Butte Basin Groundwater Model: Using IWFM/IDC for Water Budget Development & Exploring Growth and Climate Change

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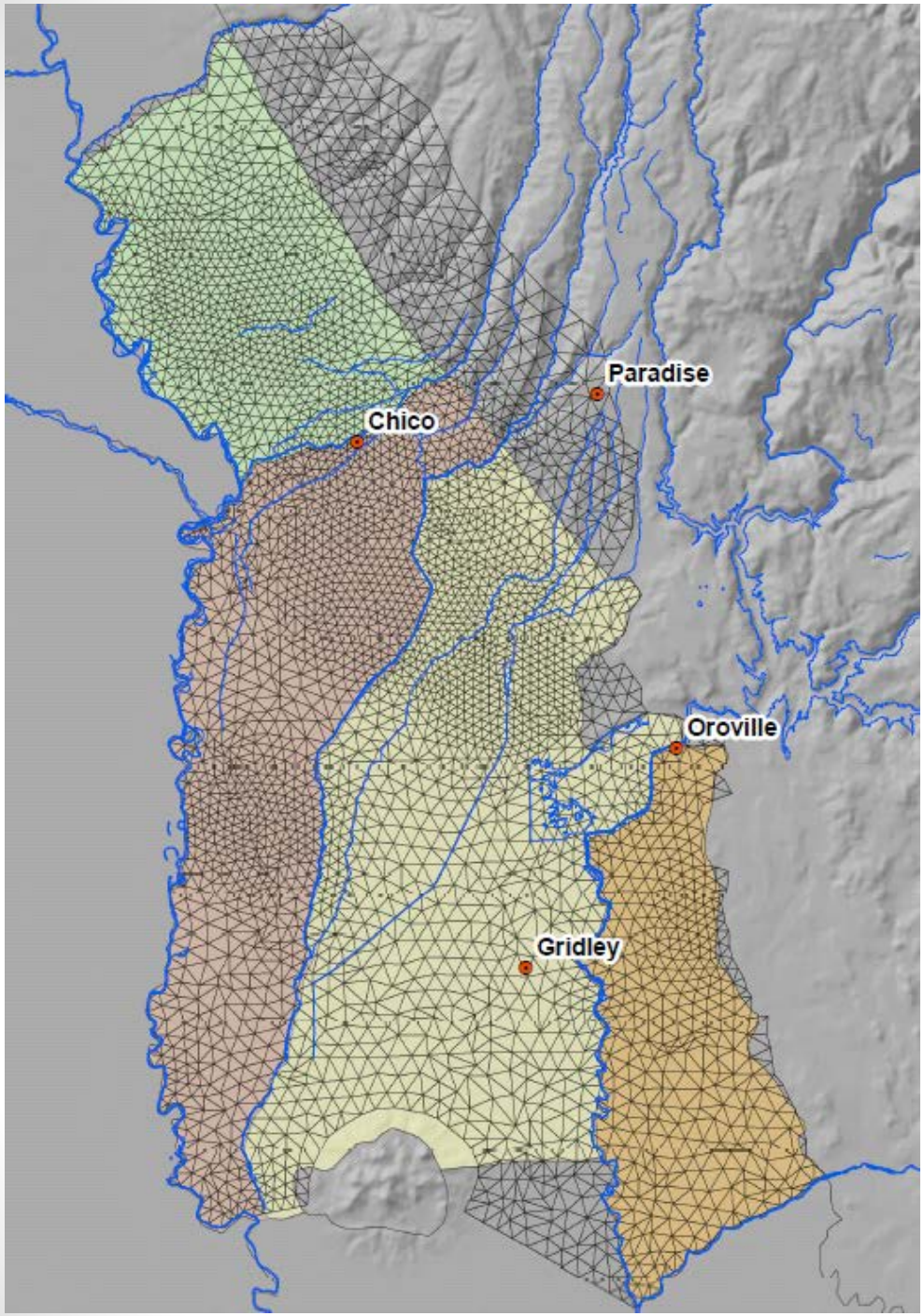
IWFM/IDC Users Group Meeting

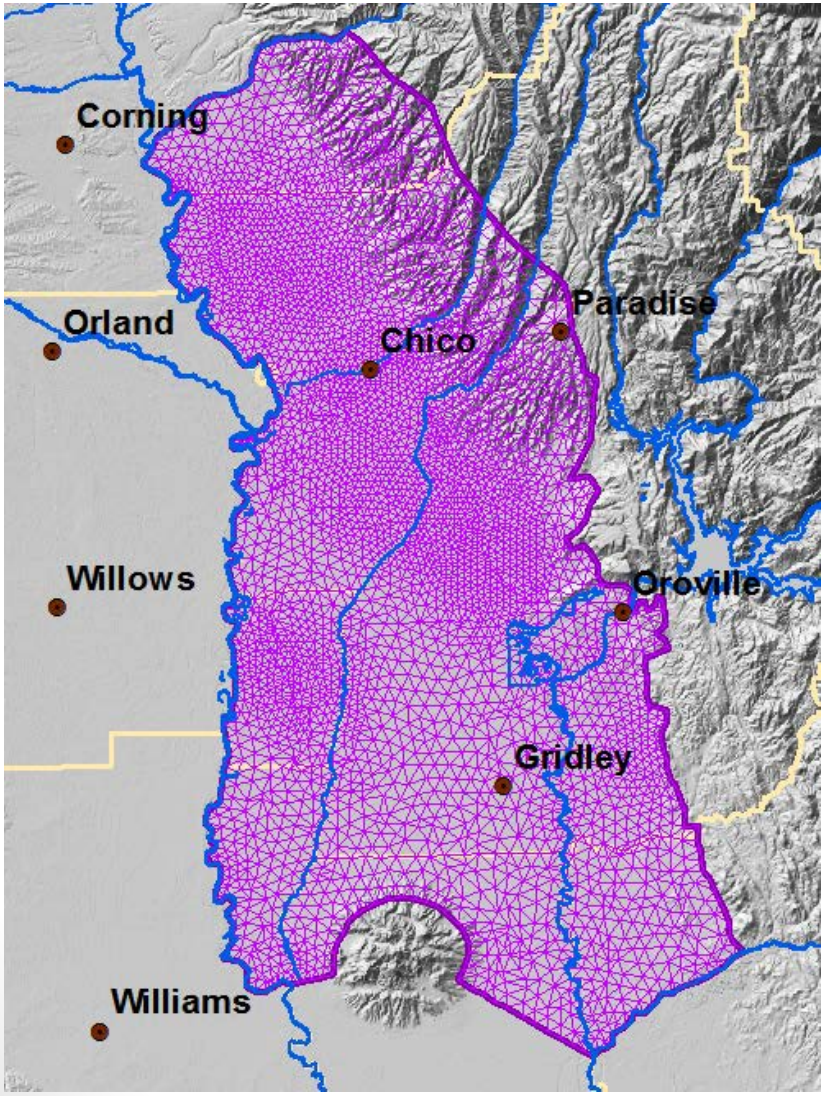
December 1, 2015



Model Domain

- 1,265 square miles
- Node spacing: 2,500-5,000 feet
- 7200+ elements 15-670 acres (average 112 acres)
- Boundaries:
  - Deer Creek,
  - Sacramento River,
  - North side of Sutter Buttes/Yuba River
  - Eastern foothills

Original Objectives

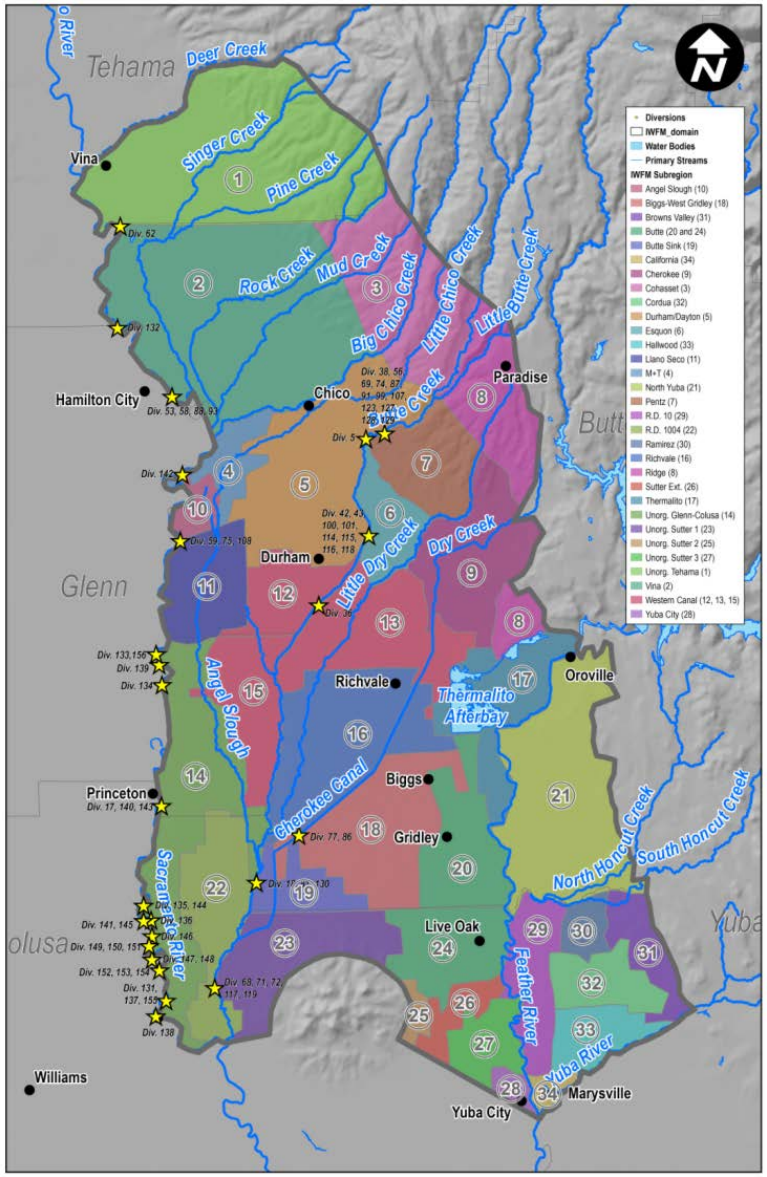


1. To assess the groundwater resources of Butte Basin
2. To develop a quantitative hydrologic understanding of the groundwater system
3. To construct a tool for evaluating regional hydrologic impacts on the groundwater system of alternative water policy decisions

- Developed a comprehensive database of groundwater resources of Butte Basin

(HCI Final Report 1996)

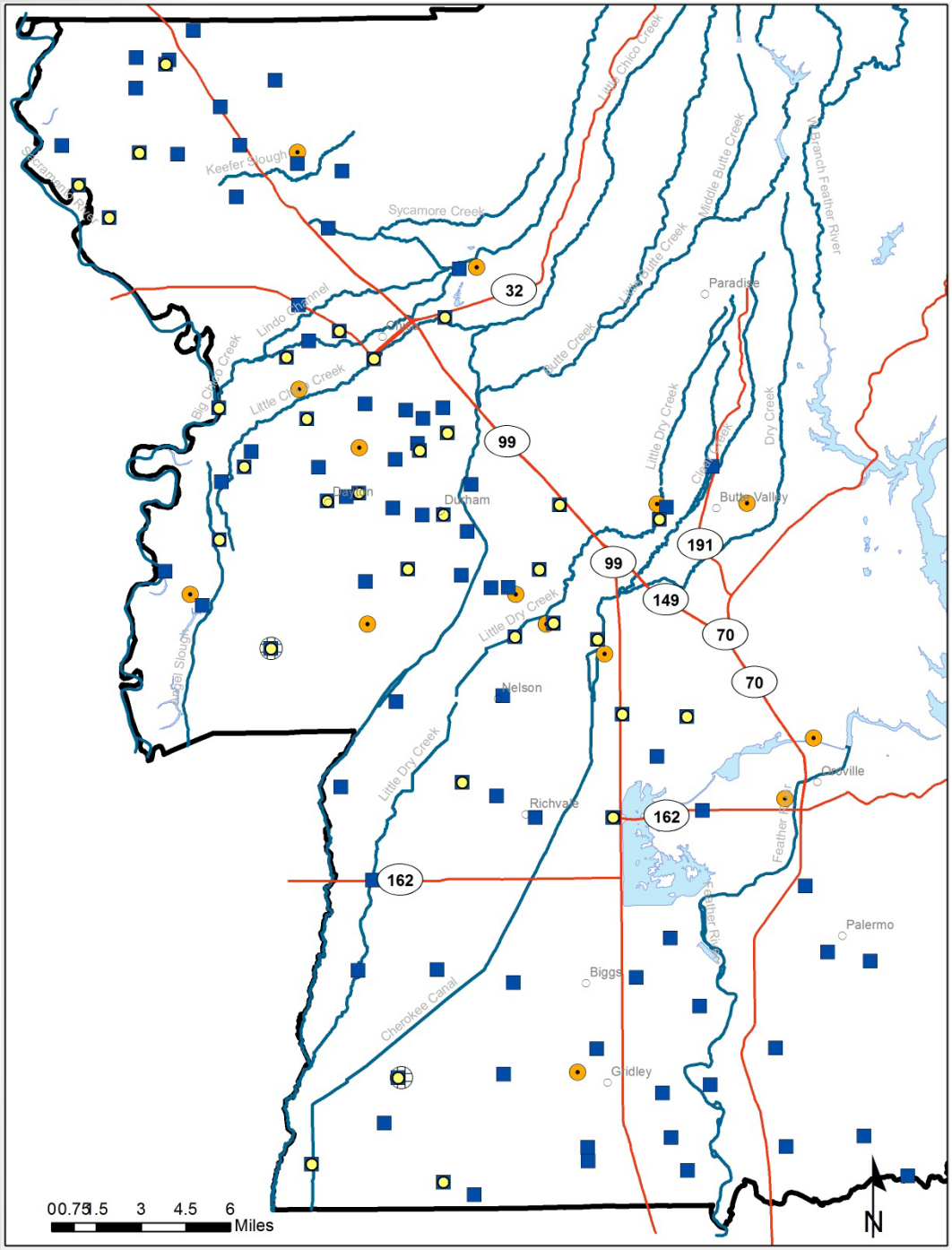
Desired Applications



Evaluate:

- Water transfer applications under Chapter 33 of Butte County Code
- Recharge project benefits and impacts
- * Project feasibility evaluations
- * Water supply/demand & water budgets by subregion
- Potential regional impacts of droughts
  - *changes in surface water availability
- * Climate change affects and system vulnerability
- * Effects of changing future ag/urban demands

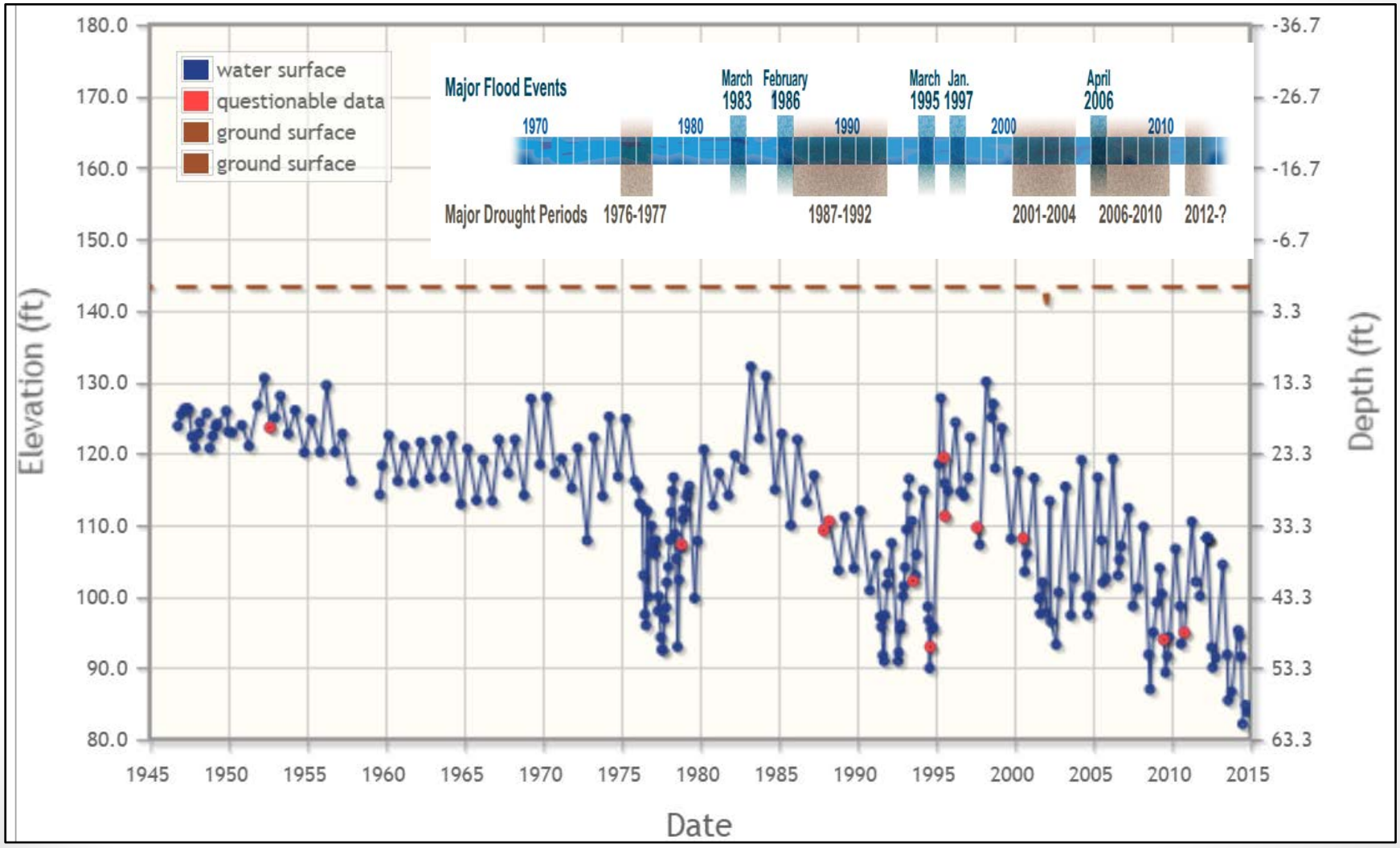
* Been done or currently underway

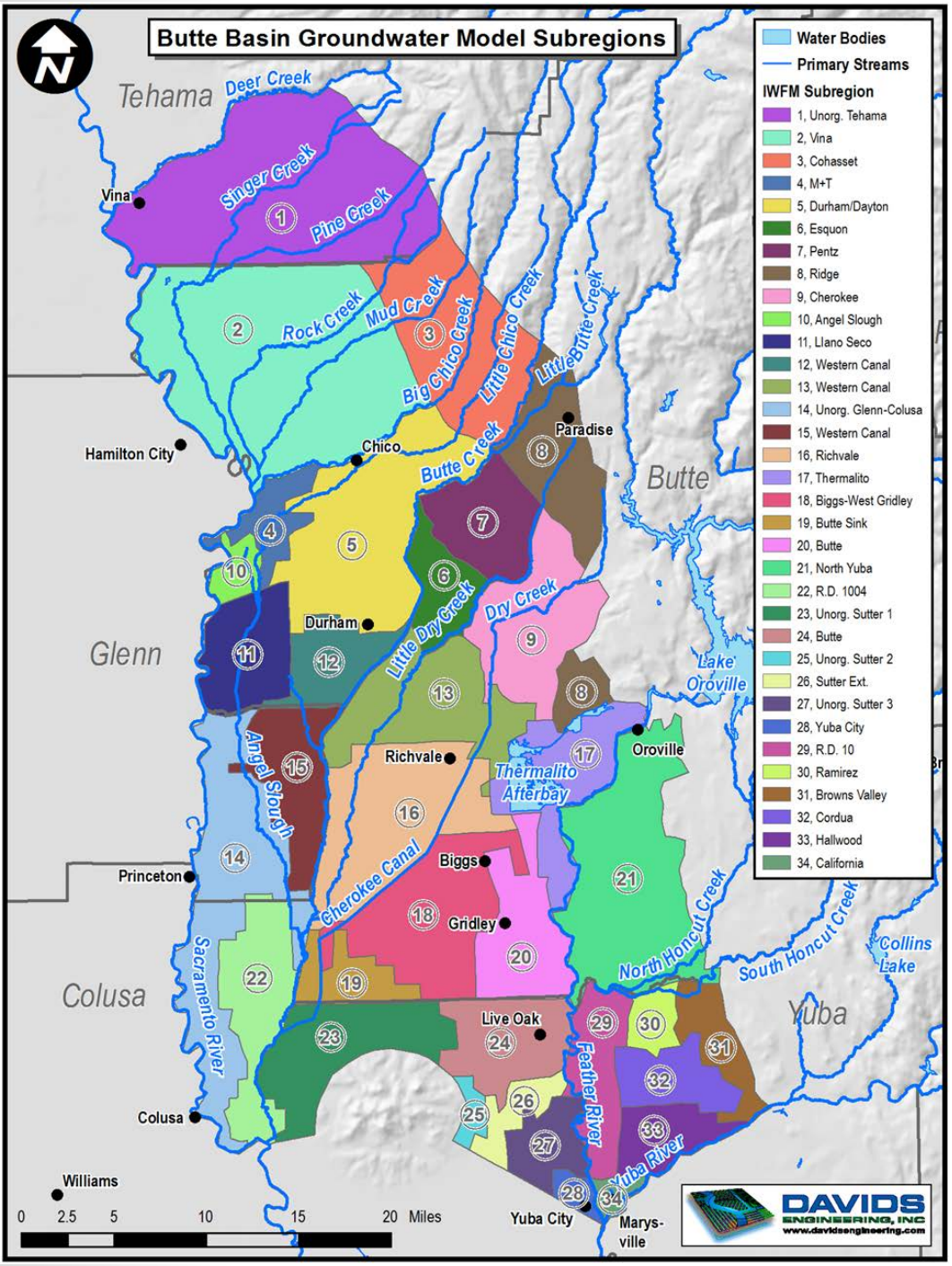


Groundwater Level Monitoring

- 125+ wells
- Manually 4x/year: Mar, Jul, Aug, Oct
- Hourly data (59 wells)
- Data available online

Groundwater Level Trends





Water Budget & Model Update

- Develop water budgets for each sub-region to inform the local conversation on resource use and sustainability

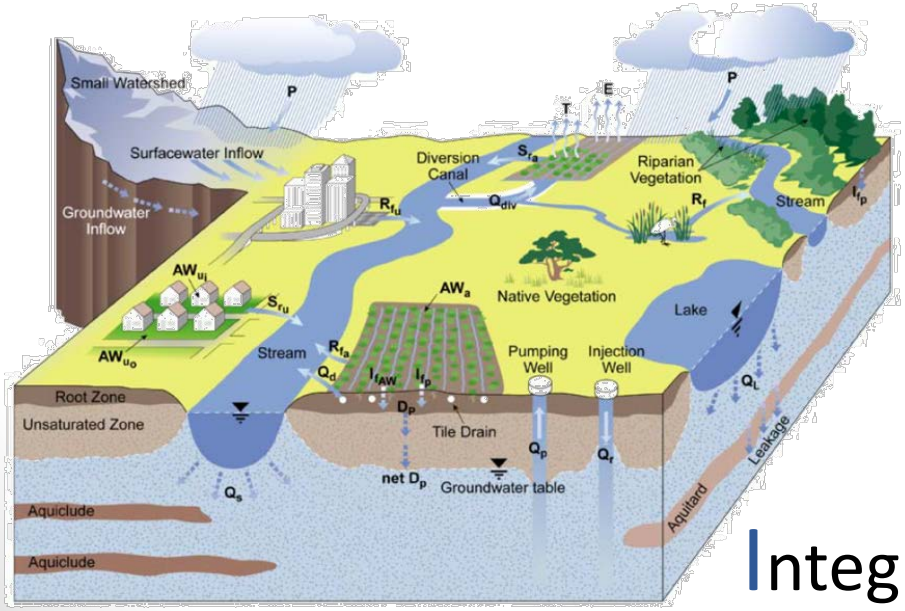
→Helpful for SGMA efforts

→Drought Response

- Develop forecast scenarios for urban/ag demands and climate change hydrology scenarios

Butte Basin Groundwater Model (BBGM)

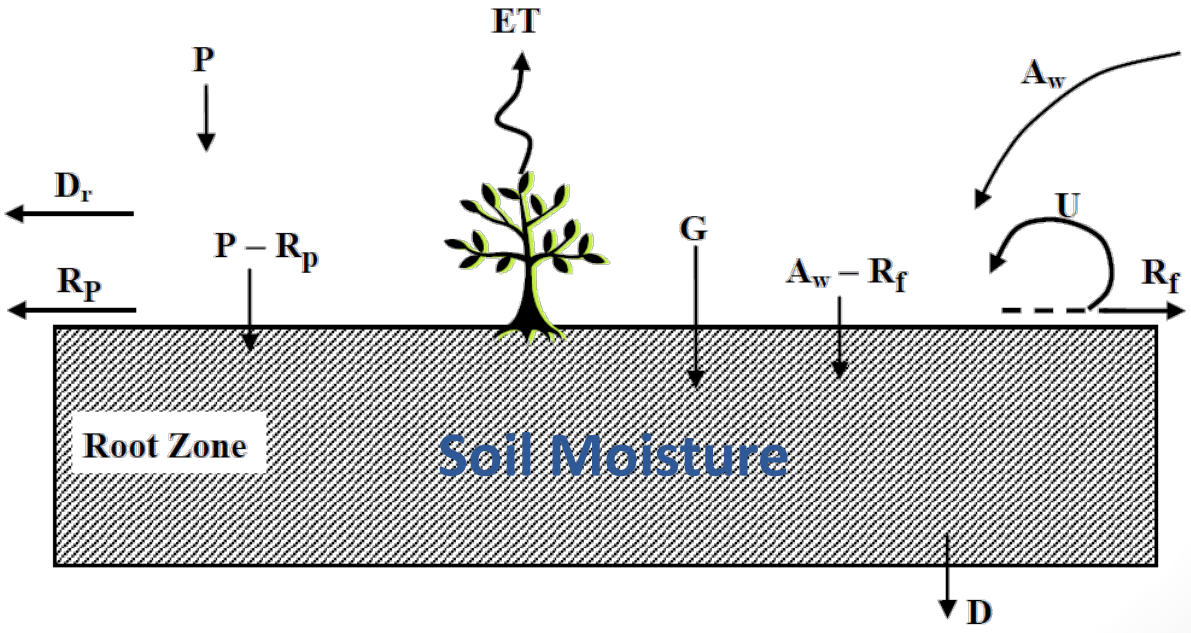
- Migrate the model from IWFM v.2.4.1
- IWFM-2015 application
- Rootzone v. 4.0 to calculate ag/urban demands
- Extend the time series to 2014 from 1970-1999
- Daily time step - some input is monthly/annual



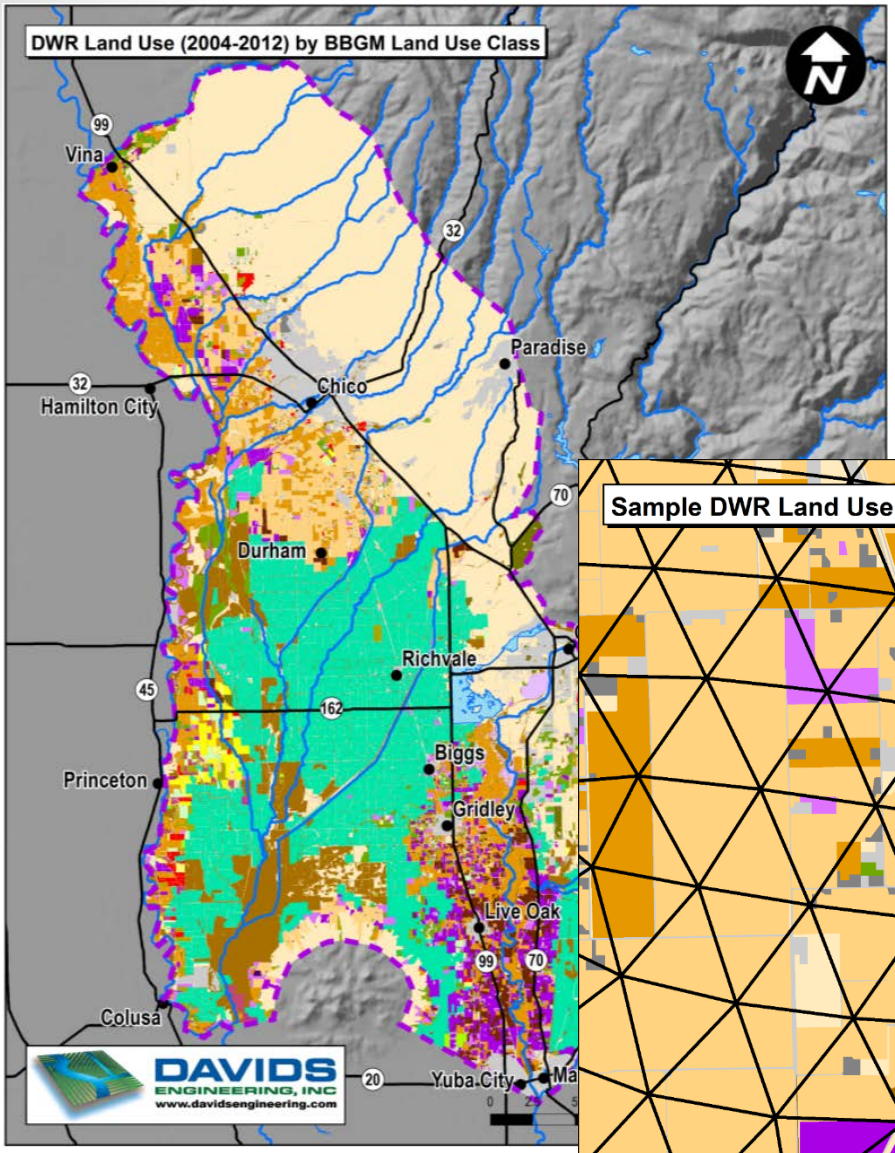
Integrated Water Flow Model

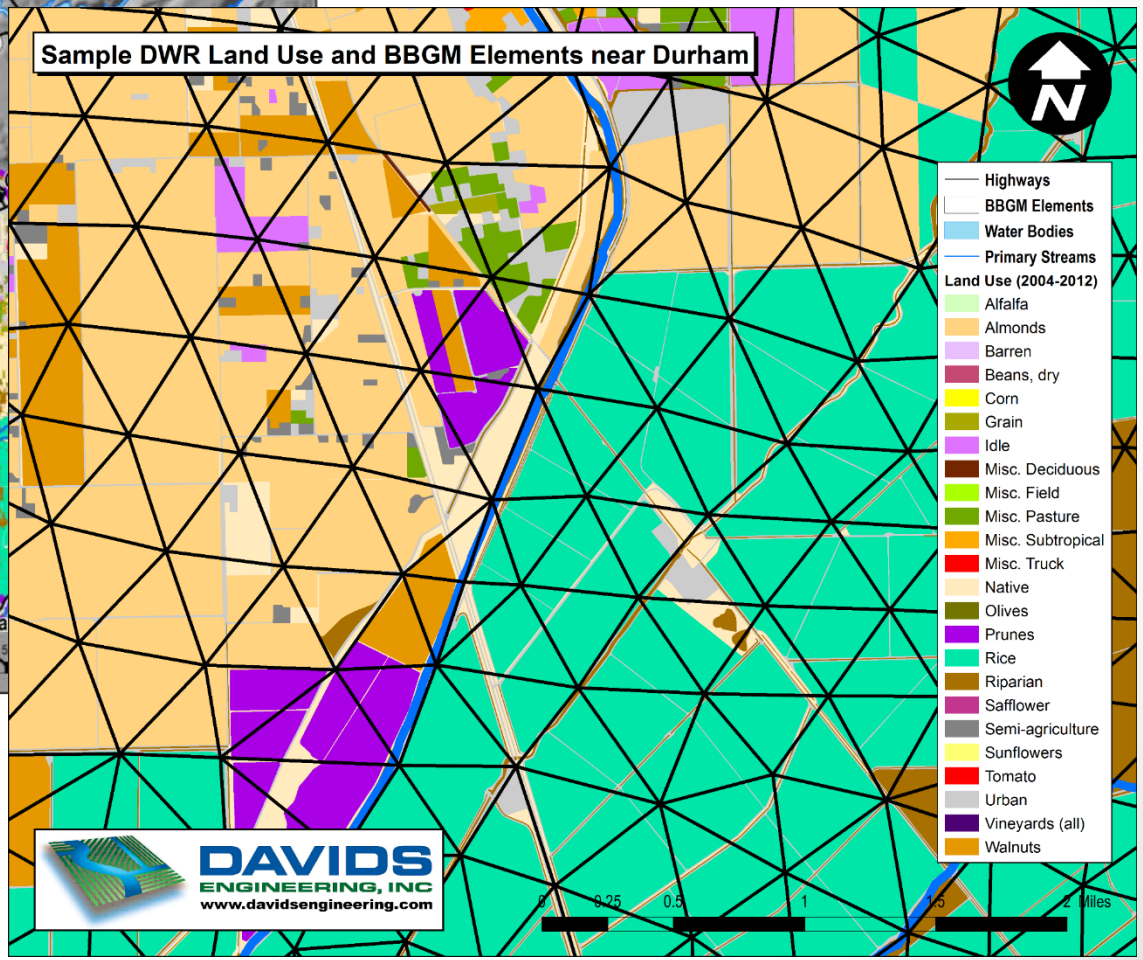
IWFM Version Migration to 4.0

- Uses demand calculator (IDC v. 4.0) to estimate crop water demand and therefore groundwater pumping
- Elemental scale land use vs. sub-regional scale



Elemental Land use



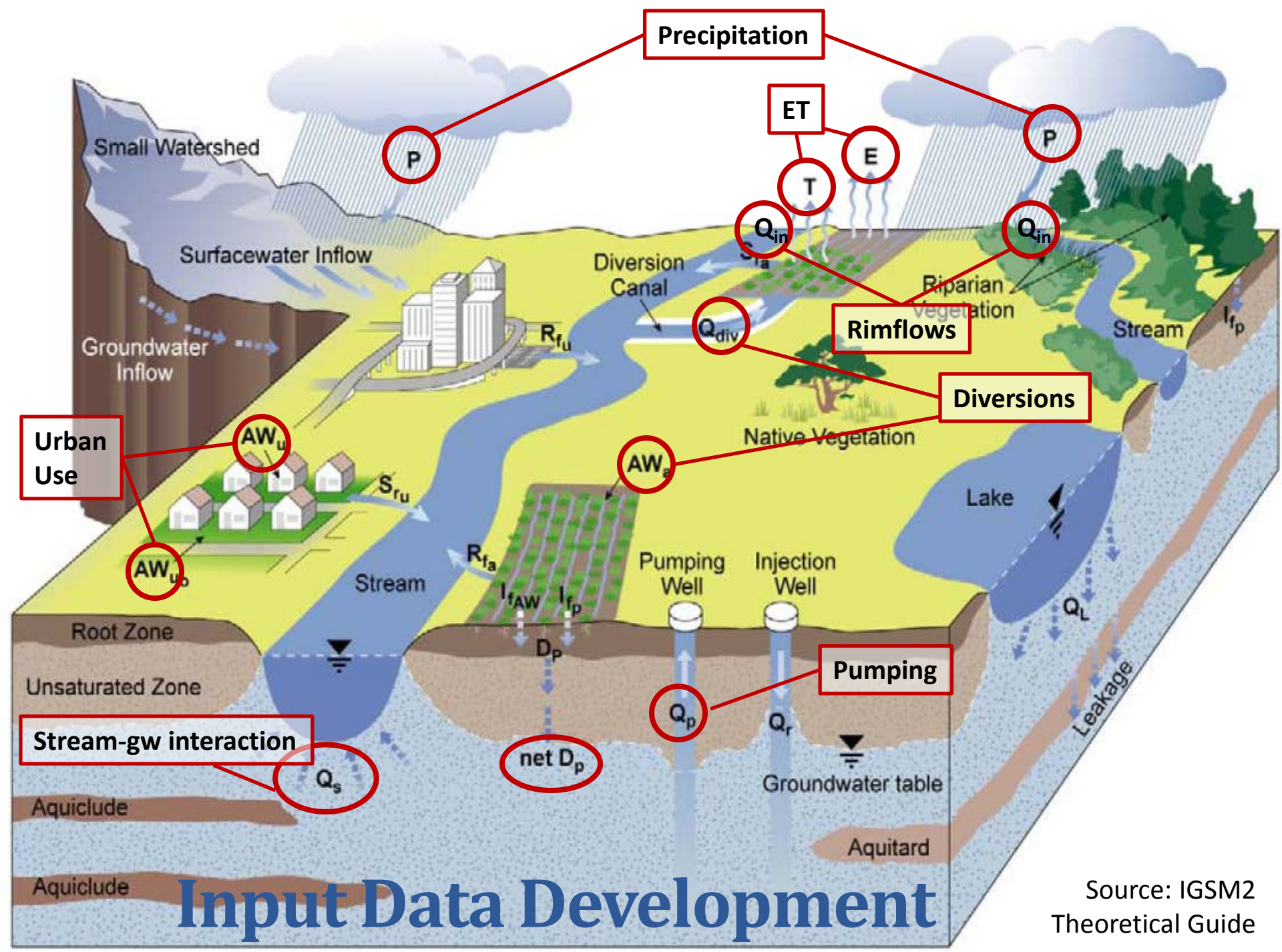


IWFM Version Migration cont.

- Ponded vs. non-ponded crops

Extending the Input Data

- Review available information describing prior methodologies
- Review existing model input and output files
- Try to avoid major changes for 1999 – 2012 update relative to existing datasets → Adopt prior methodology where reasonable
- Develop new methodology where advantageous
- Update historical (pre-1999) datasets in some cases

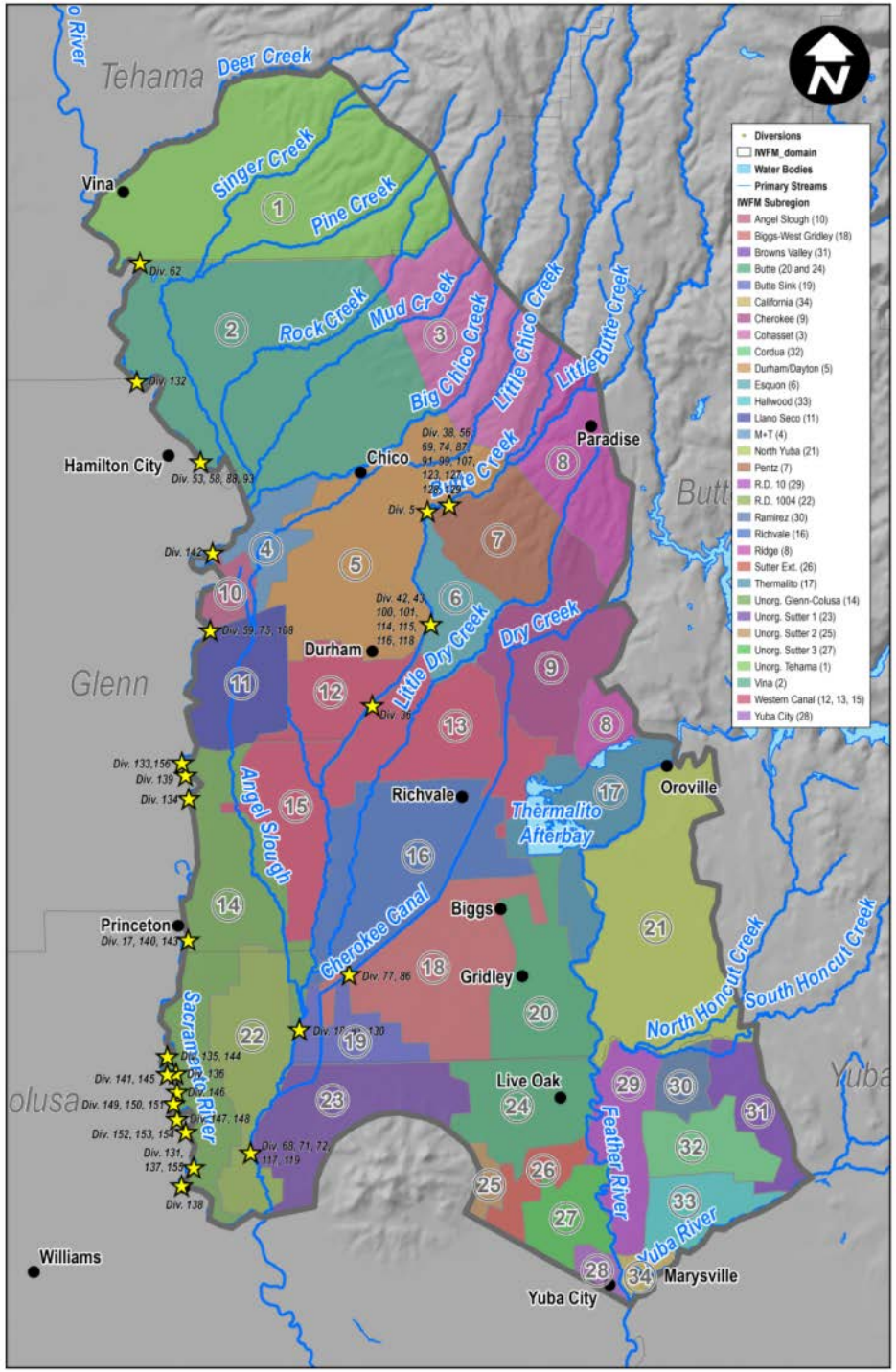


Input Data Development

Source: IGSM2 Theoretical Guide

Diversions

- 67 Diversion stream nodes
- Sources
  - Actual diversions
  - Water master field schedules
  - Correlation to streamflows
  - Estimated demands
- Ground truth with locals and water managers
- Timing issue



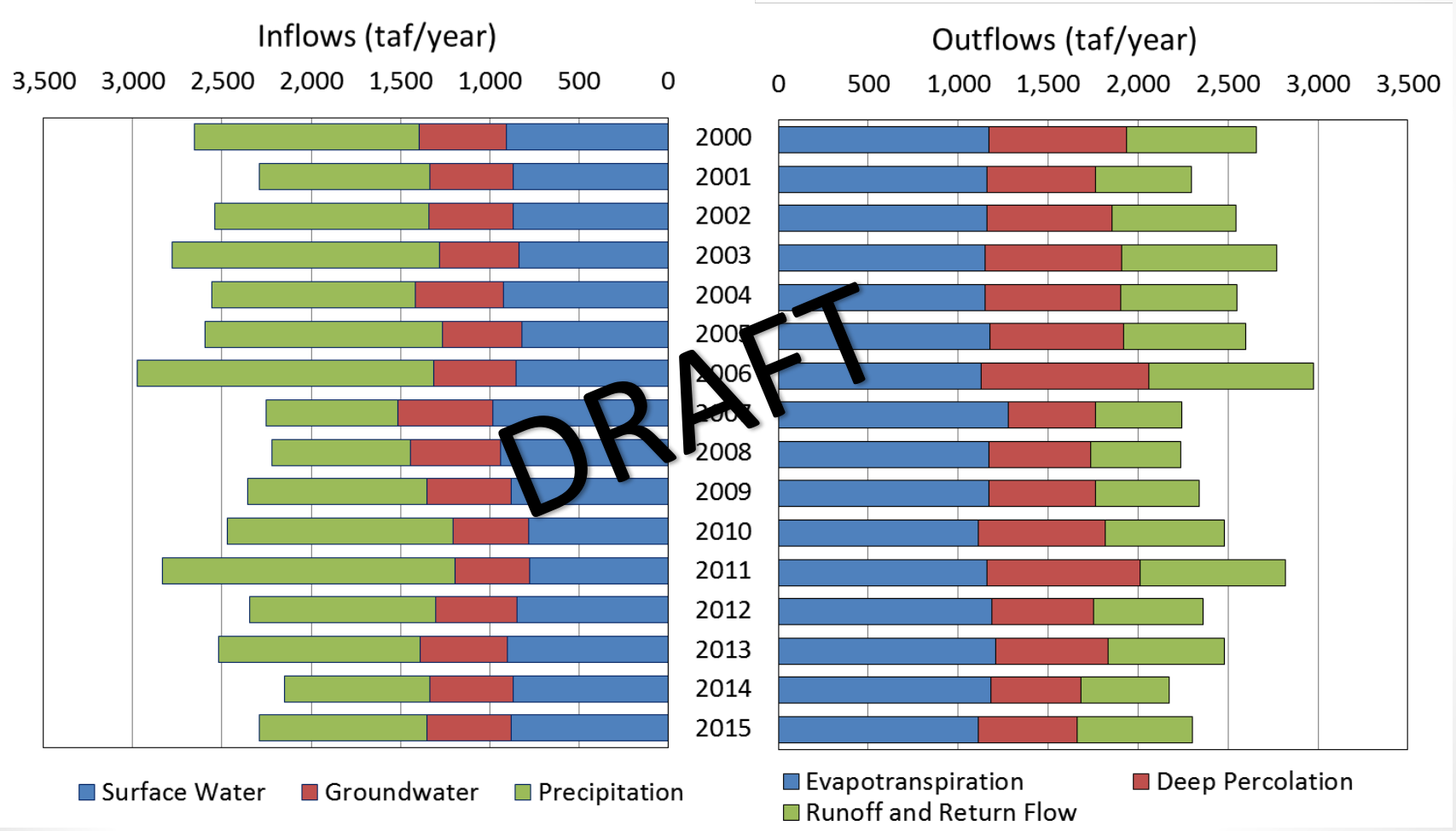
Refinements

- Incorporate increased water demand by almonds due to planting density → incremental increase in Almond ET
- Changing irrigation practices → Adjust target soil moisture fraction over time to increase irrigation efficiency from 70% in 1970s to 85% in 2010s
- Laser leveling rice fields has decreased water demand → adjust ponding depth inputs
- Less rice straw burning, more flooding → shift acreage from rice non-decomp land use to flooded decomp

Potential Future Refinements

- Rural residential groundwater use
- Frost protection pumping

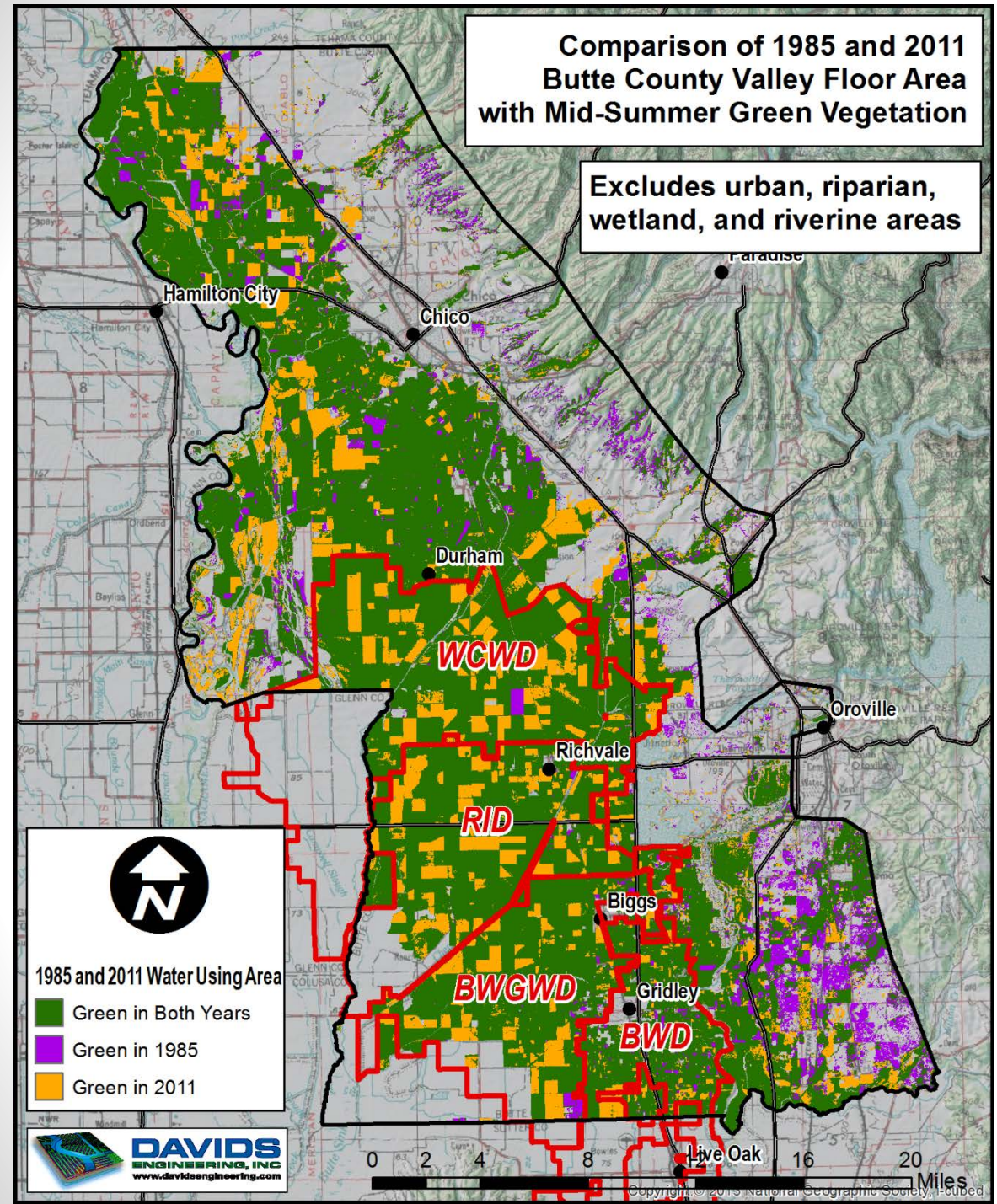
Ave. Annual Water Budget, 2000-2015



Future Growth Scenarios

- Urban: Project future pumping (2035) based on Urban Water Management Plans

- Agriculture
  - Identify areas of potential expansion based on recent trends
  - Consider topography, soils, water availability



Ag Trends

- Additional infill and less idle acreage
- Expanding orchard acreage (walnuts!)
- Changing irrigation technology and water source in some areas

Exploring Climate Change

Driving questions:

1. What effect would more winter precipitation, more rain, and less snow have on basin hydrology in general and on groundwater conditions in particular?
2. What is the vulnerability of the system to potential climate change impacts?

- Center on 2050, mid-century
- Hydrological changes (stream flows, precipitation)
- Maintain historical variability- perturbation ratios
- Not addressing changes in demand (ET, crop shifts etc.)

Developing Warmer/Drier Inputs

- 12 recommended GCMs from Climate Action Team (CAT)
- Choose one that represents a “warmer, drier” scenario
- Develop perturbation ratios for local streams from the 18 downscaled rimflows
- Water supply impacts
  - Feather River diverters
  - Estimate which years they would receive a cutback
- Precipitation
  - Spatially distributed downscaled data available
  - Perturbation ratios to adjust data for 5 climate stations in BBGM

Next Steps

- Refine inputs for water balance results
- Calibrate BBGM using PEST
- Develop inputs for growth/climate change scenarios
- Inventory and Analysis Report Update – Spring 2016
- Outreach/education…SGMA, drought, etc.

Acknowledgements

- Davids Engineering, Inc.
- Thanks to Can Dogrul for modeling support!
- DWR Bay-Delta Office Modeling Support Branch
- DWR Northern Region Office
- US Bureau of Reclamation
- HCI, CDM Smith

Thanks!

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