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Surface Water Process Updates to C2VSimFG

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Sustainable Groundwater Management Office, DWR

CWEMF annual meeting

May 13, 2025

Outline

- Groundwater Sustainability Agencies (GSAs) Outreach and Local Model data

- Surface Water process in C2VSimFG
  1. Surface water delivery
  2. Streamflow
  3. Small watersheds

- C2VSimFG v1.5 surface water summary

  Stream network:

  stream reach:110; stream nodes: 4,634;
  stream inflow: 58; Flow bypass: 18
  stream observation: 63.

  Surface water delivery:
  total diversion: 498
  Small watersheds: 957

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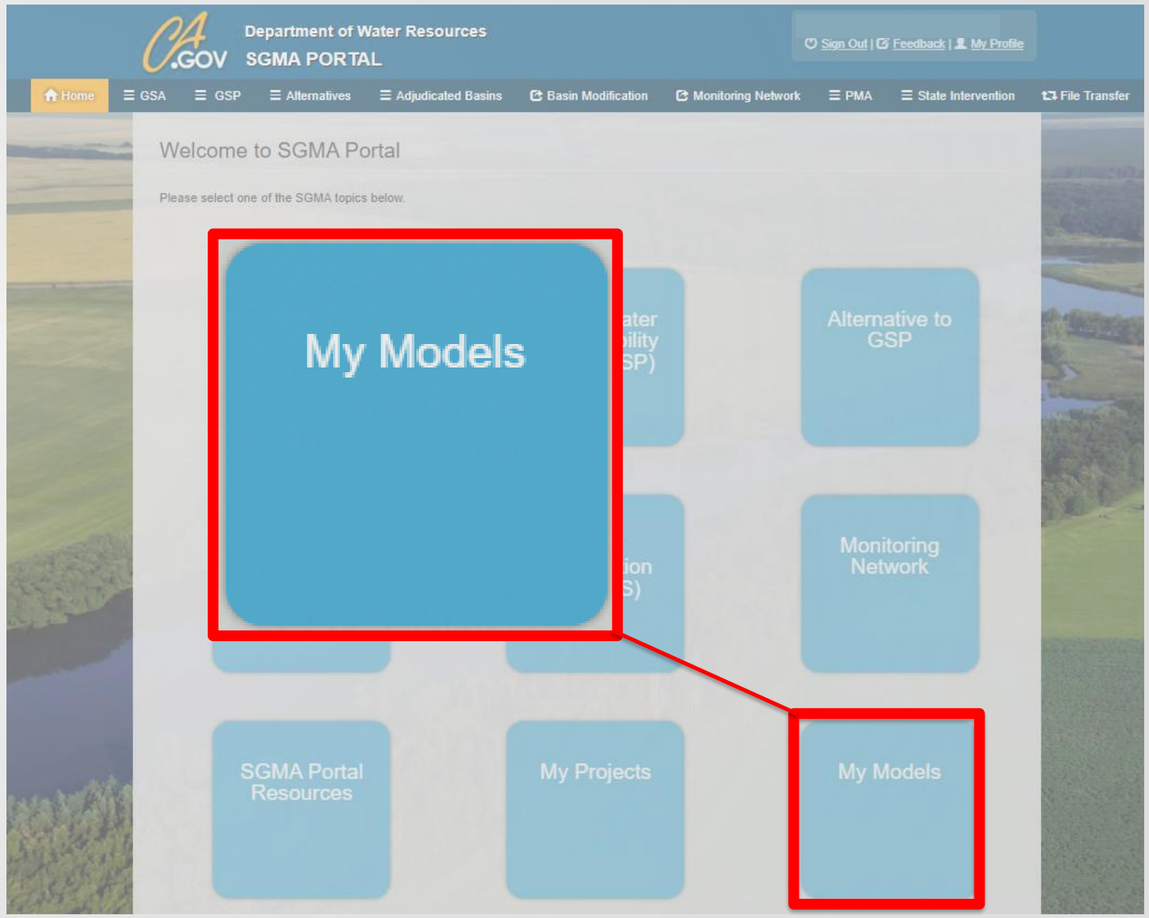
GSAs Outreach and Local Model Data - History

- DWR began an outreach and local model data request event in August 2023.
  - Emphasis on data extension (through water year 2021).
  - Priority was surface water deliveries, stream flow, and evapotranspiration (ET) ground-truthing data.
  - Many other model-related datasets requested (e.g., aquifer test, pumping rates/well logs, GIS) – see the data request here.
- Sustainable Management Groundwater Office (SGMO) and Region Office (RO) staff collaborated to contact Groundwater Sustainability Agencies (GSAs) and oftentimes consultants.
- The Sustainable Groundwater Management Act (SGMA) Portal was updated to include a Model dashboard to facilitate data uploads.
  - User Guide



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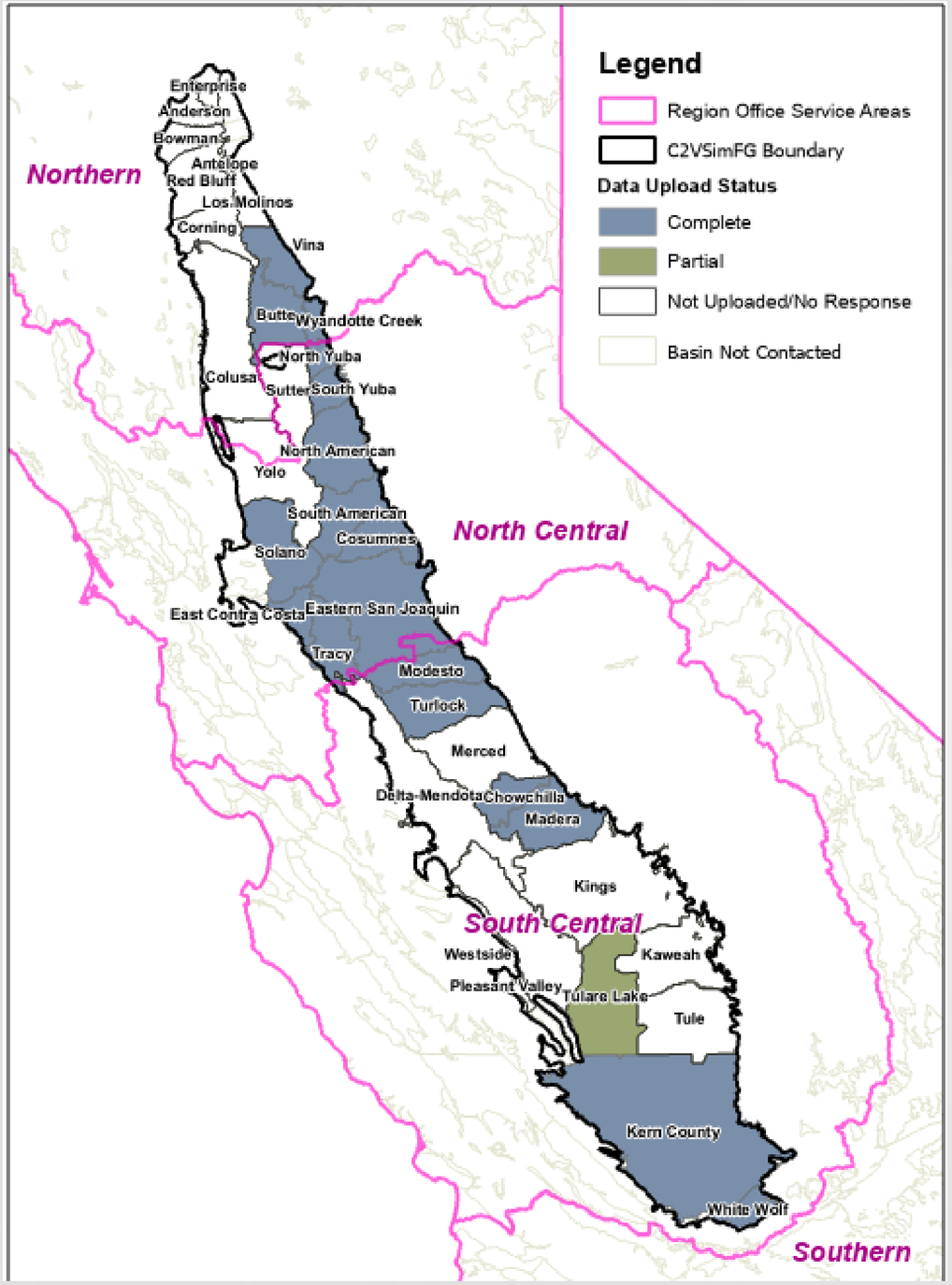
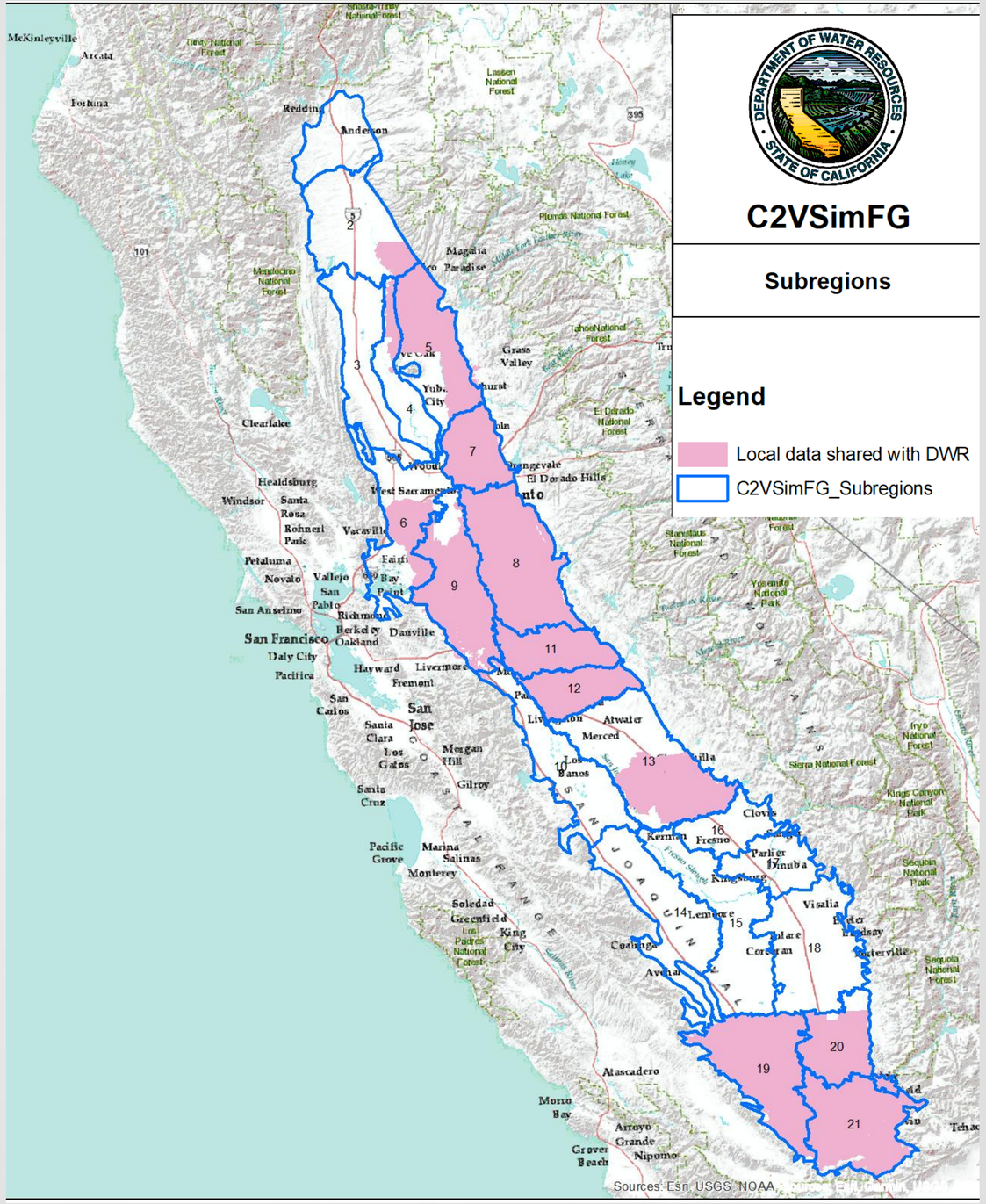
GSAs Outreach and Local Model Data - Outcome

- Data requested from the 36 groundwater subbasins in the model domain.
- Local model data has been provided for 18 groundwater (GW) subbasins, 12 model subregions.
  - 8 Sac Valley, 10 San Joaquin Valley
- Critical source data for surface water diversions, GW pumping, ground-truthed ET, and pumping tests.
- Utilize data alongside water budget components of Groundwater Sustainability Plans (GSPs) to refine/calibrate C2VSimFG.

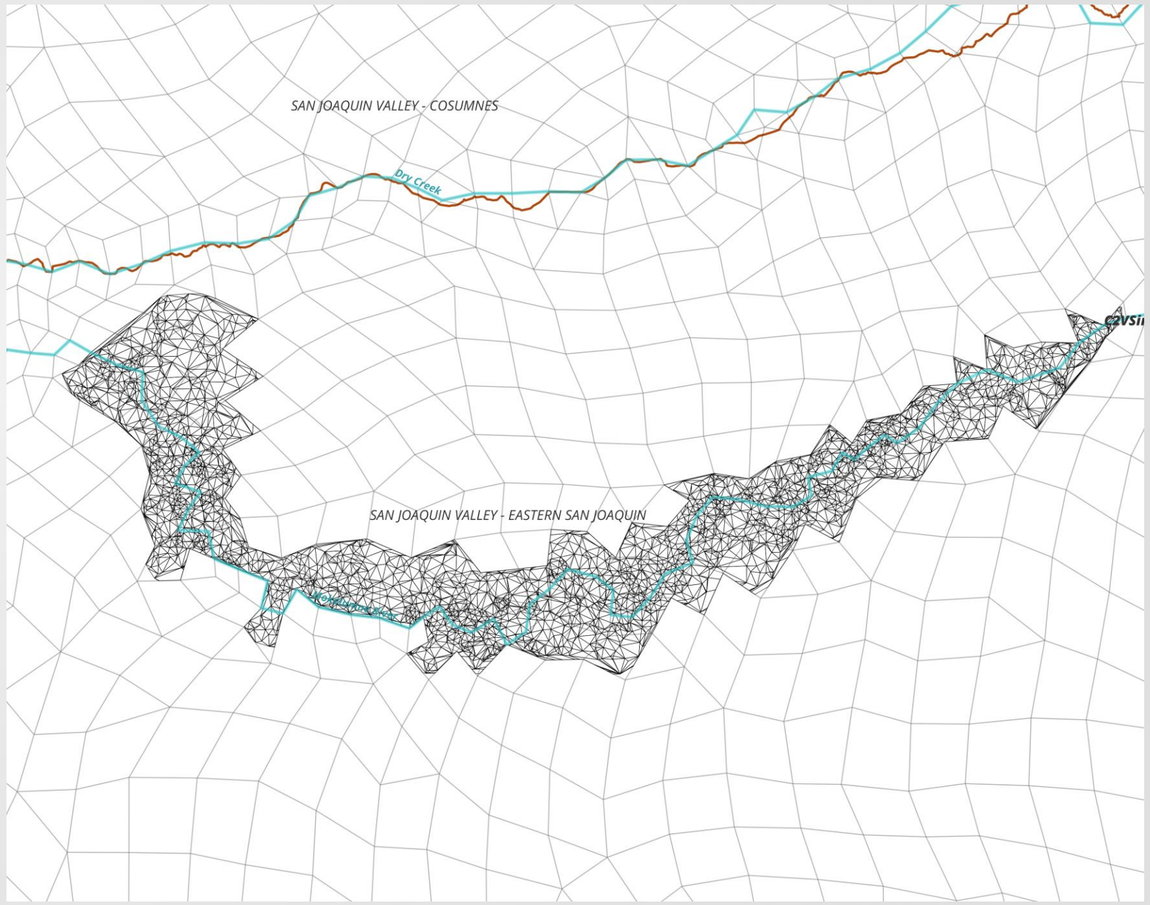
Groundwater Subbasin Name	Local Groundwater Model	Model Code
SACRAMENTO VALLEY - NORTH YUBA	YGM	IWFM
SACRAMENTO VALLEY - SOUTH YUBA	YGM	IWFM
SACRAMENTO VALLEY - NORTH AMERICAN	CoSANA	IWFM
SACRAMENTO VALLEY - SOUTH AMERICAN	CoSANA	IWFM
SAN JOAQUIN VALLEY - COSUMNES	CoSANA	IWFM
SACRAMENTO VALLEY - WYANDOTTE CREEK	Butte Basin Groundwater Model	IWFM
SACRAMENTO VALLEY - BUTTE	Butte Basin Groundwater Model	IWFM
SACRAMENTO VALLEY - VINA	Butte Basin Groundwater Model	IWFM
SAN JOAQUIN VALLEY - MODESTO	C2VSim-TM	IWFM
SAN JOAQUIN VALLEY - TURLOCK	C2VSim-TM	IWFM
SAN JOAQUIN VALLEY - CHOWCHILLA	MCSim	IWFM
SAN JOAQUIN VALLEY - MADERA	MCSim	IWFM
SAN JOAQUIN VALLEY - KERN COUNTY	C2VSim-Kern	IWFM
SAN JOAQUIN VALLEY - TRACY	C2VSimFG used; local data shared	IWFM
SAN JOAQUIN VALLEY - WHITE WOLF	WWGFM	MODFLOW
SAN JOAQUIN VALLEY - EAST CONTRA COSTA	ECCSim	IWFM
SACRAMENTO VALLEY - SOLANO	Solano IHM	IWFM
SAN JOAQUIN VALLEY - EASTERN SAN JOAQUIN	ESJWRM	IWFM


Legend
Region Office Service Areas
C2VSimFG Boundary
Data Upload Status
Complete
Partial
Not Uploaded/No Response
Basin Not Contacted
Northern
North Central
South Central
Southern
Enterprise
Anderson
Bowman
Antelope
Red Bluff
Los Molinos
Corning
Vina
Butte
Wyandotte Creek
North Yuba
Colusa
Sutter
South Yuba
North American
Yolo
South American
Cosumnes
Solano
East Contra Costa
Eastern San Joaquin
Tracy
Modesto
Turlock
Merced
Delta-Mendota
Chowchilla
Madera
Kings
Westside
Kaweah
Pleasant Valley
Tulare Lake
Tule
Kern County
White Wolf


C2VSimFG
Subregions
Legend
Local data shared with DWR
C2VSimFG_Subregions
Sources: Esri, USGS, NOAA

GSAs Outreach and Local Model Data – Looking Forward

- Continue model data requests
  - Maintain sensitivity to GSA's other SGMA (annual reports, GSP revision, periodic evaluations, etc.) & non-SGMA commitments.
  - **Folks are welcome to upload updated data at anytime.**
- Continue to incorporate local model data into C2VSimFG
- Develop local model toolset
- Thank you GSAs, consultants, and RO staff



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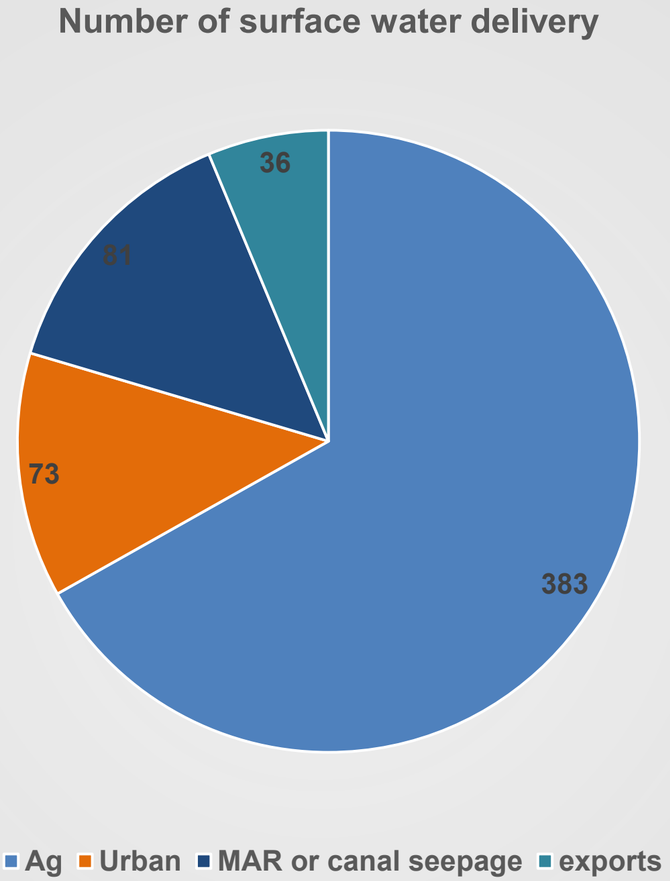
Surface Water Deliveries

(1) Ag. And urban water supply

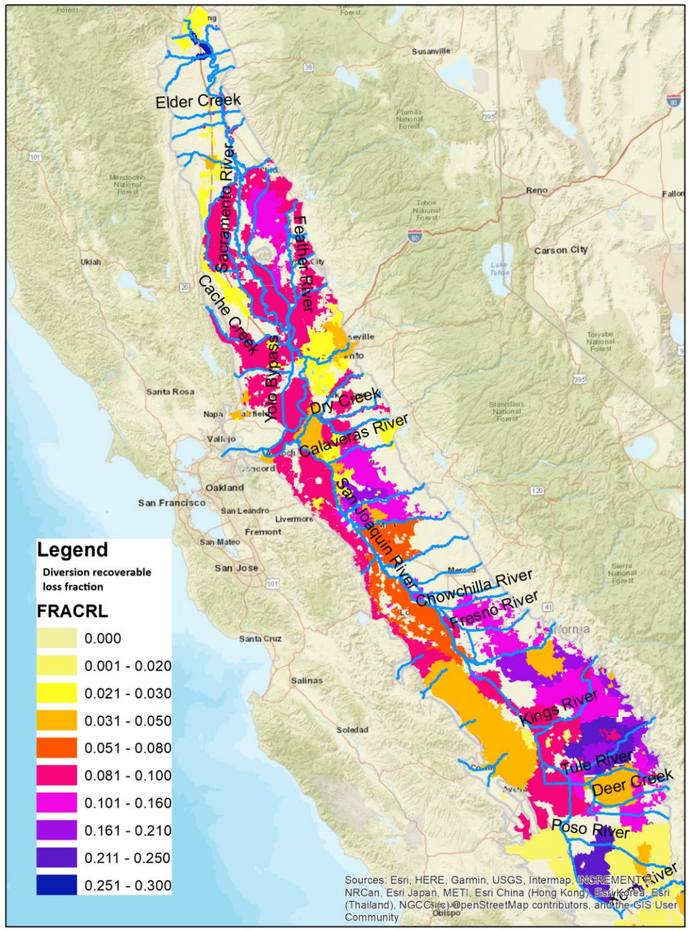
- **Groundwater pumping is estimated by IWFM-IDC using surface water use input**
- **Surface water surplus become return flow to streams.**

Data source:

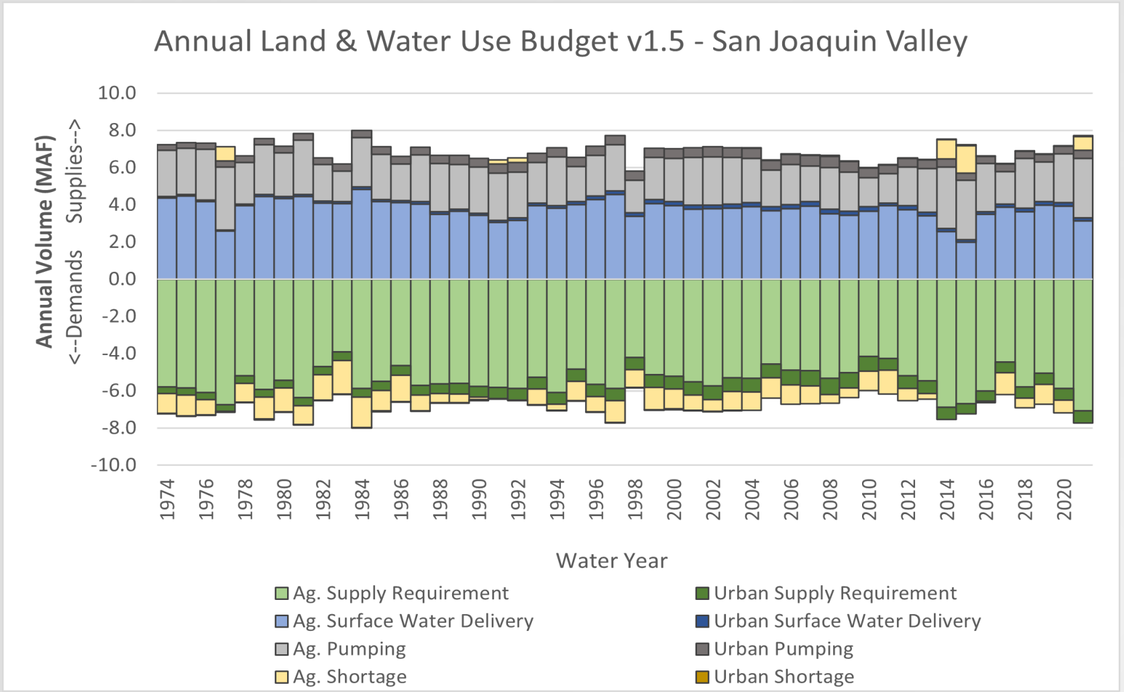
- The three main surface water supply source: SWP, CVP, and local water
- CVP and SWP delivery data are publicly available.
- Surface water supply time series data from local water source are not always available:
  - Many groundwater subbasins rely on local surface water
  - GSP annual reports: only available from Water Year 2021 (critical overdraft basins from WY2019).
  - eWRIMS database by SWRCB
  - Farm gate reporting (DWR)
- Earlier time series data and delivery areas are often estimated.

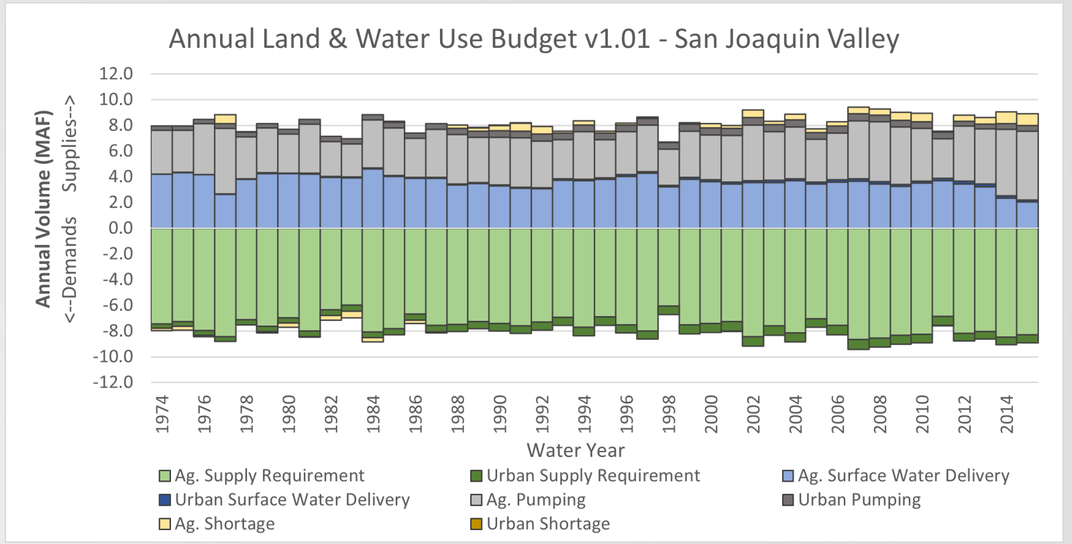


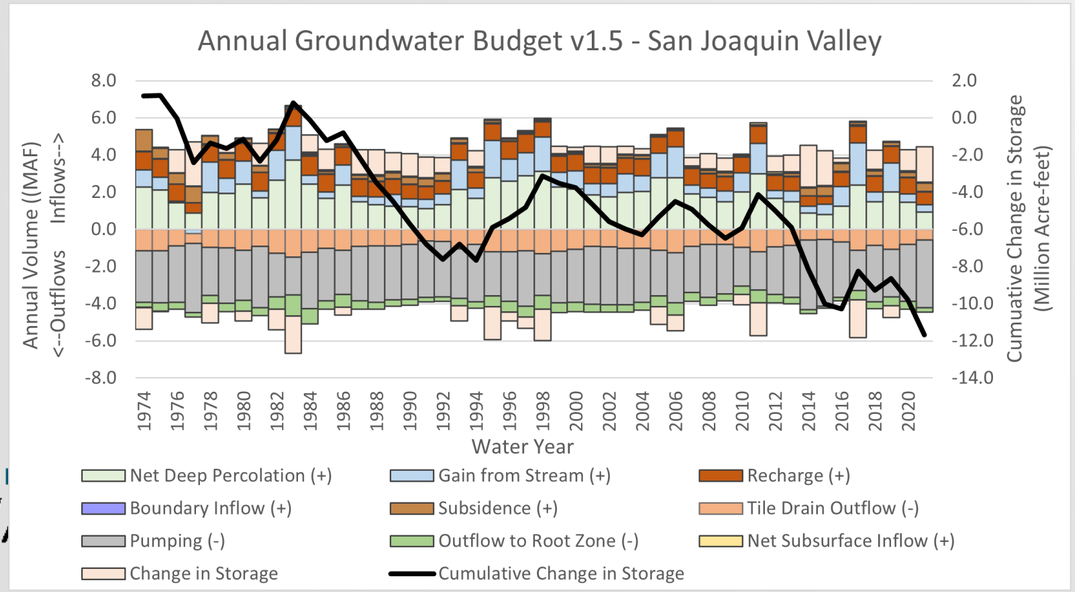
Prespecified fraction of Ag/urban surface water delivery to GW recharge (recoverable loss)

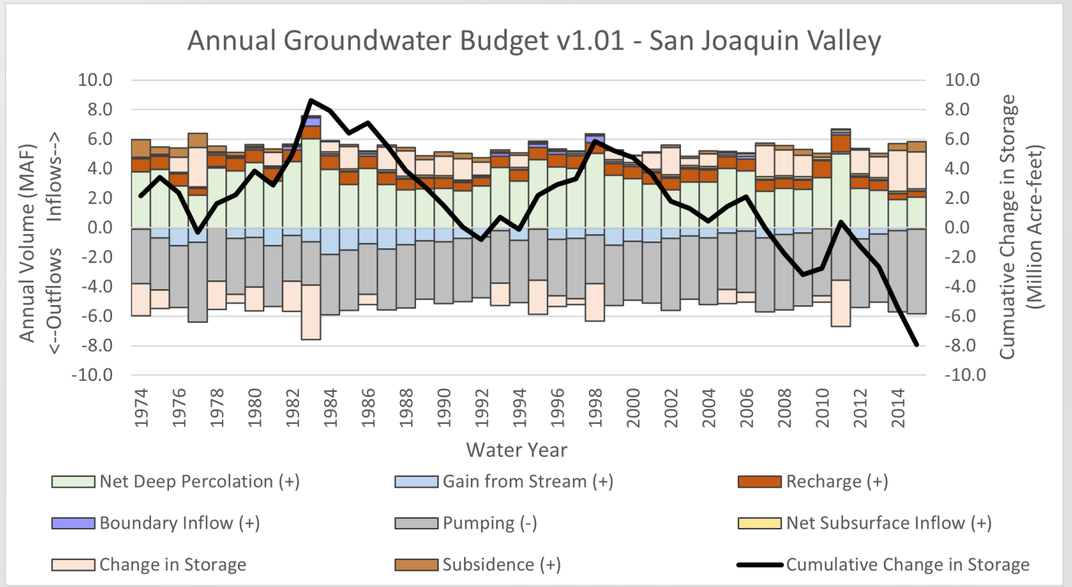


Land water use and groundwater budget for San Joaquin Valley (Subregions 9 through 13) showing Ag. Shortage (+) or surplus (-); recharge to GW (canal seepage + MAR)



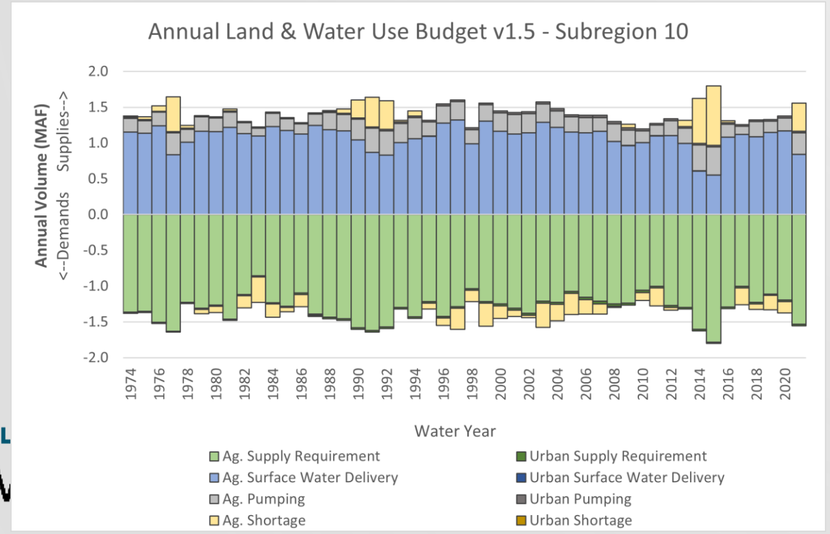




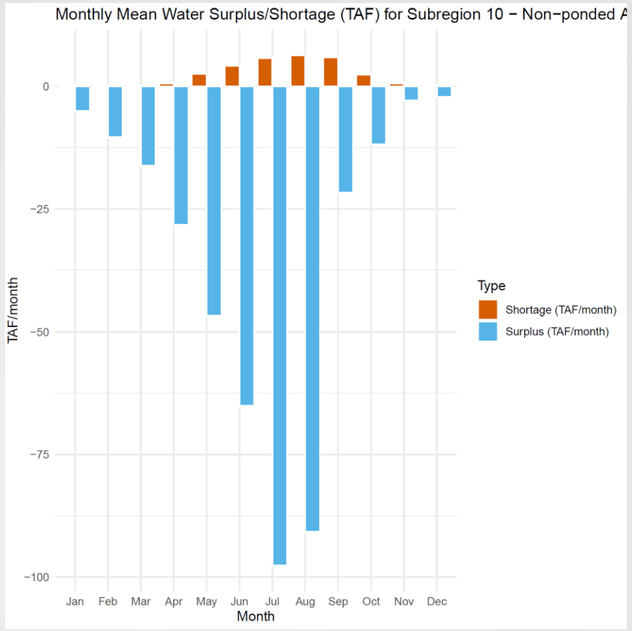


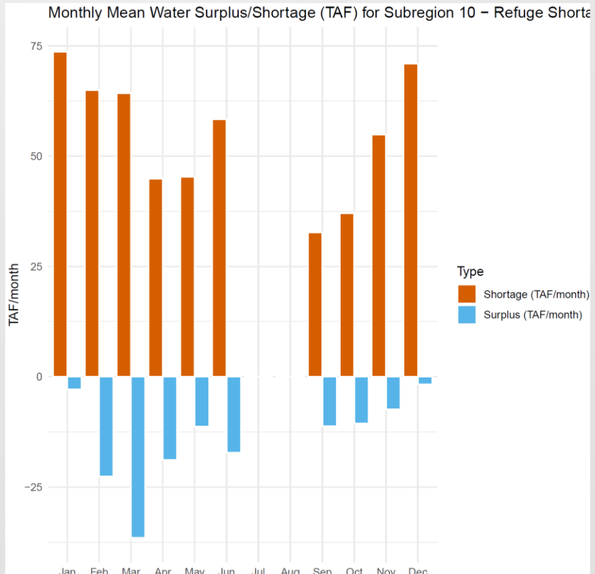
Surface Water use in C2VSimFG

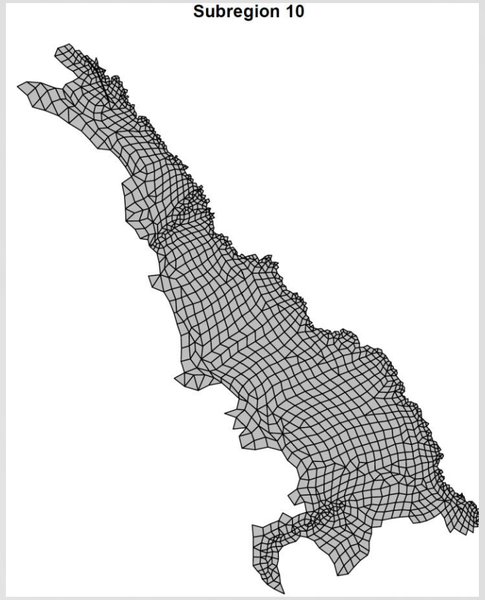
- IWFM land water use budget output aggregated Ag. Shortage (+) or surplus (-).
  1. Use of R script to isolating element level shortage and surplus values into two separate terms in zonal land water use budget files.
  2. The results are quite revealing.
- Delta surface water delivery was assumed to be demand based and auto adjusted in model simulations to match Ag. Demand with GW pumping turned off.
- Reconstructed historical land use and historical surface water delivery data did not align well for some location and time.

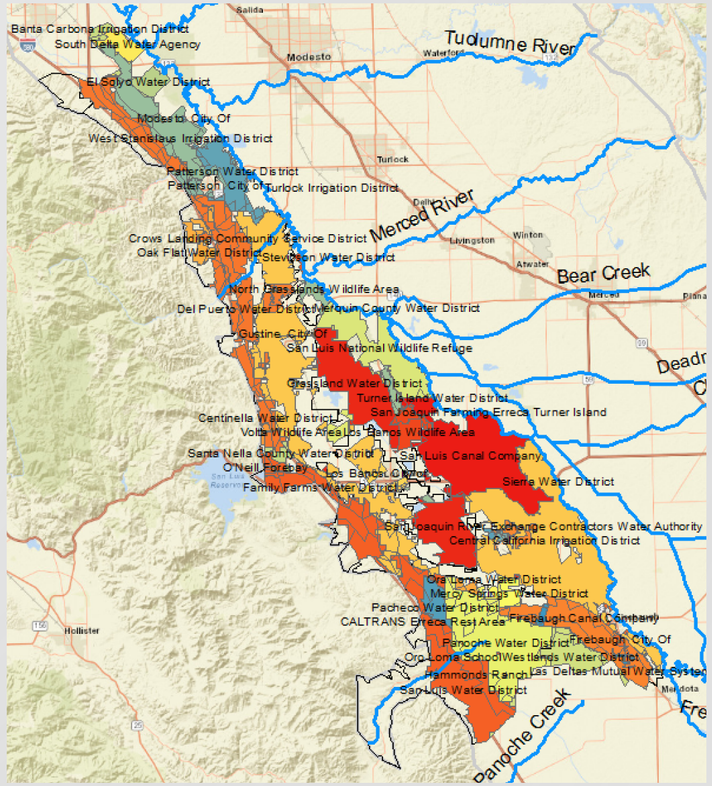


Element level separation of Ag. supply surplus/shortage for Subregion 10 – Delta Mendota with non-ponded crops and managed wetland.









Surface Water Deliveries
(2) Managed Aquifer Recharge (MAR)

- The C2VSim-Kern model provides detailed MAR temporal and spatial distribution and recovery well pumping in Kern County groundwater basin.

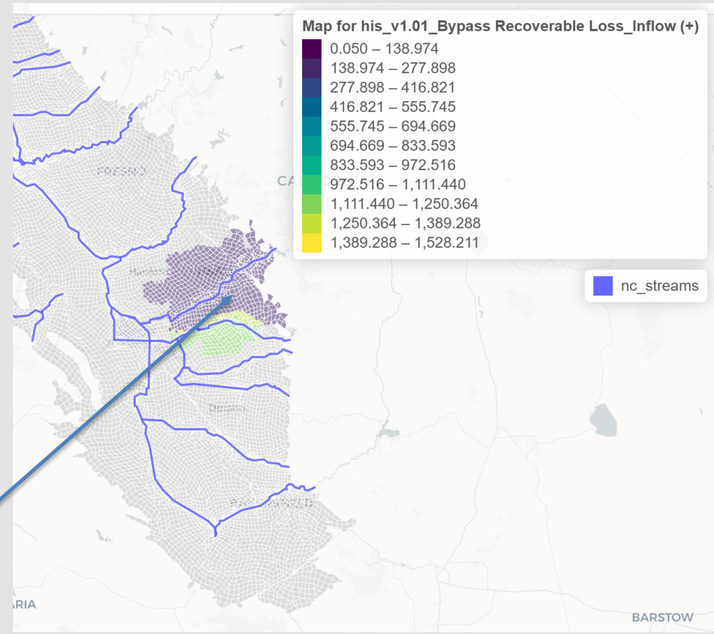
- Other MAR setup is based on assumption of non-irrigation delivery being for MAR (e.g., Friant-Kern and Madera Canals).

- Kaweah and Tule River flood water:

1. Unknown potential flood water for MAR simulated as flood bypass to 100% GW recharge along the rivers in v1.01; this caused unrealistic high GW elevations.
2. This has been removed in v1.5, and improved simulated GW elevations in Subregion 18.

Distribution of Managed Aquifer Recharge (MAR) and Major Canal seepage loss to GW

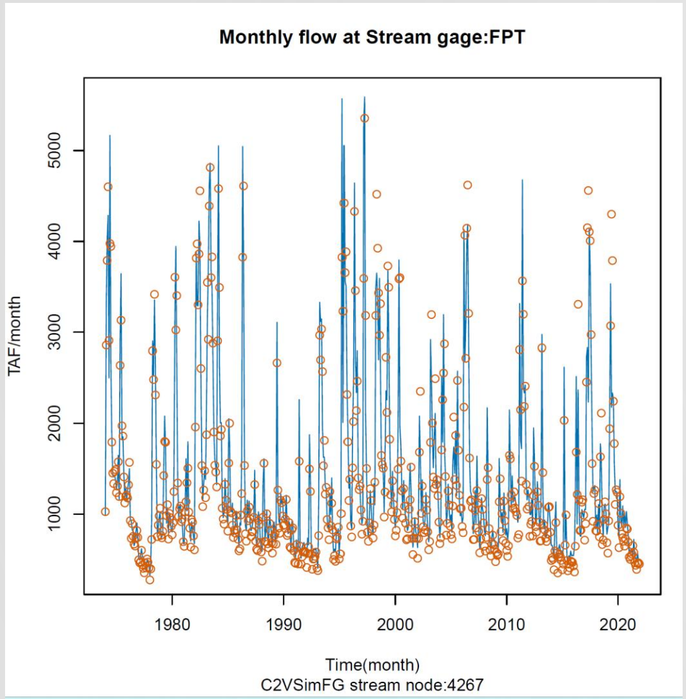
Distribution of Flow Bypass recoverable loss to GW in C2VSimFG v1.01 for Kaweah and Tule Rivers

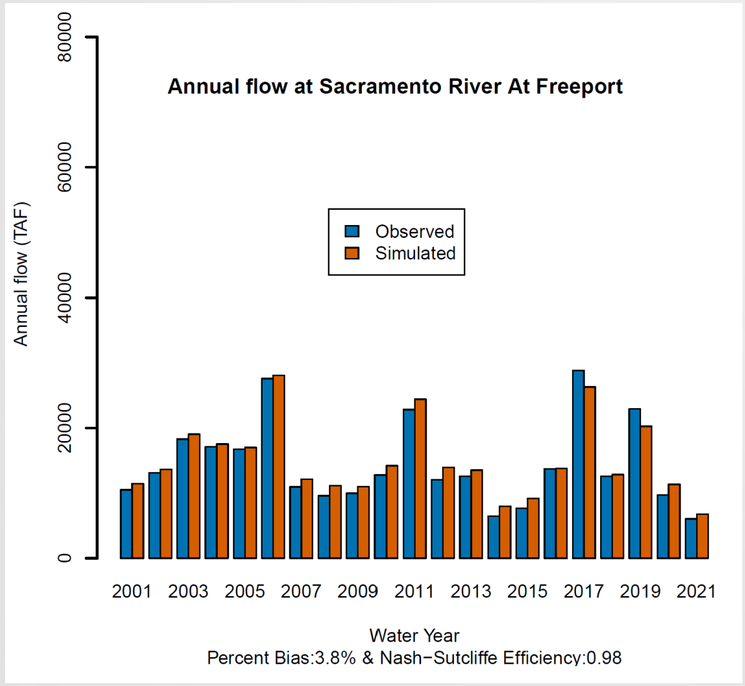


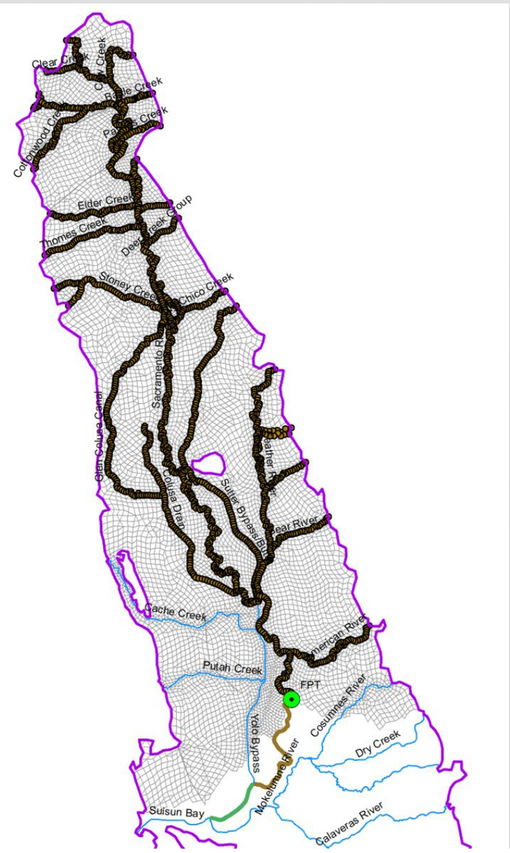
Simulated Streamflow – Sacramento Valley Sacramento River at Freeport (CDEC: FPT)

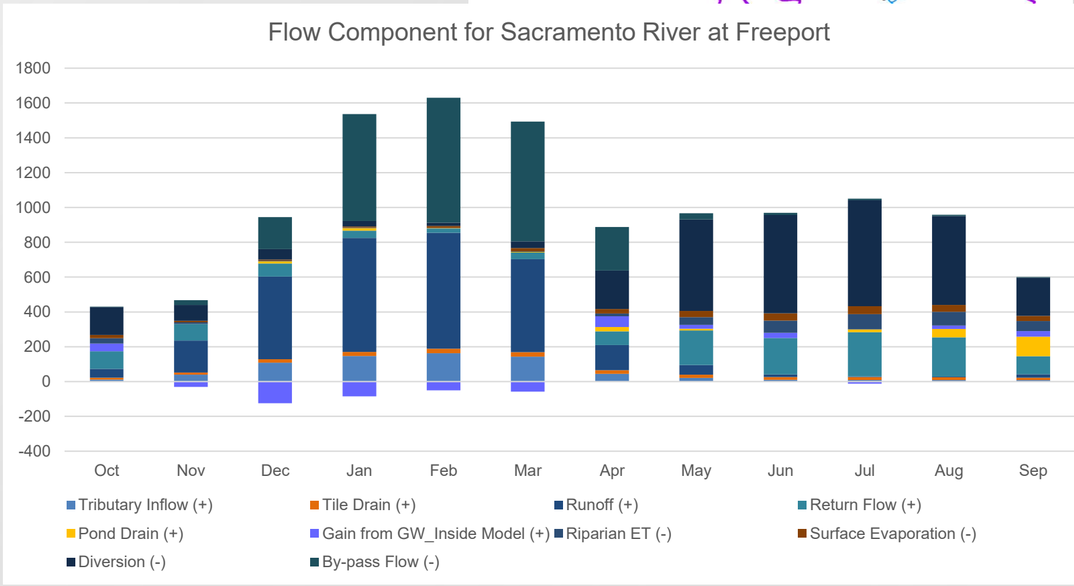
- Simulated hydrograph compared with observed flow data
- Percent bias: +3.8%

Stream Gage	Percent Bias (%)	Nash−Sutcliffe Efficiency
Sacramento River At Red Bluff	0.6	0.99
Sacramento River At Vina Bridge − Main Channel	4.6	0.93
Sacramento River At Hamilton City − Main Channel	3.0	0.98
Sacramento River At Verona	6.0	0.94
Sacramento River At Freeport	3.8	0.98
Feather River Nr Gridley CA	3.0	0.99
Yuba R Nr Marysville CA	-1.0	0.99









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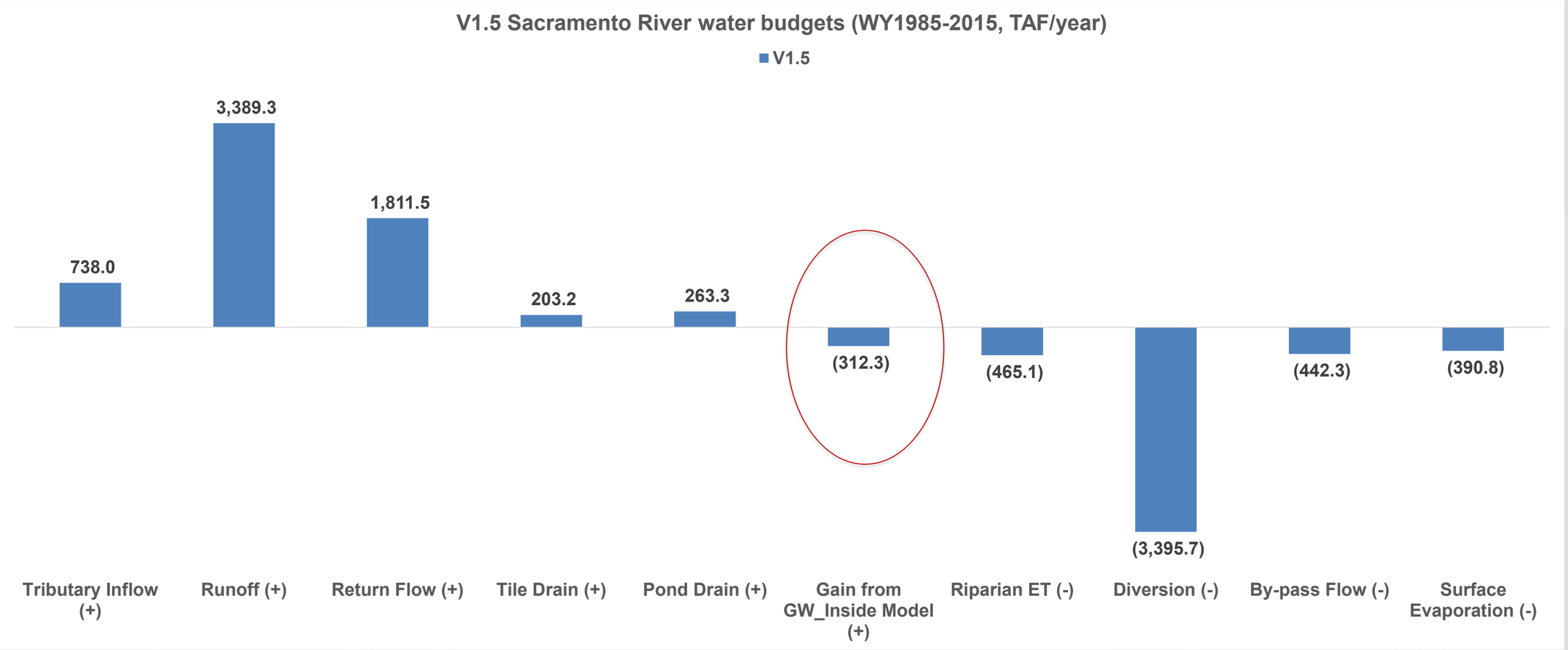
Stream flow components between upstream gaged inflows and observed outflow ranking order: runoff, diversion, return flow and tributary inflow for Sacramento River stream reaches.



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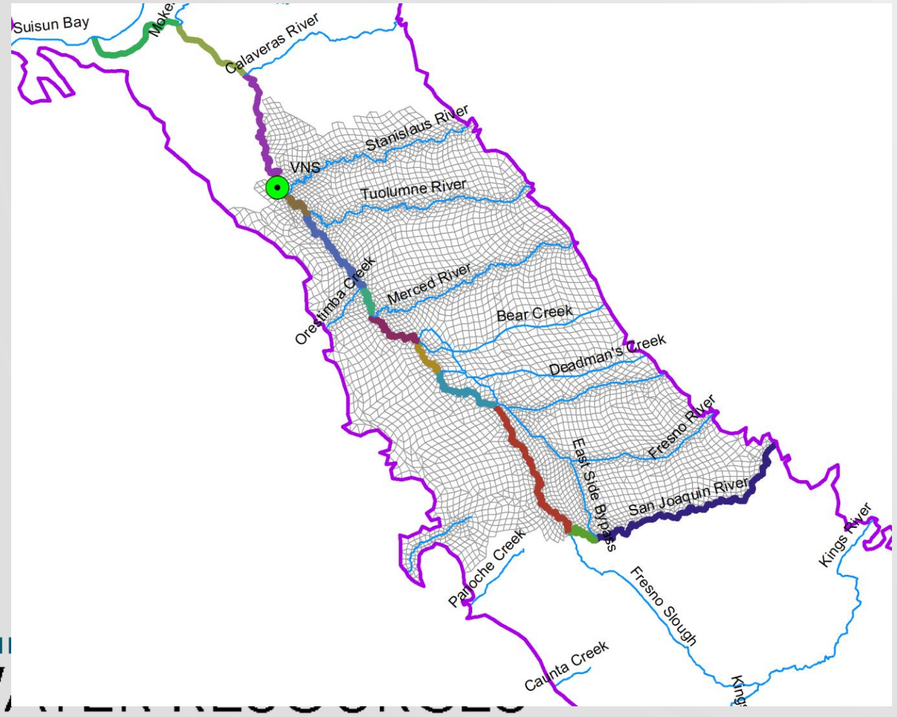
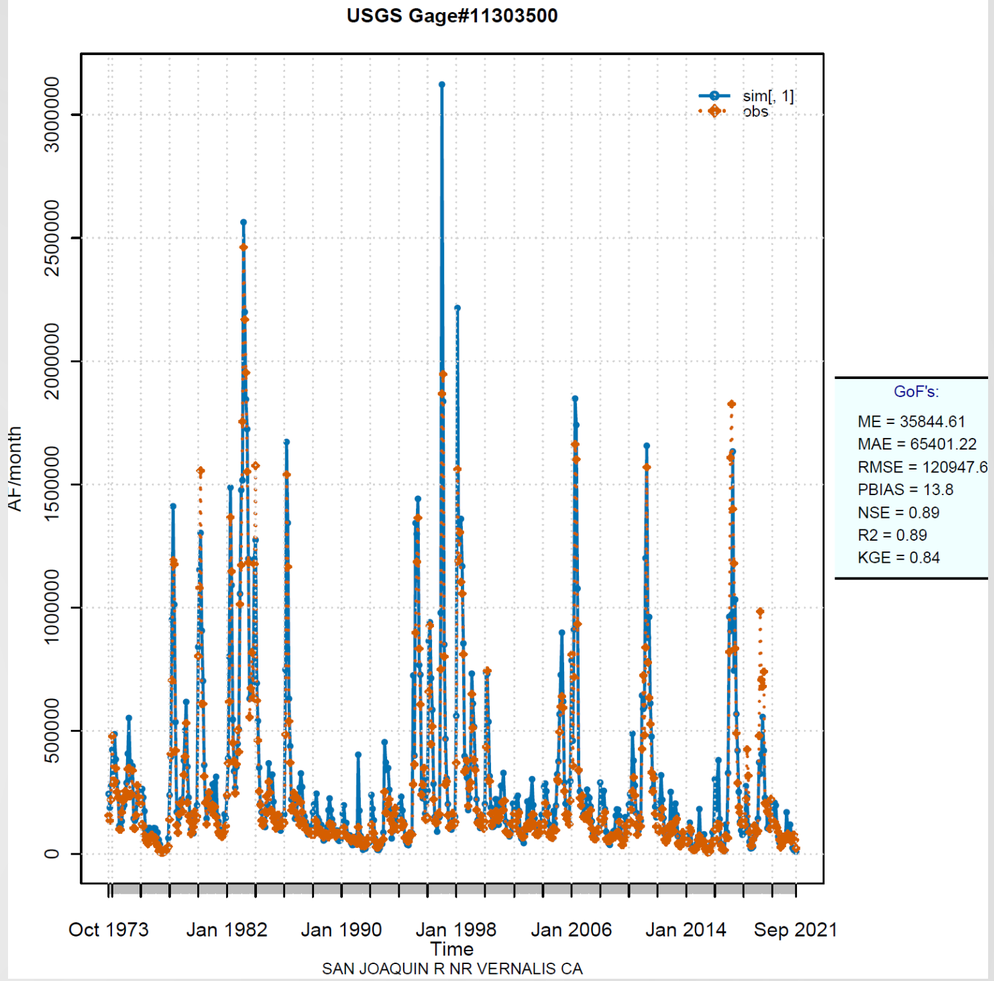
Simulated Streamflow San Joaquin Valley: San Joaquin River at Vernalis (CDEC: VNS)

- The stream gage at San Joaquin River near Vernalis (USGS 11303500 and CDEC VNS) measures inflows from the San Joaquin Valley to the Delta

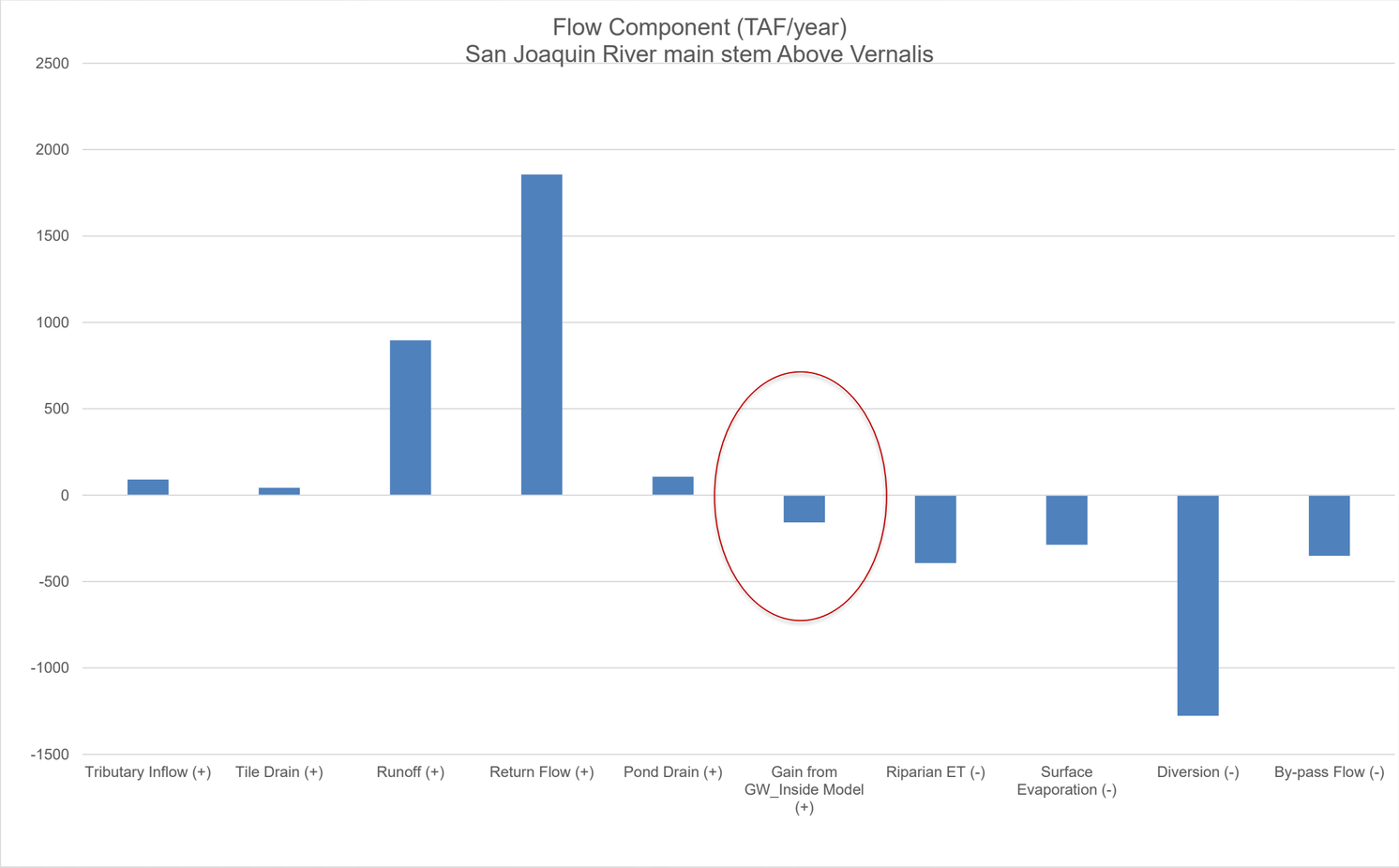
- Simulated hydrograph compared with observed flow data, percent bias: +17% and +13.8%, respectively, for C2VSimFG v1.01 and v1.5.

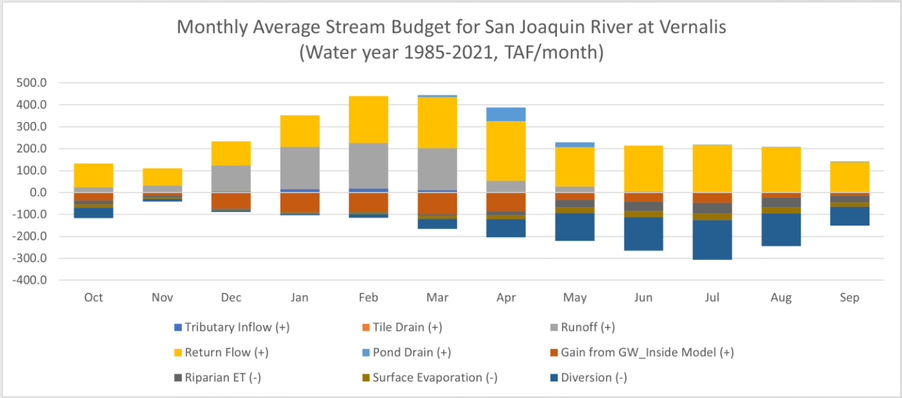




Stream water budget for San Joaquin River above Vernalis

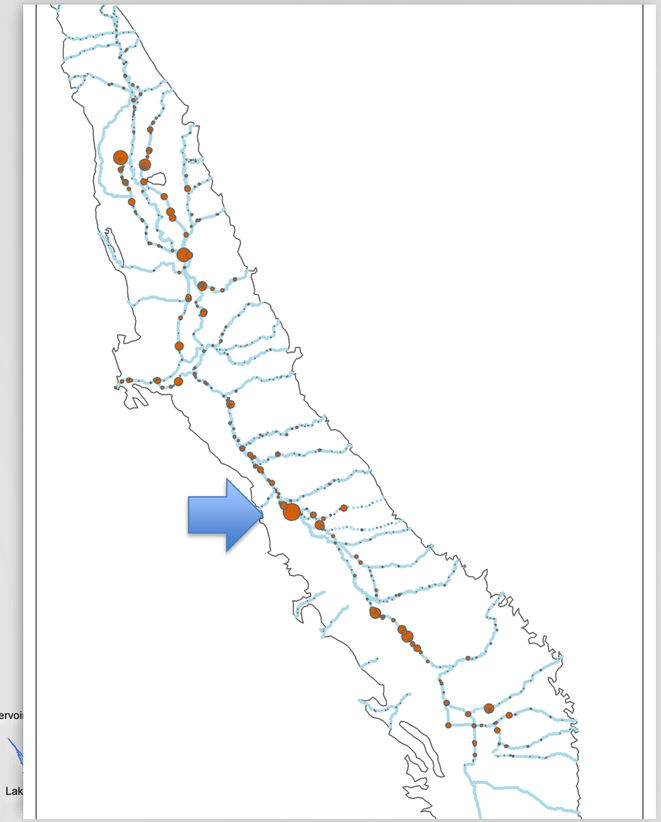
- Flow components ranking order: return flow, diversion, runoff, stream gain from GW.
- Main flow calibration target: return flow (Ag. Water use) and runoff (CN number)
- stream gain from GW (-) is relatively small comparing to other major terms.
- Monthly distribution shows both runoff and return flow peak in spring months.

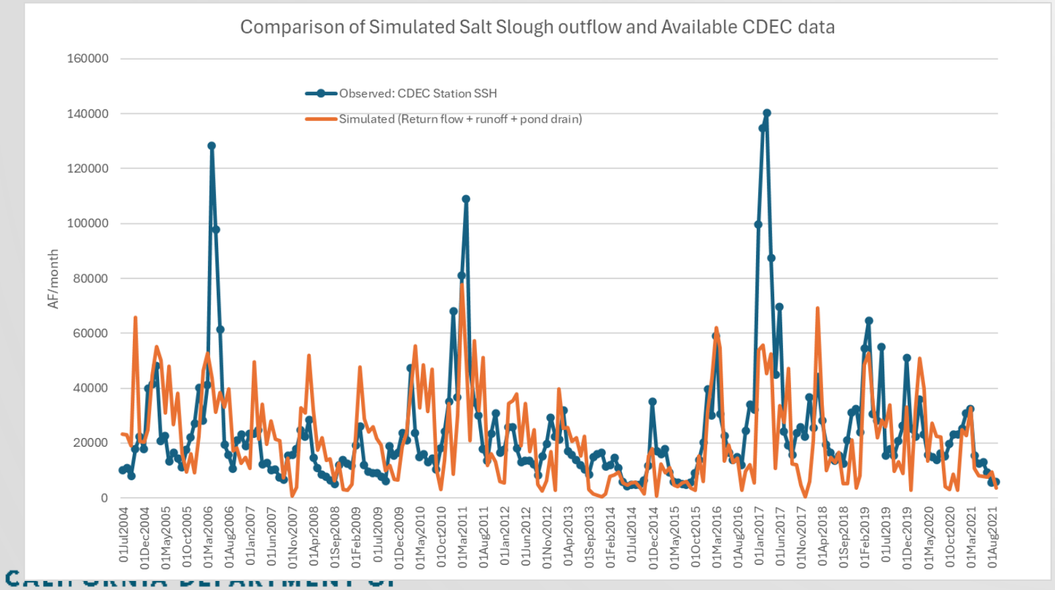


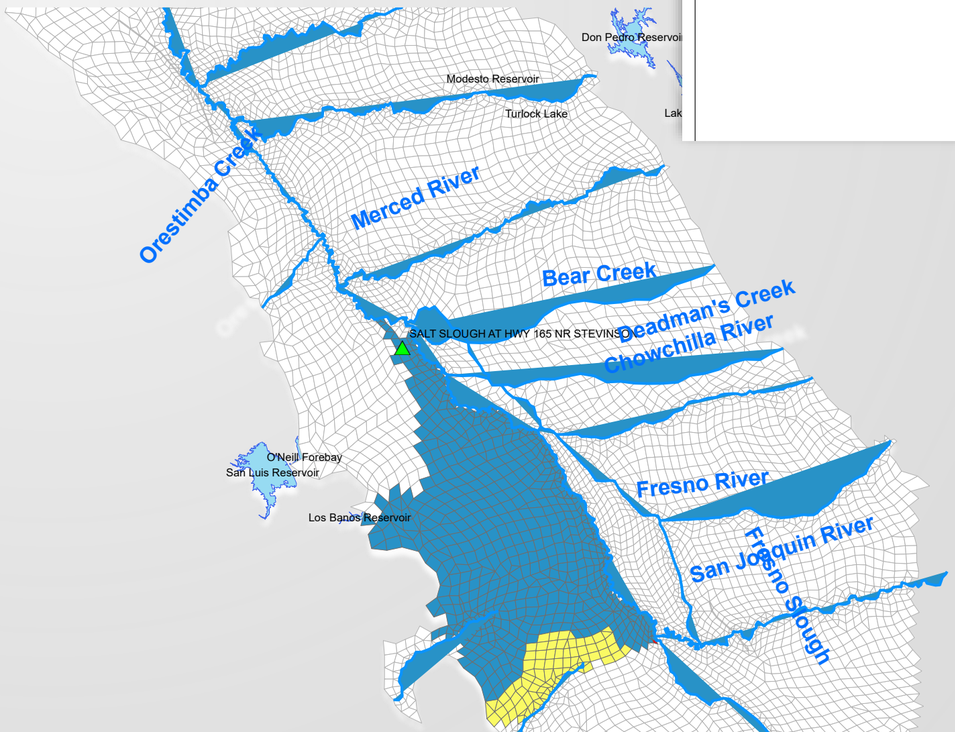


San Joaquin River – Are return flow and rainfall-runoff overestimated?

- San Joaquin main stem stream node #1698 receiving the largest return flow: (Salt Slough outlet, CDEC: SSH)
- C2VSim simulated (runoff + net return flow + refuge pond drain) flow volume is 89% of SSH total volume.







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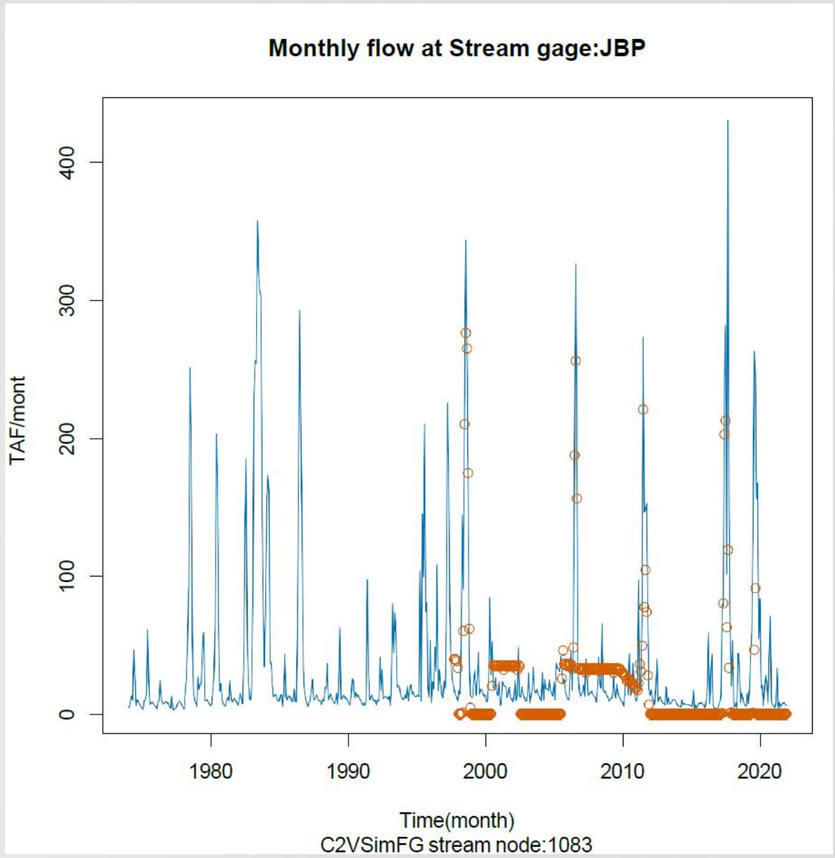
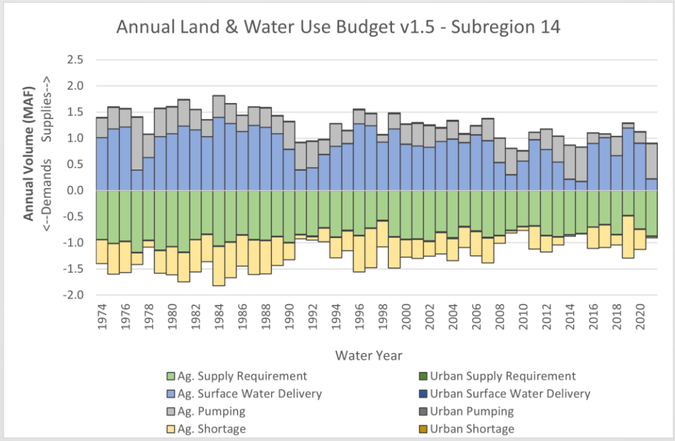
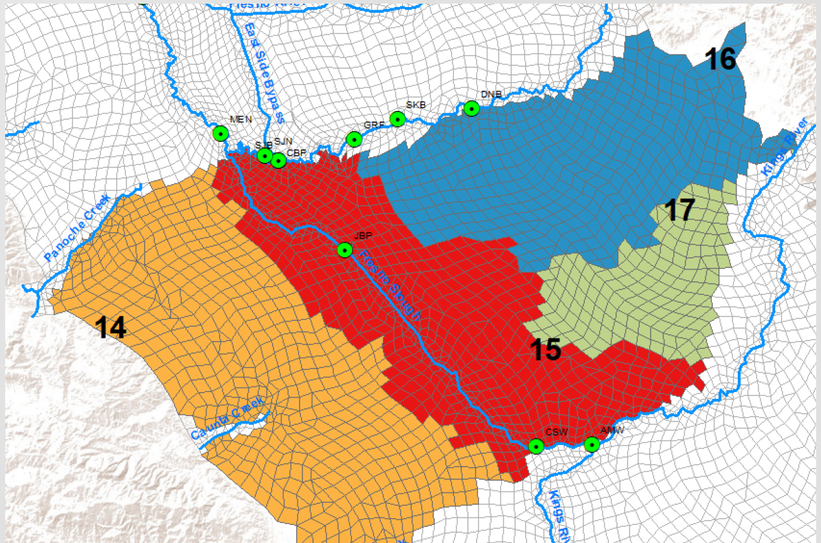
Fresno Slough as Inflow to San Joaquin River

- North Fork Kings River flood water outlet
- Overestimating baseflow by Ag. return flow and runoff (see figure for drainage pattern from Subregions 14,15, 16 and 17)
- Significant stream loss to GW
- What if: using CDEC (WY2009 - 2019): JBP as inflow to San Joaquin river: 279.3 TAF/year in place of simulated 576.3?

➡ Reducing VNS annual flow by 10% (-297 TAF/year from Fresno Slough, and observed VNS =2,903 TAF)







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Tulare basin

- Tulare lakebed not explicitly simulated in the model.
- Kings, Kern, Kaweah and Tule Rivers
- The only surface flow outlet is James Bypass (Fresno Slough)

- The “outflow” from Tulare Lakebed in v1.5: 292.9 TAF/year.
- Tulare lake subbasin GSP annual report: Lake bottom storage in WY2023: 458 TAF, acted as a surface water source for Ag.

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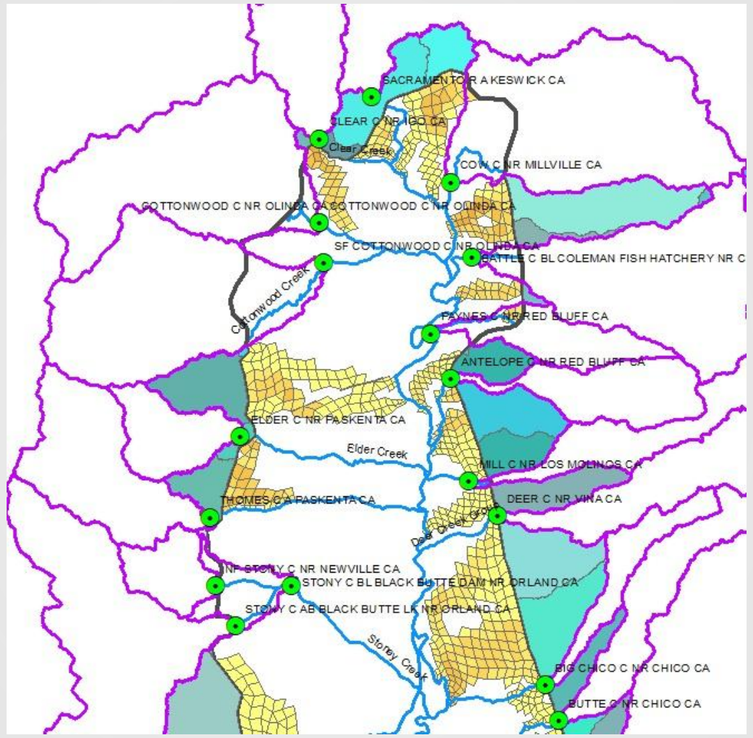
Small watersheds

- Limited Streamflow observation for small watersheds (available outside of C2VSimFG simulation period WY1974-2021)
- Spatial coverage along model boundary
- Avoid overlapping with stream inflow drainage:

C2VSimFG Version	V1.0	V1.01	v1.5
Total number of small watersheds	1024	1000	957



Small watershed runoff to stream nodes and subsurface inflow to groundwater highlighted by shaded elements

USGS Stream gages for small watersheds

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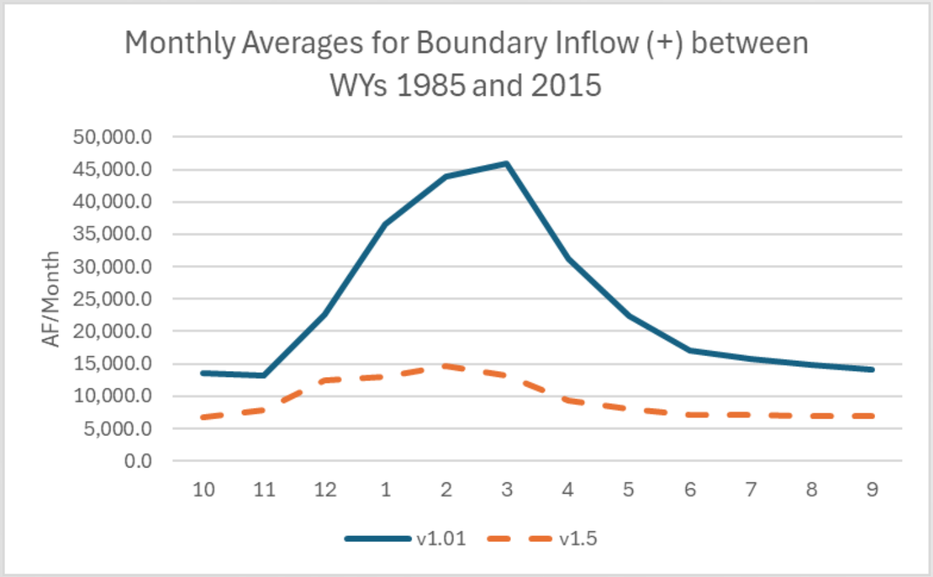
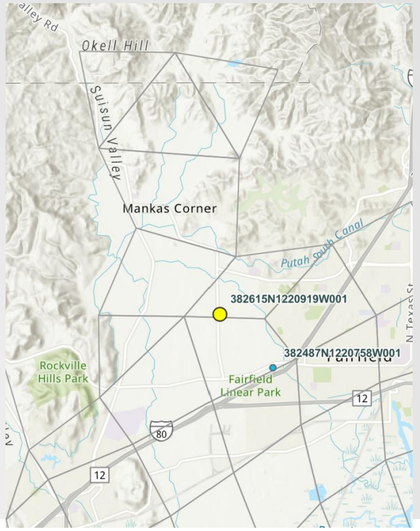
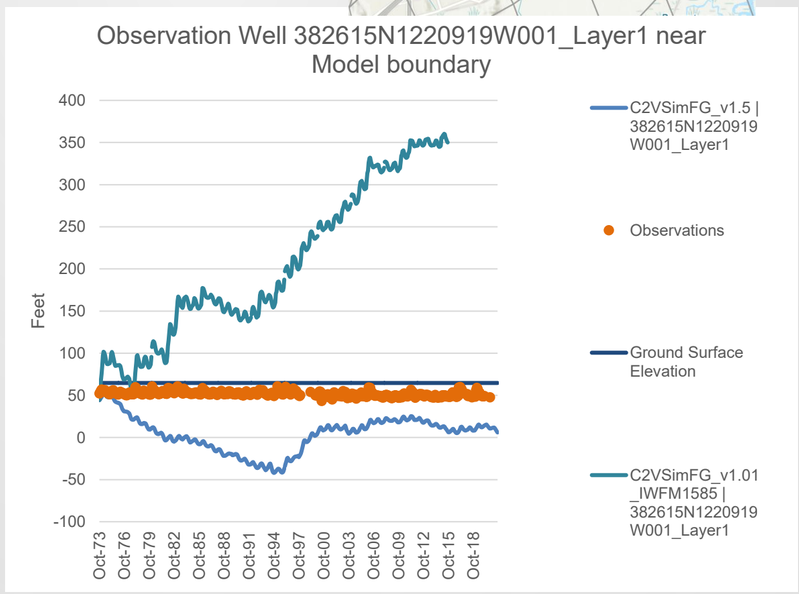
Small watersheds

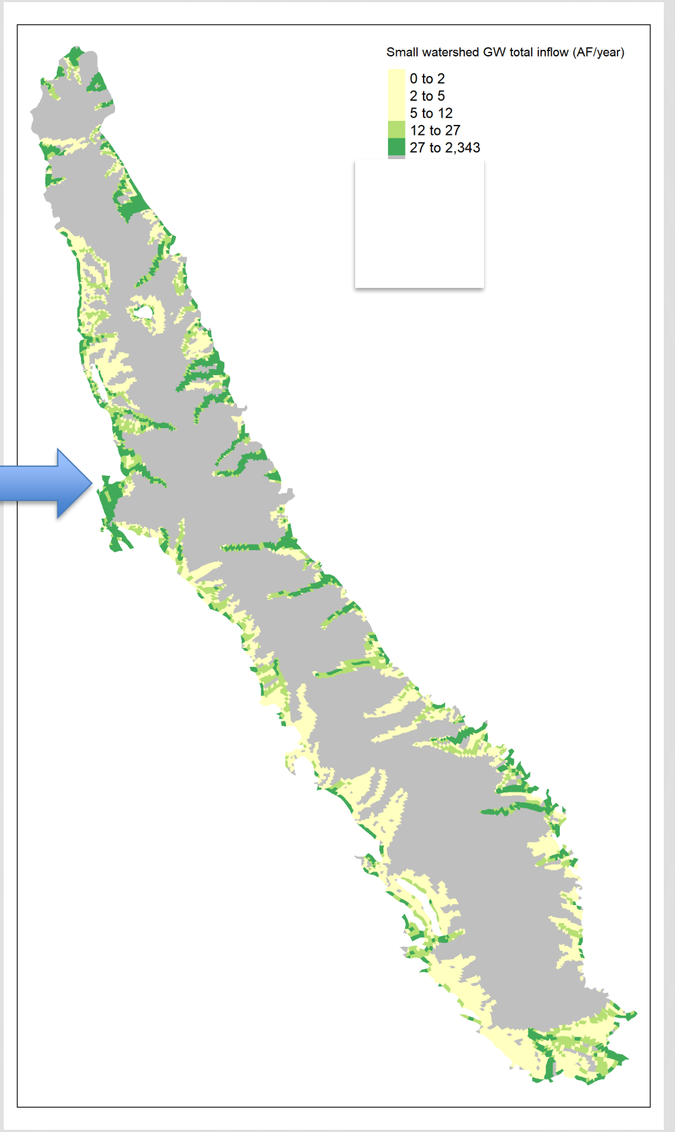
- Calibration of small watershed parameters based on limited stream gage data and bug fixes (e.g., Bear Creek (Small watershed#1003, USGS 11374100 BEAR C NR MILLVILLE CA, 10/1959 - 09/1967), Marsh Creek, etc.)
- Large reduction in both total runoff and subsurface inflow







Element level small watershed subsurface inflow to GW (AF/year)



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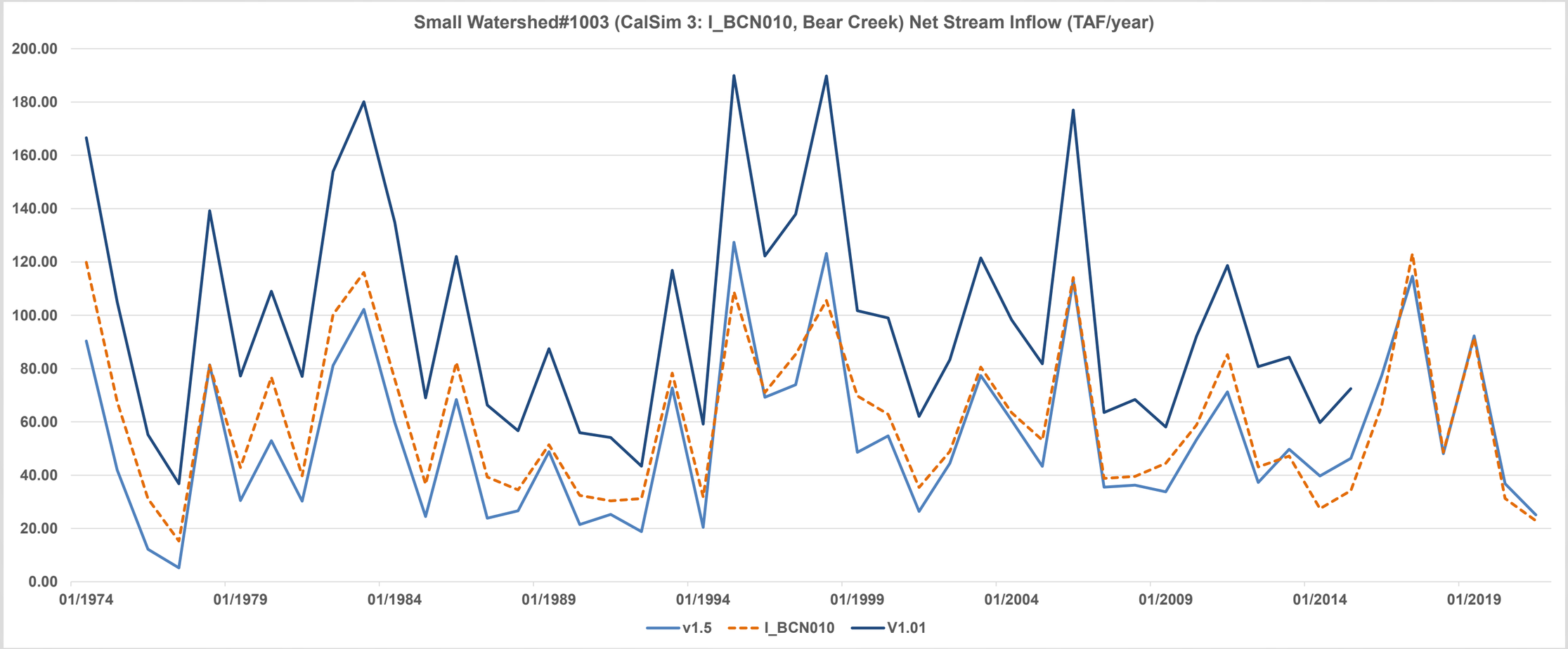
Small watershed#1003 simulated and observed streamflow



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Key Takeaways and Next Steps

1. C2VSimFG Model: Relies on GSA outreach & local data.
2. Simulated Streamflow (Major Rivers): Affected by rootzone & groundwater.
3. Surface Deliveries: Supply Ag/Urban use & support groundwater recharge.
4. Small Watershed Calibration: Limited by scarce near-boundary stream & groundwater data.
5. Model Recalibration (Surface Water Updates):Rootzone curve number & net return flow. Streambed conductance (using flow & river stage data from 63 gages).