# C2VSimCG

## *C2VSimCG Data Updates, Calibration & Baseline Development*

*Presented By:*

*Ali Taghavi*

*Andres Diaz*

*Sara Miller*

CALIFORNIA DEPARTMENT OF WATER RESOURCES

BAY-DELTA OFFICE

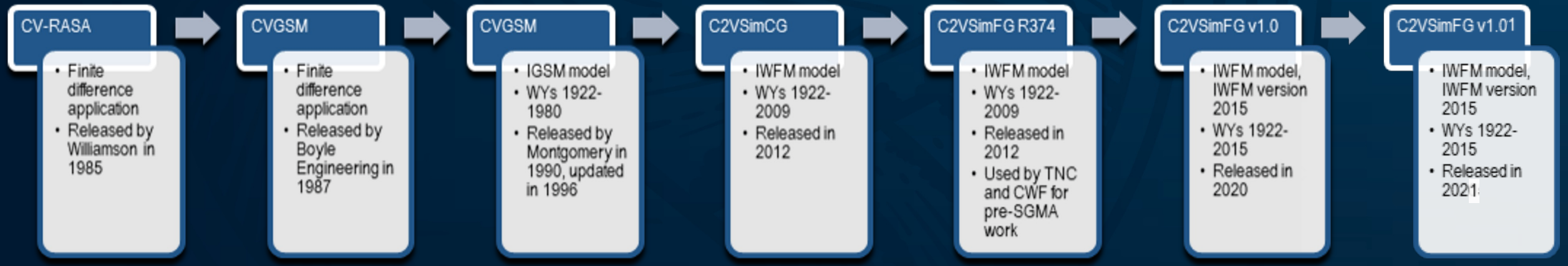
Woodard & Curran

*CWEMF 2022 Annual Meeting*

April 4, 2022

# Project Background

- Continuation of decades of Central Valley modeling
  - 1990s CVGSM (IGSM platform) -> 2010 C2VSim (IWFM platform)
  - Finite element grid (C2VSimFG)– more detailed spatial scale for analysis



# Project Goals

- Update and calibrate C2VSimCG using updated data from C2VSimFG v1.01
- Investigate better ways to represent and simulate the Delta
- Develop existing conditions baseline
- Coordinate linking of C2VSimCG to CVSOM
- Model documentation

# Presentation Outline

- Historical Model Update
  - Mapping of Data
  - Review of Data
- Historical Model Calibration and Results
  - Manual Calibration
  - PEST-Assisted Calibration
  - Model Results
- Existing Conditions Baseline Development
- Acknowledgements and Questions

# California Central Valley Groundwater-Surface Water Simulation Model – Coarse Grid (C2VSimCG)

## Historical Model Update

Mapping of Data
Review of Data

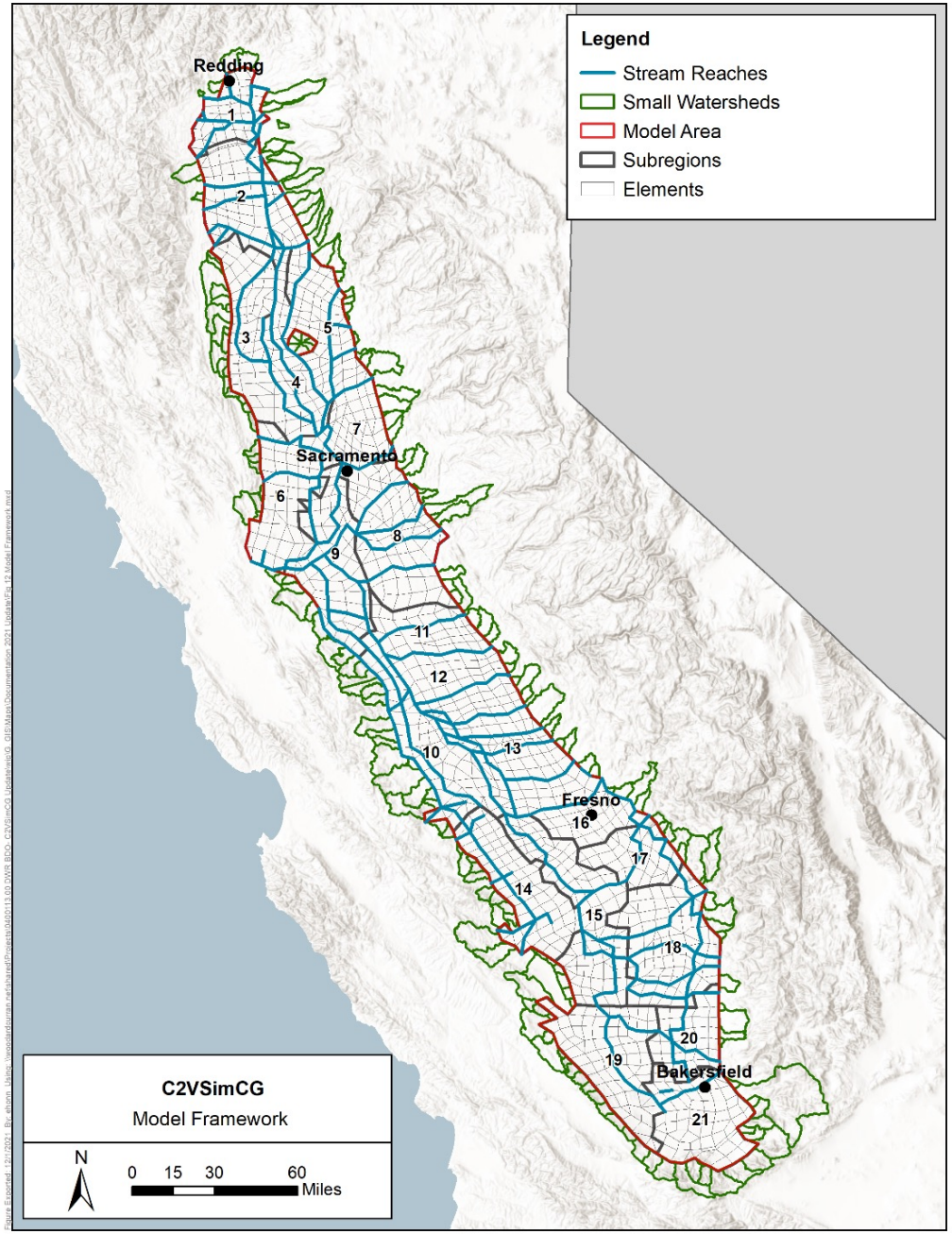
Woodard & Curran

# Major Changes Since Last Public Release of C2VSimCG

- IWFM version 3.02 to IWFM-2015
- All updates made to C2VSimFG v1.01 upscaled to C2VSimCG
  - Extensive update and refinement of datasets
  - Extension of data through Water Year 2015
  - From 3 aquifer layers to 4
  - Simulation of more streams
  - Diversion data from CalSim 3 and local models
  - And more

# C2VSimCG Overview

- IWFM-2015
- Monthly data from October 1921 through September 2015
  - Simulation period of WY 1974 through 2015
- Finite Element Grid with 1,393 nodes and 1,392 elements
  - Grouped into 21 subregions based on Depletion Study Areas (DSAs)
- 4 aquifer layers and 1 aquitard representing Corcoran Clay
  - 2 faults represented with hydrologic conductivity
- 110 stream reaches and 663 stream nodes
- 197 small watersheds
- Runs in under 30 minutes

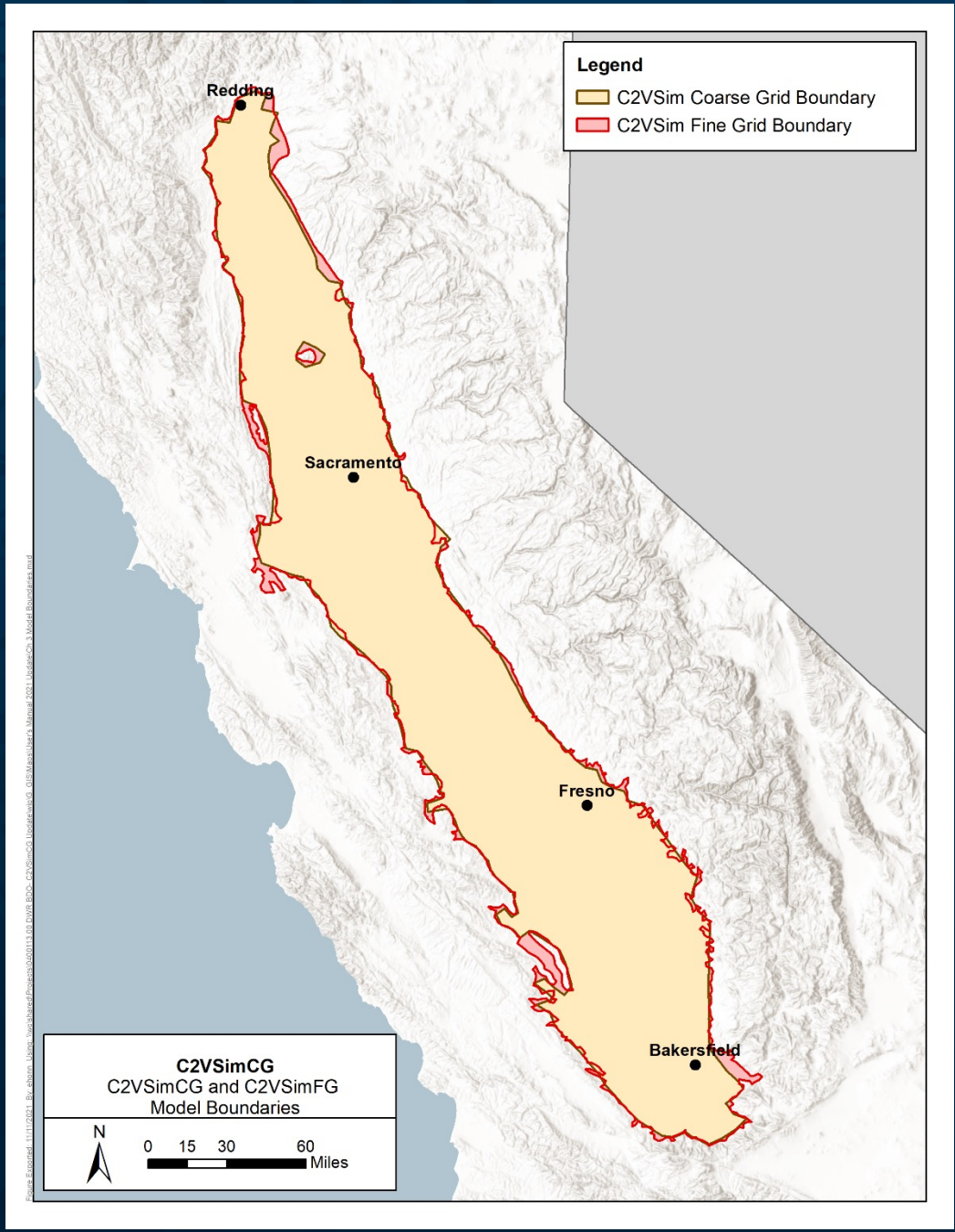


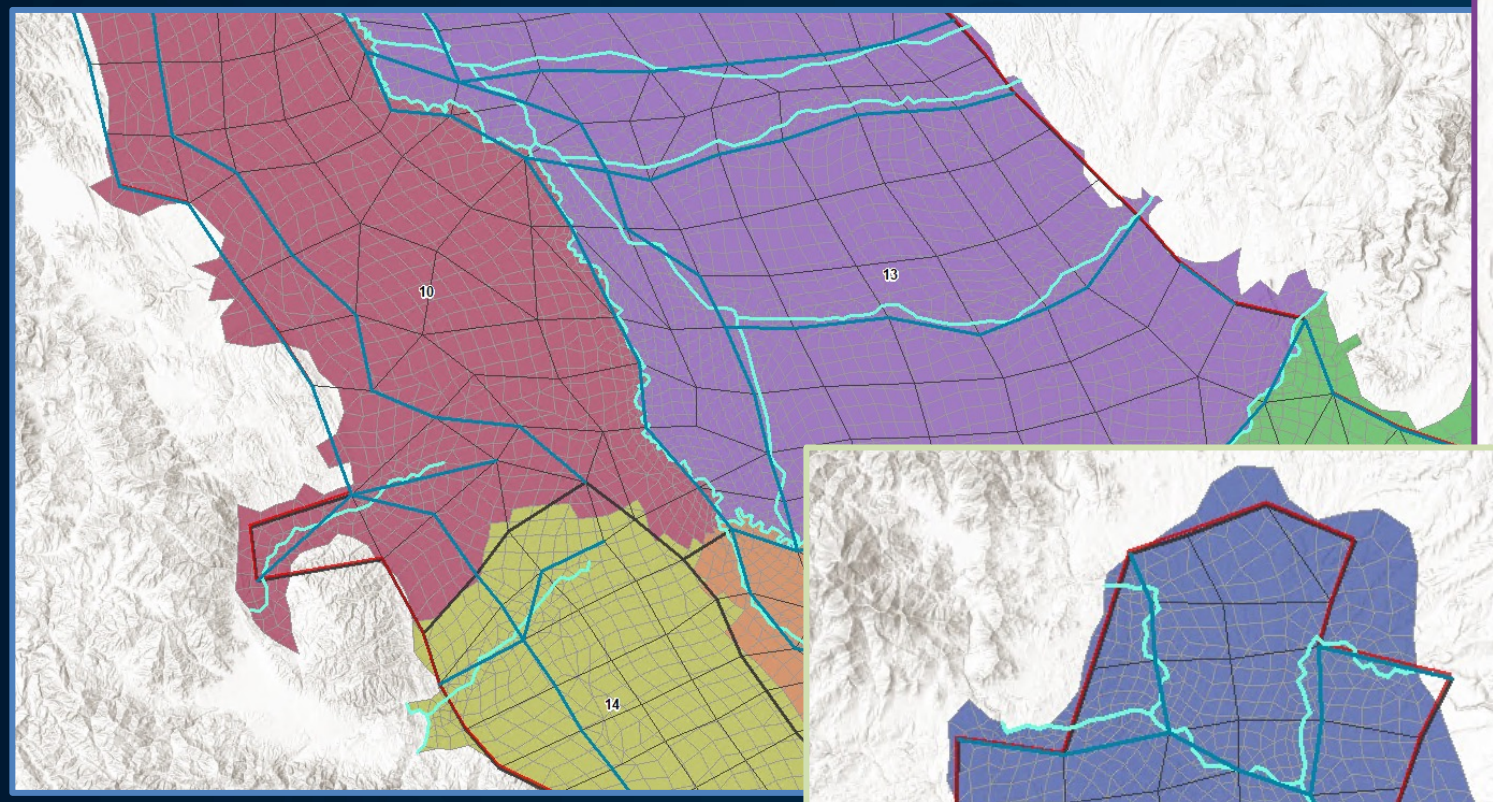
# Mapping of C2VSimFG to C2VSimCG

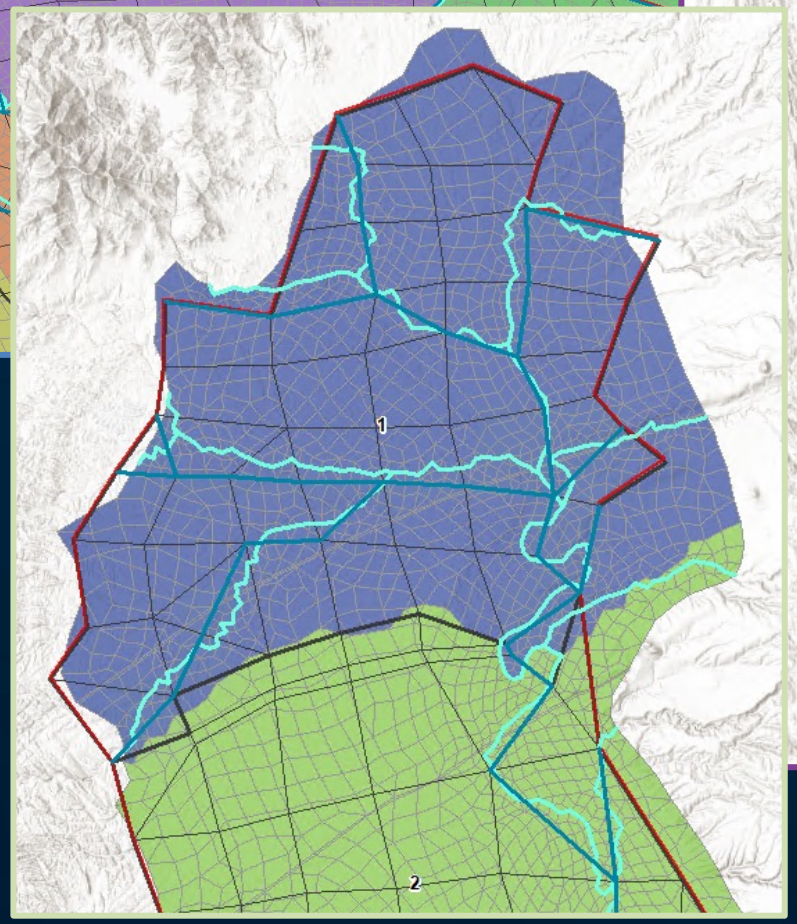
- Element to element
  - Area-weighted average of overlapping elements
    - precipitation, land use
  - Average by centroid
    - unsaturated zone, curve number, root zone parameters
  - Overlapping of area (by both % of total area and % of element overlapped)
    - delivery groups
- Node to node
  - Used data from closest C2VSimFG stream node
  - Mapped from raster created from C2VSimFG node data
    - stratigraphy, initial groundwater head
  - Average by Thiessen polygons
    - aquifer parameter

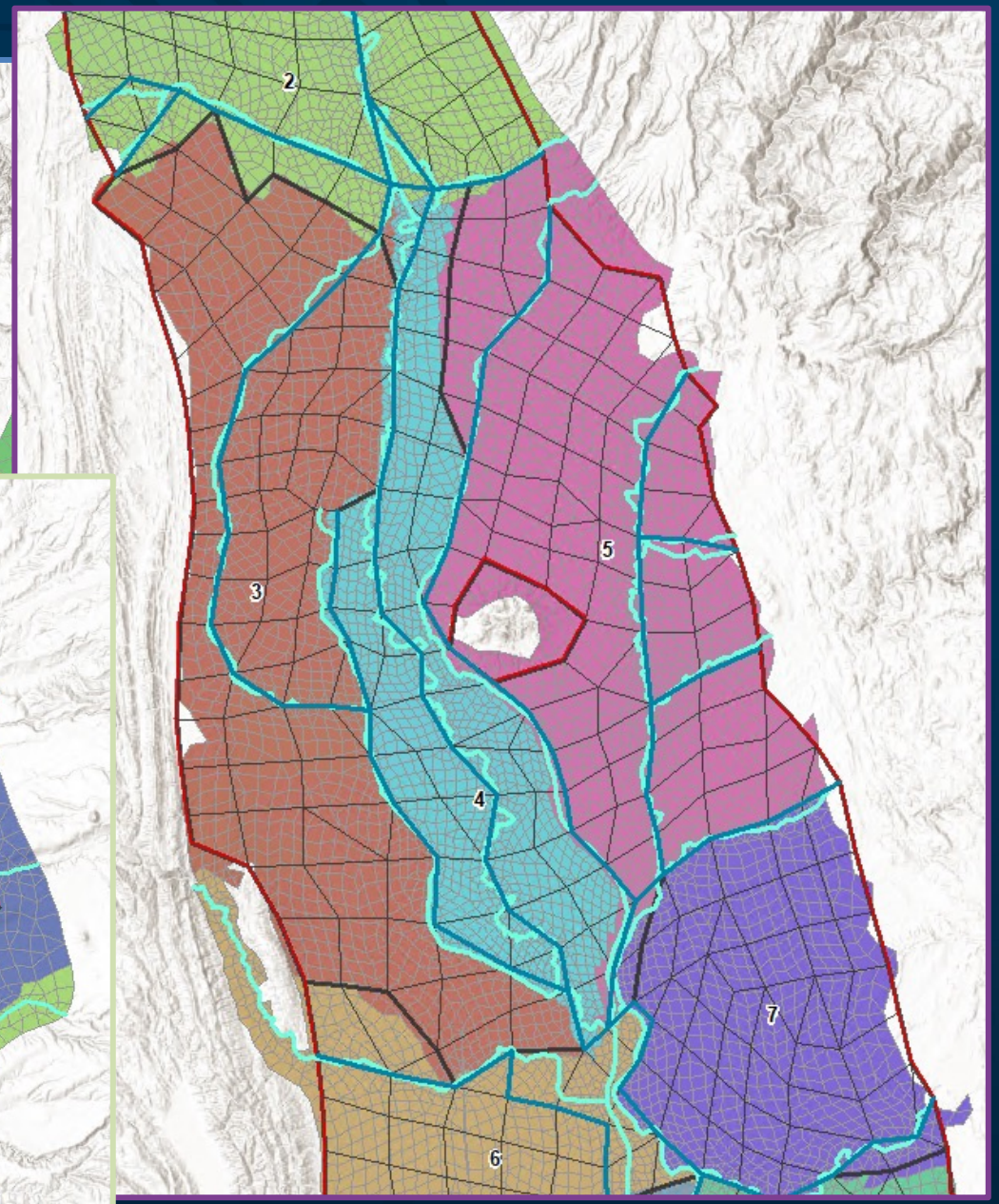
# Mapping Challenges

- Differences in element sizes, model boundaries, and subregion boundaries between C2VSimCG and C2VSimFG
- Sample challenges
  - Data extrapolation to extend to C2VSimCG boundary
  - Land use acreage
  - Location of streams and stream nodes
  - Surface water delivery areas, distribution, and loss fractions




10
13
14


1
2


2
3
5
4
7
6

# Delta Modifications*

- Updated using existing studies and models
  - DAYFLOW
  - DICU/DSM2
  - Delta Atlas
  - DEM
  - USACOE Delta Maps
- Model changes
  - Stream network and bypasses
  - Surface water diversion locations and monthly rates
  - Stratigraphy and ground surface elevation
  - Tile drains
  - Set Delta island groundwater pumping to zero
  - Aquifer parameters

* See presentation by Charles Brush on “Updates to the Delta Area” (Session 4)

# California Central Valley Groundwater-Surface Water Simulation Model – Coarse Grid (C2VSimCG)

## Historical Model Calibration and Results

Manual Calibration
PEST Calibration
Model Results

DEPARTMENT OF WATER RESOURCES · STATE OF CALIFORNIA ·

Woodard & Curran

# Calibration

- Starting from C2VSimFG calibrated parameters
- Calibration period for water years 1986 through 2015
- Manual Calibration
  - Review of demand at subregion scale
    - Per acre agricultural demand
    - Per acre refuge and rice demand
  - Water budgets at model, hydrologic region, and subregion scale
  - Refinement of Delta groundwater levels
- Automated Calibration
  - PEST-assisted calibration

# PEST-Assisted Calibration

- Calibration Approach
  - Consistency with C2VSimFG calibration approach*
  - Uses local geologic information
    - As a result, it creates natural heterogeneity
  - Needs fewer calibration parameters
- Texture2Par
  - Pre-processing program to estimate aquifer parameters
  - Estimates aquifer parameter values based on texture data
    - Power Law

$$K_h = \left[F_c K_c^p + F_f K_f^p\right]^{1/p}$$

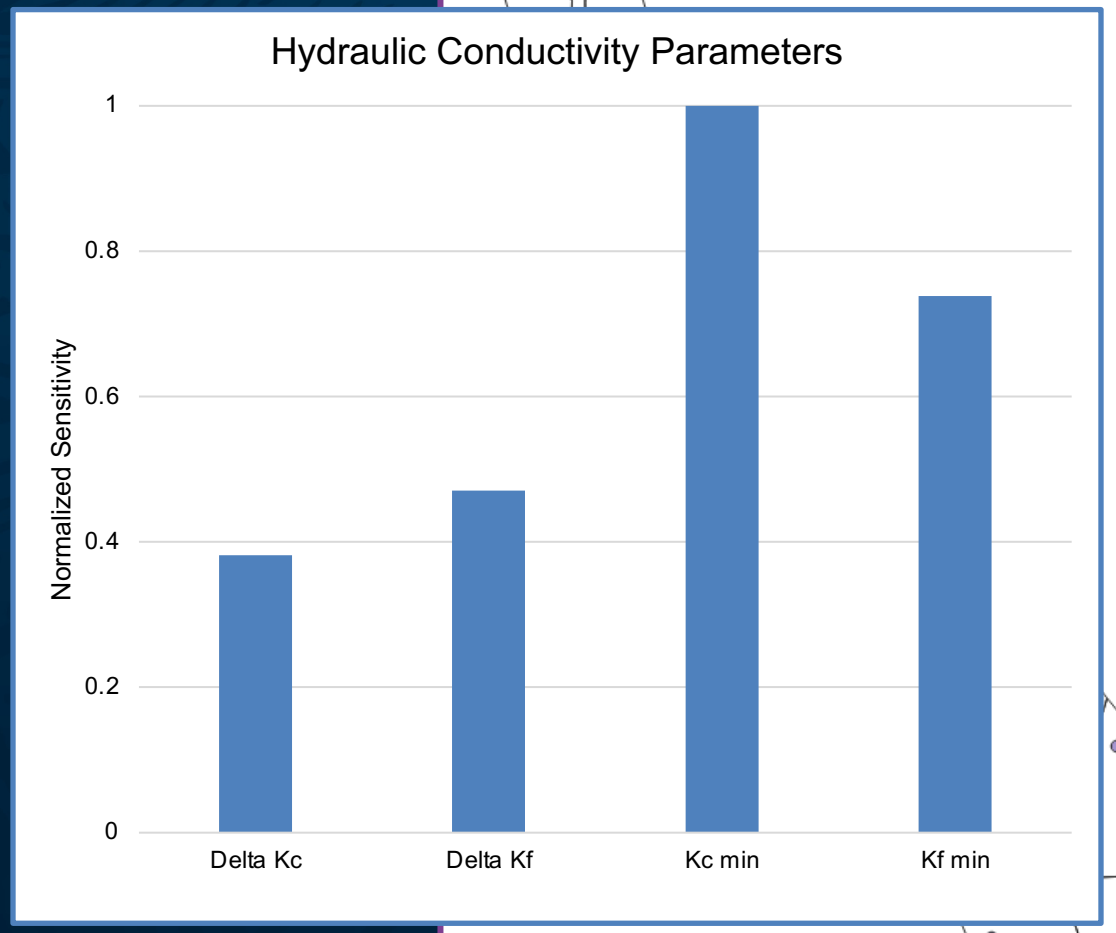
    - Depth dependency

$$K_h = K_{min} + (\Delta K)\exp(-kd)$$

* See presentation by Mesut Cayar, Sercan Ceyhan, and Vivek Bedekar on “Historical Calibration of C2VSim-FG” (Session 7)

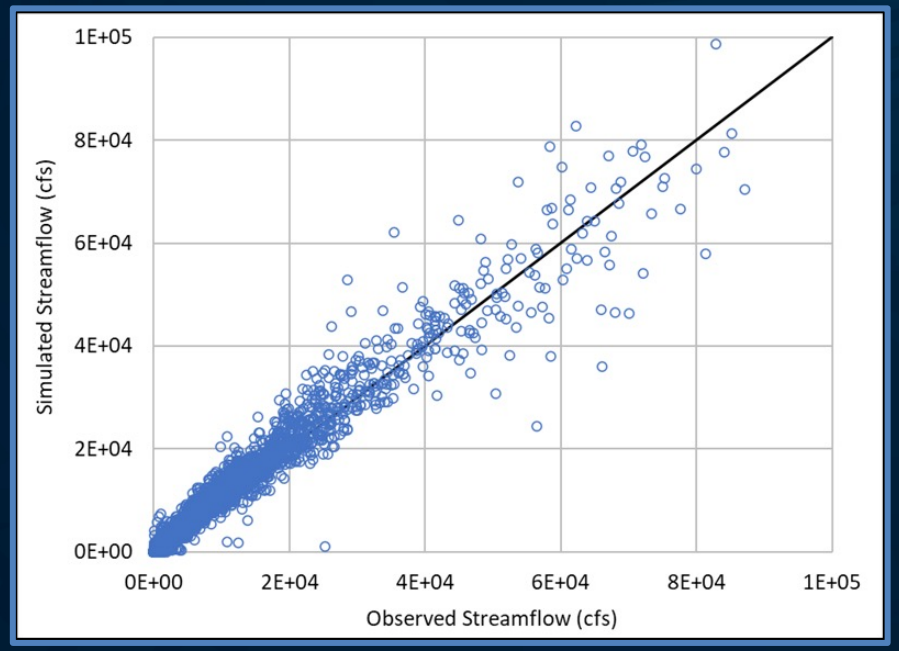
# PEST-Assisted Calibration

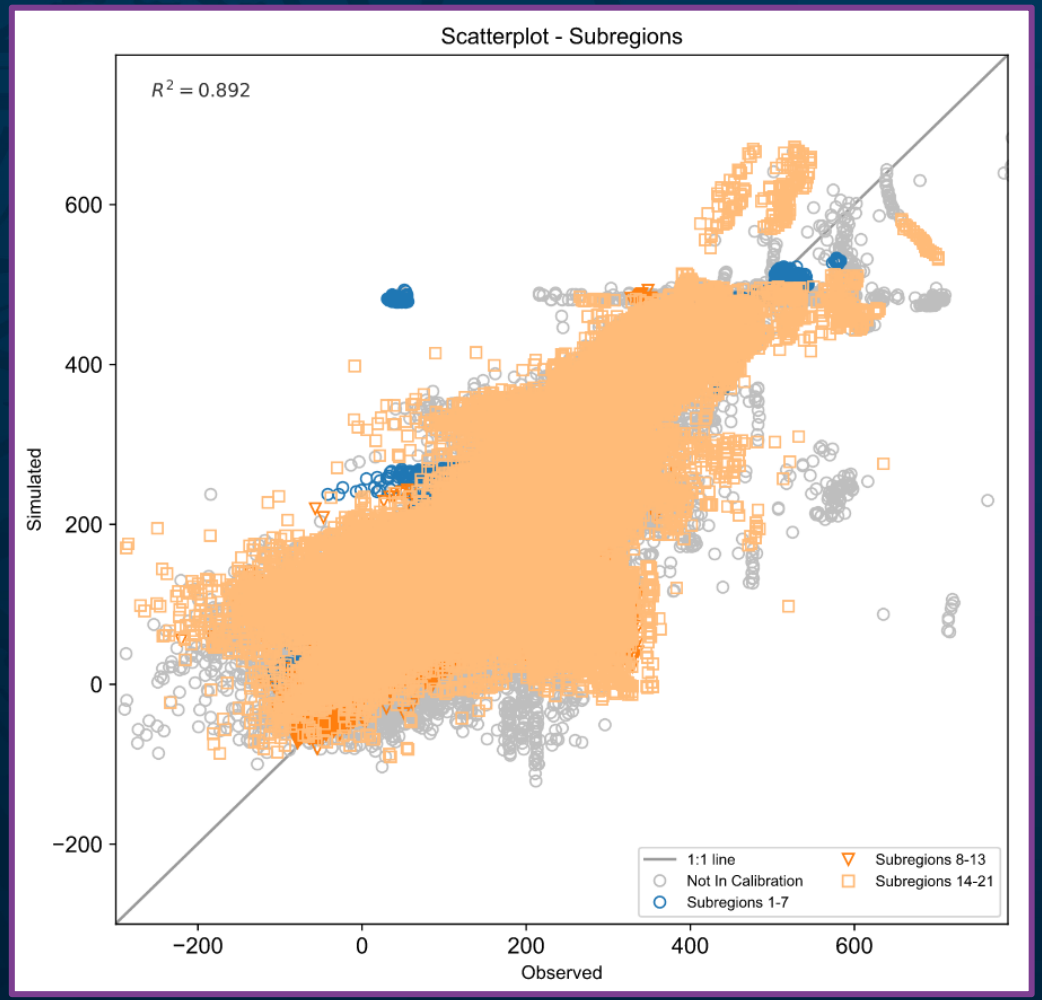
- Calibration Setup
  - 71 Pilot points
  - Grouped in 20 groups
    - 7 in Sacramento Valley
    - 6 in San Joaquin Valley
    - 6 in Tulare Region
    - 1 in Corcoran Clay area
- Sensitivity Analysis



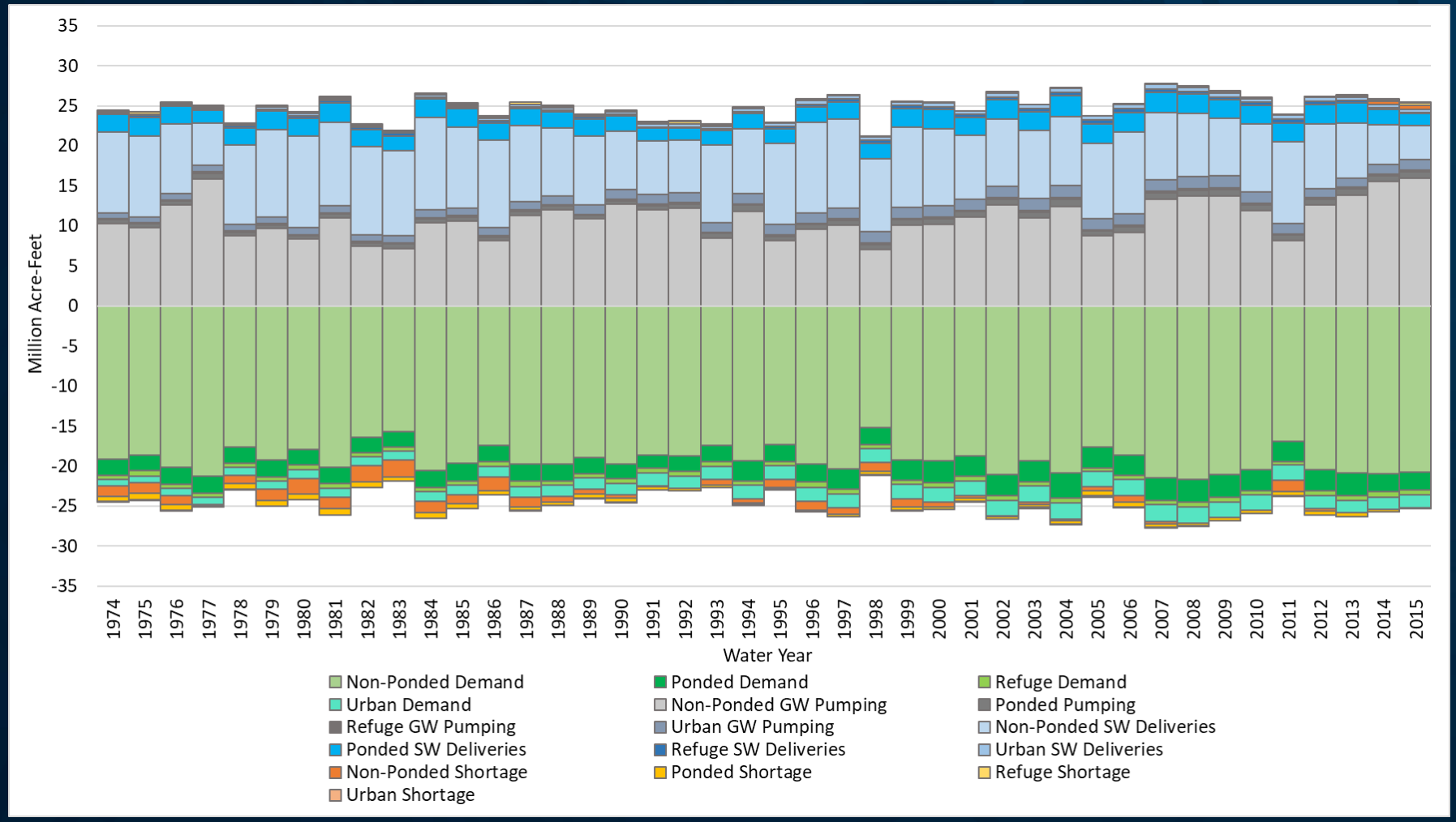
# Calibration Verification

- Comparison to C2VSimFG v1.01 results
- Review of root mean squared errors and cumulative residuals between simulated and observed values of groundwater heads, vertical groundwater head differences at select multi-completion wells, and stream flows



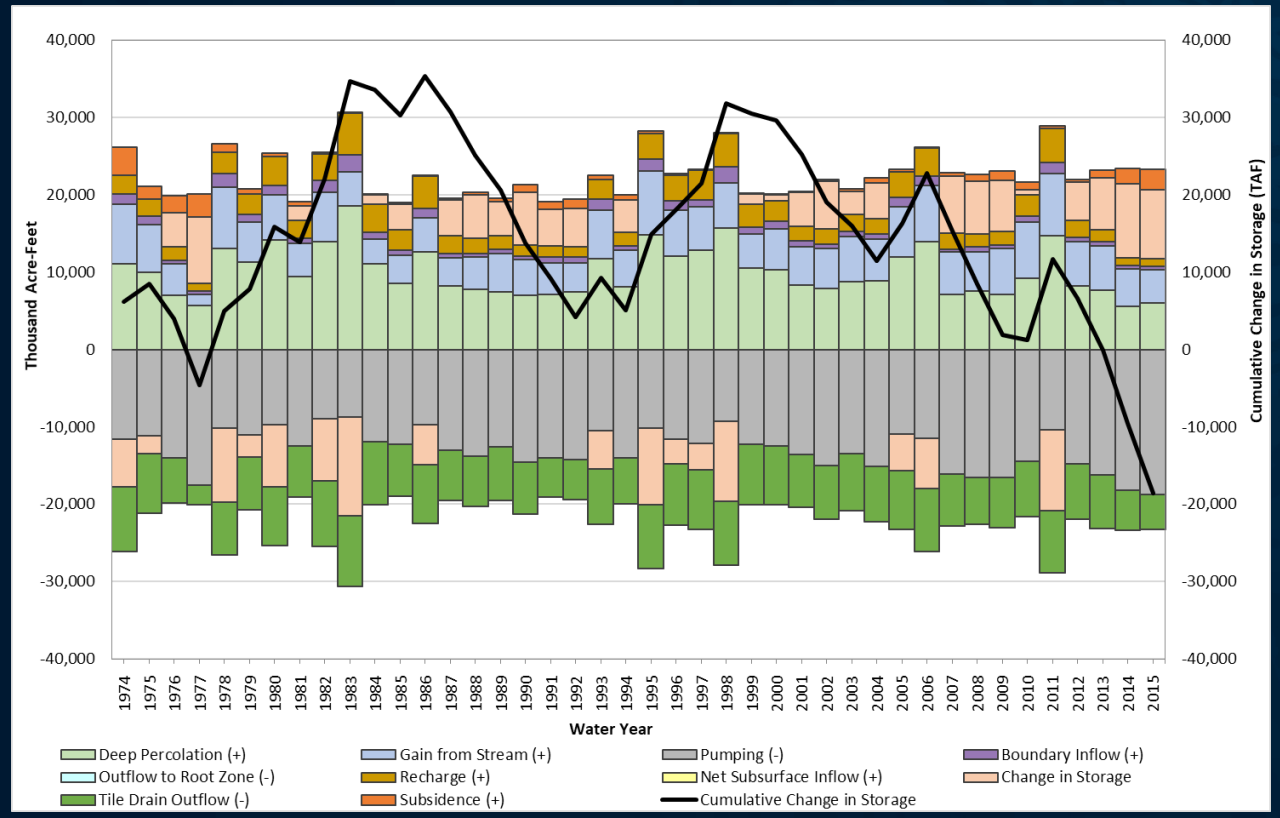



# Land & Water Use Budget (Central Valley)

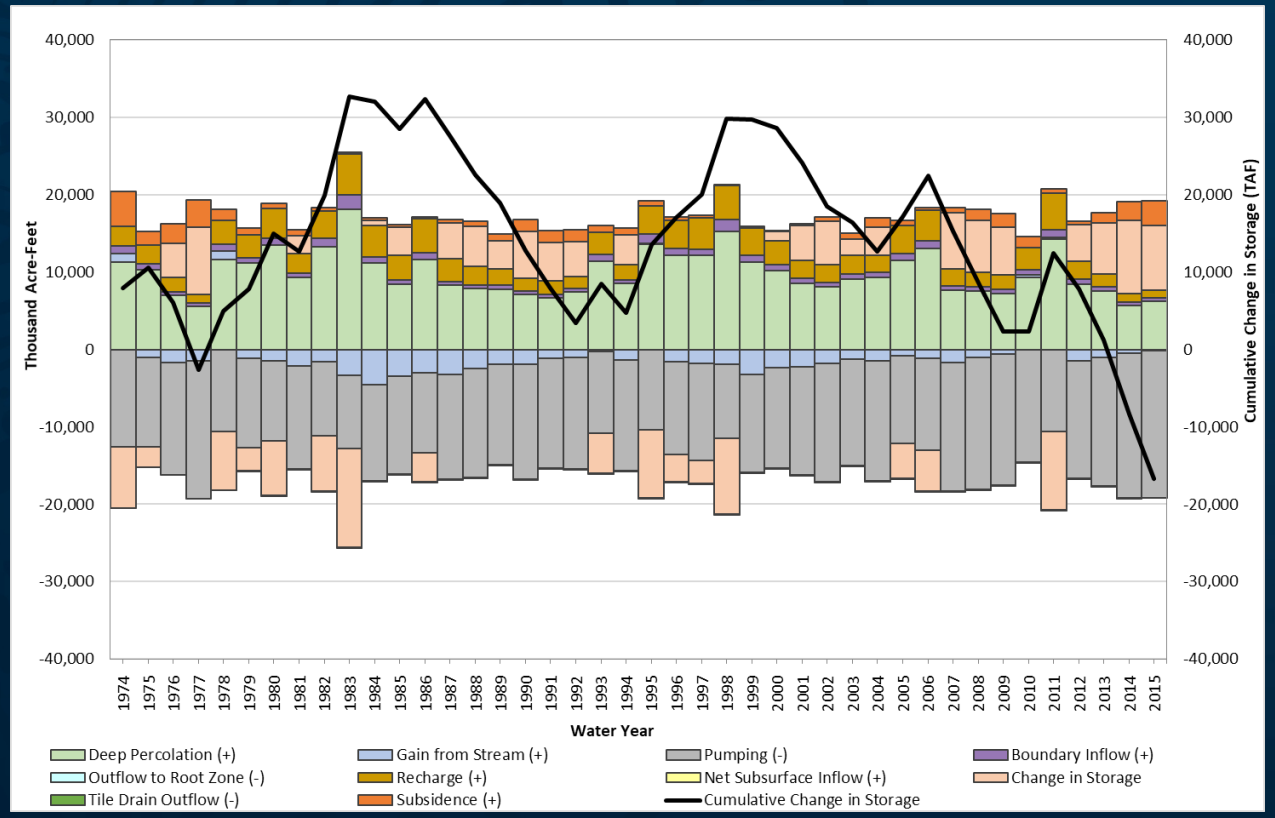


# Groundwater Budget (Central Valley)

## C2VSimCG

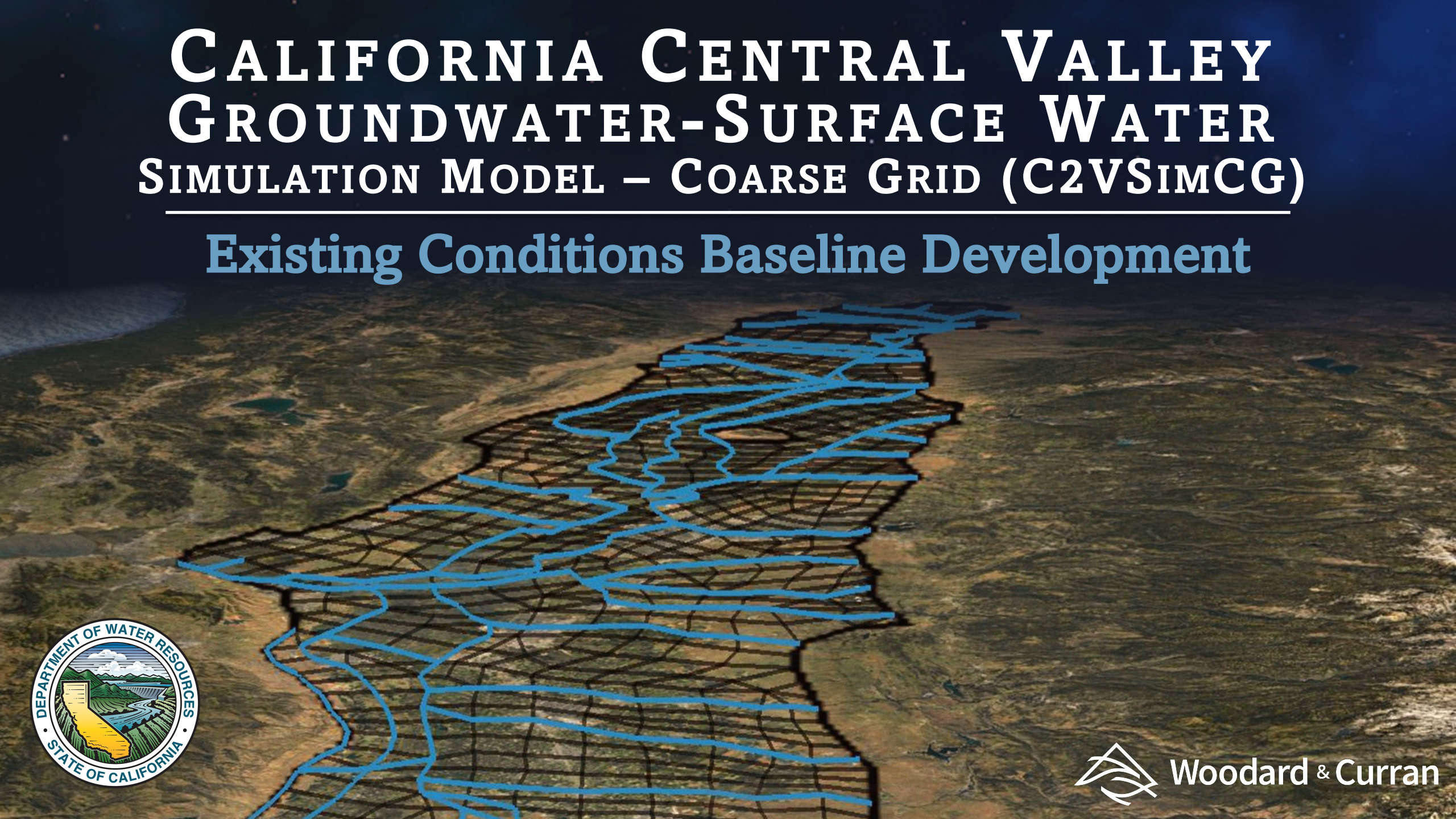



## C2VSimFG



# California Central Valley Groundwater-Surface Water Simulation Model – Coarse Grid (C2VSimCG)

## Existing Conditions Baseline Development



DEPARTMENT OF WATER RESOURCES · STATE OF CALIFORNIA ·

Woodard & Curran

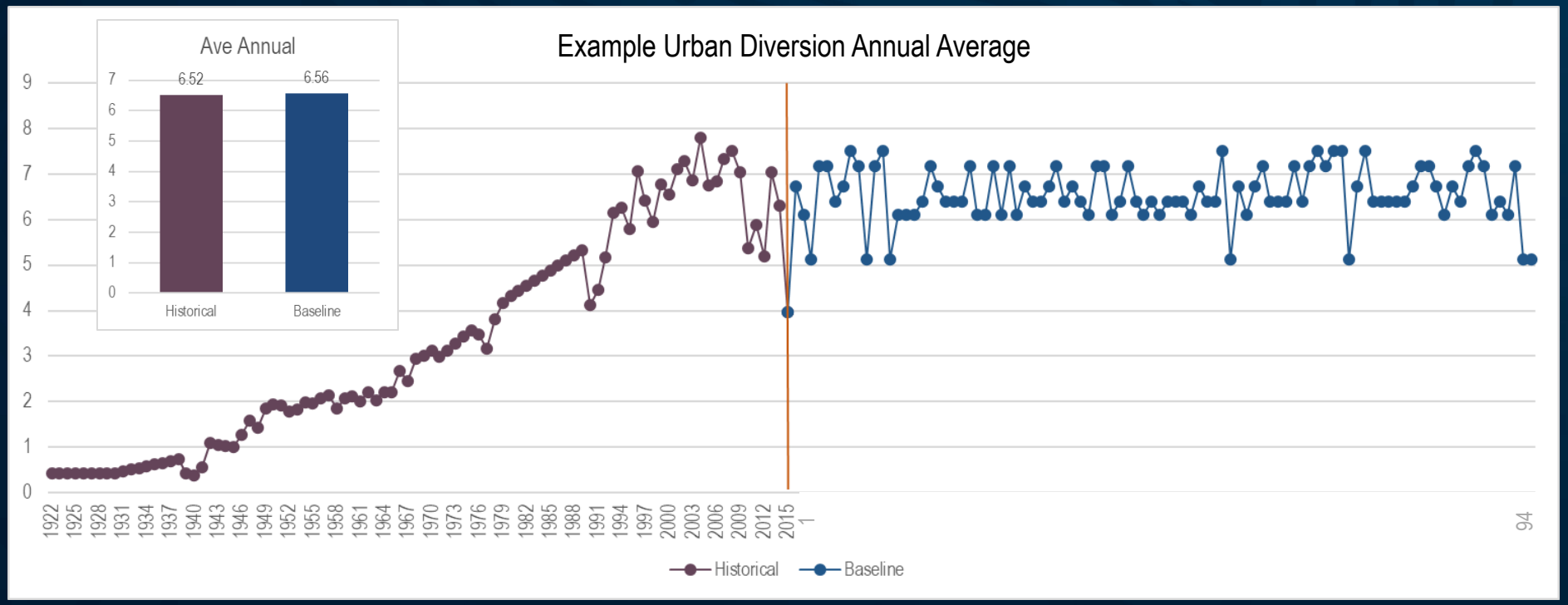
# Baseline Development

- Examines impact of historical hydrology (94 years from Water Year 1922-2015 for precipitation, evapotranspiration, and stream inflows) on demands based on a current level of development
- Using the same mapping techniques as for the historical C2VSimCG, mapped datasets from interim version of C2VSimFG baseline*

* See presentation by Liz DaBramo and Guobiao Huang on “C2VSim-FG Baseline Development” (Session 7)

# Baseline Data

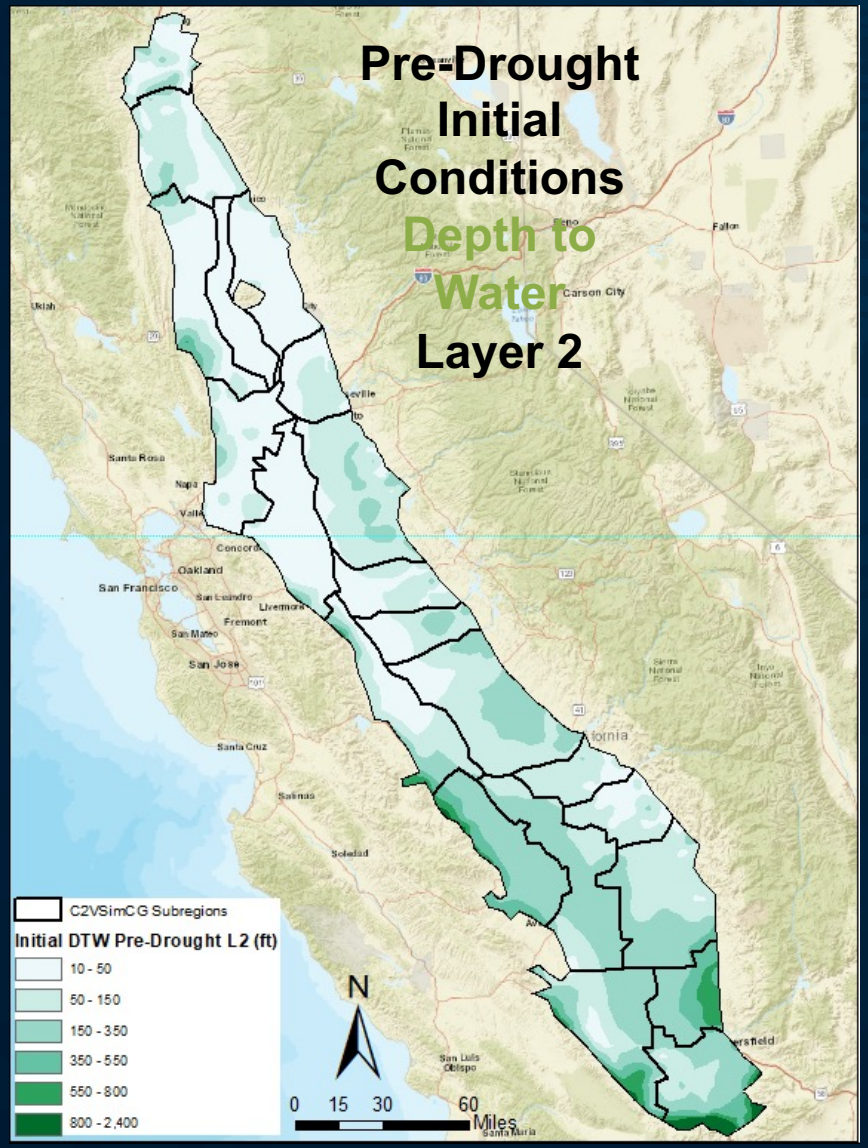
- Major datasets
  - Initial groundwater levels
  - Land use data
  - Surface water diversion time series

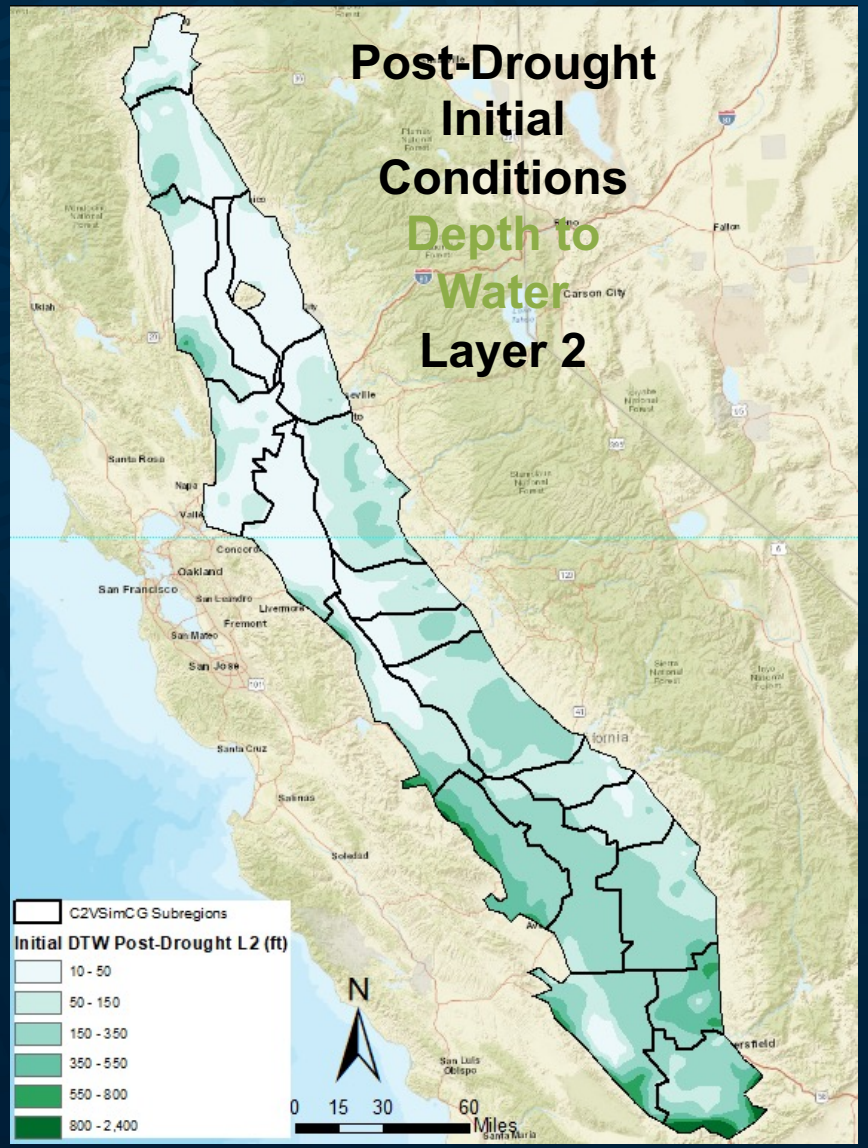


# Initial Groundwater Levels

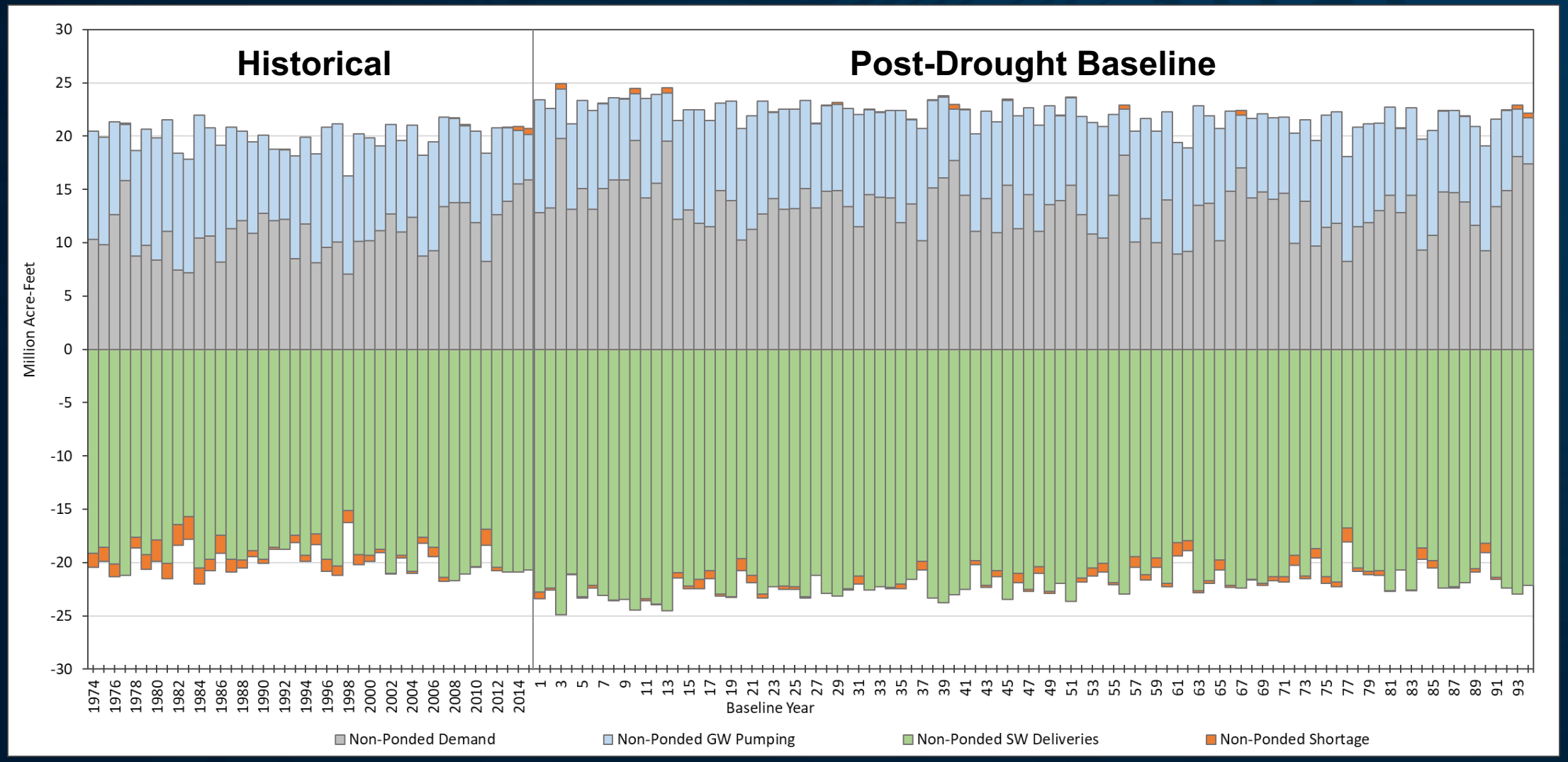
- “Pre-” (Fall 2010-2012) and “Post-Drought” (Fall 2018-2020) initial conditions developed from observed groundwater levels
- Layer 1 and Layer 2 separated in the Corcoran clay area based on wells with known and estimated perforation
- Refinement and QC of initial conditions consisted of:
  - Comparison of initial conditions to local data
  - Removal of wells with GWL observation outliers
  - Supplementing “gap” areas with estimated groundwater levels from historical observations outside of period of interest
  - Verifying locations where Layer 2 > Layer 1 in the Corcoran clay area

# Baseline Depth to Water

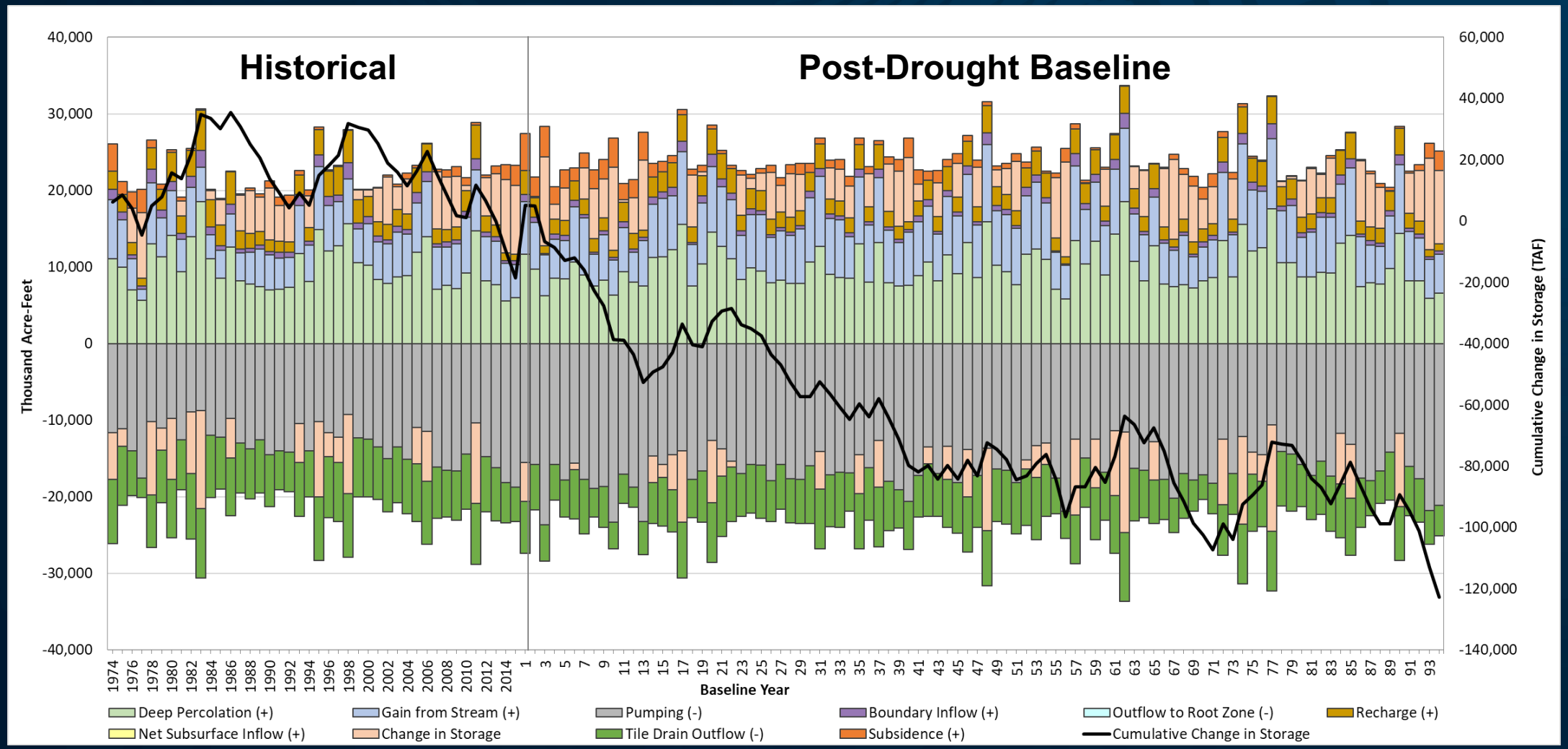


# Non-Ponded Land & Water Use Budget (Central Valley)



# Groundwater Budget (Central Valley)



# California Central Valley Groundwater-Surface Water Simulation Model – Coarse Grid (C2VSimCG)

## Acknowledgements


**Department of Water Resources**
- Tyler Hatch
- Tariq Kadir
- Can Dogrul
- Guobiao Huang
- Norman Johns
- Steven Jepsen

**Woodard & Curran**
- Ali Taghavi
- Mesut Cayar
- Sara Miller
- Sercan Ceyhan
- Andres Diaz
- Nery Barrera
- Dominick Amador
- Reza Namvar

**Hydrolytics, Inc.**
- Charlie Brush


## Presenting


**Ali Taghavi**
ATaghavi@woodardcurran.com
**Andres Diaz**
ADiaz@woodardcurran.com
**Sara Miller**
SMiller@woodardcurran.com


Woodard & Curran