Integrated Modeling to Optimize Ecological and Agricultural Water Supply Enhancement

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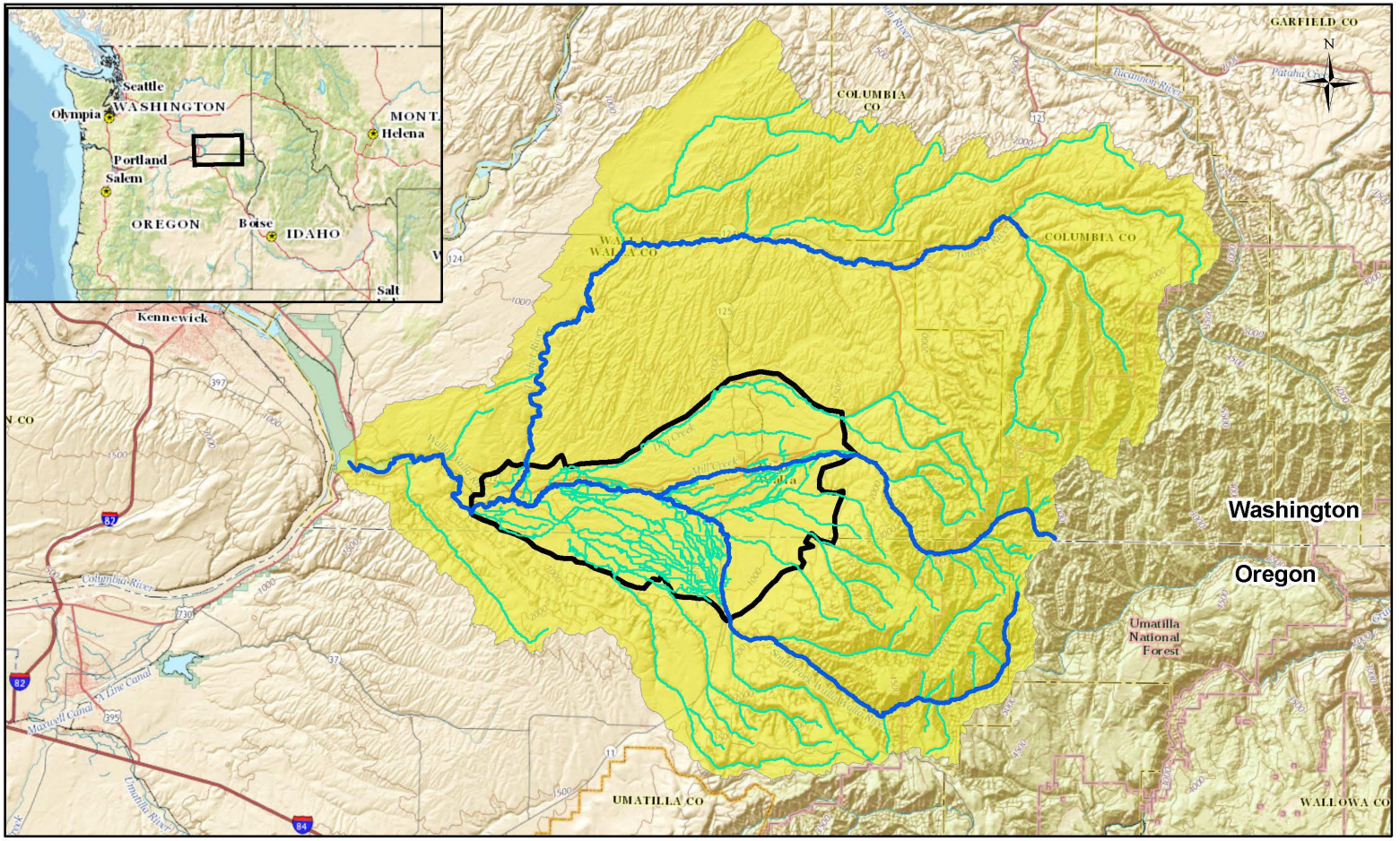
Location


Seattle
WASHINGTON
Olympia
Portland
Salem
OREGON
Boise
IDAHO
MONT.
Helena
Salt
GARFIELD CO
N
COLUMBIA CO
COLUMBIA CO
Kennewick
Washington
Oregon
Umatilla National Forest
UMATILLA CO
WALLOWA CO
Columbia River
Legend
Walla Walla Basin
Walla Walla Basin Rivers
IWFM Model Boundary
Walla Walla Basin Streams
0
10
20
40
Miles

Water Resource Issues in the Walla Walla Basin

- Over allocation
  - Historic dewatering of river during summer (until 2000)
  - Agreement to maintain minimum flows in Walla Walla River for fish habitat (25 cfs)

- Endangered fisheries
  - ESA listed Steelhead and Bull Trout
  - Reintroduced Chinook Salmon

- Declining aquifer
  - Water table decline of 2 inches per year since 1950
- River seepage
  - Estimated 20% loss of stream flow (source of aquifer recharge)

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Project Goals

- Develop calibrated groundwater-surface water model for alluvial aquifer portion of the Walla Walla Basin
- Quantify current demands and distribution of water resources
- Evaluate surface water and groundwater management scenarios:
  - Baseline – Current canal conditions and managed aquifer recharge (MAR) levels
  - Canal lining (piping) and:
    - No MAR
    - Current MAR
    - Increase MAR
    - Maximum MAR

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Current Managed Aquifer Recharge (MAR)

- Water diverted from Walla Walla River (November to May)
- Permeable basins or infiltration galleries (perforated underground pipeline)
- Uses existing irrigation conveyance network
- Used as seasonal storage to:
  - Supplement irrigation
  - Build groundwater levels
  - Increase base flows

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Model Development and Calibration

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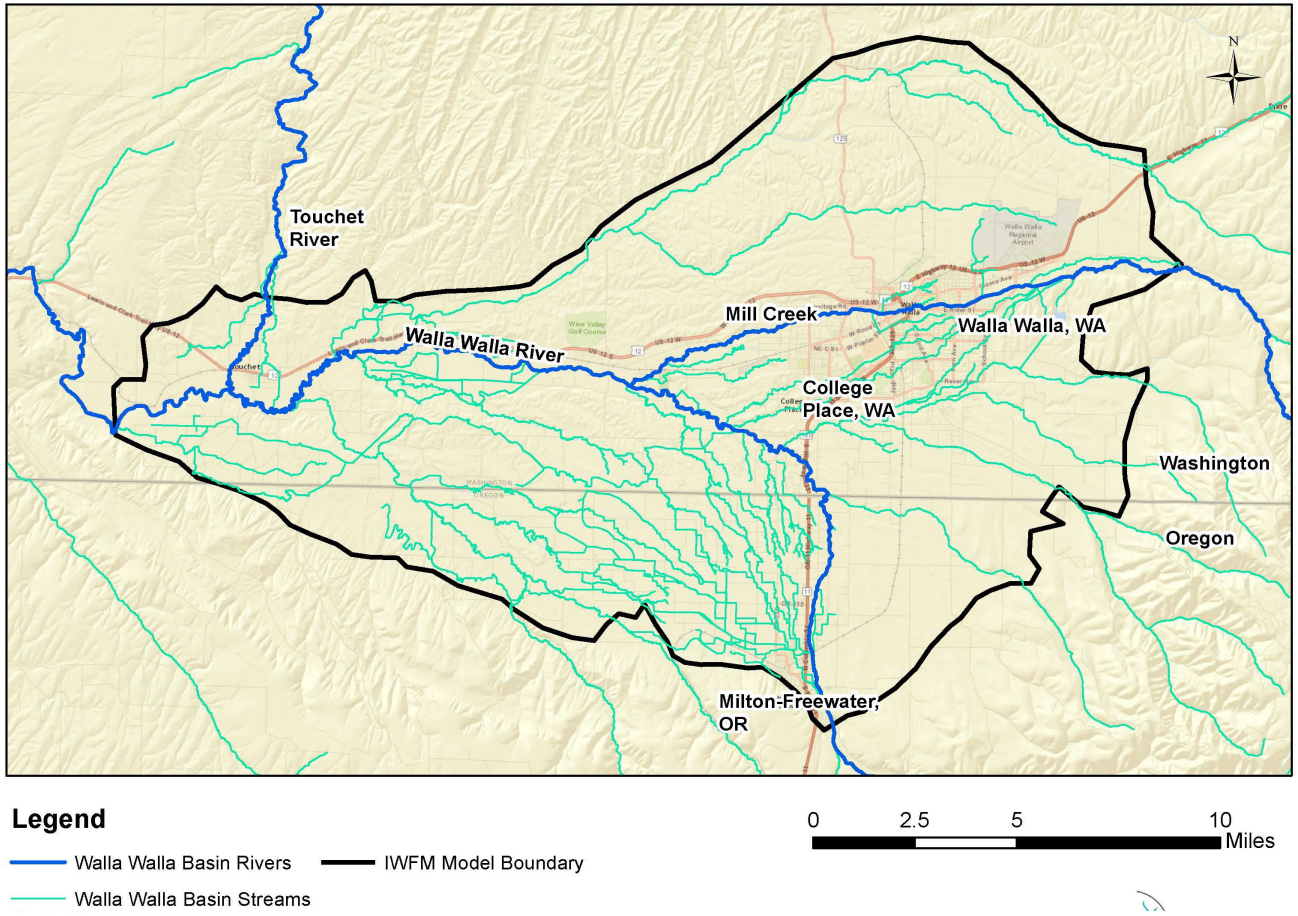
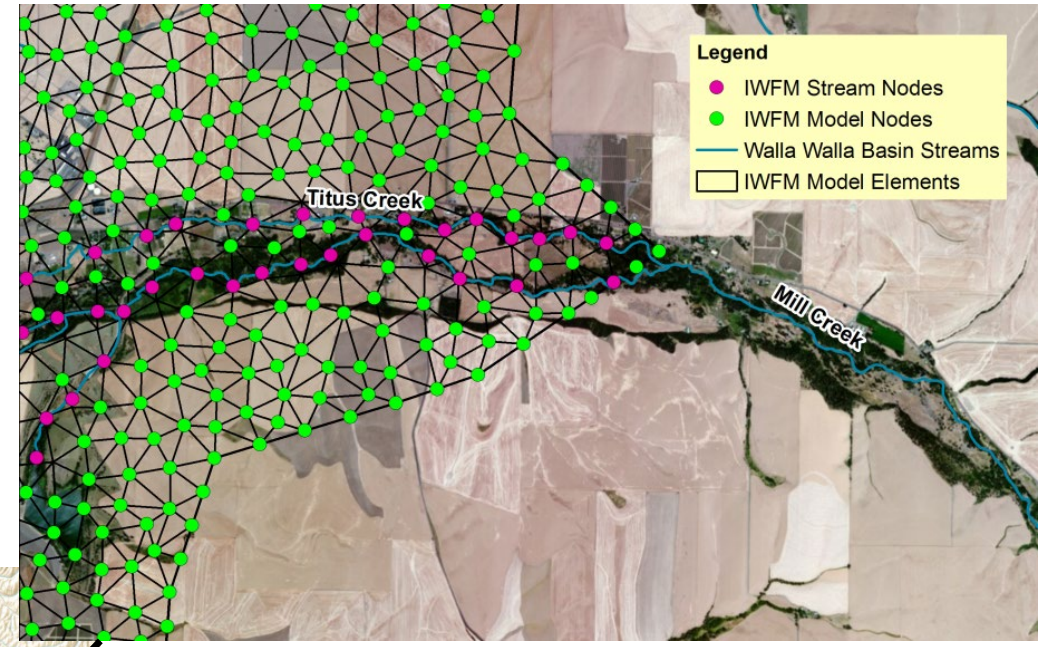
Integrated Water Flow Model

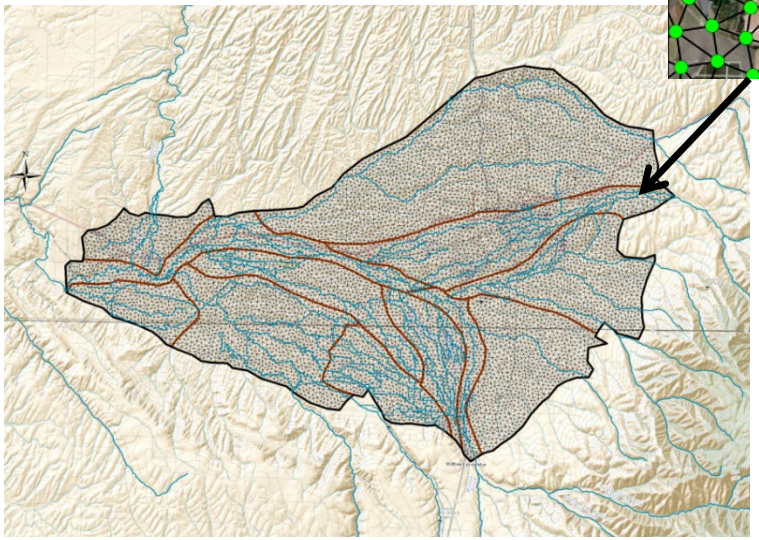
- IWFM code developed by CA DWR
- 240 square miles



Model Grid

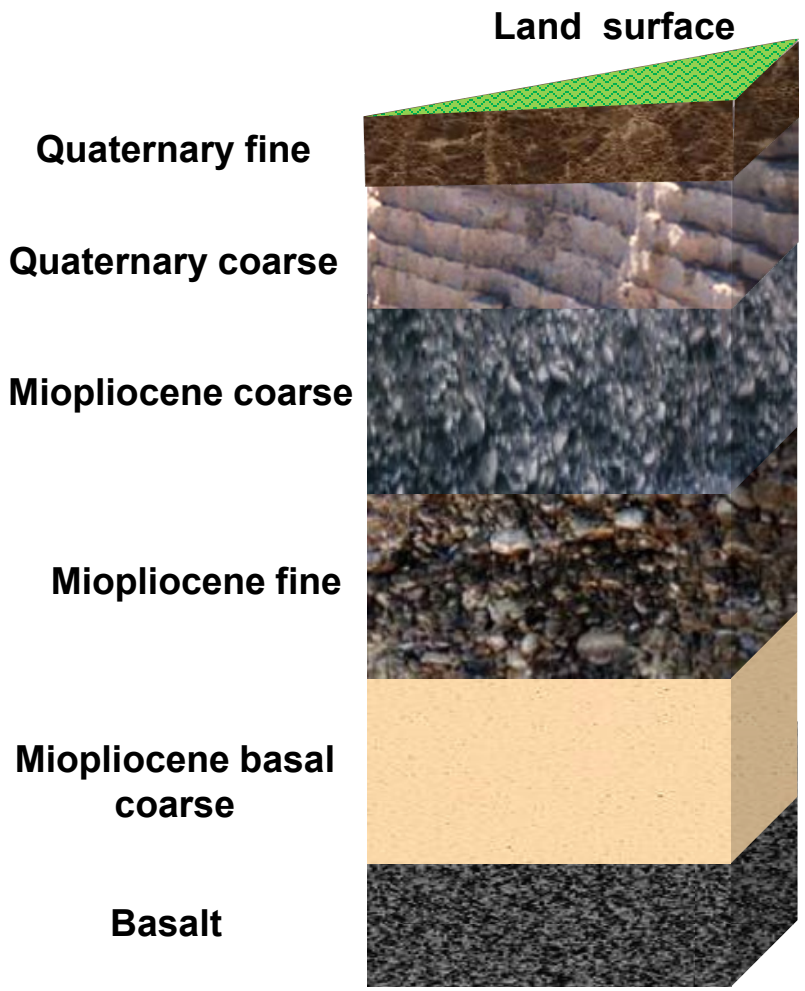
- 16,215 model elements (average ~10 acres)
- 8,294 nodes (average spacing ≈1,000 feet)
- 1,506 stream nodes
- 91 stream segments



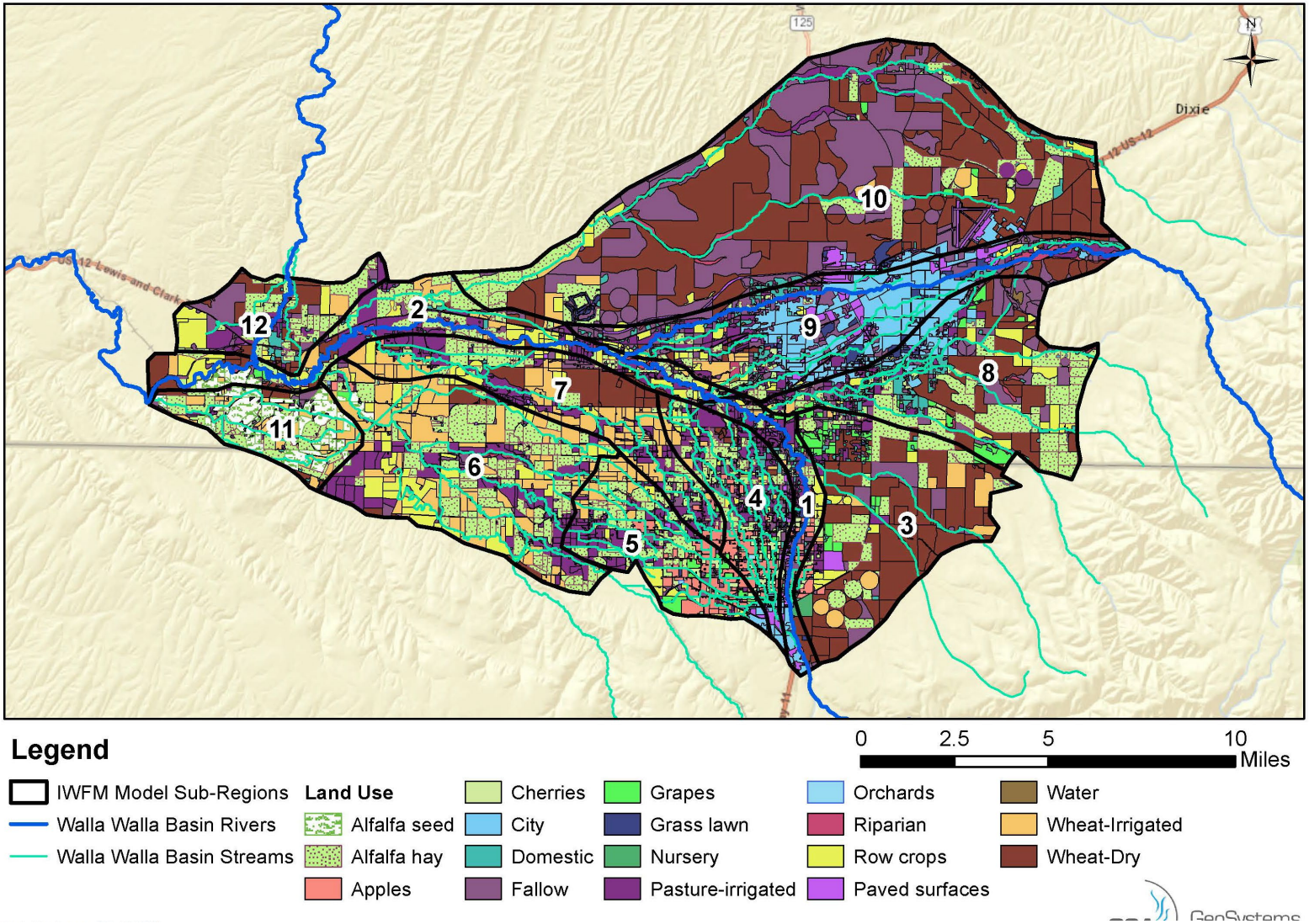


Model Layers

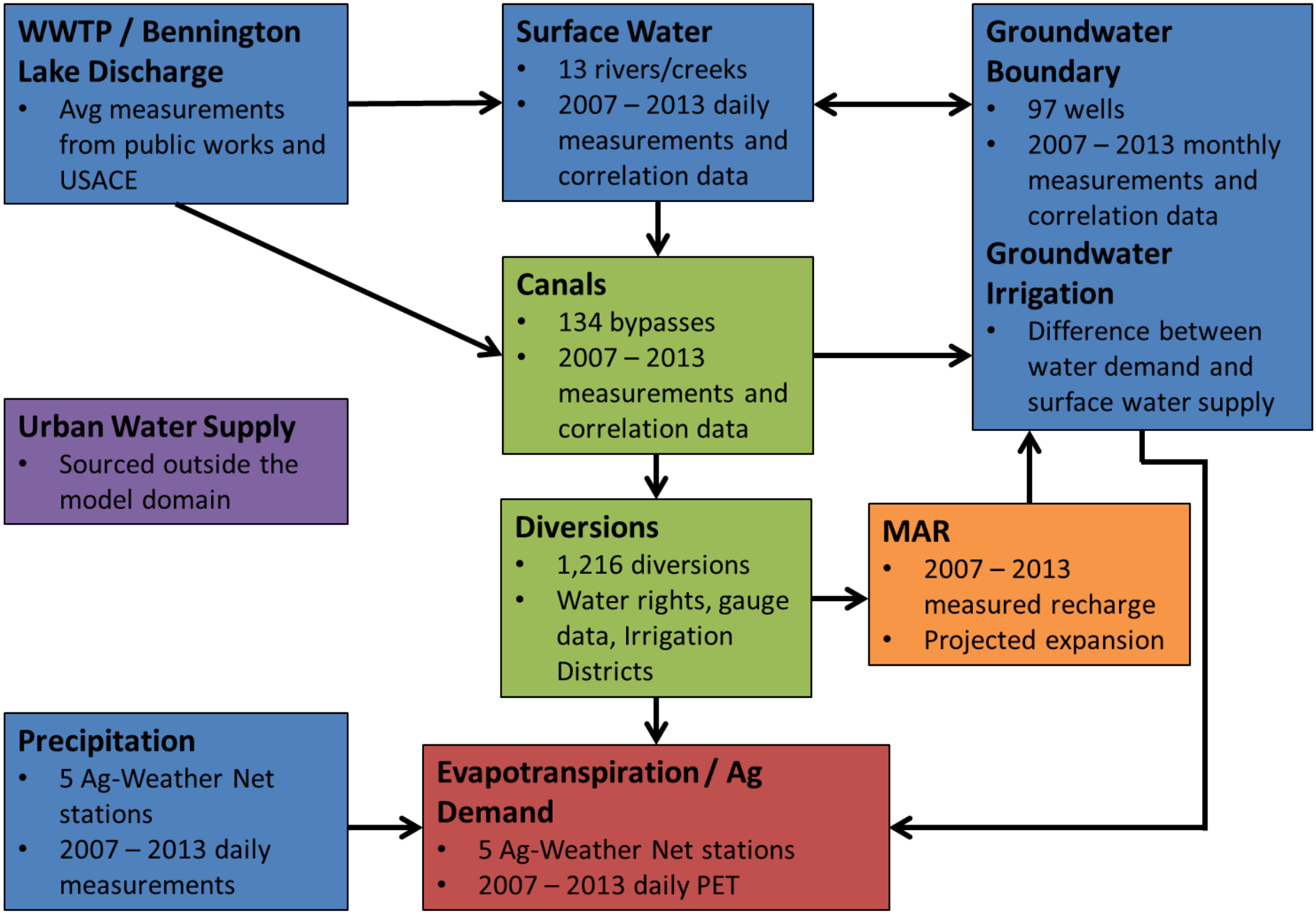
Representative finite element



Land Use

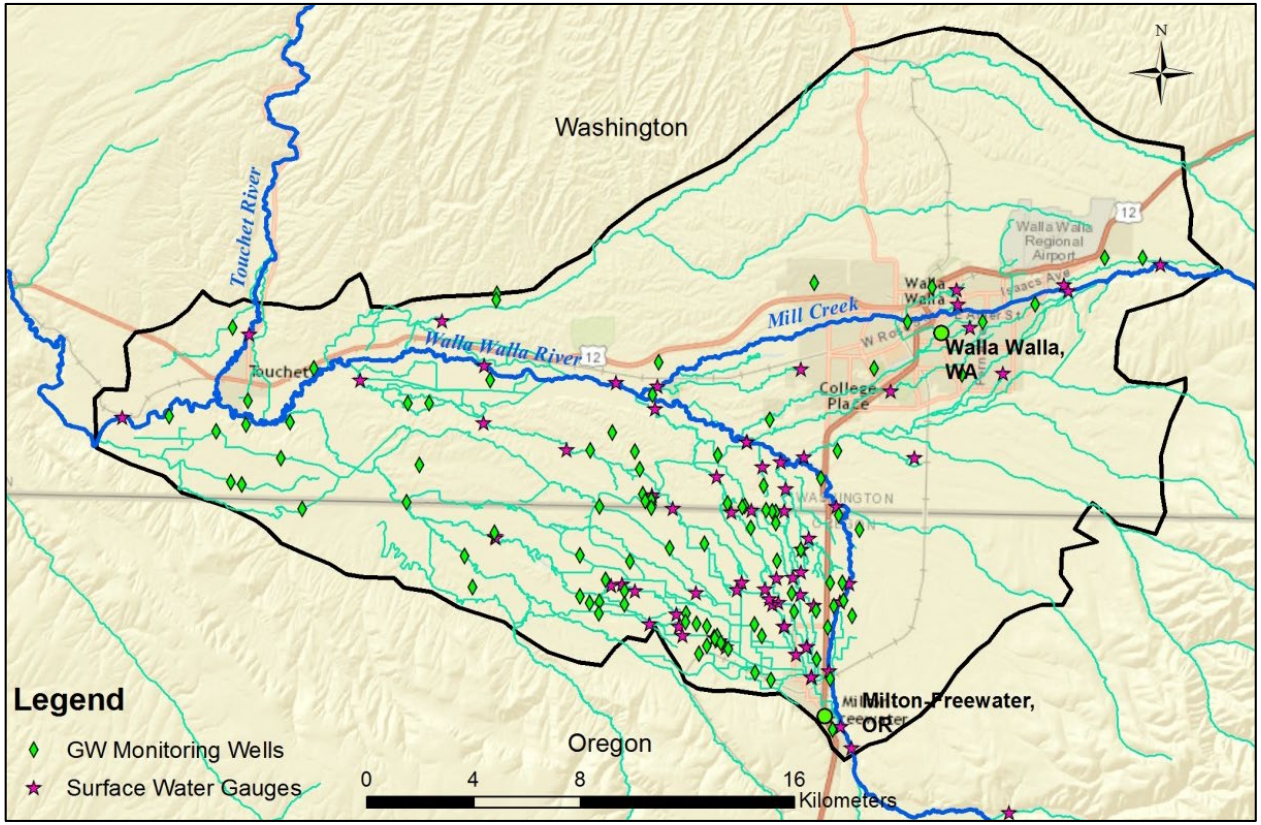

125
N
Dixie
12-US-12
US-12-Lewis-and-Clark
12
2
10
9
8
7
11
6
4
1
3
5
Legend
IWFM Model Sub-Regions
Walla Walla Basin Rivers
Walla Walla Basin Streams
Land Use
Alfalfa seed
Alfalfa hay
Apples
Cherries
City
Domestic
Fallow
Grapes
Grass lawn
Nursery
Pasture-irrigated
Orchards
Riparian
Row crops
Paved surfaces
Water
Wheat-Irrigated
Wheat-Dry
0
2.5
5
10
Miles

Walla Walla Basin Model Flow System



Model Calibration

- Sensitivity analysis on hydraulic conductivity parameters
- Systematically adjust sensitivity parameters to improve fit of simulation to data
- Calibration data 2007-2009, 2011, 2013
- Validation Data 2010 & 2012



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Model Scenarios

Model Inputs

- Forward model projection (steady-state)
- Apply calibrated model parameters
- Average daily data from model development period for:
  - Climate
  - GW boundary conditions
  - Stream inflows
  - Agricultural/municipal water use
- MAR rates

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Model Scenarios

1. Baseline Forward Model (BFM)
   - 9,014 acre-ft/yr MAR at 7 current active sites
   - No additional canal piping (50 miles piped canals)
2. Canal piping + no MAR (86 miles added piping)
3. Canal piping + current MAR
4. Canal piping + increased MAR
   - 14,566 acre-ft/yr MAR at 22 locations
5. Canal piping + maximum MAR
   - 24,201 acre-ft/yr MAR at 60 locations

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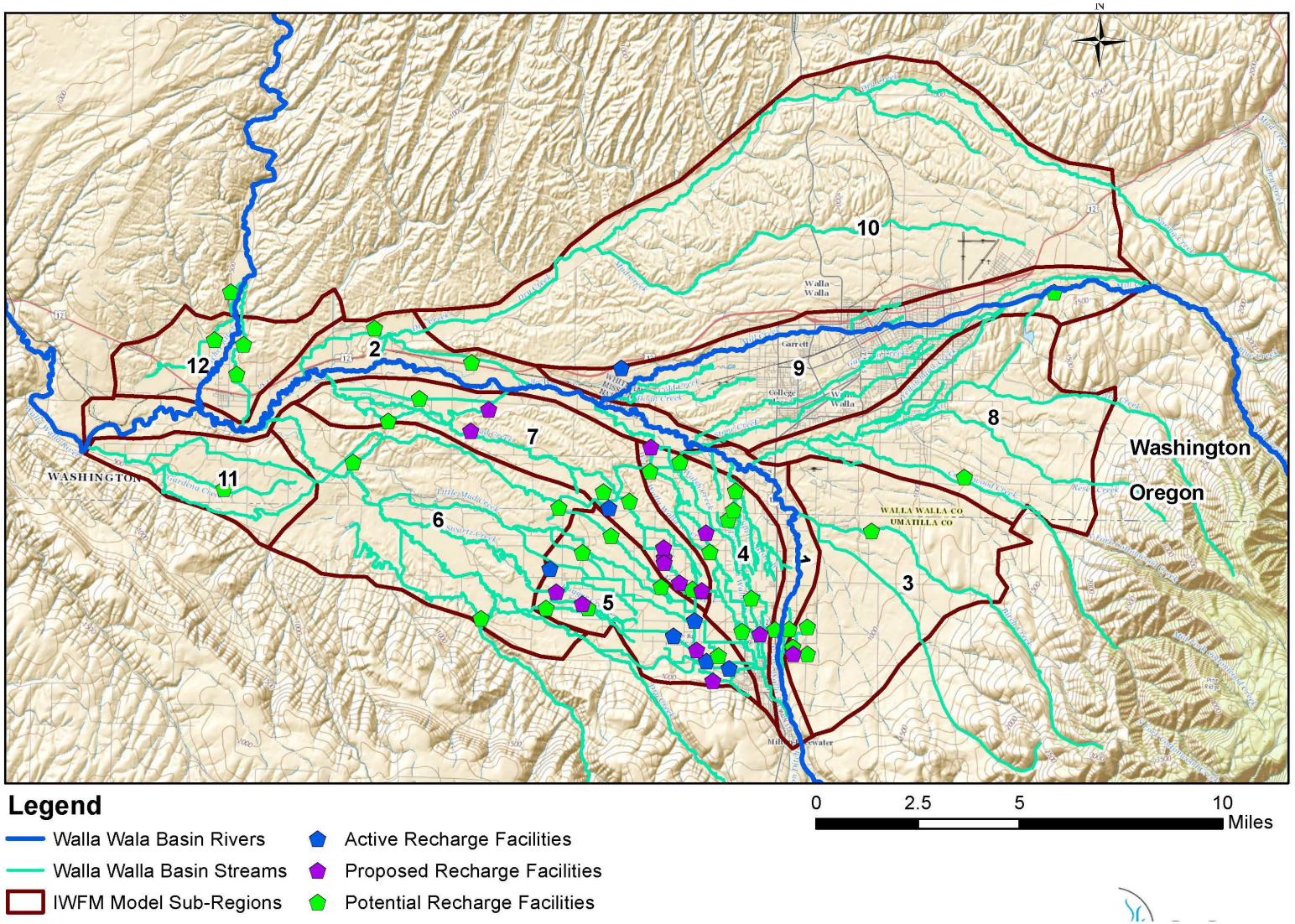
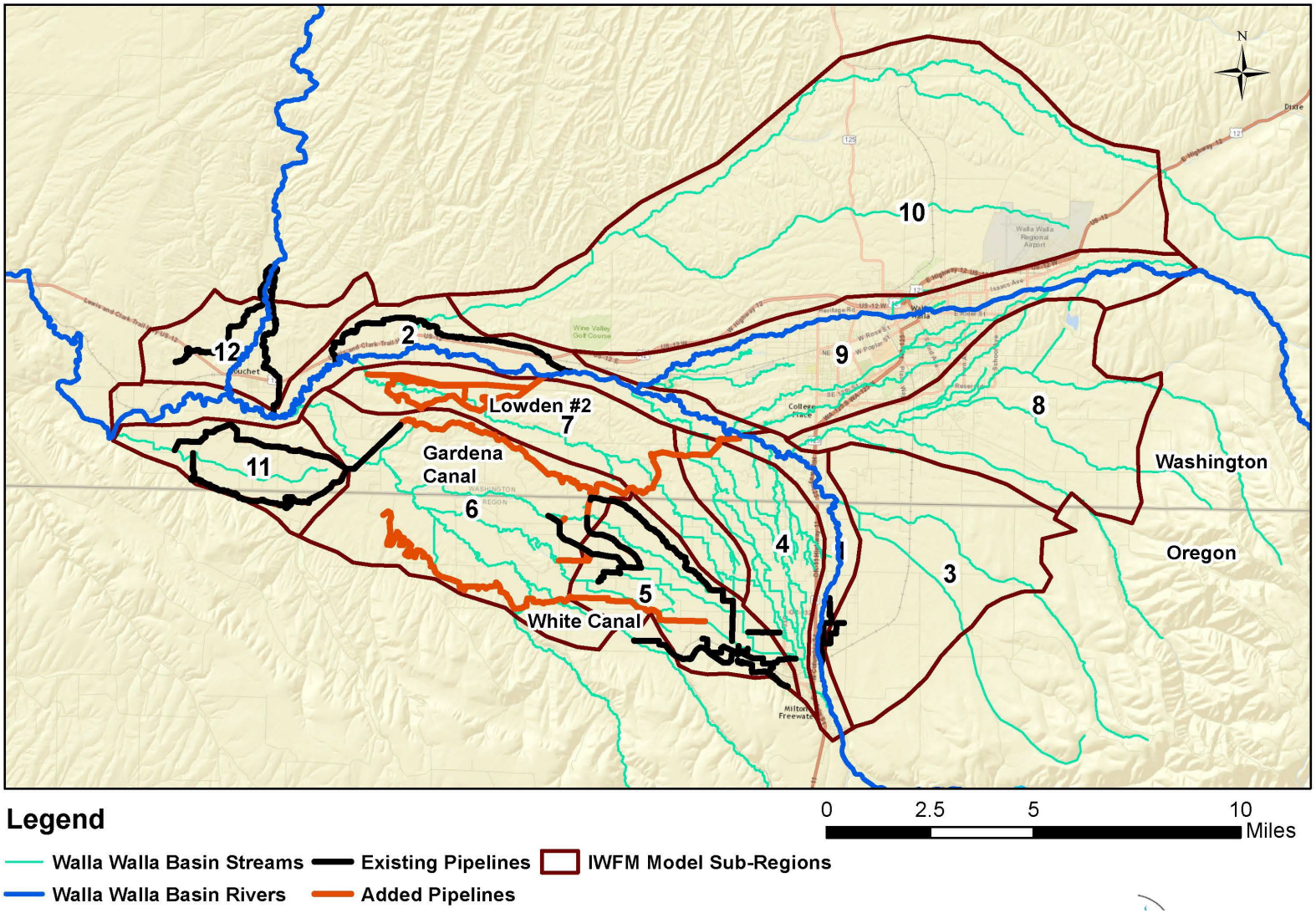
MAR Locations



Piping Locations



Model Results

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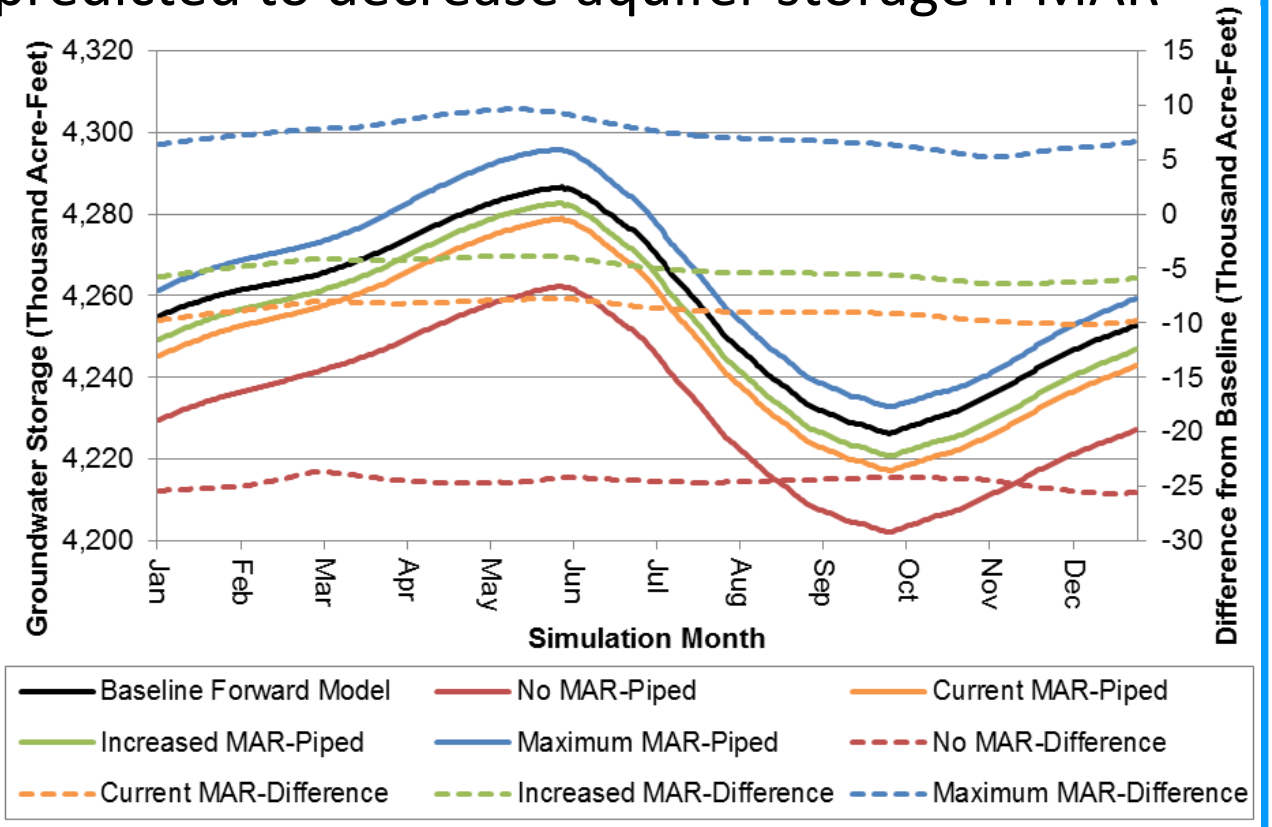
Groundwater Storage

- Seasonal changes in response to recharge and groundwater pumping
- Pipe installation predicted to decrease aquifer storage if MAR not increased
- Maximum MAR compensates for lost storage



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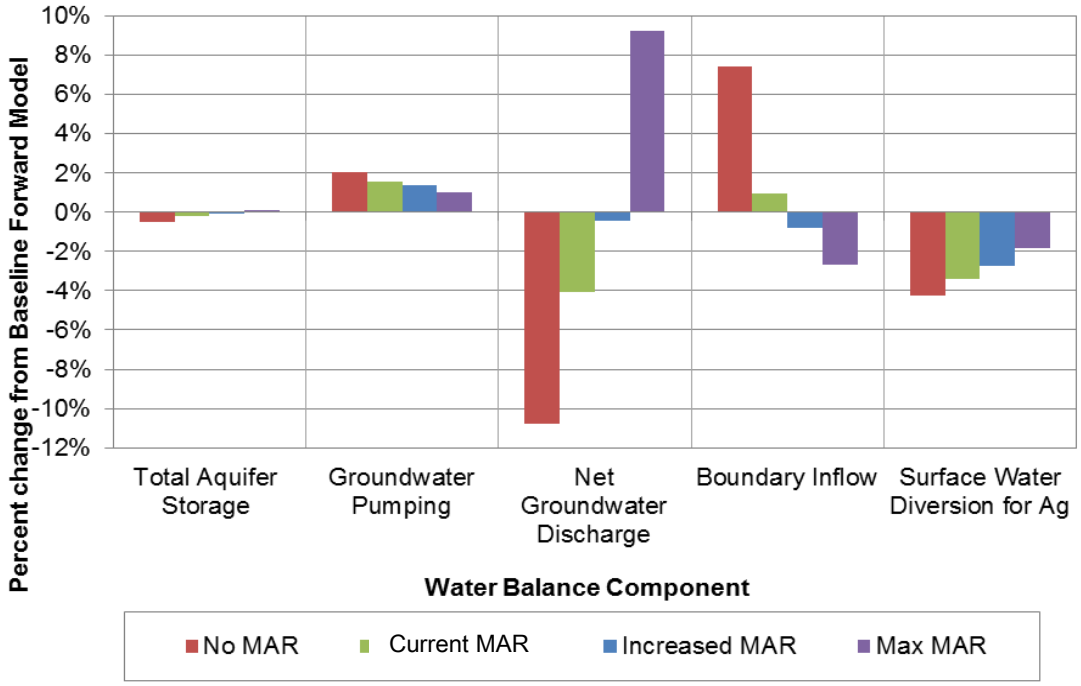
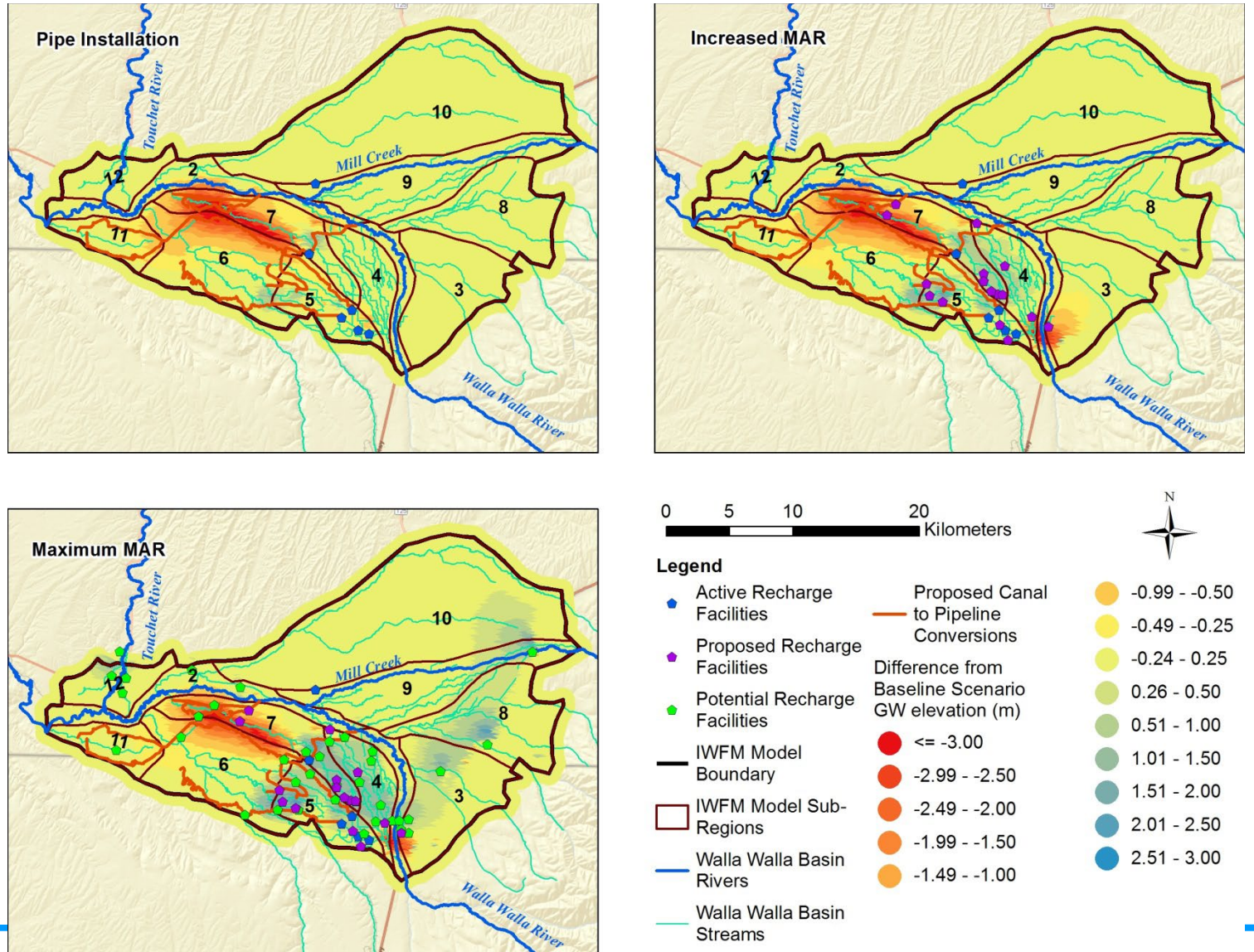
Water Budget

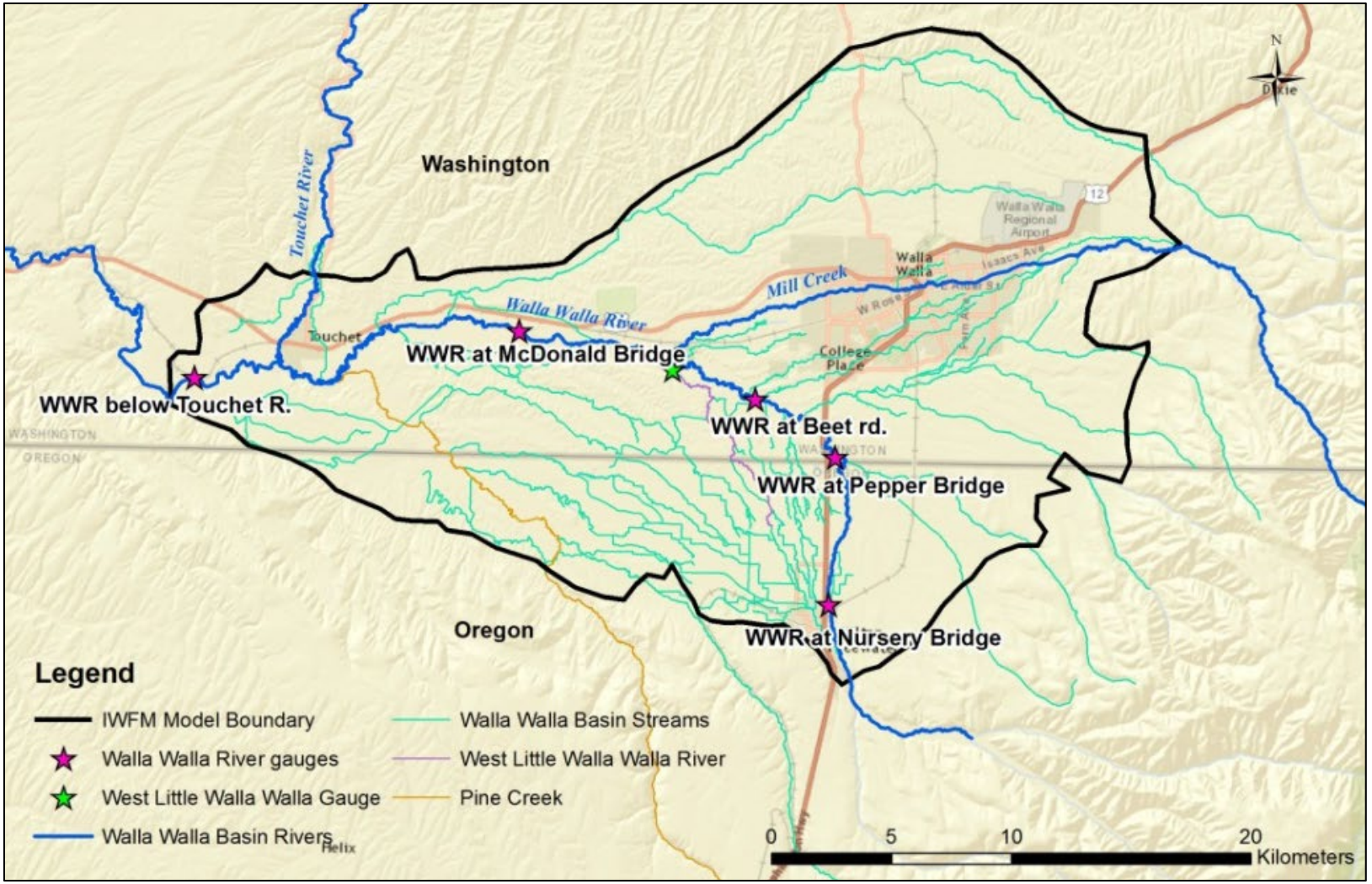
- Groundwater discharge to streams
  - No MAR: 11% decrease
  - Current MAR: 4% decrease
  - Increased MAR: 0.5% decrease
  - Maximum MAR: 9% increase



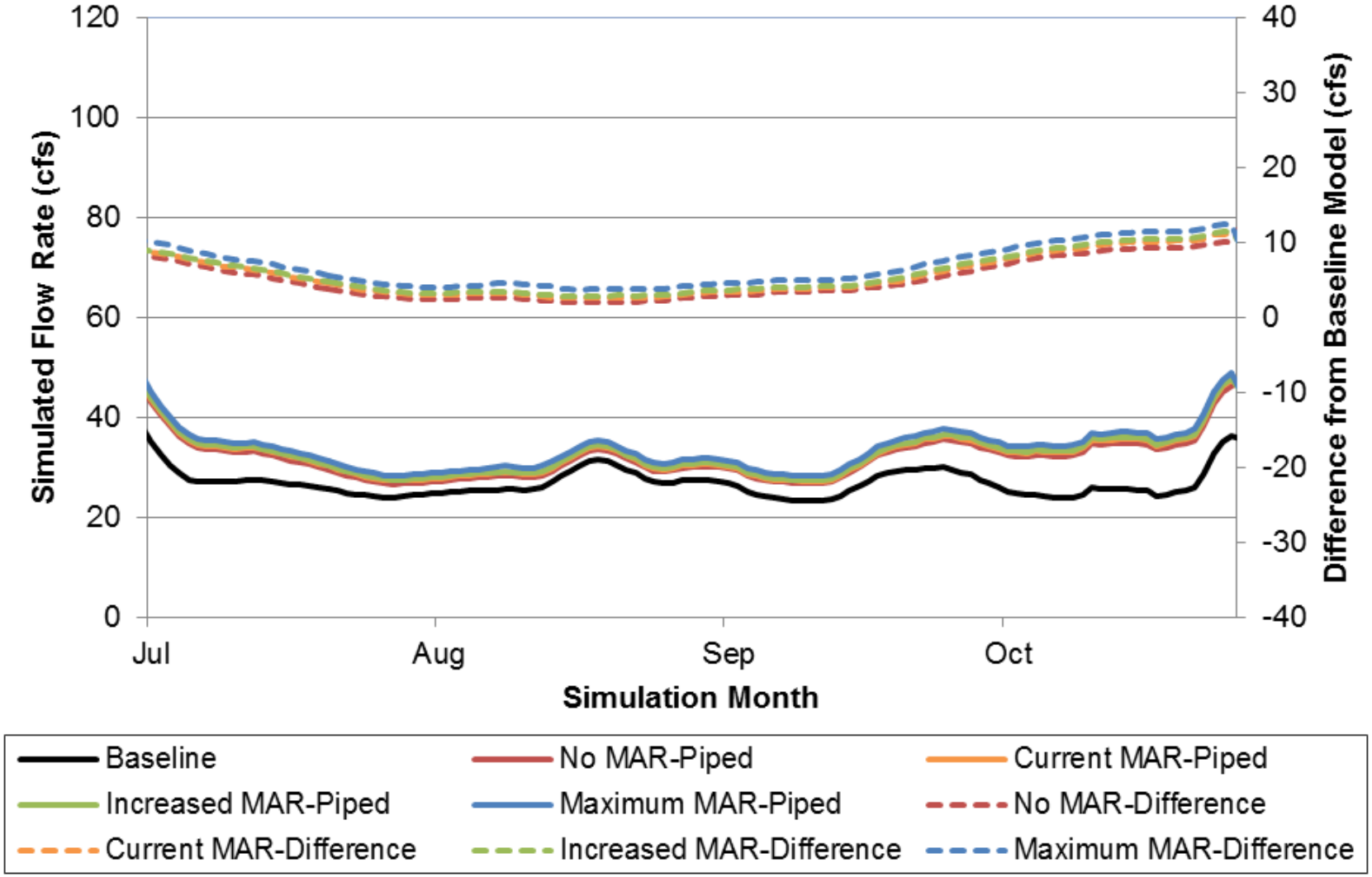
Change in Groundwater Elevation



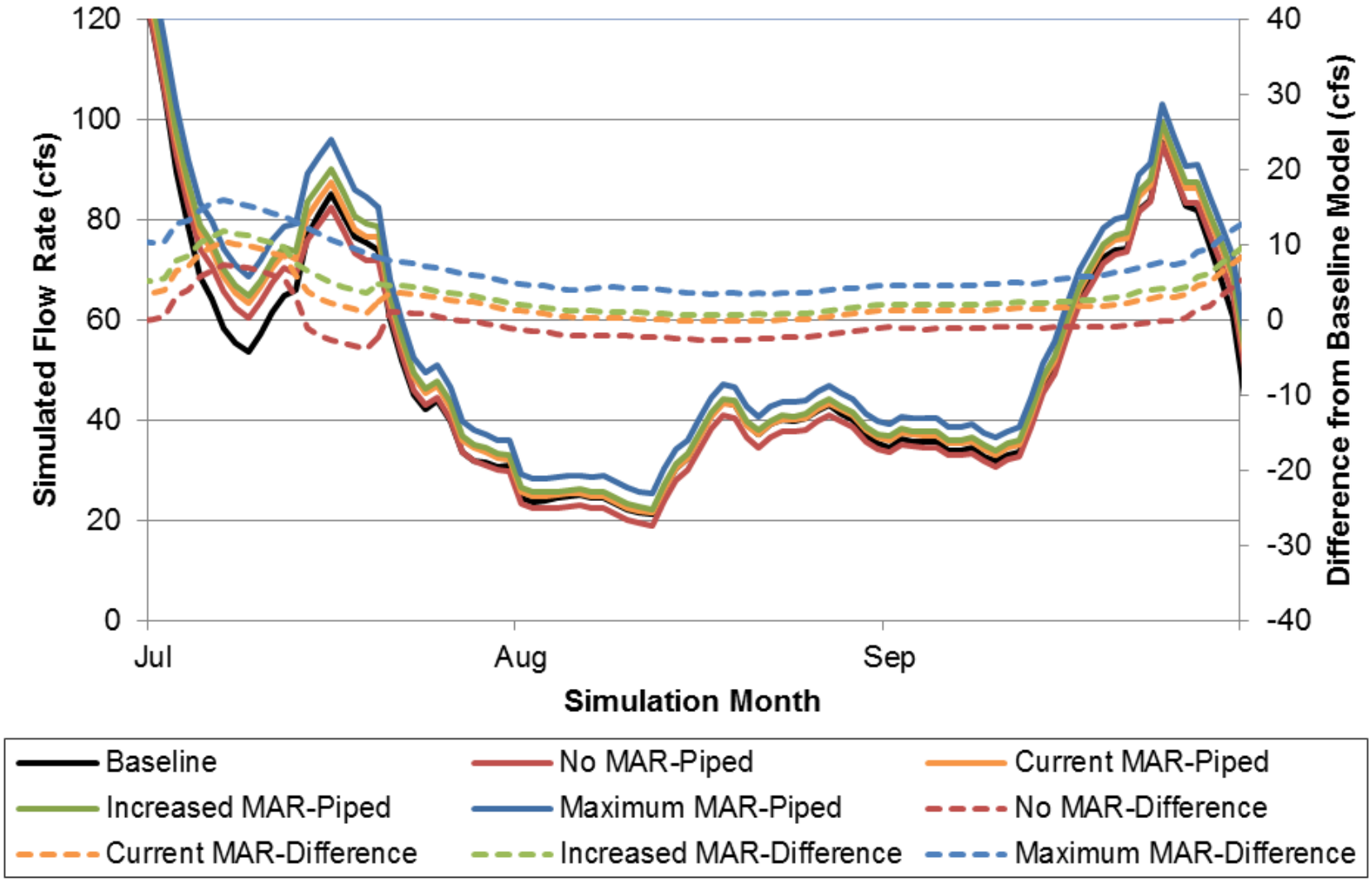
Streamflow Locations



Pepper Bridge



Touchet


120
100
80
60
40
20
0
Simulated Flow Rate (cfs)
40
30
20
10
0
-10
-20
-30
-40
Difference from Baseline Model (cfs)
Jul
Aug
Sep
Simulation Month
Baseline
No MAR-Piped
Current MAR-Piped
Increased MAR-Piped
Maximum MAR-Piped
No MAR-Difference
Current MAR-Difference
Increased MAR-Difference
Maximum MAR-Difference

Conclusions

- Canal piping likely to have negative impact on groundwater resources and limit instream water savings
- Combining piping with MAR can mitigate impacts
  - Increased MAR nearly mitigates impact
  - Maximum MAR (60 sites) provides most widespread benefit to fish habitat by allowing for significantly increased summer flows
- Conjunctive management of groundwater and surface water can provide water for irrigators while increasing summer flows

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