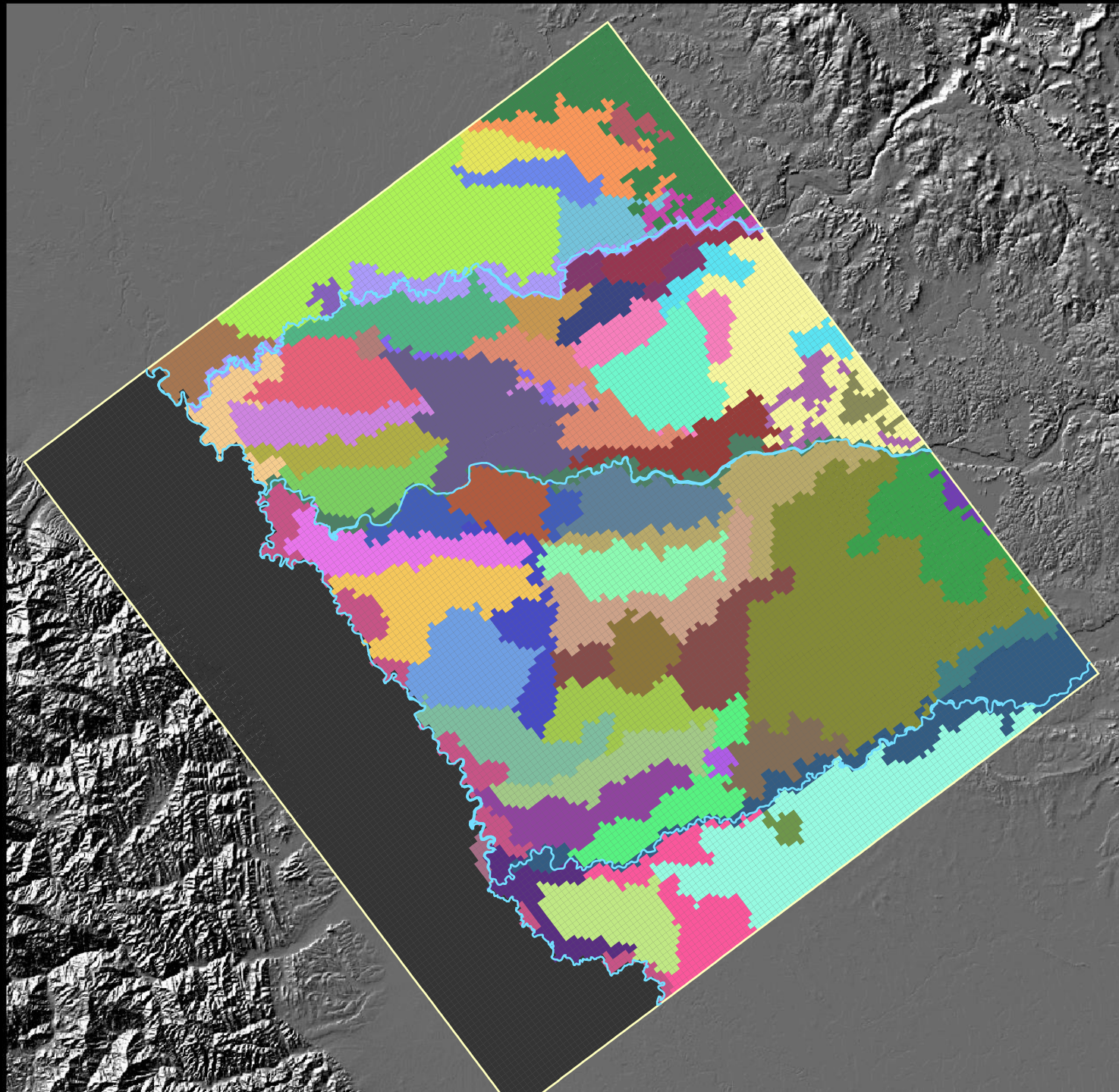
Farm Inflow – Farm Outflows

= Change in Farm Water Storage



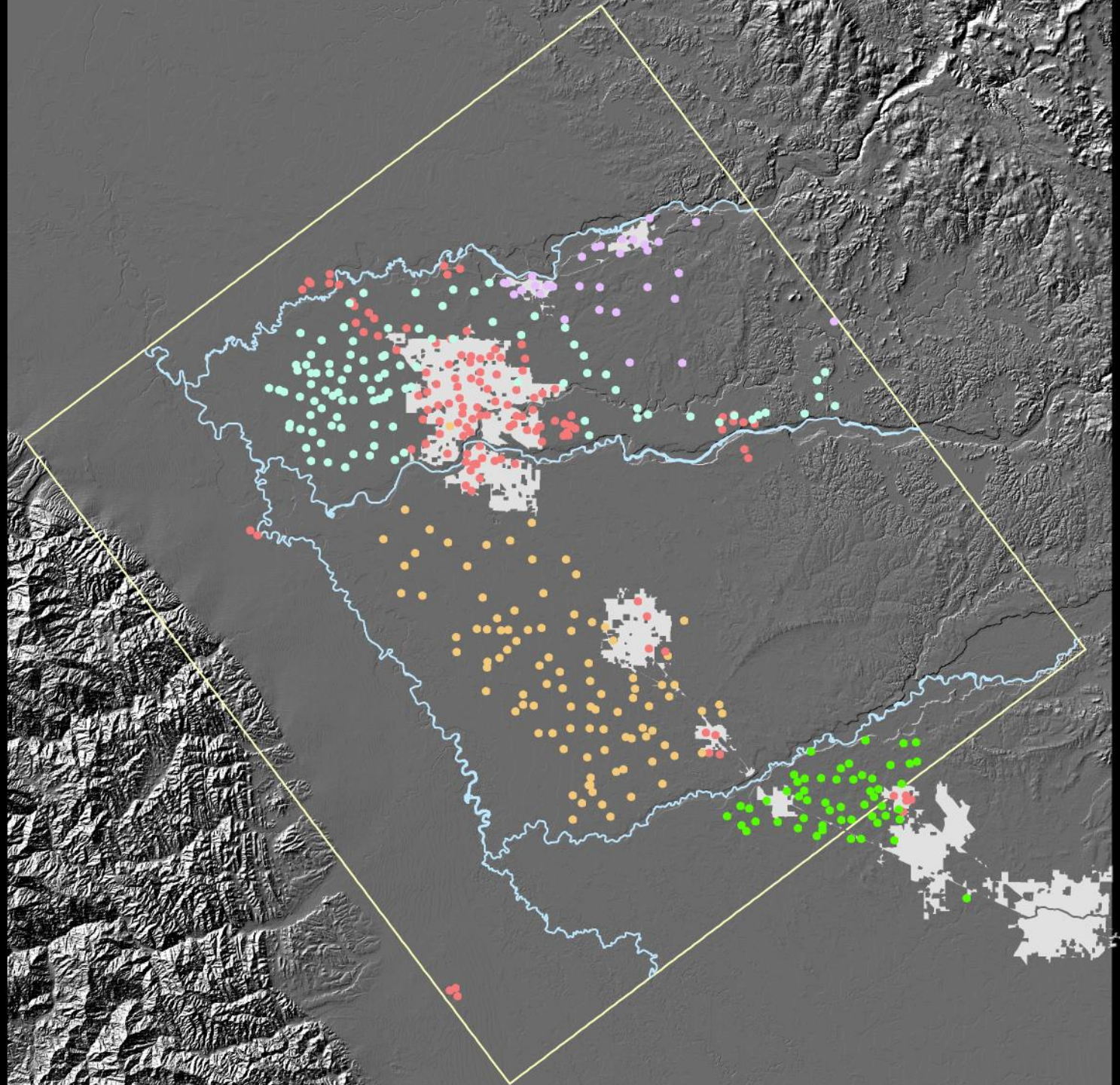
Designation of water budget areas

Based primarily on known water deliveries



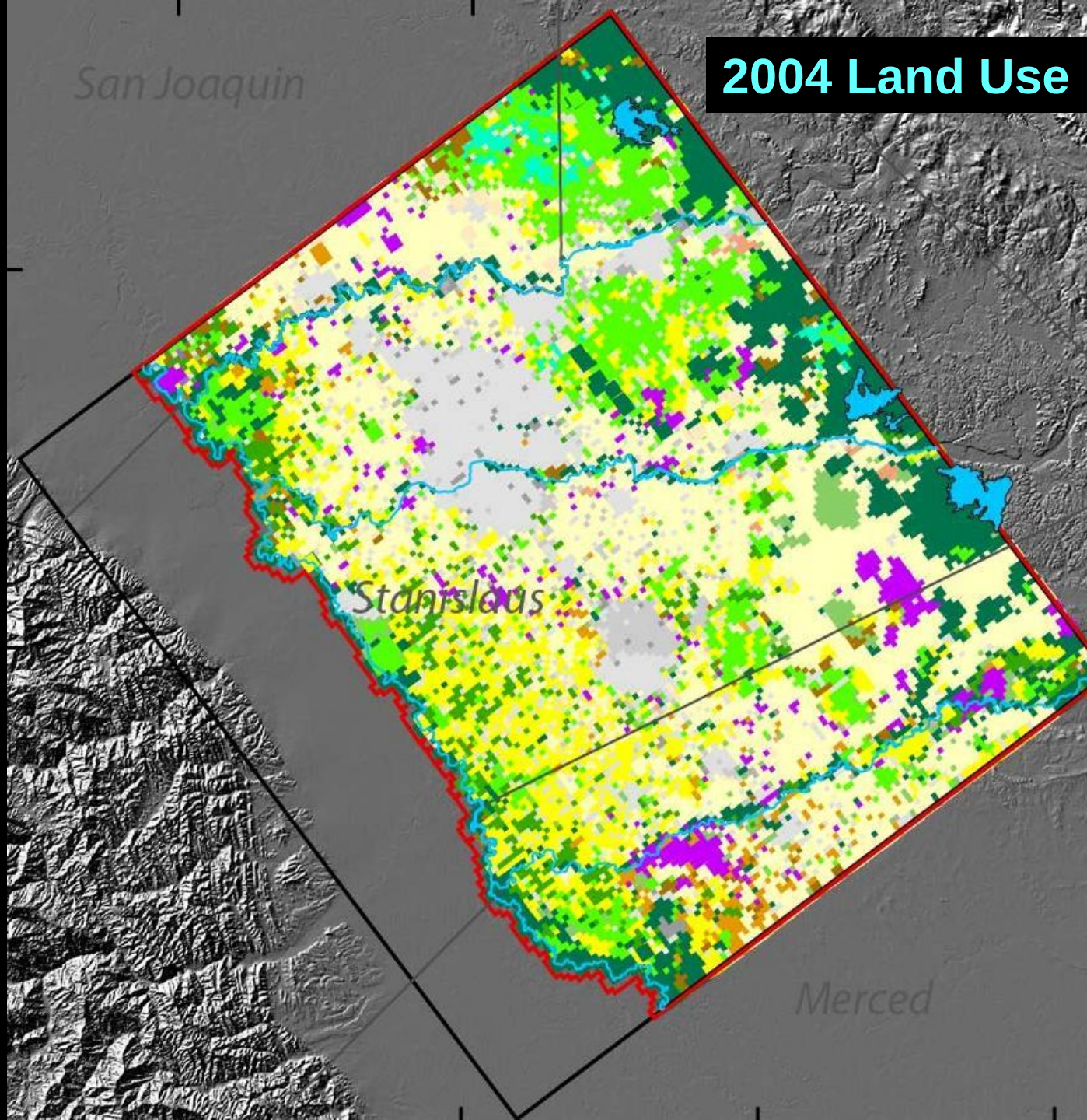
Wells with known pumpage (urban, drainage, and some ag.)

→ Farm Process estimates private irrigation pumpage

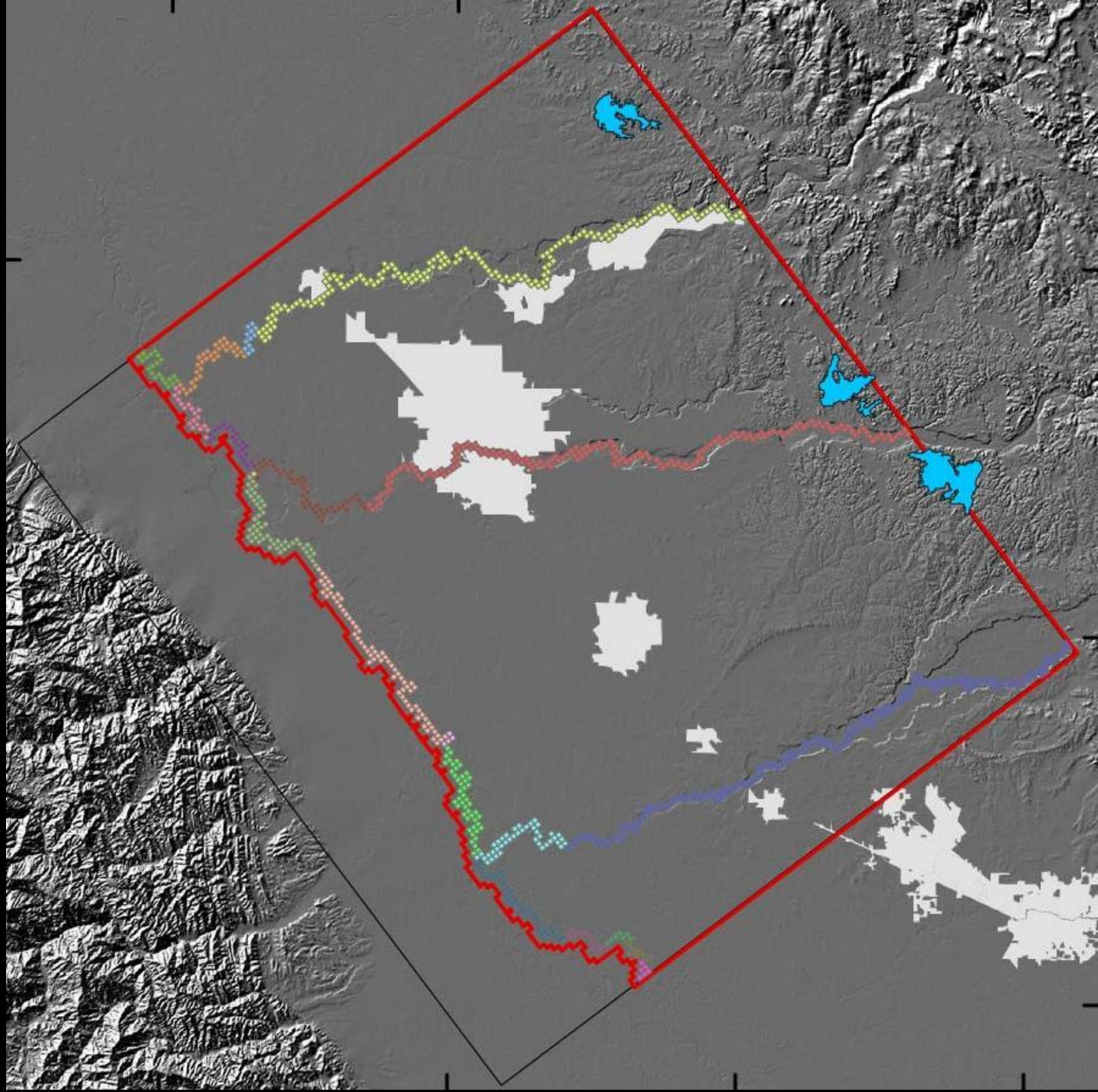


Farm Process input includes:

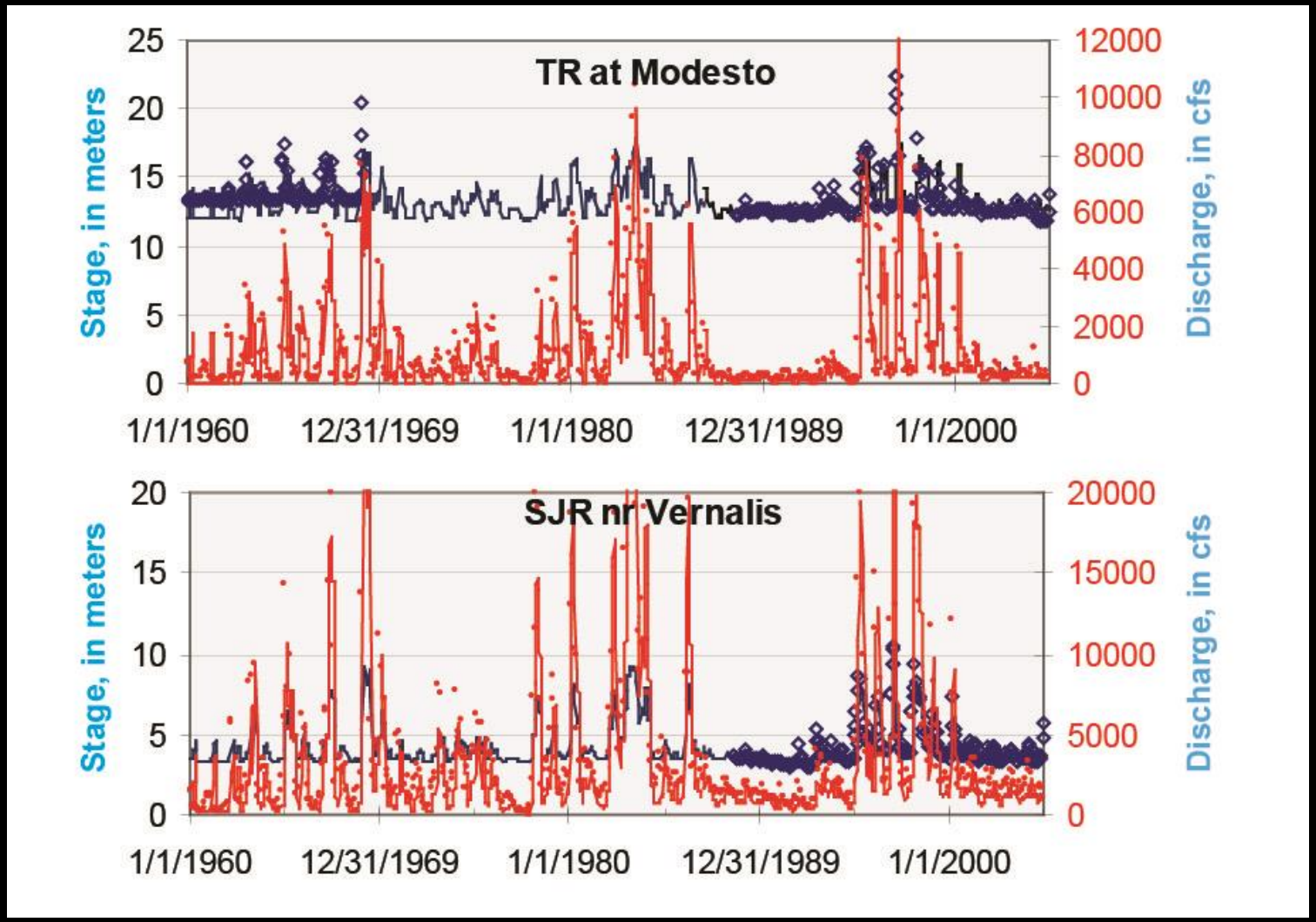
- Land use
- Precip
- ETo
- Kc
- Root depths
- Soil type
- % runoff
- and more



Simulation of rivers & stream-aquifer interaction



Calibration to streamflow

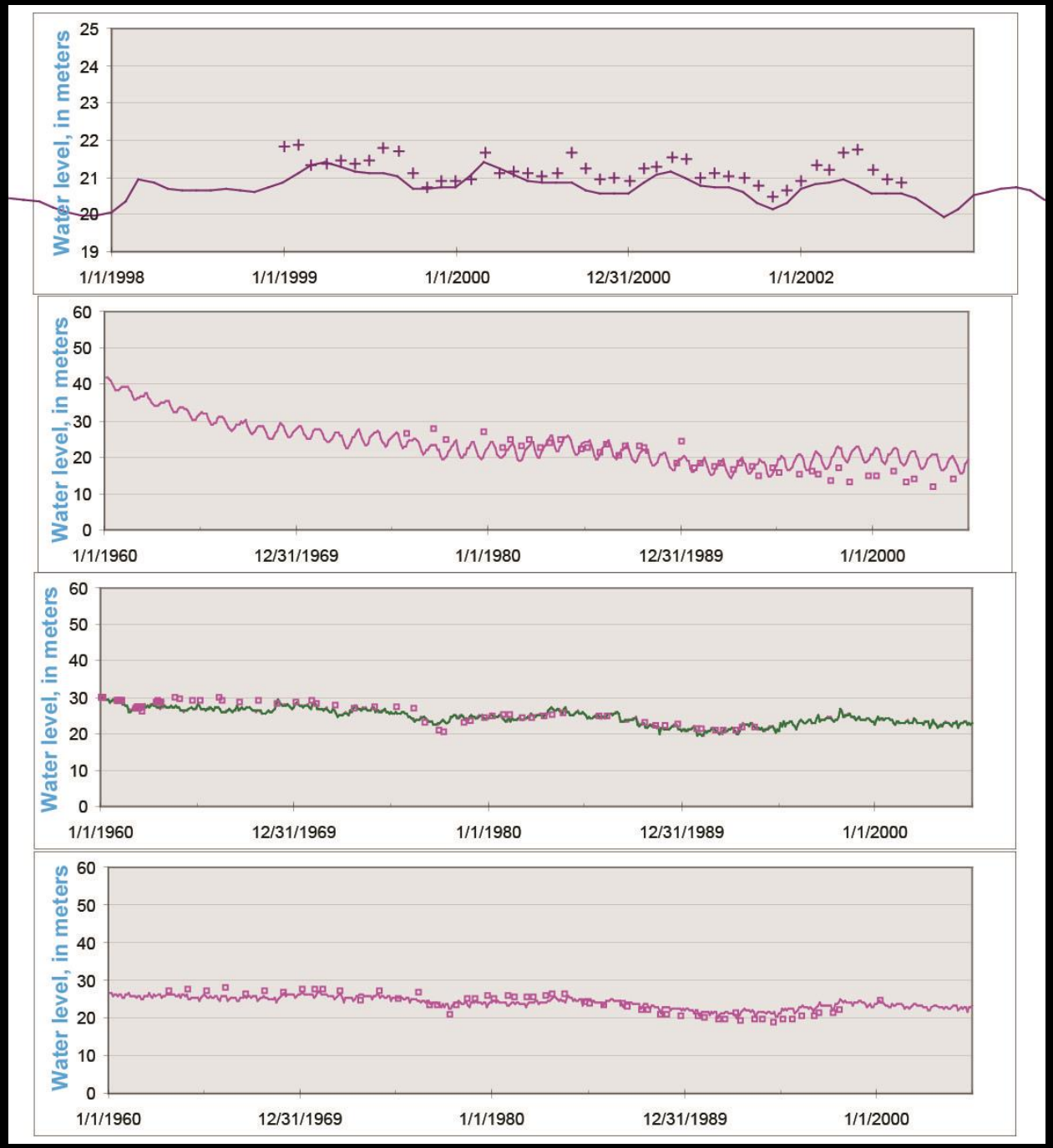


TID, shallow well

Eastside WD, deep well

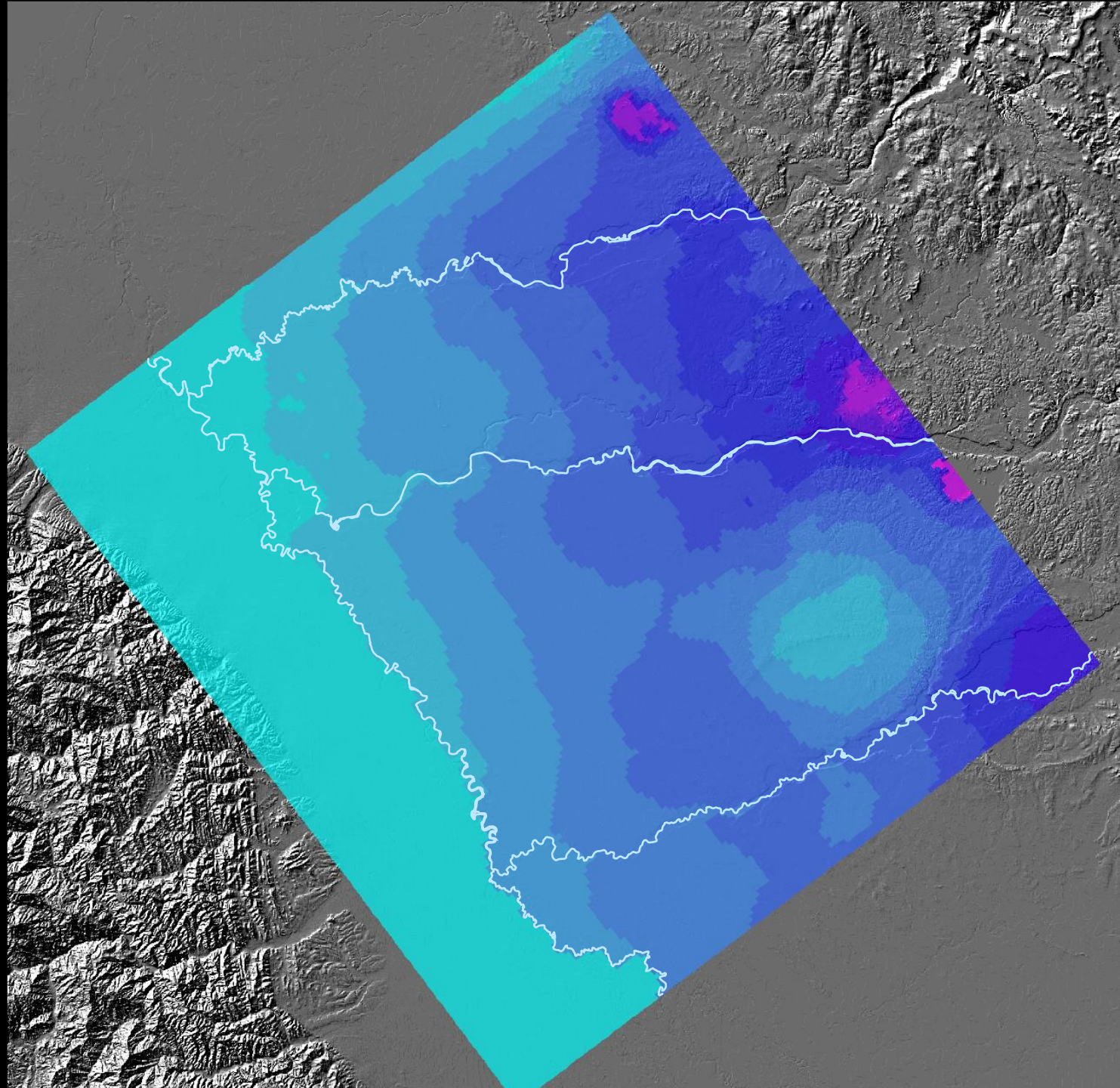
OID, deep well

MID, deep well



Model Output:

Simulated water levels, 5m (~15 ft) interval, year 2000



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Next Steps

- Model documentation report – publication target is Sept 30, 2014
- Potential applications of the model
  - Evaluation of water management options
  - Groundwater/surface-water interactions
  - Effects of recent development in upslope areas [will require updating the model]
  - Potential effects of drought & climate change
  - etc.

Thank You!

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