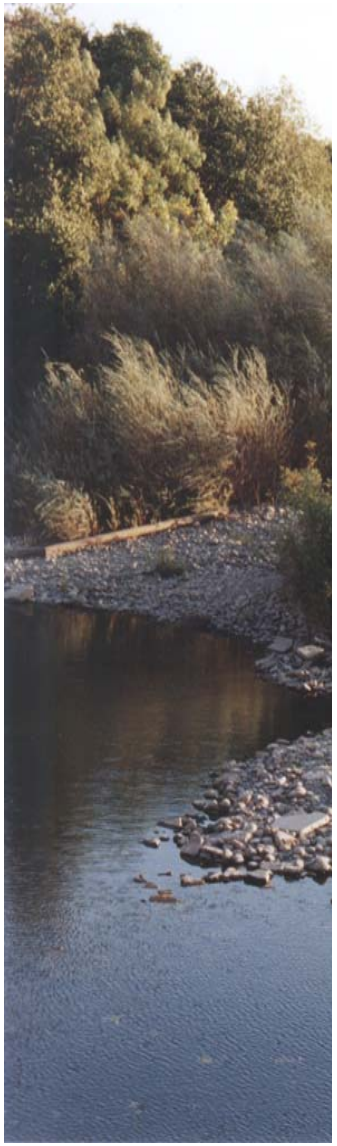
# High Resolution Groundwater Models of the San Joaquin River Riparian Zone

*for Evaluation of Surface Water/Groundwater Interactions under Alternate River Flow Regimes*

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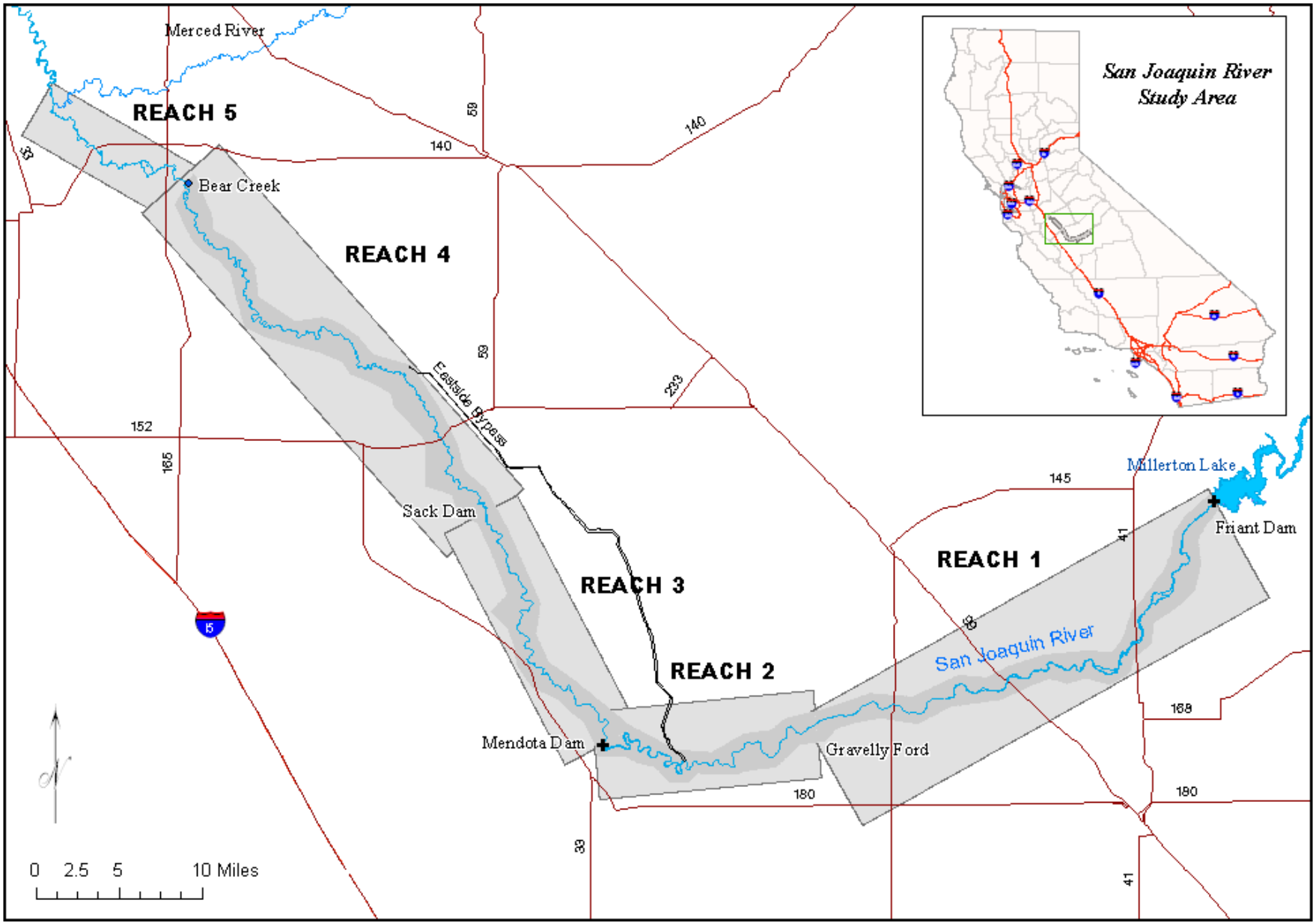
**CWEMF Workshop**


S.S. Papadopulos & Associates, Inc.

# *Project Study Area:*

## *Friant Dam to the Merced River*


Merced River
REACH 5
Bear Creek
REACH 4
Eastside Bypass
Sack Dam
REACH 3
REACH 2
Mendota Dam
Gravelly Ford
REACH 1
San Joaquin River
Millerton Lake
Friant Dam
San Joaquin River Study Area
0 2.5 5 10 Miles
59
140
152
165
233
145
41
168
180
33
5

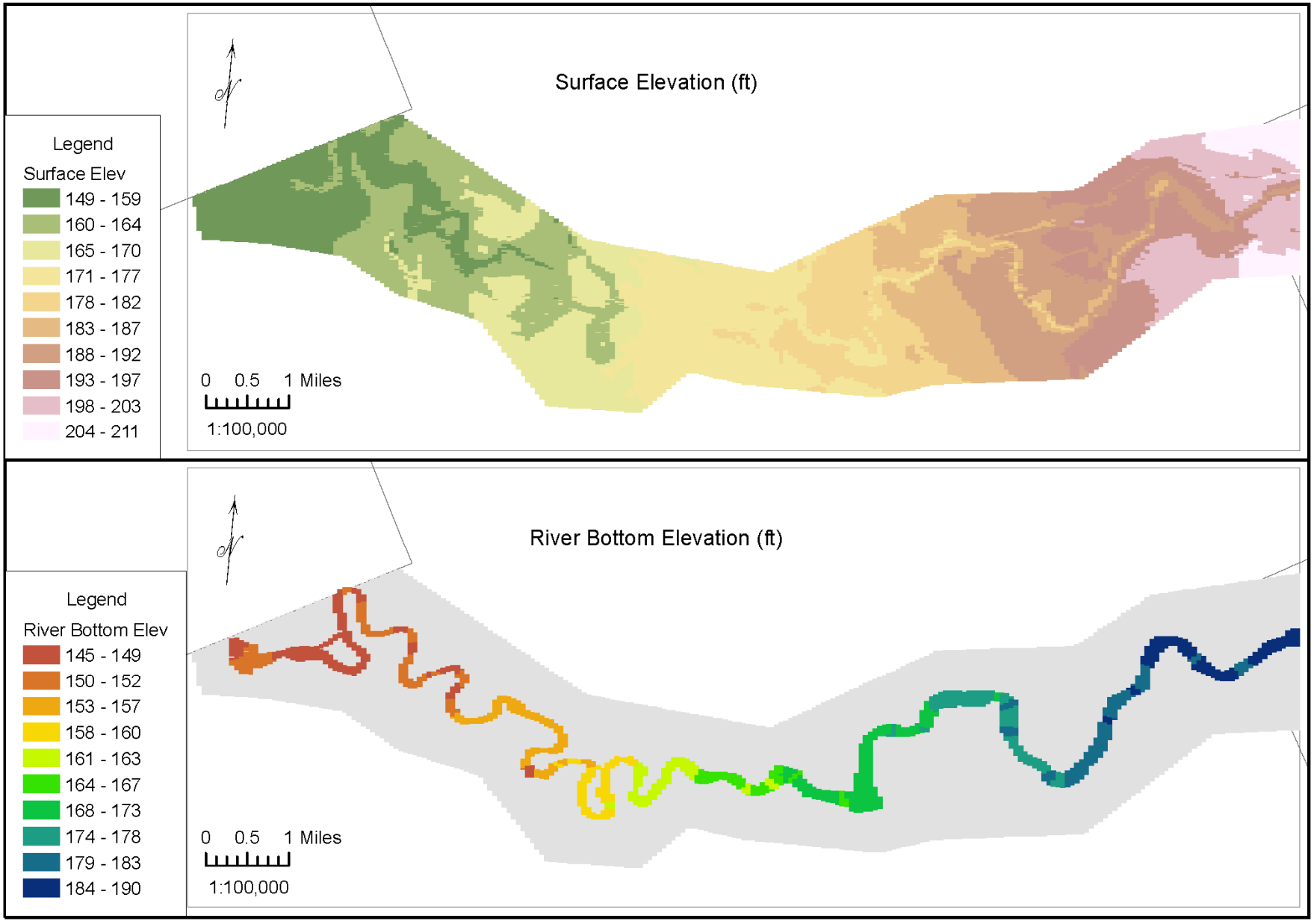
# *Model Capabilities*

- Characterize
  - Near-river groundwater elevations
  - River seepage losses
  - Boundary flux (regional/local interface)
- As function of
  - River stage
  - River extent
  - Regional groundwater boundary conditions
  - Antecedent flow conditions and resulting groundwater condition

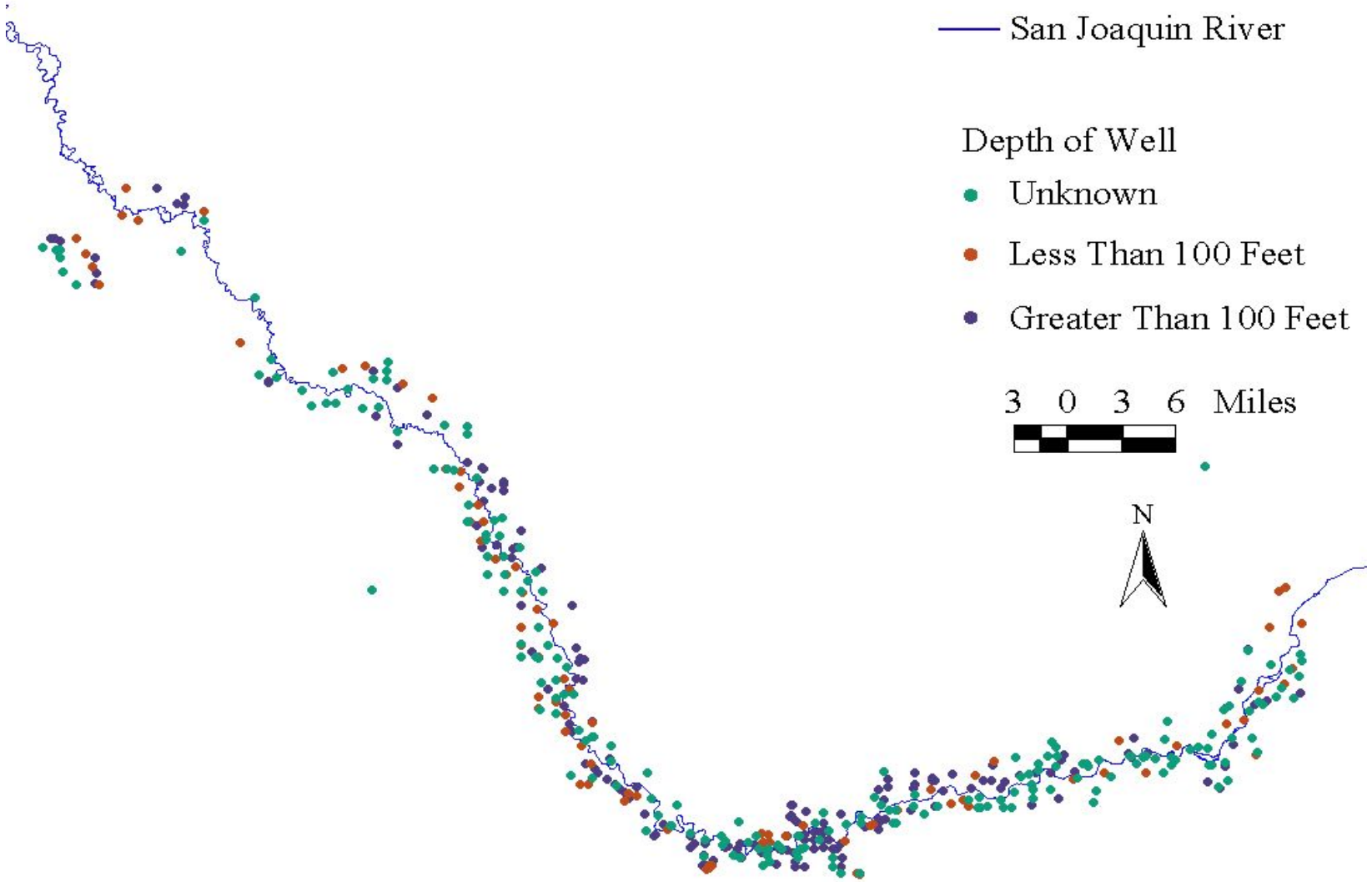
# *Model History - 1*

- **1999-2000**: For SJRRHRP (USBR contract)
  - ***Domain***: Extent of mapped riparian vegetation, 5 reaches
  - ***Resolution***: 300 x 50 ft model cells, 5 to 13 model layers
  - ***Parameterization***: Soil texture analysis, 300+ logs; calibration
  - ***Calibration***: Reach 1 & 2 only, shallow piezometer data
  - ***River boundary***: HEC-2 models (MEI, 2000), 3 flow exceedence levels
  - ***Code:*** MODFLOW, with custom package for 2-D unsaturated flow
  - ***ET***: variable by plant group and time of year
  - ***Applications***: Sensitivity analyses illustrating dynamic nature of surface water/groundwater conditions

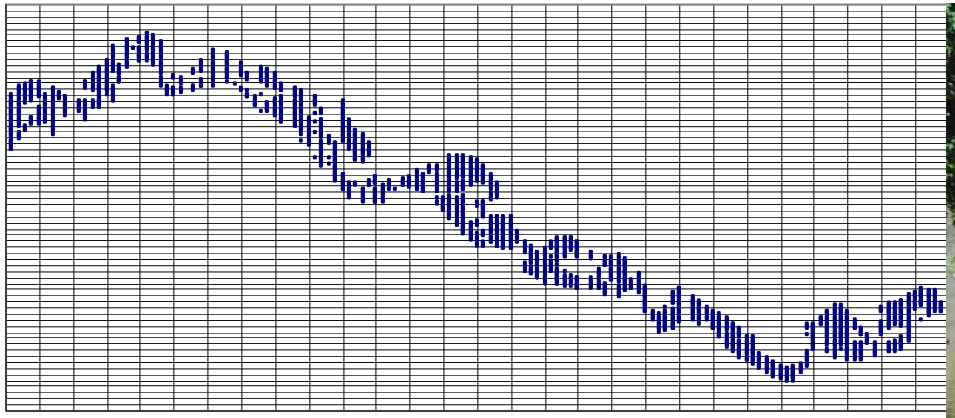
# Model Input: Land Surface and River Bottom Elevations, Reach 2

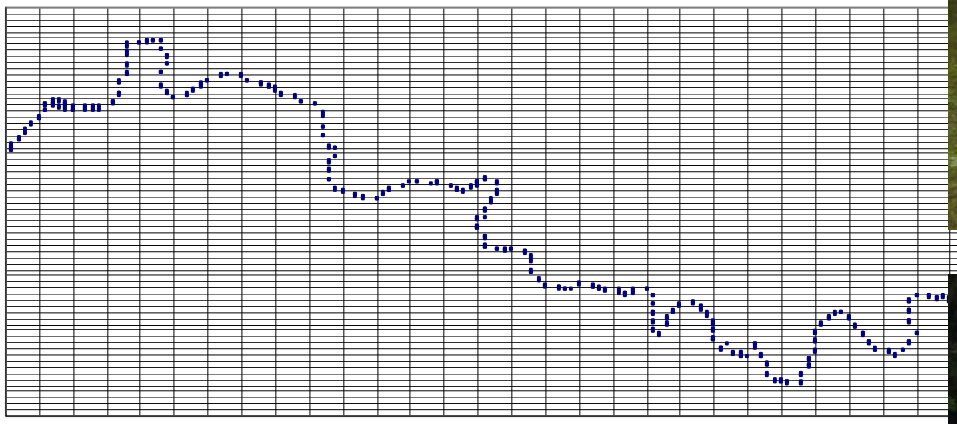


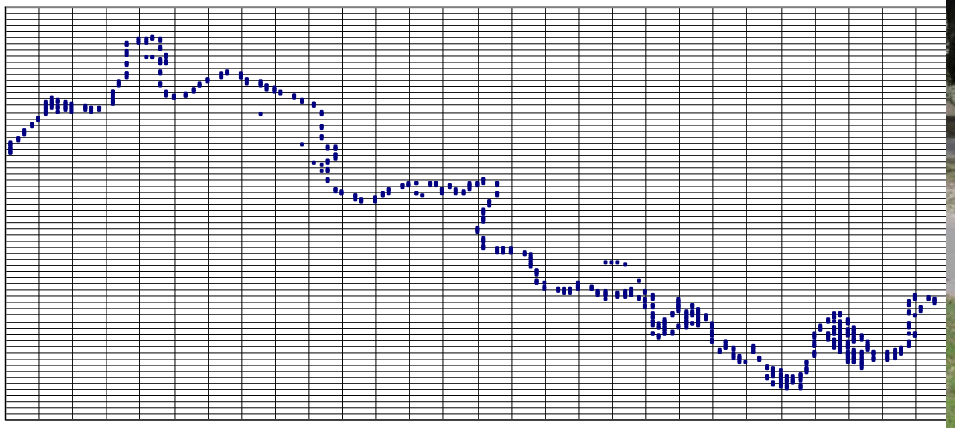
# *Distribution of Wells Providing Lithologic and Water-Level Data*



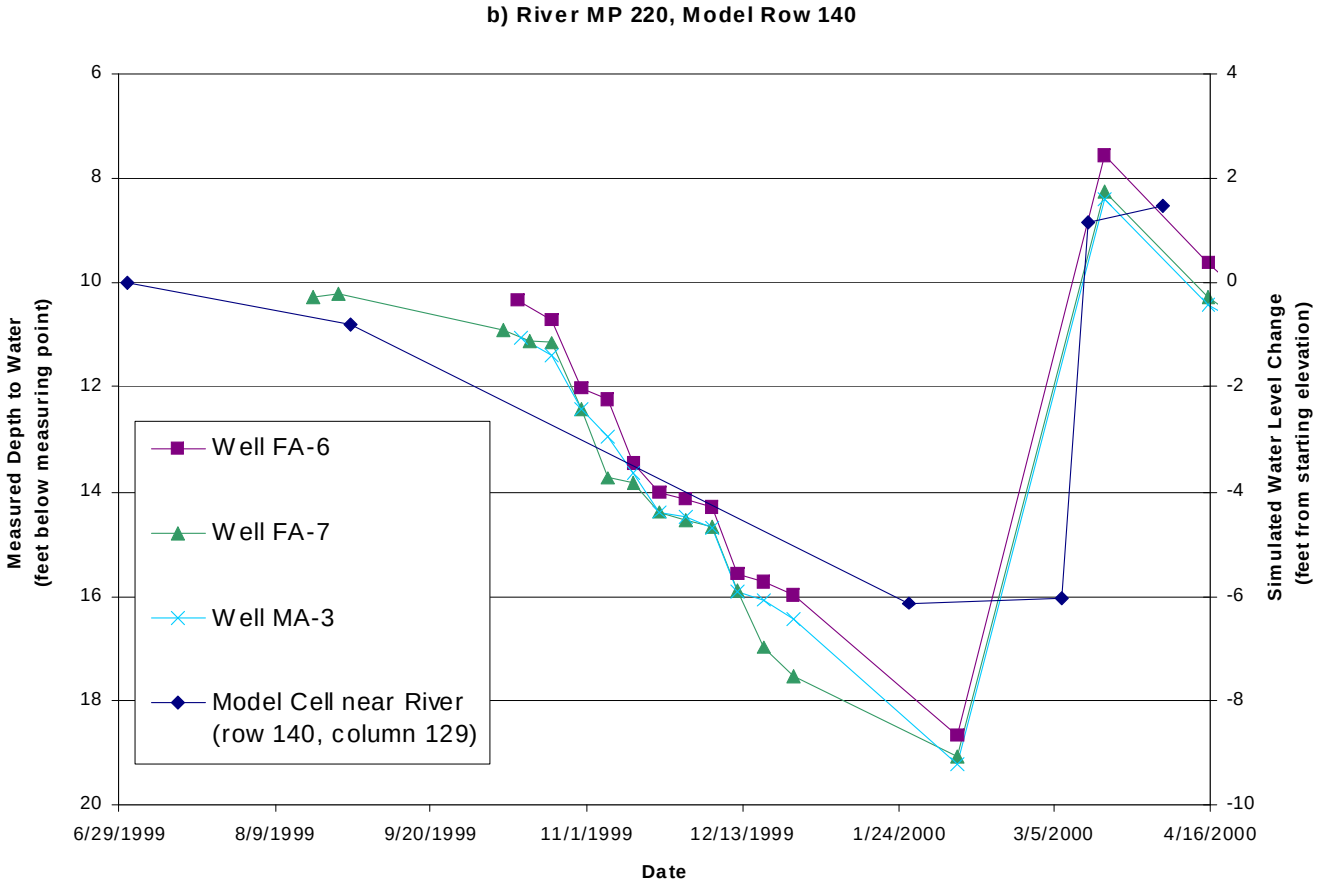
# River Cell Coverage under Alternate Discharge Profiles



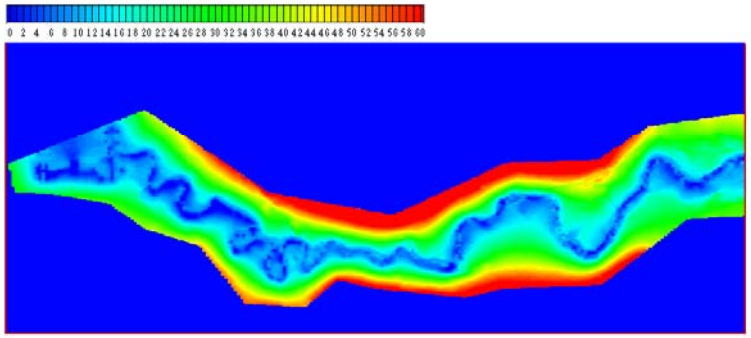


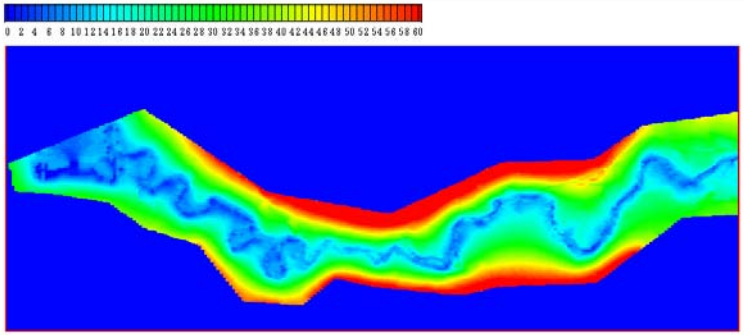
# *Original Model Calibration in Reach 2 using data from 1999 pilot releases*



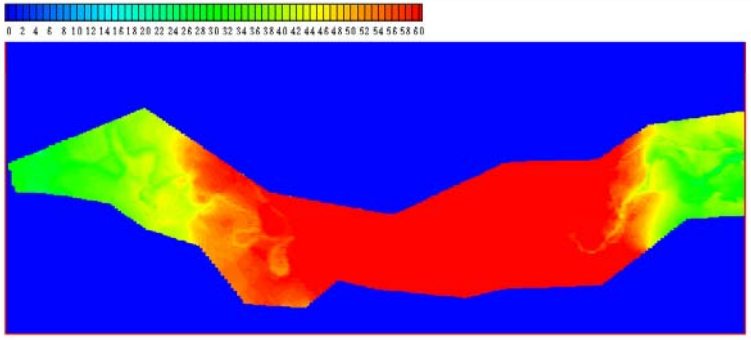

# *Example Sensitivity Analysis: Steady State Depth to Water under Alternate River Flow Conditions*



High River Stage



Base Case



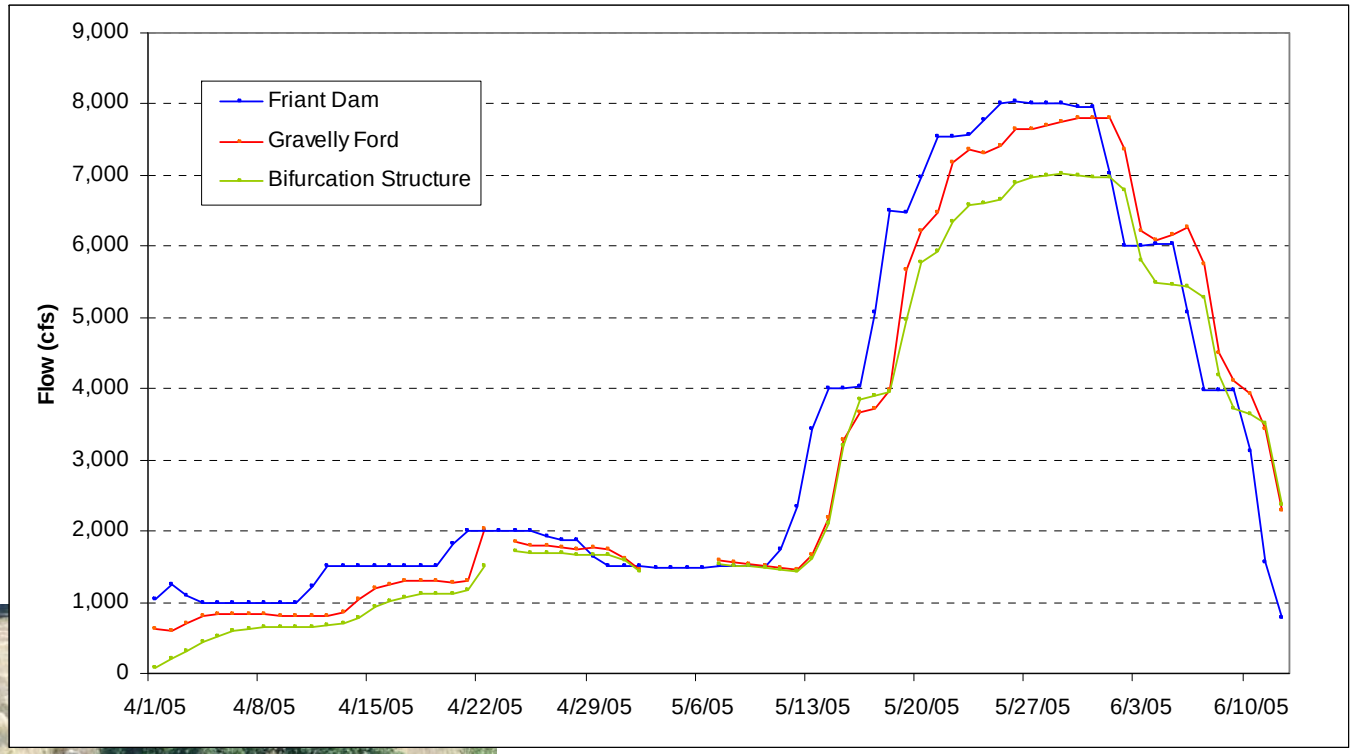
Low River Stage

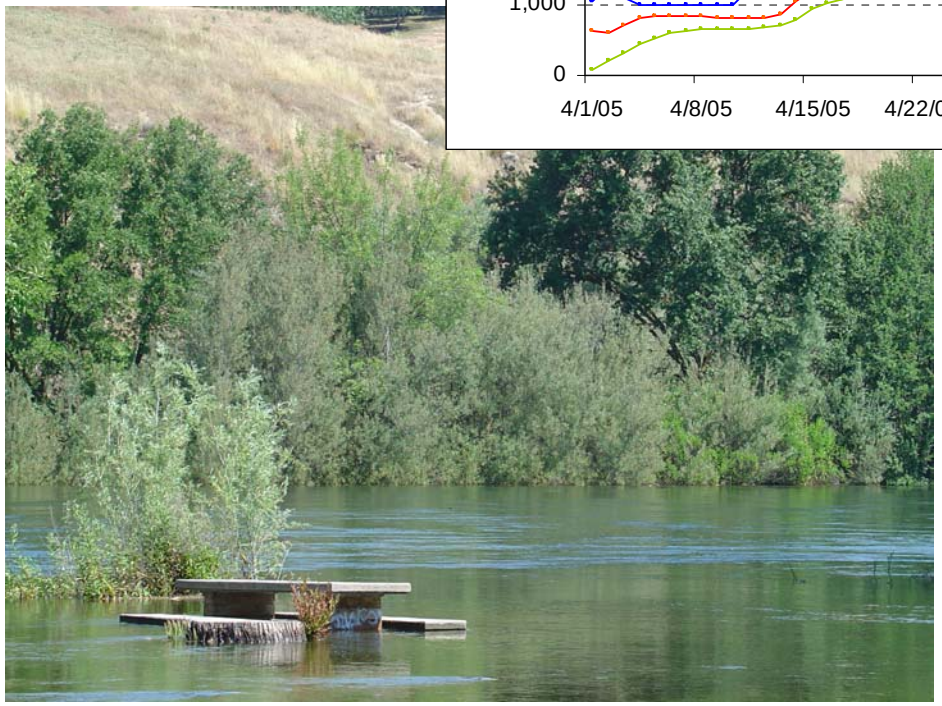
*DEPTH TO WATER*

*Red = 52 – 60 ft*
*Yellow = 44 – 50 ft*
*Green = 20 – 44 ft*
*Blue = 0 – 20 ft*

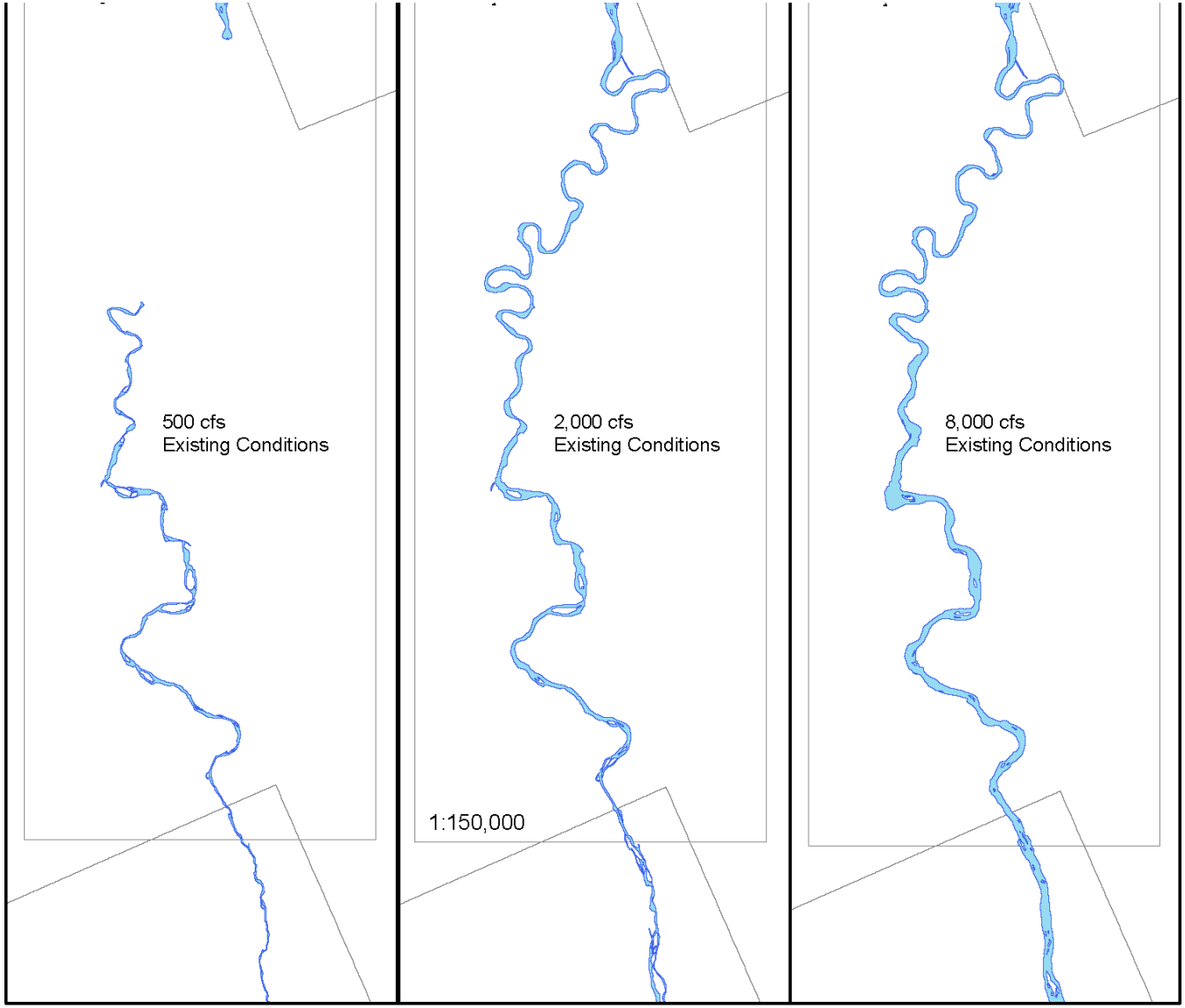
# Model History - 2

- **2005**: Model Update and Assessment of Proposed Restoration Hydrographs
  - ***Domain***: Unchanged
  - ***Resolution***: 300 x 50 ft model cells, 3 model layers
  - ***Parameterization***: Updated, new monitoring data
  - ***Calibration***: Reach 1 & 2, seepage losses and groundwater elevations
  - ***River boundary***: Updated HEC-2 models (MEI '05), 6 RIV Pkgs
  - ***ET***: variable by plant group and time of year
  - ***Applications***: Evaluation of seepage losses and groundwater conditions with alternate restoration hydrographs



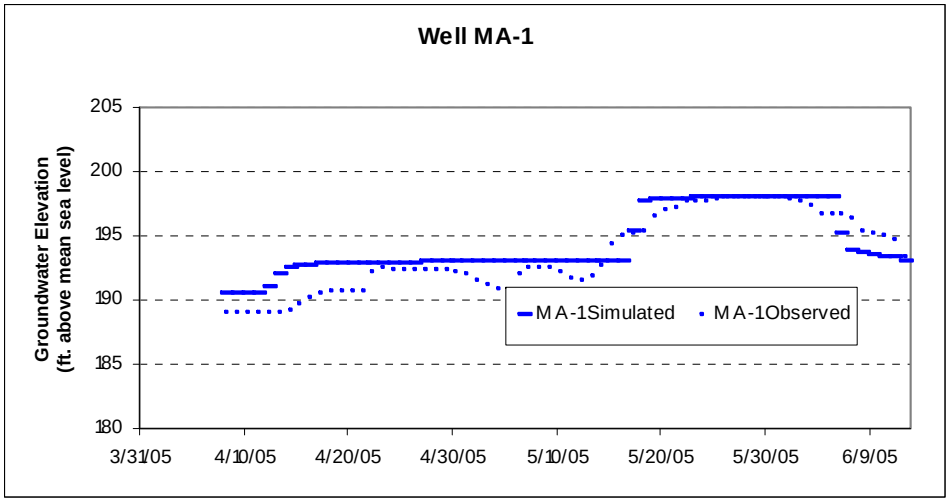



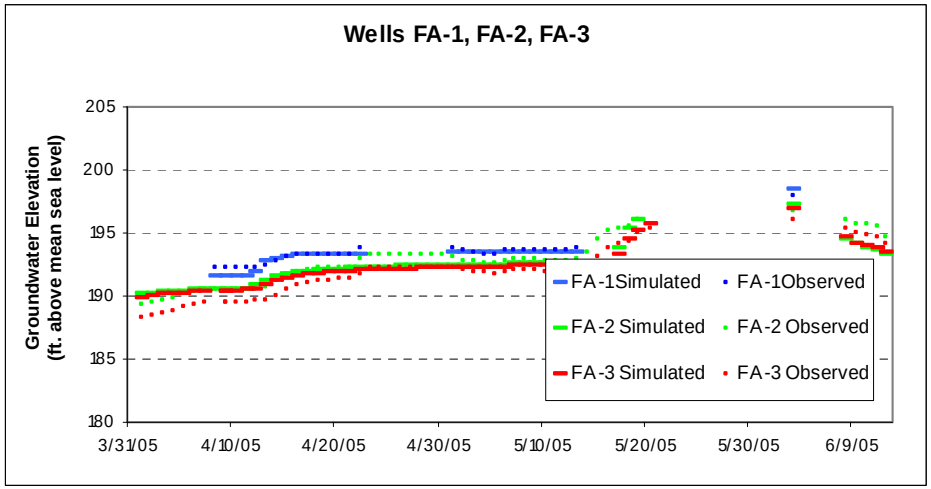
# *Updated Model Calibration, Spring 2005 Flood Release*

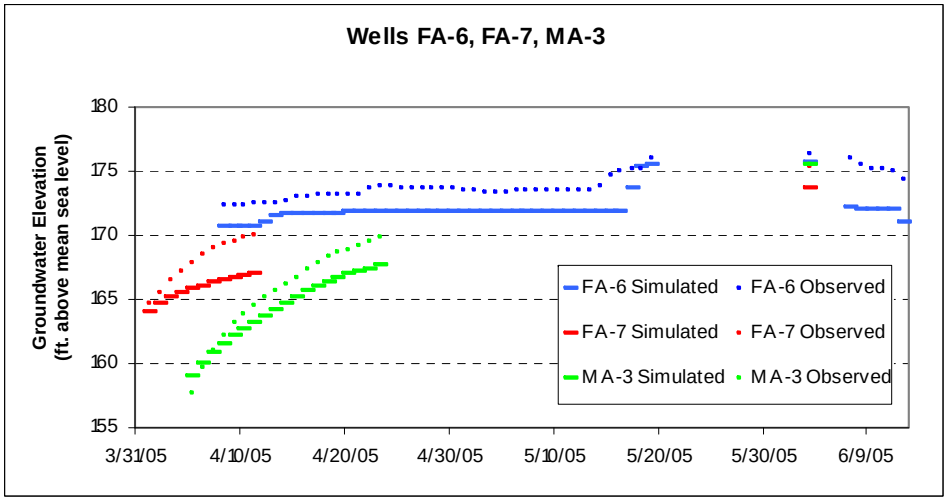



*River Coverage in Reach 2 for RIV Pkg at 500, 2,000 and 8,000 cfs*

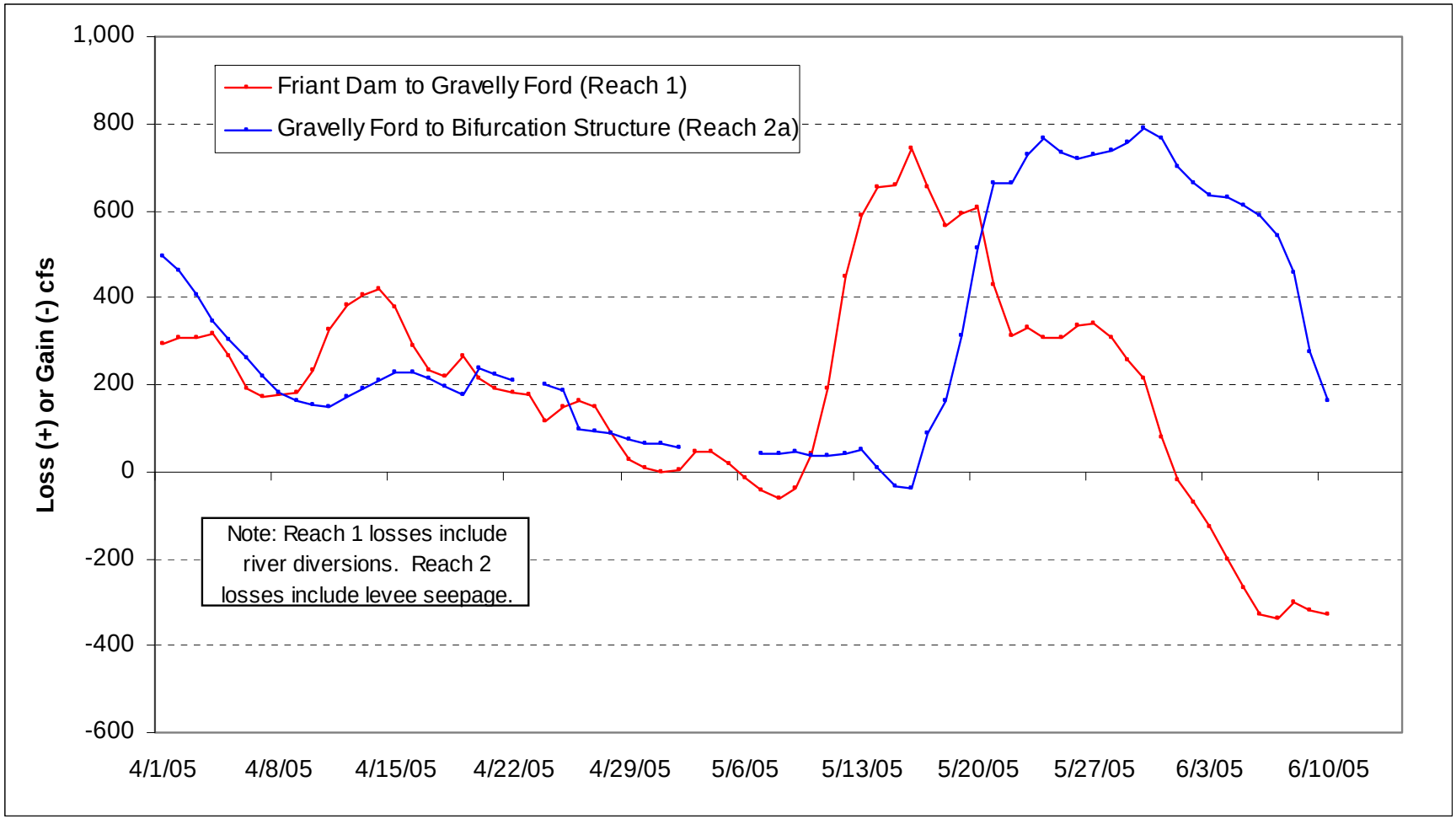
# *Updated Model Calibration, Simulated and Observed Groundwater Levels*



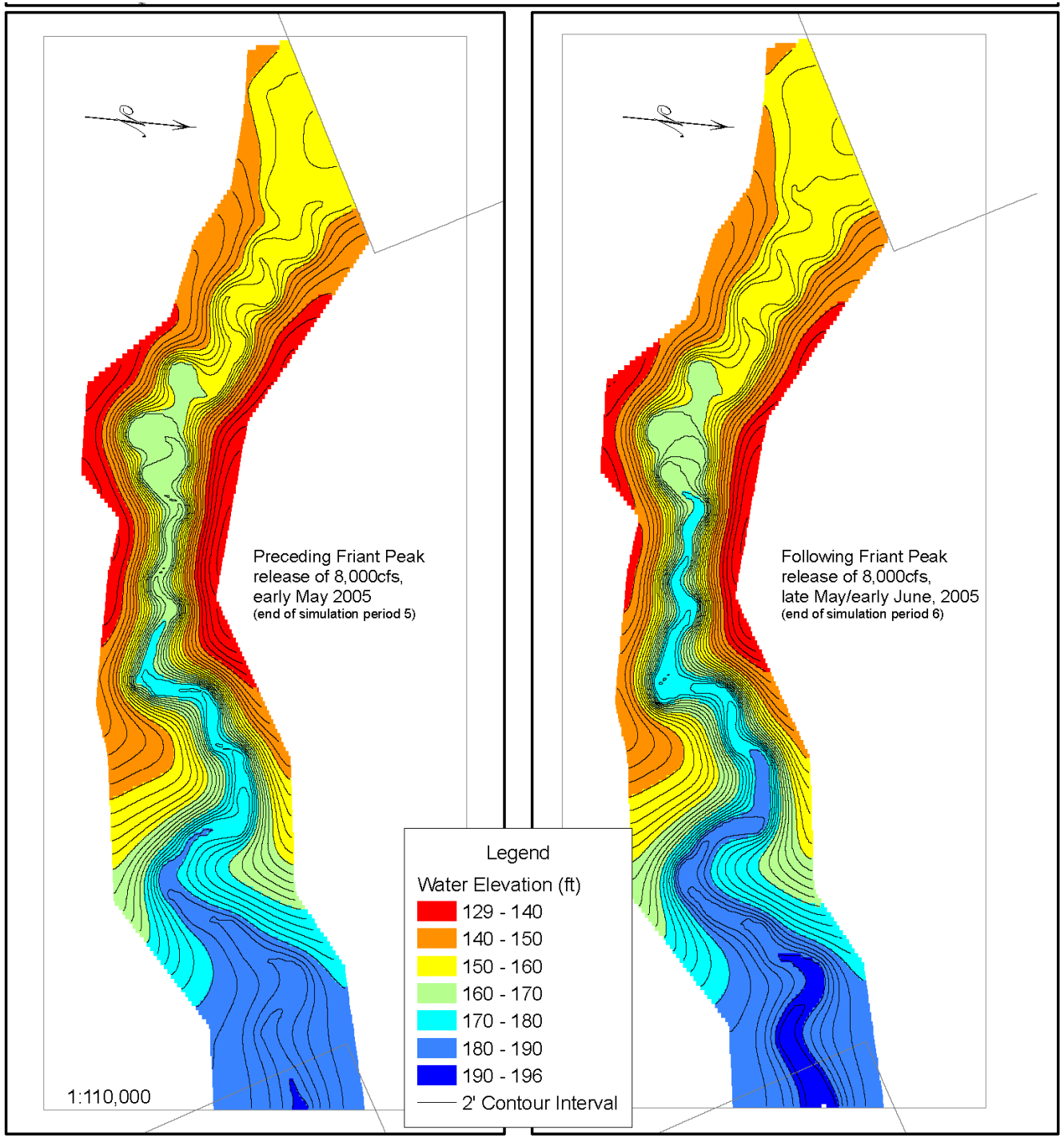



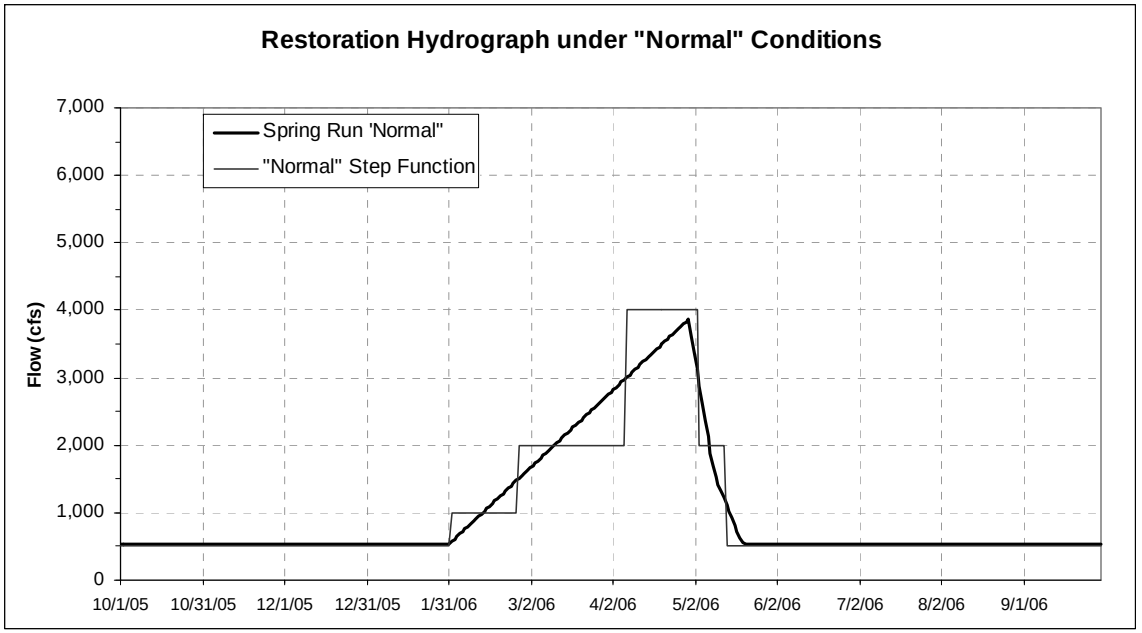
# *Updated Model Calibration, Spring 2005, River Seepage Targets*



# *Simulated Groundwater Elevation before and after 2005 Peak Flow, Reach 2*



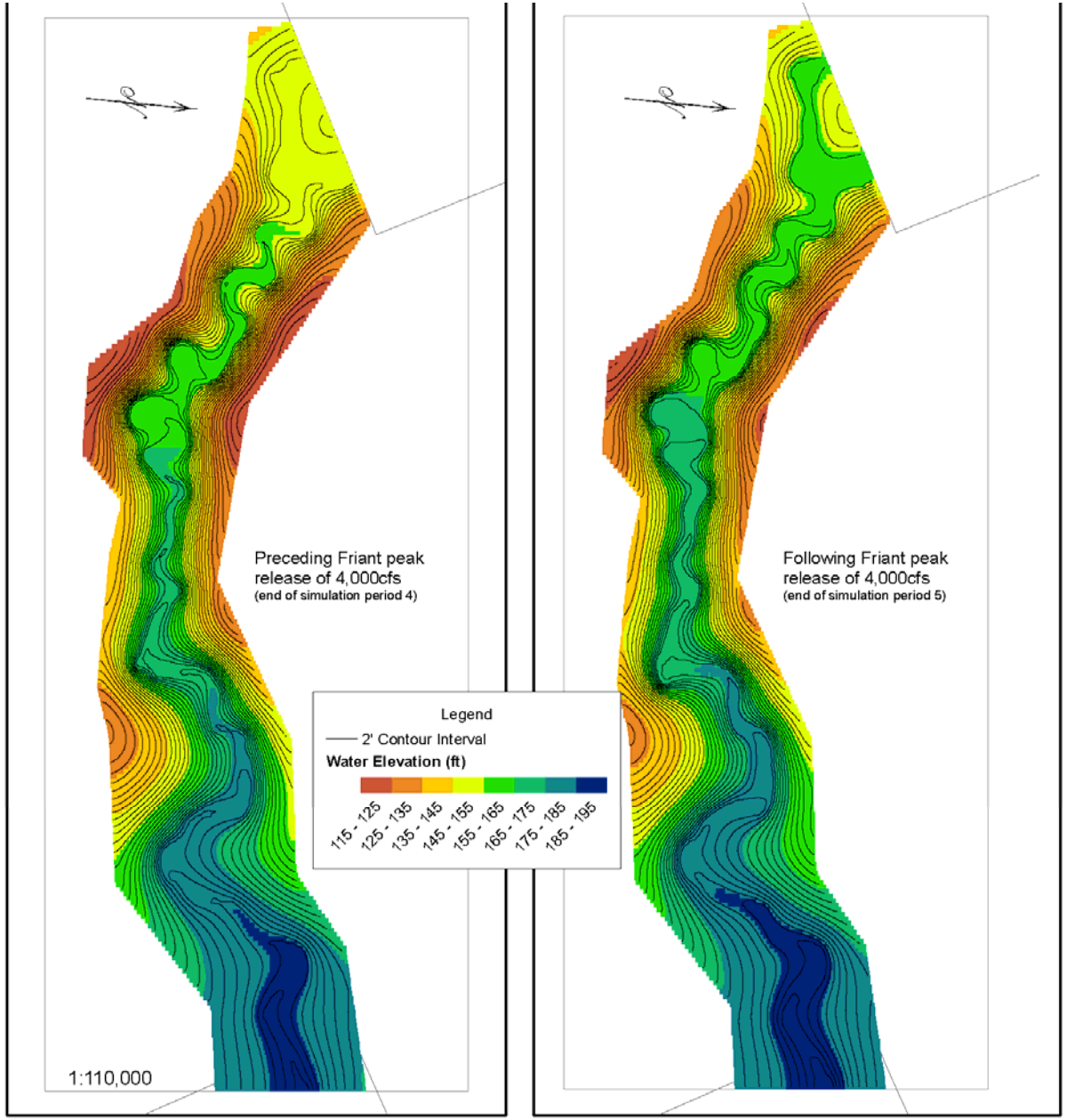
# *Example Restoration Hydrograph and Simulated Reach Losses*




**Normal Condition Hydrograph**

| Date | Flow (cfs) | Reach 1a | Reach 1b | Reach 2a | Reach 2b | Total, cfs | Total acre-ft |
|---|---|---|---|---|---|---|---|
| 10/1-1/31 | 500 | 46 | 30 | 166 | 3 | 245 | 59,772 |
| 2/1-2/25 | 1,000 | 77 | 53 | 96 | 279 | 505 | 25,041 |
| 2/26-4/6 | 2,000 | 89 | 57 | 83 | 81 | 310 | 24,595 |
| 4/7-5/3 | 4,000 | 155 | 88 | 100 | 86 | 429 | 22,975 |
| 5/4-5/13 | 2,000 | -65 | -29 | 18 | -13 | -89 | -1,765 |
| 5/14-7/22 | 500 | -4 | -4 | 29 | -8 | 13 | 1,805 |
| 7/23-9/30 | 500 | 29 | 16 | 37 | 2 | 84 | 11,663 |
| **Reach 1 and 2 Annual Seepage Loss, acre feet** | | | | | | | **144,085** |

**Left: before 4,000 cfs peak**
**Right: after 4,000 cfs peak**



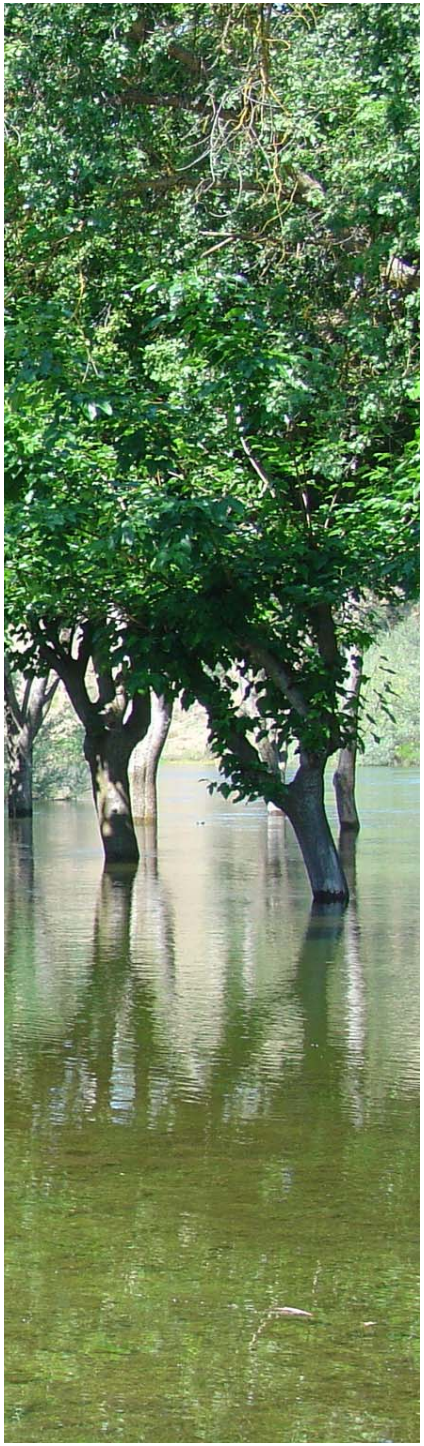

*Simulated Groundwater Elevation, under Restoration Hydrograph for "Normal" Year, Reach 2, after "Dry" Year*

# Observations

- River seepage losses are dynamic:
  - Non-linear dependency on river flow
  - Dependent on past year's flow history
  - Dependent on regional groundwater levels
  - Not all losses will return as bank storage.
- Groundwater elevations are dynamic:
  - Dependent on river flows
  - Dependent on pumping in near and distant regions
  - Impacted by vegetation and stream bed

# *Implications*

- River losses will vary substantially throughout a season;
- Losses in any given year will likely vary from those seen in a prior year.
- Making most efficient use of available water to meet river restoration goals will require sophisticated understanding of groundwater conditions impacting river seepage losses.



# *Improving Model Reliability*

- DATA, DATA, DATA....
  - Groundwater piezometers
  - Well logs
  - Hydraulic testing
  - Land surface and river bed elevation data
  - Flow data

- CALIBRATE, VERIFY, CALIBRATE, VERIFY. CALIBRATE.....
  - Restoration program data can be used to refine tools and improve their value to the program in meeting water management and restoration goals.


Questions?