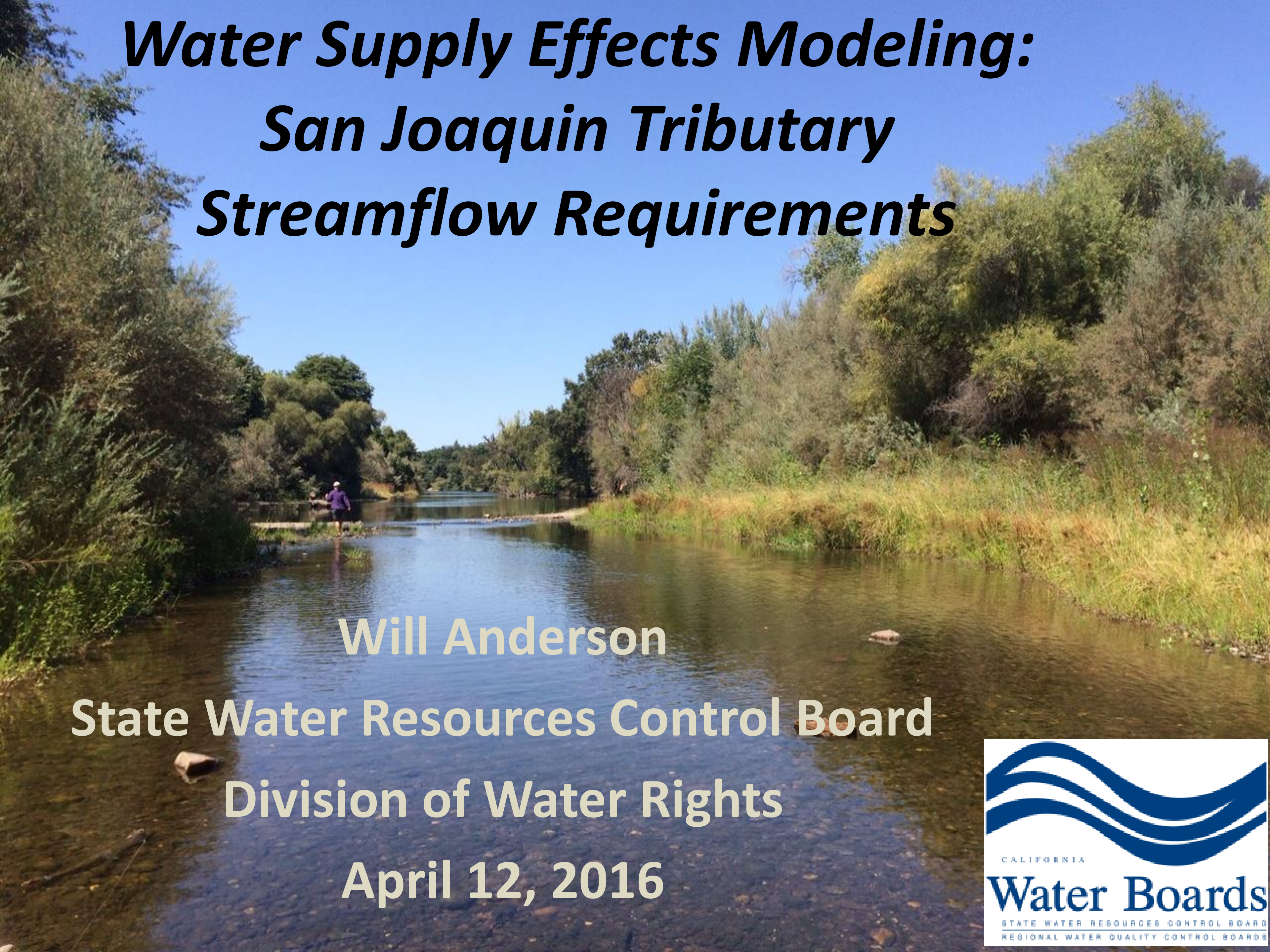

Water Supply Effects Modeling: San Joaquin Tributary Streamflow Requirements

Will Anderson

State Water Resources Control Board

Division of Water Rights

April 12, 2016

Overview

- Regulatory background and setting
- Unimpaired flow concept
- System characterization (San Joaquin tribs)
- Irrigation District water balance
- CALSIM, Water Supply Effects Model Results
- HEC-5Q Temperature Model and Results

Delta Reform Act, 2009

- Water Code §85086 (c) (1) "For the purpose of informing planning decisions for the Delta Plan and the Bay Delta Conservation Plan, *the board shall, pursuant to its public trust obligations, develop new flow criteria for the Delta ecosystem necessary to protect public trust resources*. . . The flow criteria for the Delta ecosystem shall include the *volume, quality, and timing* of water necessary for the Delta ecosystem under different conditions."

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Bay-Delta Planning Process

- *Phase 1:* San Joaquin River flow and southern Delta salinity
- *Phase 2:* Delta outflow and Sacramento River flows
- *Phase 3:* Water Rights implementation
  (of phases 1 and 2)
- *Phase 4:* Instream flows for other Delta tributaries
- *Related Processes:*
  - Water Quality Certifications: FERC relicensing of Hydroelectric Projects on Merced and Tuolumne Rivers

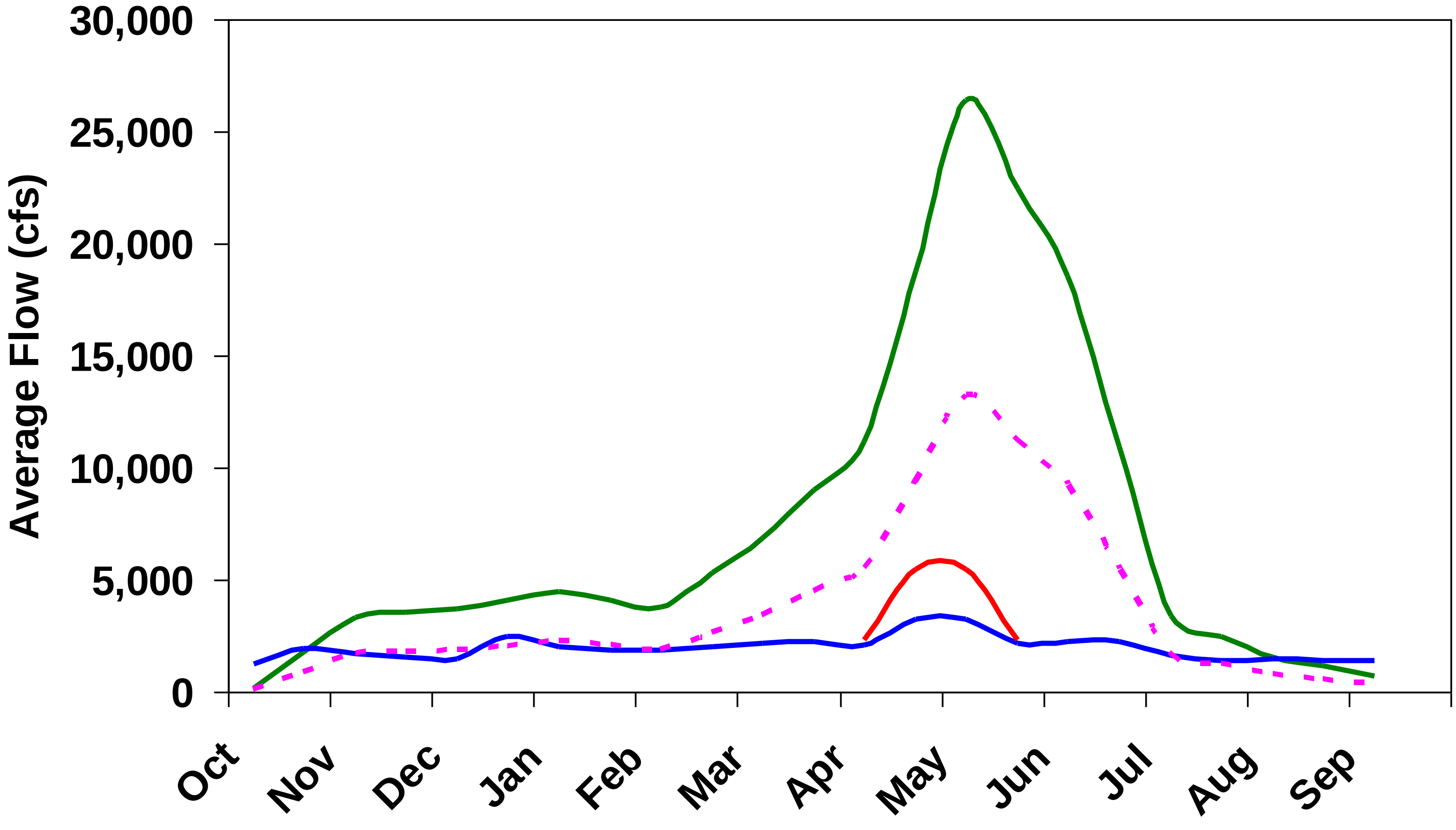
San Joaquin Flow Proposal

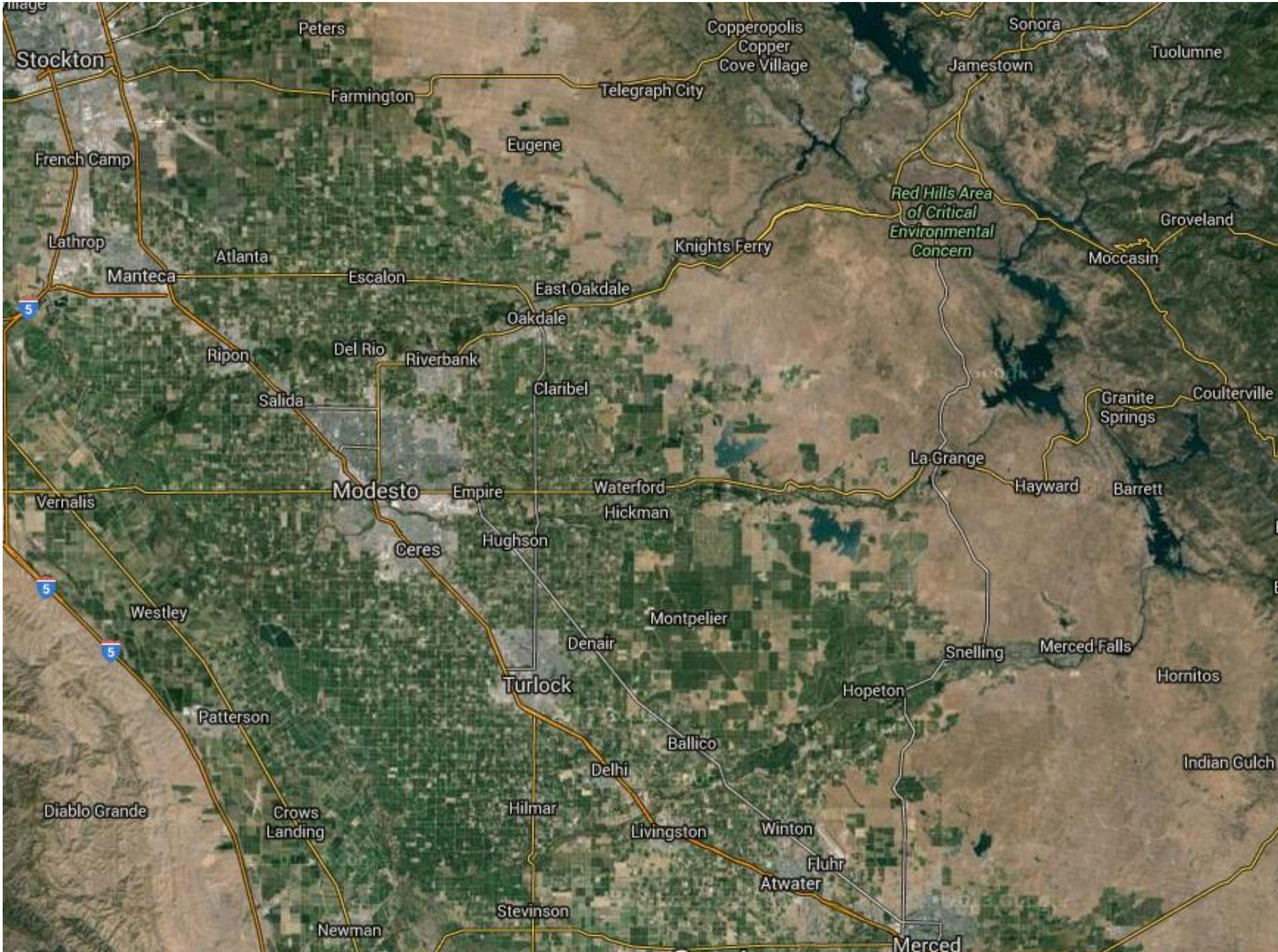
- Intended to reasonably protect fish
  - Specific numeric objectives
  - Narrative standard… *"to provide the flow conditions necessary to support the native fisheries in the Lower San Joaquin River and its salmon-bearing tributaries"*
- Minimum percentage of unimpaired flow is during the critical juvenile salmon out-migration period of February-June
- Provides flexibility to modify both timing and %

Why Percent of Unimpaired Flow?

- An index quantity, and fraction or "share"
- Allocate between public trust and other uses
  - An environmental-use "bank account" that can be "shaped" to provide functionally-useful flows
- Current Vernalis objective is also based on unimpaired flow (for water year classification) but is "stepwise" and more complicated

Unimpaired Flow Concept
San Joaquin River Near Vernalis Flow
Water Year 2003 (Below Normal)

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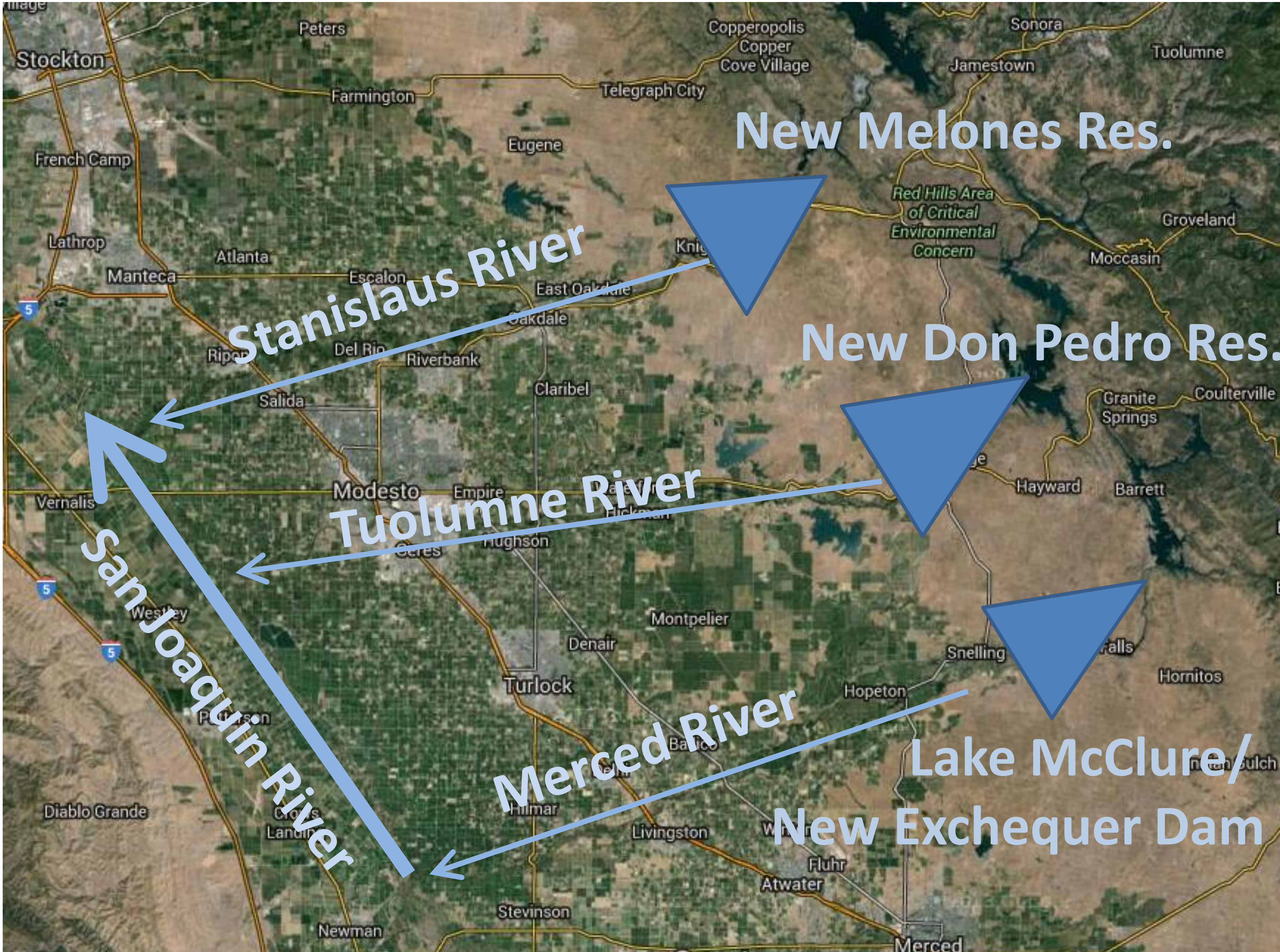
Copper
Cove Village
Sonora
Stockton
Tuolumne
Jamestown
Farmington
Telegraph City
Eugene
French Camp
Red Hills Area
of Critical
Environmental
Concern
Groveland
Lathrop
Knights Ferry
Moccasin
Atlanta
Manteca
Escalon
East Oakdale
5
Oakdale
Ripon
Del Rio
Riverbank
Claribel
Salida
Granite
Springs
Coulterville
La Grange
Modesto
Empire
Waterford
Hayward
Barrett
Vernalis
Hickman
Hughson
Ceres
5
Westley
Montpelier
Denair
Snelling
Merced Falls
5
Hornitos
Turlock
Hopeton
Patterson
Ballico
Delhi
Indian Gulch
Diablo Grande
Crows
Landing
Hilmar
Livingston
Winton
Fluhr
Atwater
Stevinson
Newman
Merced


New Melones Res.
New Don Pedro Res.
Lake McClure/
New Exchequer Dam
Stanislaus River
Tuolumne River
Merced River
San Joaquin River
Stockton
Peters
Copperopolis
Copper
Cove Village
Sonora
Tuolumne
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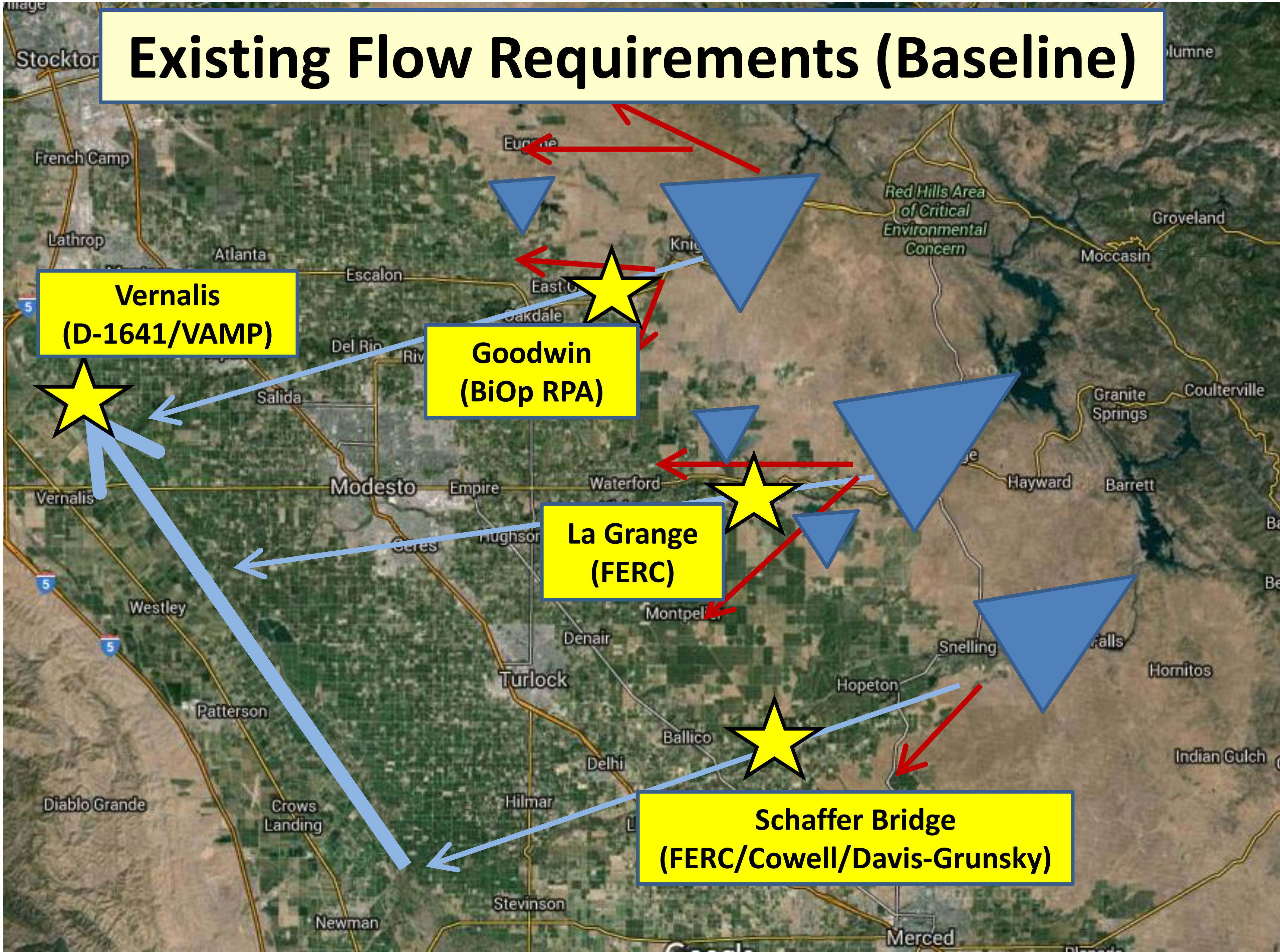
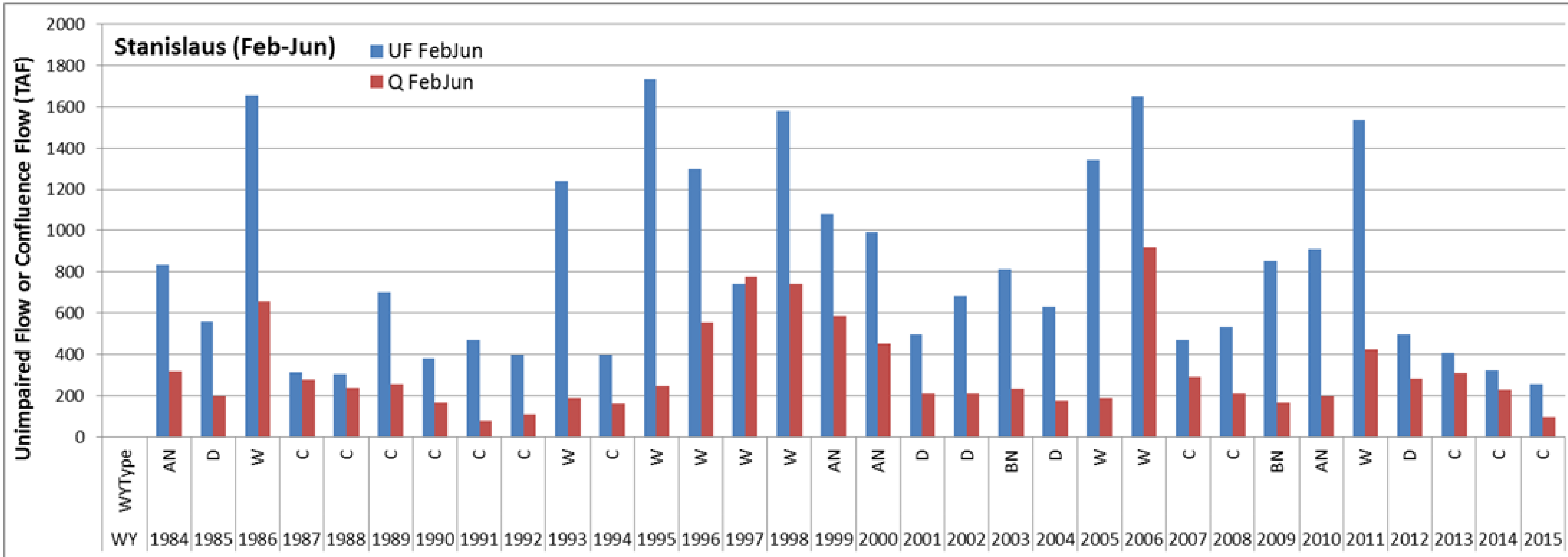
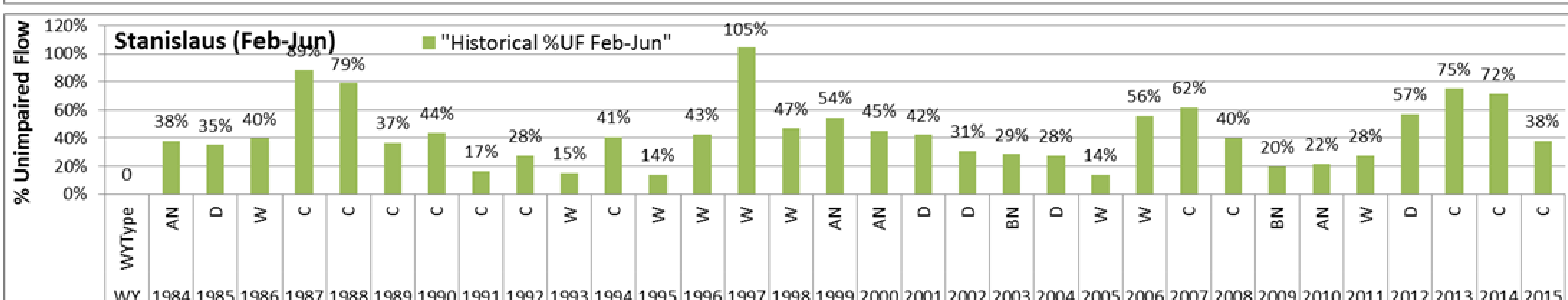
Turlock
Hopeton
Diablo Grande
Hilmar
Livingston
Fluhr
Atwater
Stevinson
Newman
Merced

Existing Flow Requirements (Baseline)



Stanislaus Historical Streamflows





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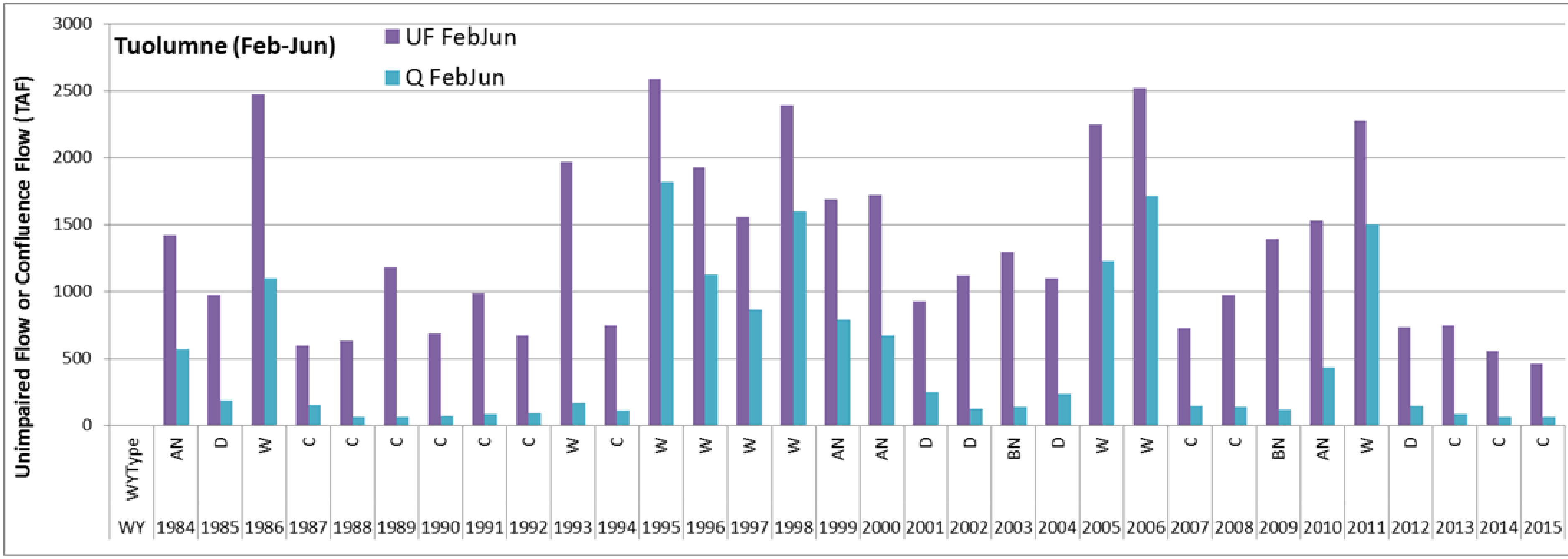
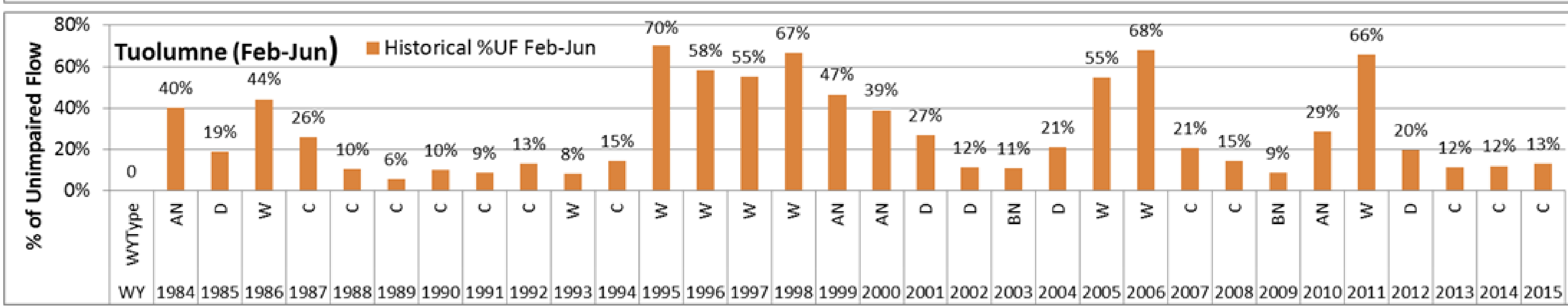
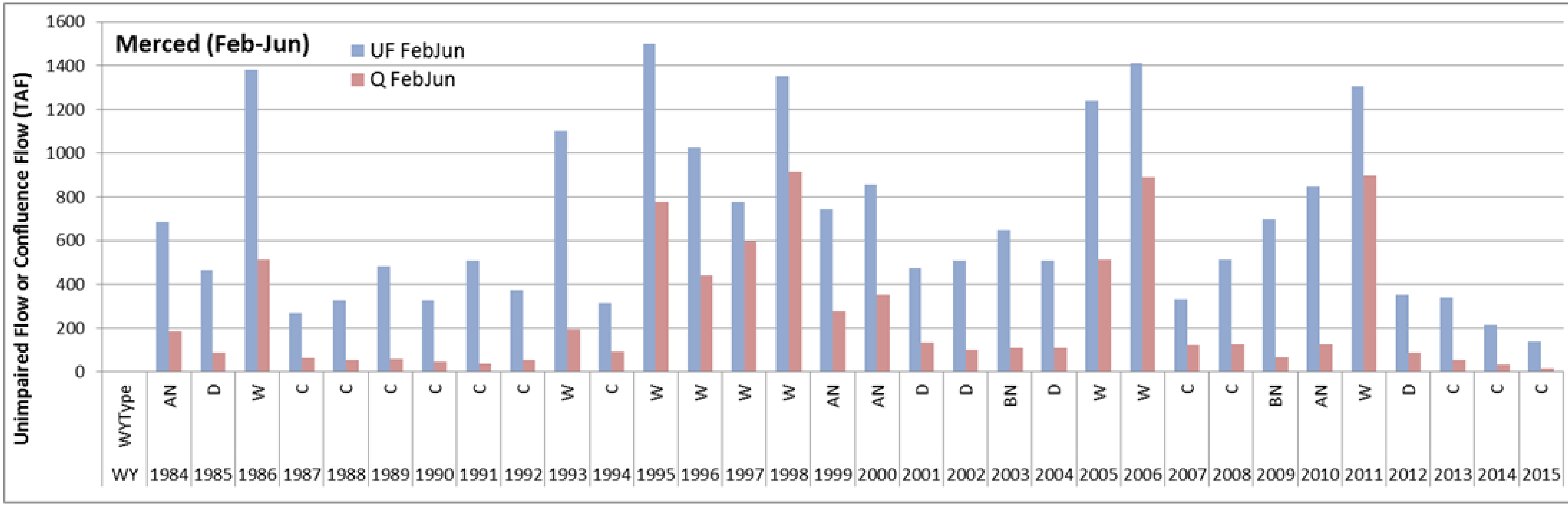
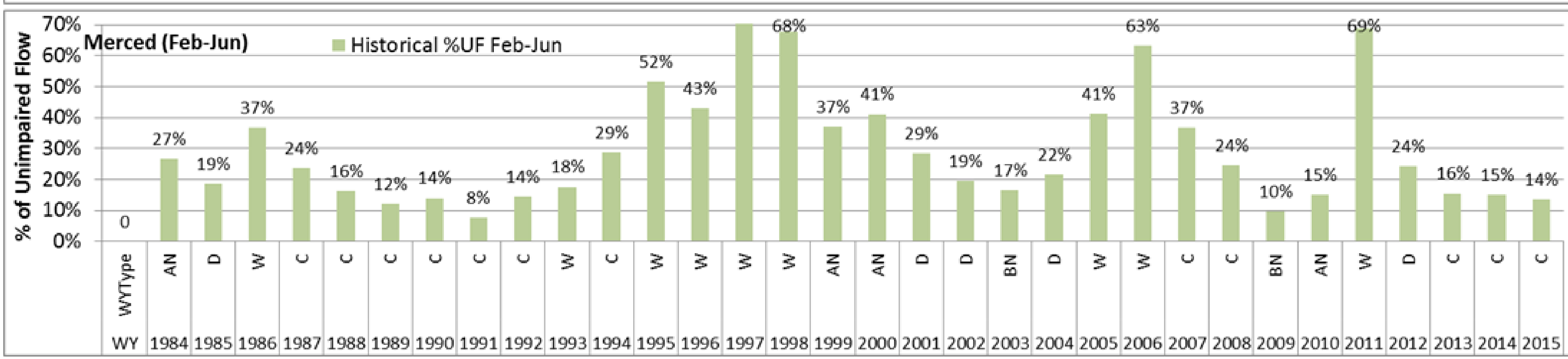
Tuolumne Historical Streamflows





Merced Historical Streamflows





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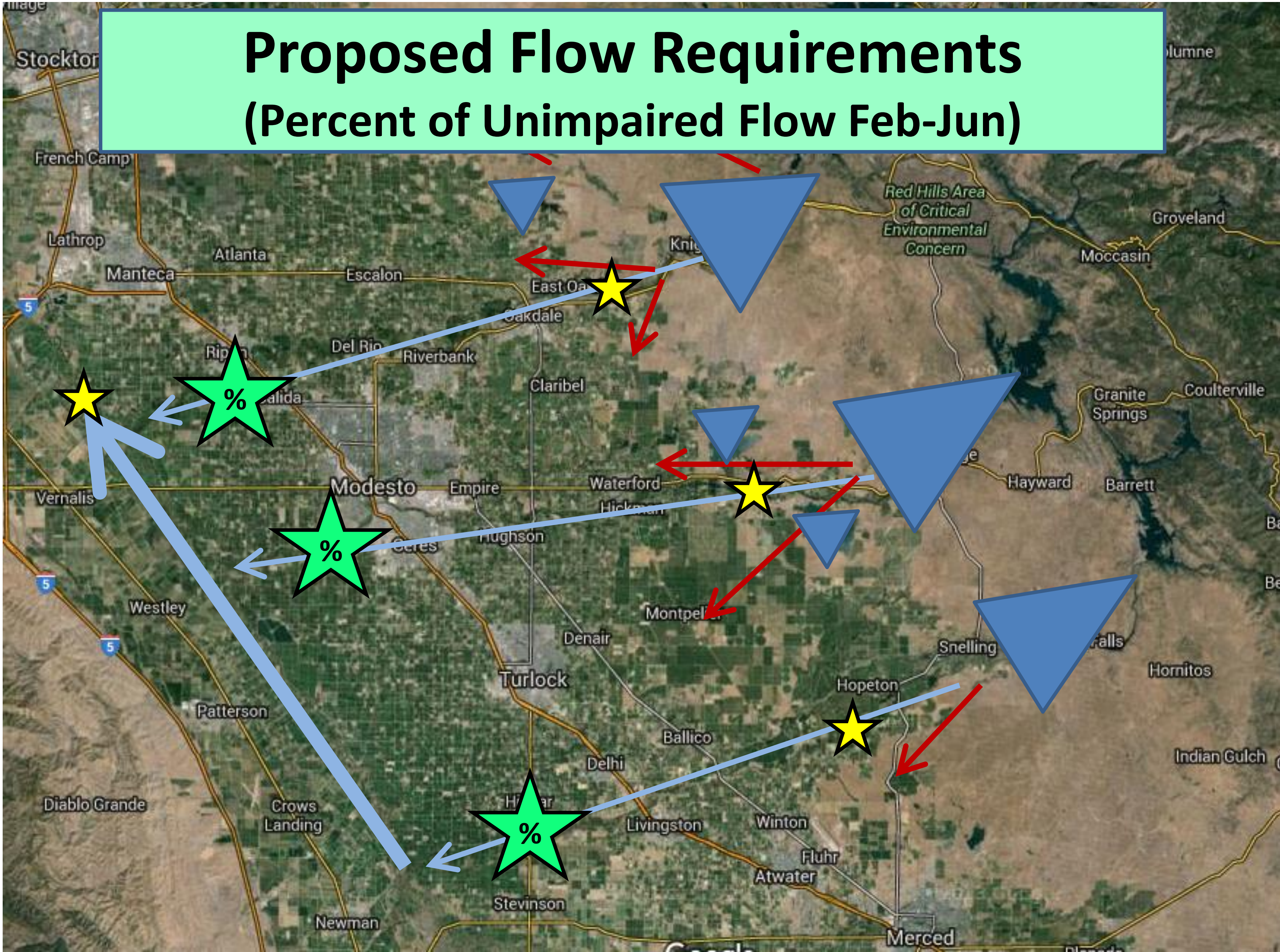
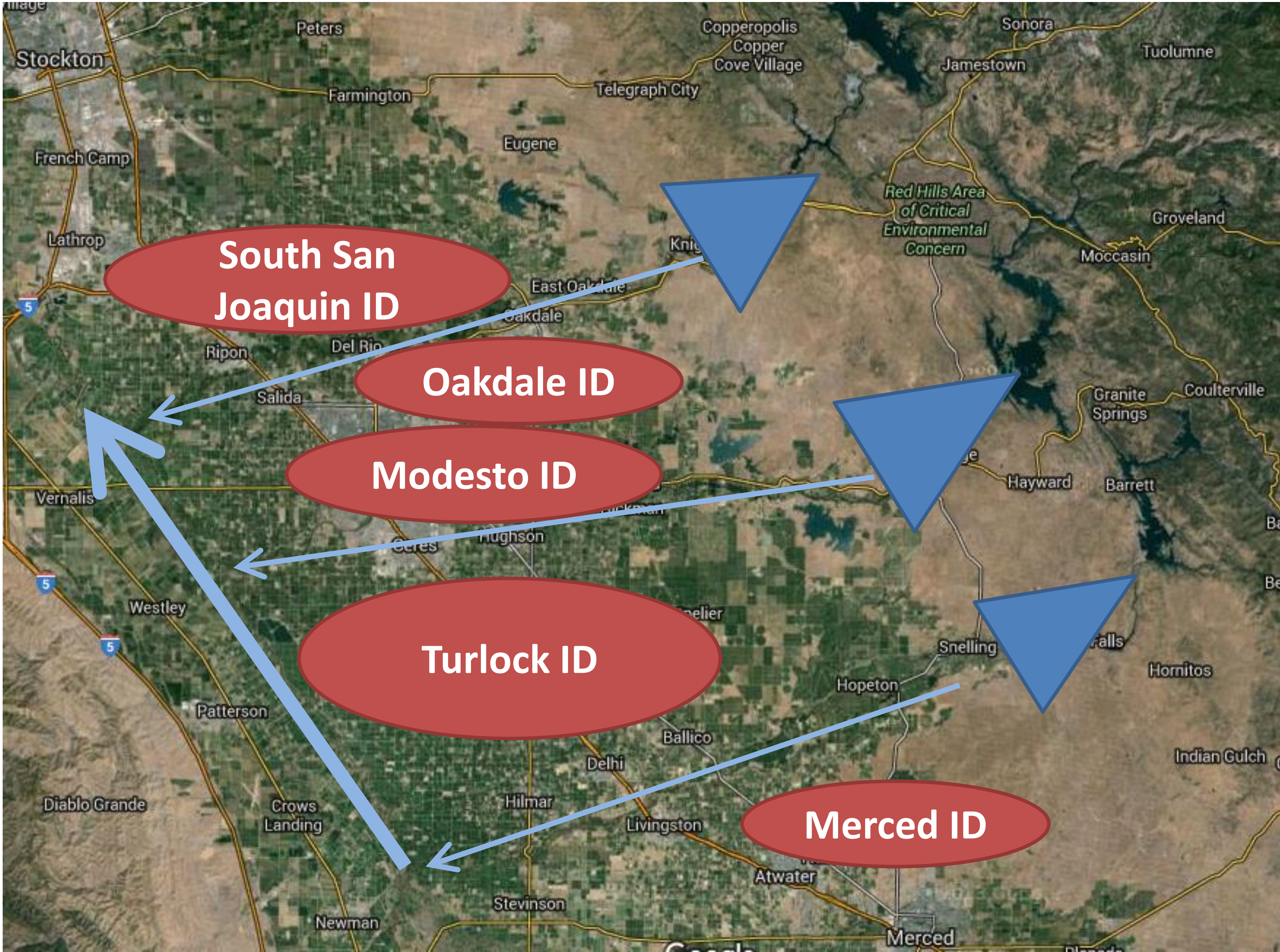
Proposed Flow Requirements
(Percent of Unimpaired Flow Feb-Jun)



Irrigation District Characterization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Oakdale ID
Modesto ID
Turlock ID
Merced ID
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Peters
Farmington
Copperopolis
Copper Cove Village
Telegraph City
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Diablo Grande
Crows Landing
Hilmar
Livingston
Atwater
Stevinson
Newman
Merced

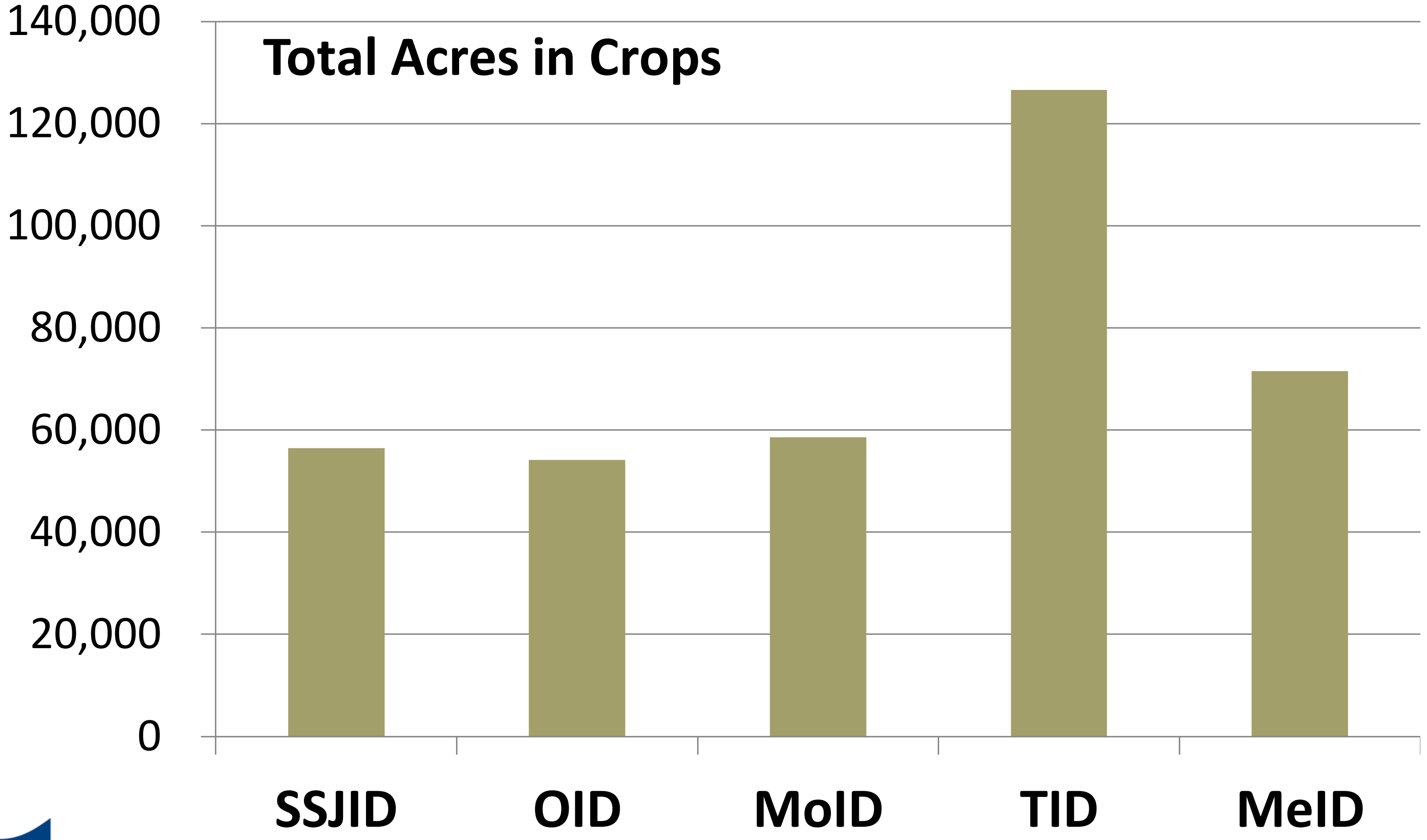
2015 AGRICULTURAL WATER MANAGEMENT PLAN

Prepared by

DAVIDS ENGINEERING, INC
www.davidsengineering.com

December 2015

AWMP Irrigated Acreage by District



Irrigation District water budgets

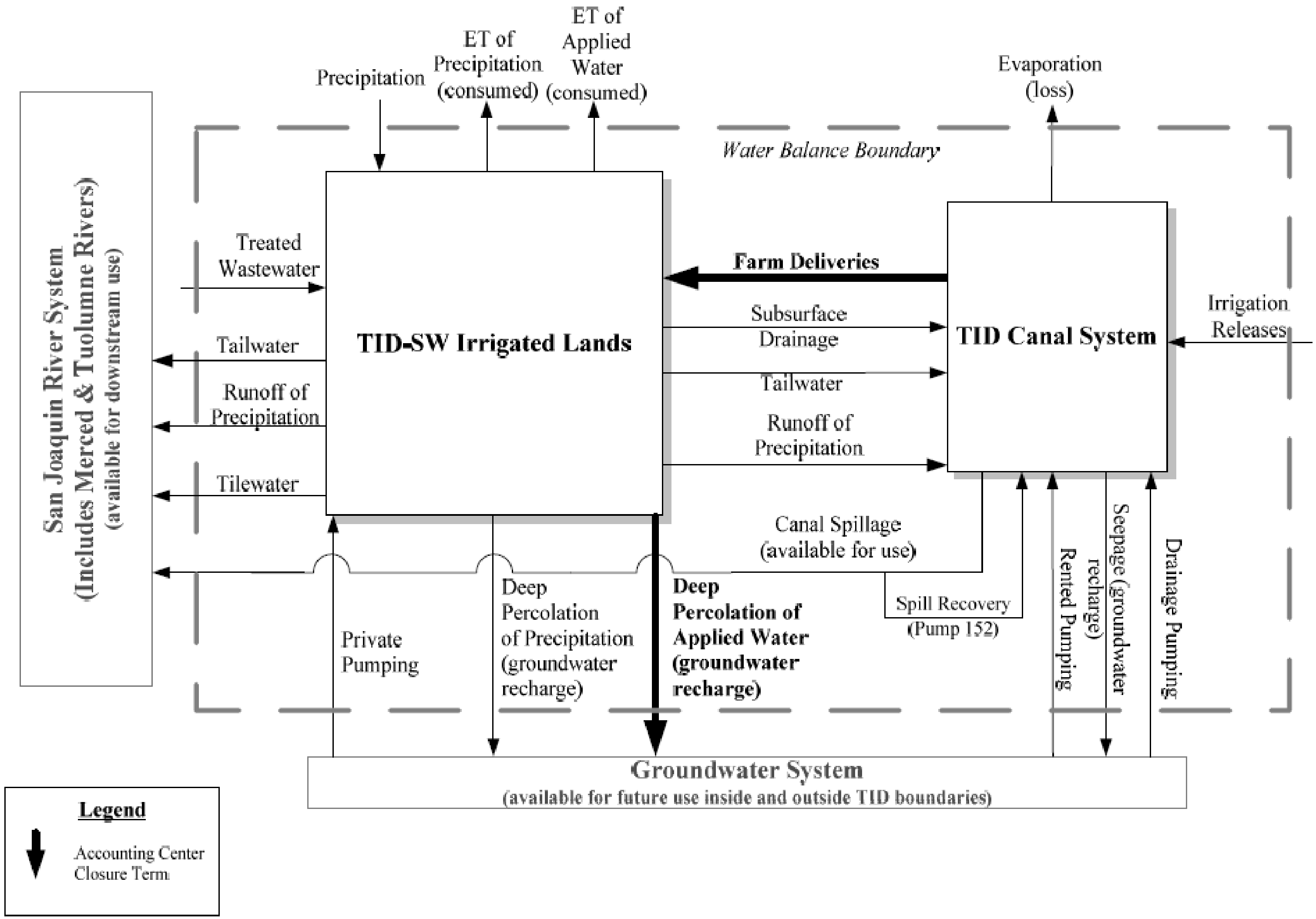
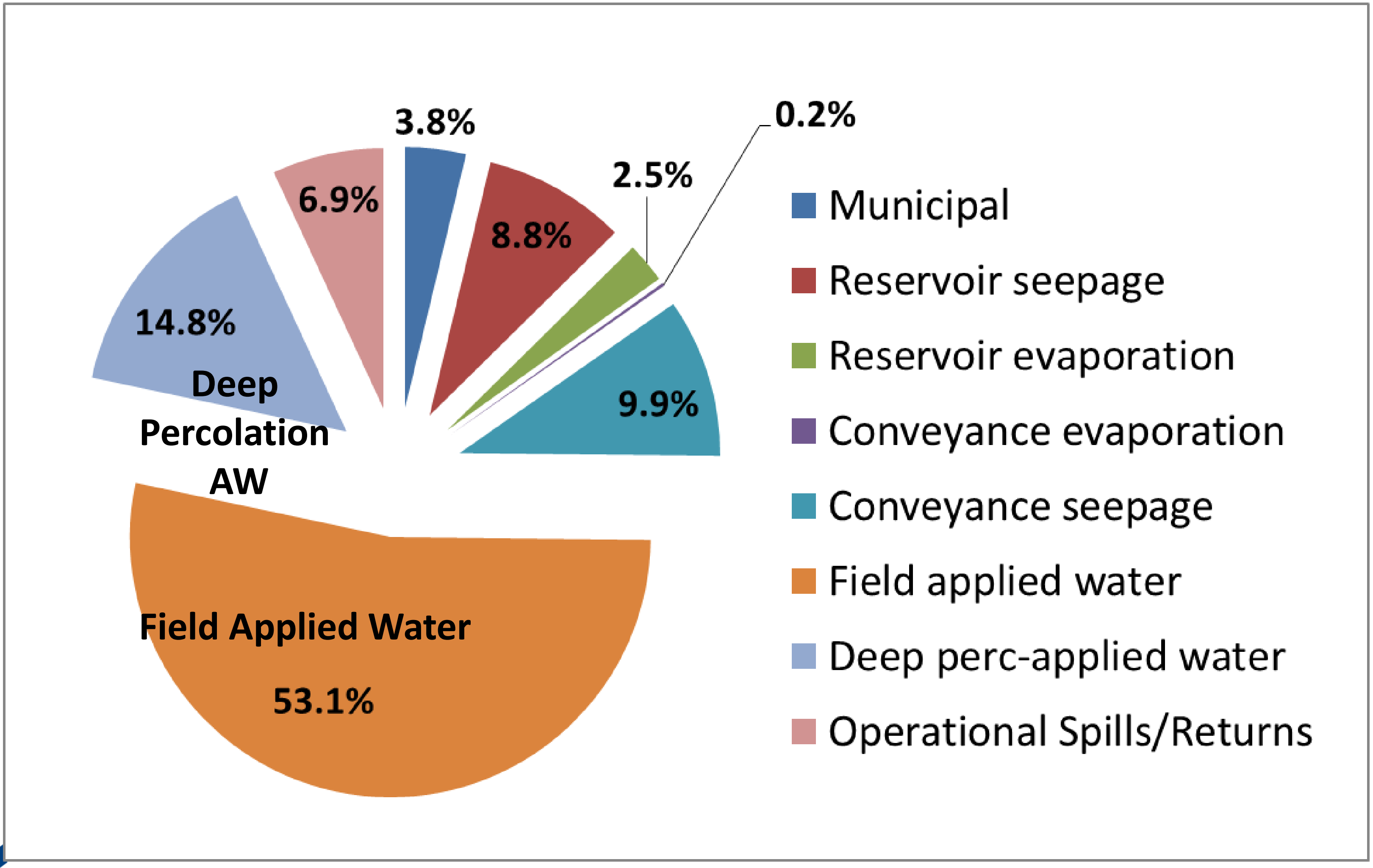


Figure 4.1. TID Water Balance Structure.

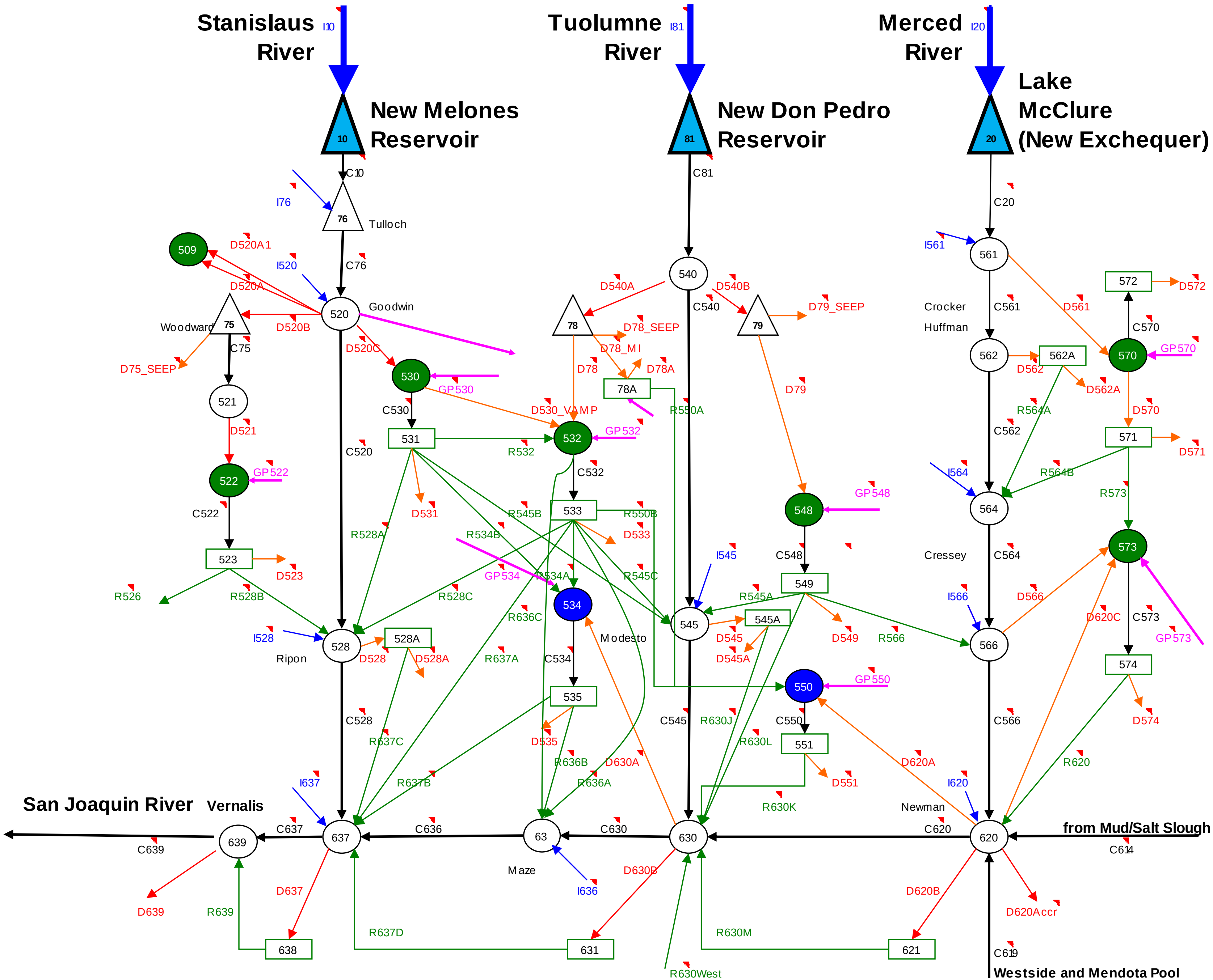
Irrigation District Water Balance

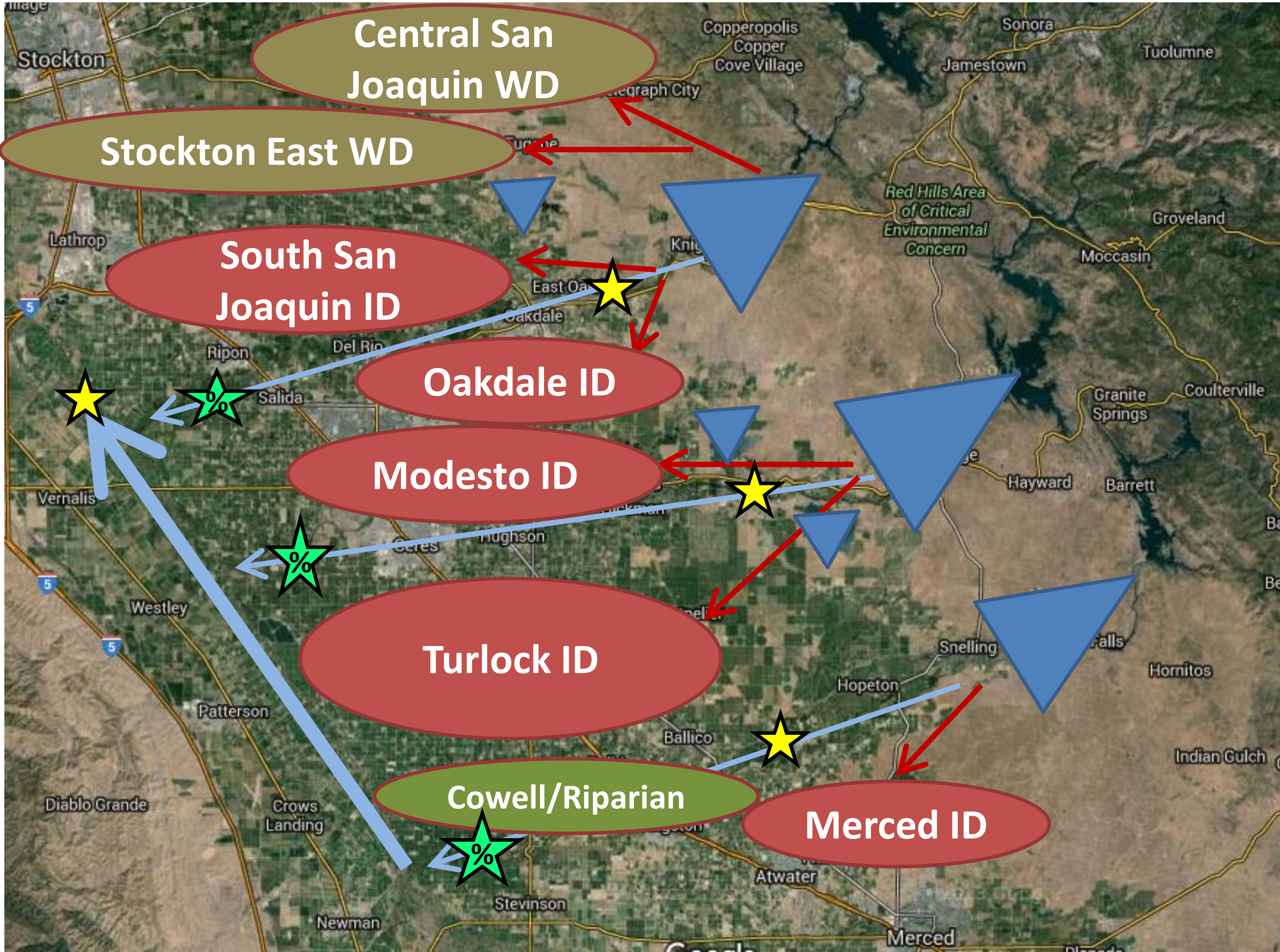


Water Boards

How Do We Model System?

CALSIM SAN JOAQUIN RIVER SCHEMATIC





Central San Joaquin WD
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Merced

CALSIM II
"San Joaquin River Basin"

- DWR and USBR Versions
- An operations mass-balance model
- 82 years of monthly record:
  - Water years 1922-2003
- Inflow boundaries to each Reservoir
- Diversion demands, Allocations, Return Flows
- Local hydrology inflows +/-

“SWRCB-CALSIM Baseline”

- SWRCB application of CALSIM Baseline
- Includes Vernalis Adaptive Management Program (VAMP) criteria
- D-1641 Requirements at Vernalis (flow/salinity)
- FERC/RPA requirements at diversion dams
- Includes ~LOD 2005 demand estimates for IDs

WSE = Water Supply Effects Model

- Excel spreadsheet by Lucas Sharkey to evaluate %UF flow alternatives
- Borrows CALSIM mass-balance framework
- Allocates water based on demand and availability
  - Growing season: March-September
  - Availability:
    - Inflows, Reservoir Storage
  - Constraints:
    - Carryover storage, minimum allocation, drought refill

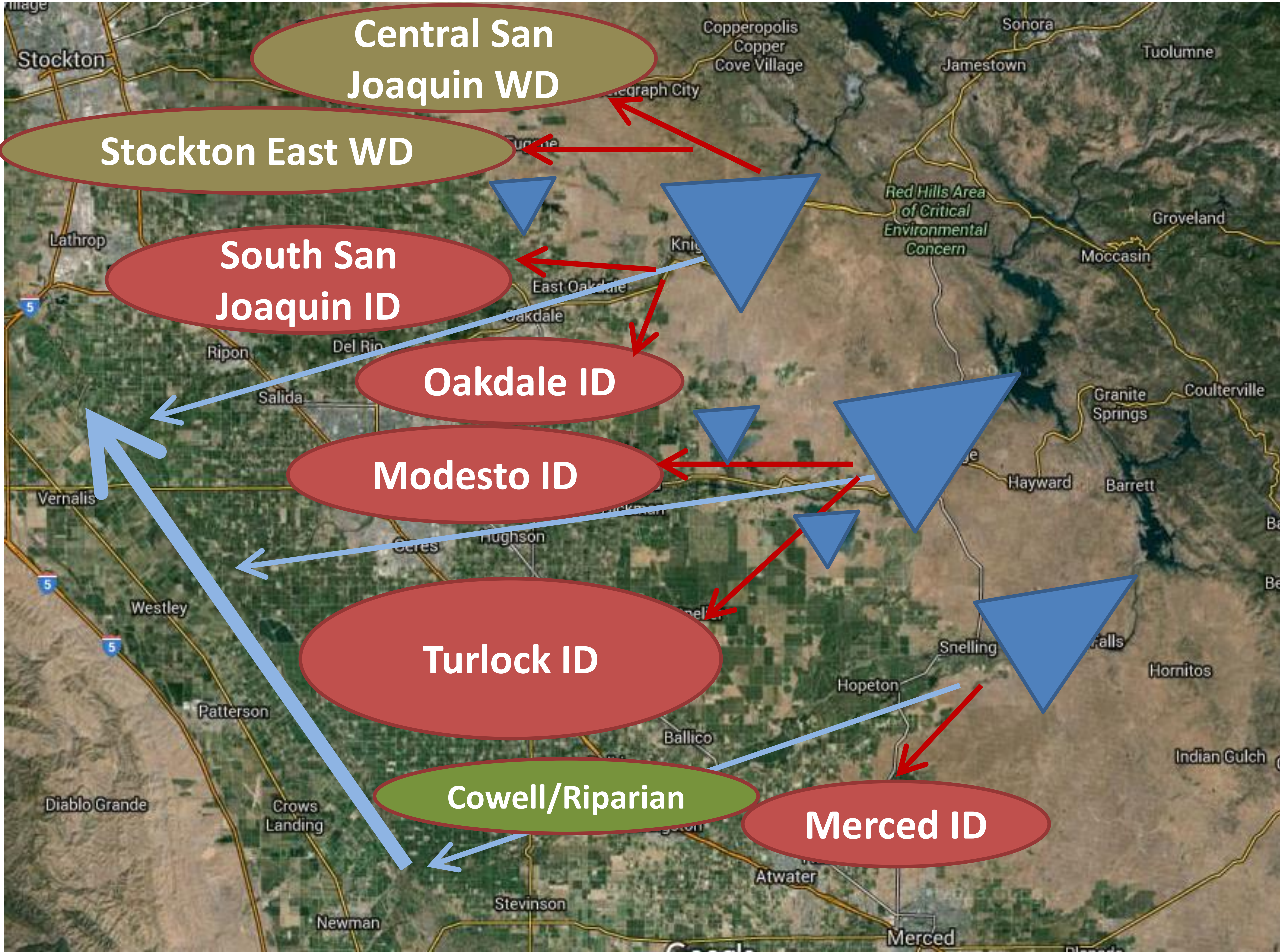
WSE Model – CALSIM Framework

B_WSE_Model_v4.16 - Microsoft Excel

Tributary Nodes (cfs unless otherwise noted)

Calendar Date	Days per month	Calendar Month	Water Year	Water Year Type	Unimpaired Flow	New Melones Reservoir			Reservoir Node 10	Tulloch Reservoir			Reservoir Node 76							Flow Node 520
					TAF	+TAF	-	TAF		+TAF	-	TAF		+TAF	-	-	-	-		
CD	DPM	CM	WY	WYT	SUF	I10	E10	S10	C10	I76	E76	S76	C76	I520	D520A	D520A1	D520B	D520C	520%TotD	C520
Oct-21	31	10	1922	W	4	31	55	951	1,252	0	10	57	1,454	0	145	0	327	185	98%	797
Nov-21	30	11	1922	W	6	34	24	956	464	0	4	57	460	0	103	0	142	16	100%	200
Dec-21	31	12	1922	W	25	49	13	982	360	3	2	57	403	0	90	0	117	0	100%	200
Jan-22	31	1	1922	W	35	45	12	1,003	373	3	2	57	420	0	76	0	115	0	100%	232
Feb-22	28	2	1922	W	107	110	23	1,110	23	22	4	57	412	2	76	0	129	0	100%	236
Mar-22	31	3	1922	W	103	96	34	1,185	317	8	5	59	424	1	85	0	149	0	100%	200
Apr-22	30	4	1922	W	170	113	53	1,146	2,506	6	8	62	2,528	0	118	0	612	293	99%	1,512
May-22	31	5	1922	W	495	370	94	1,332	2,889	2	15	67	2,830	0	299	0	863	388	96%	1,282
Jun-22	30	6	1922	W	378	374	138	1,566	2,212	0	21	67	2,198	0	458	0	978	399	96%	363
Jul-22	31	7	1922	W	87	92	165	1,512	2,209	0	24	67	2,185	0	501	0	989	429	96%	265
Aug-22	31	8	1922	W	17	44	149	1,421	2,060	0	22	67	2,038	0	385	0	952	419	97%	283
Sep-22	30	9	1922	W	4	31	112	1,364	1,358	0	17	63	1,400	0	227	0	597	326	97%	250
Oct-22	31	10	1923	AN	6	28	64	1,313	1,226	0	9	57	1,322	0	138	0	253	158	99%	774
Nov-22	30	11	1923	AN	16	39	27	1,326	413	1	4	57	426	0	103	0	124	0	100%	200
Dec-22	31	12	1923	AN	79	78	16	1,391	185	13	2	57	391	1	90	0	117	0	100%	200
Jan-23	31	1	1923	AN	78	78	17	1,450	304	7	2	57	409	0	76	0	115	0	100%	226
Feb-23	28	2	1923	AN	55	65	29	1,494	337	5	4	57	427	0	76	0	129	0	100%	229
Mar-23	31	3	1923	AN	77	69	45	1,450	1,791	2	6	59	1,797	0	111	0	454	206	100%	1,029
Apr-23	30	4	1923	AN	207	143	66	1,450	2,352	4	9	62	2,343	0	97	0	550	189	98%	1,512
May-23	31	5	1923	AN	356	285	101	1,534	3,157	2	14	67	3,095	0	284	0	945	424	96%	1,444
Jun-23	30	6	1923	AN	161	158	133	1,552	2,219	1	19	67	2,210	0	471	0	978	399	97%	363
Jul-23	31	7	1923	AN	73	88	163	1,494	2,219	0	24	67	2,199	0	515	0	989	429	96%	265
Aug-23	31	8	1923	AN	12	40	148	1,397	2,070	0	22	67	2,048	0	394	0	952	419	97%	283
Sep-23	30	9	1923	AN	10	38	110	1,359	1,182	0	17	64	1,224	0	195	0	499	281	97%	250

SJR_Flow(Estimate2) | SJR_Flow(Final) | CUAW-CALSIM | Stan-CALSIM | Tuol-CALSIM | Merc-CALSIM



Central San Joaquin WD
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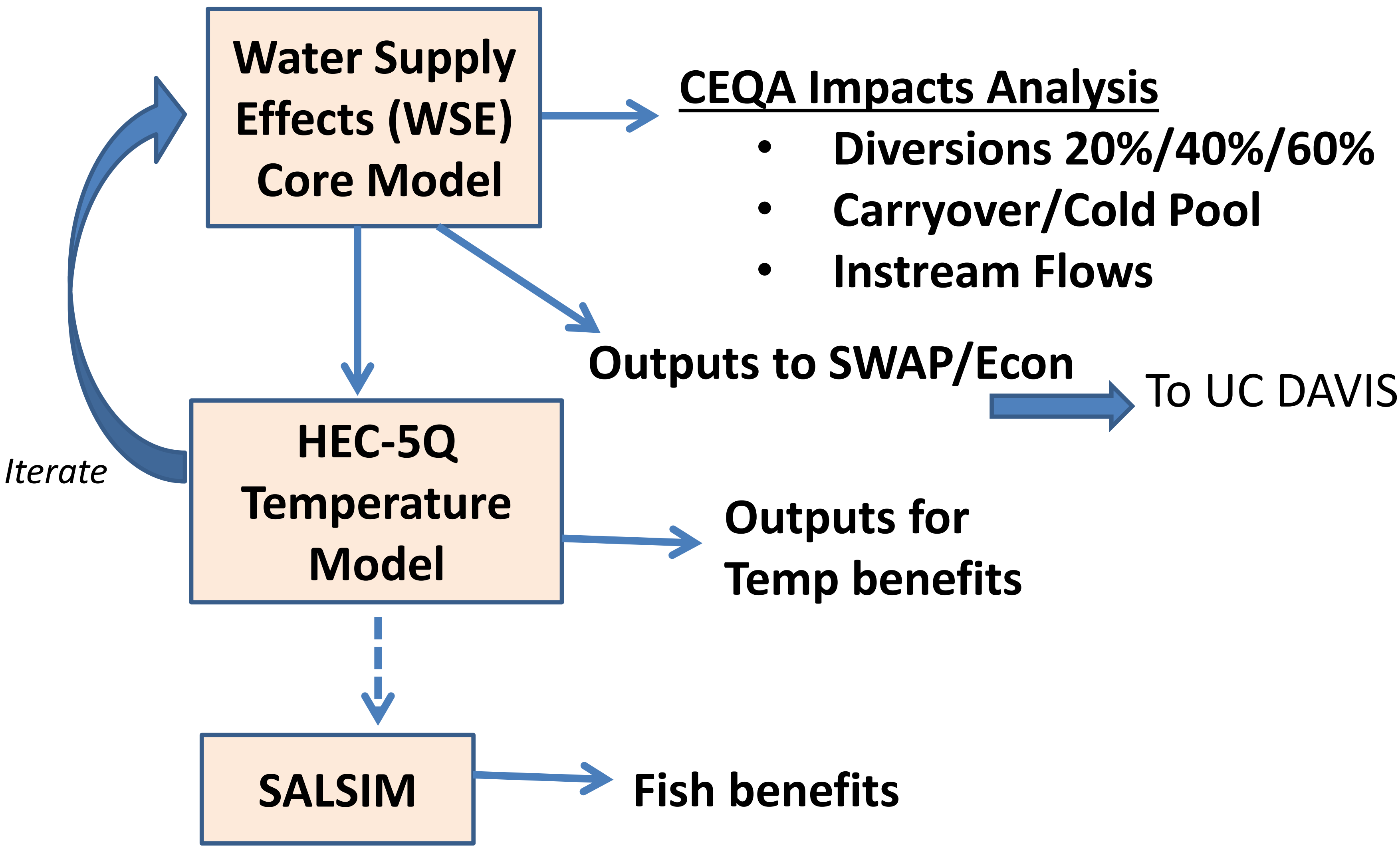
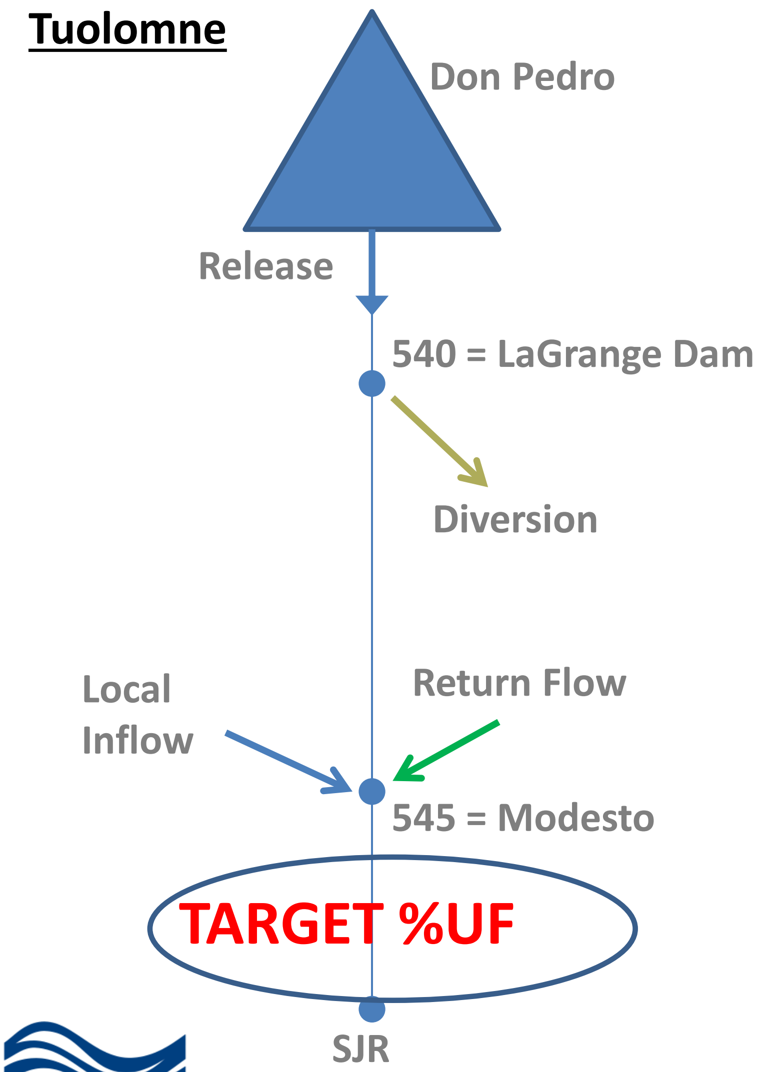
Tuolumne

Modeling Flow Chart



How to apply streamflow target

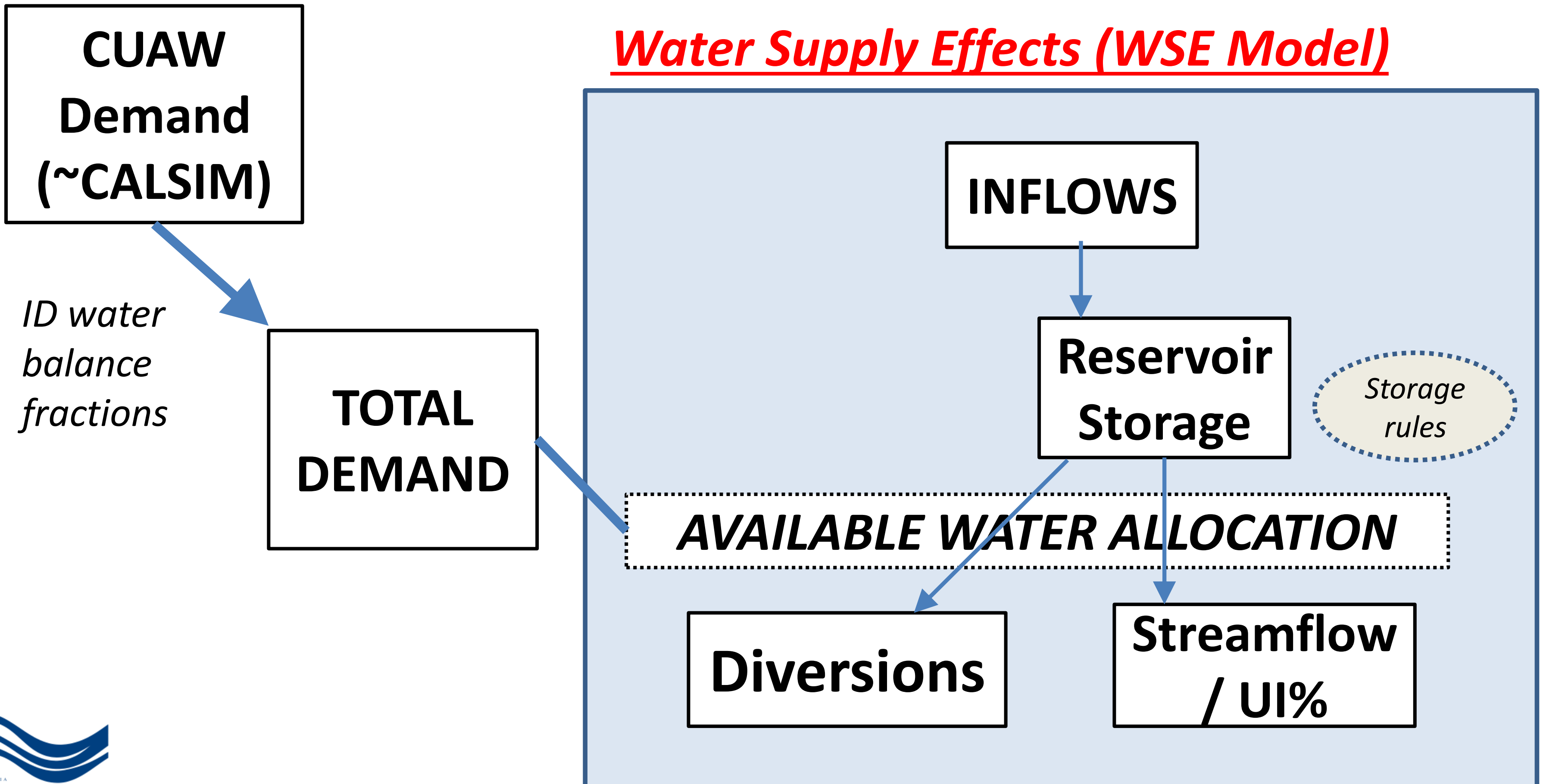


- Calculate Available Water from All Inflows (incl. Return and Local Inflows)
- Calculate Diversions Available
- Recalculate release to meet target

Water Boards

Water Supply Effects: Allocation

- Peripheral inputs of ID water balance (component fractions)
- Note CUAW Demand also used for GW effects, cost analysis



Water Boards

Annual Allocation

- Similar to New Melones Index:

  = [End-of-Feb. Storage] + **[Anticipated Inflow Mar-Sept.]**
- Add reservoir carryover storage parameters
  - (target "guideline" and % draw)
- Subtract streamflow requirements Mar-Sept
- If enough water, districts get demands met
- If not enough, districts are cut

Calculation of Annual Allocation

1. *Determine Streamflow Requirement*
   – (Feb-Jun %UF, BiOp, Vernalis, etc.)
2. *Determine "Available Water"*

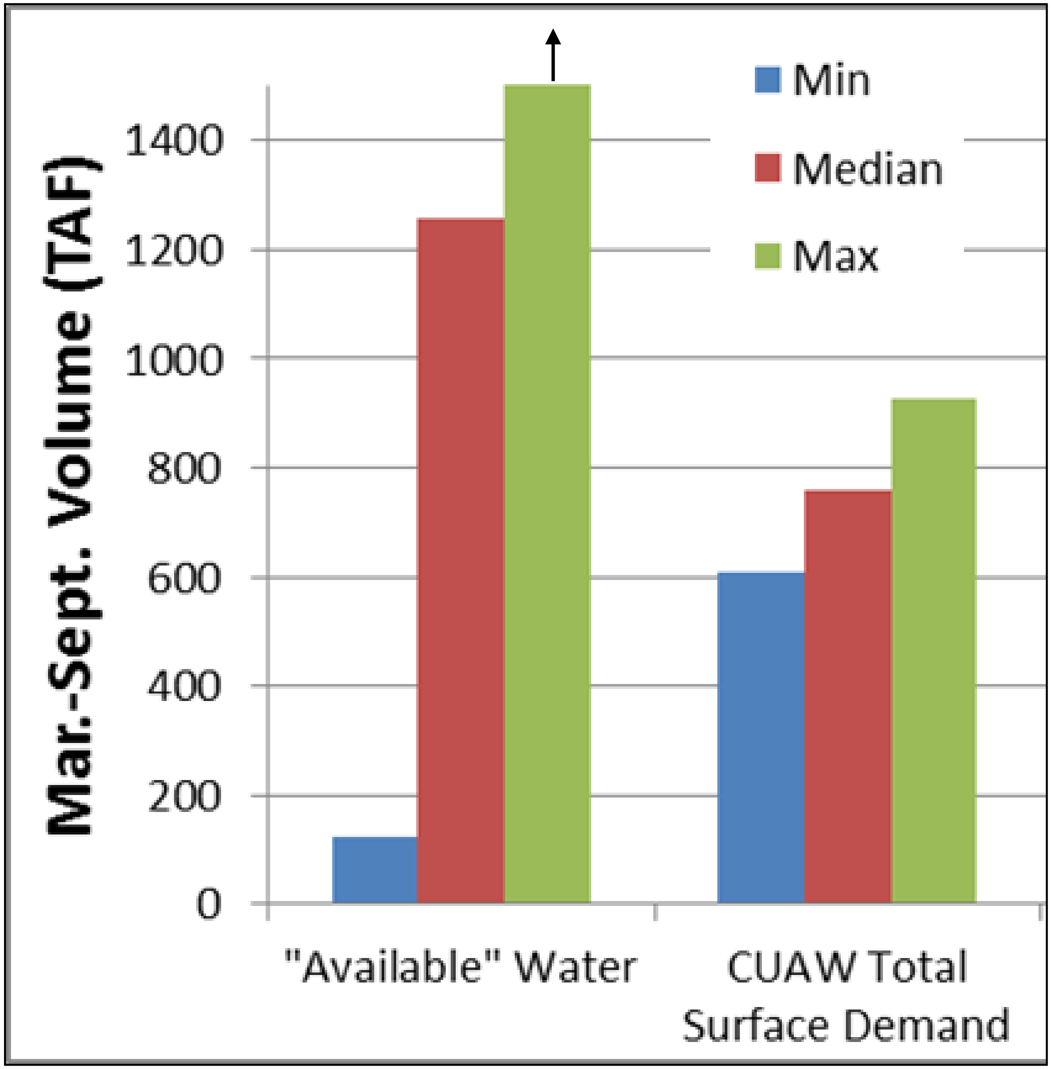
   from: -net inflows,
   -storage,
   -storage End-of-Sept. constraints
3. *Determine Growing Season Demand*

   (Total Surface Demand *March-Sept.*)
4. *Growing Season Diversion =*

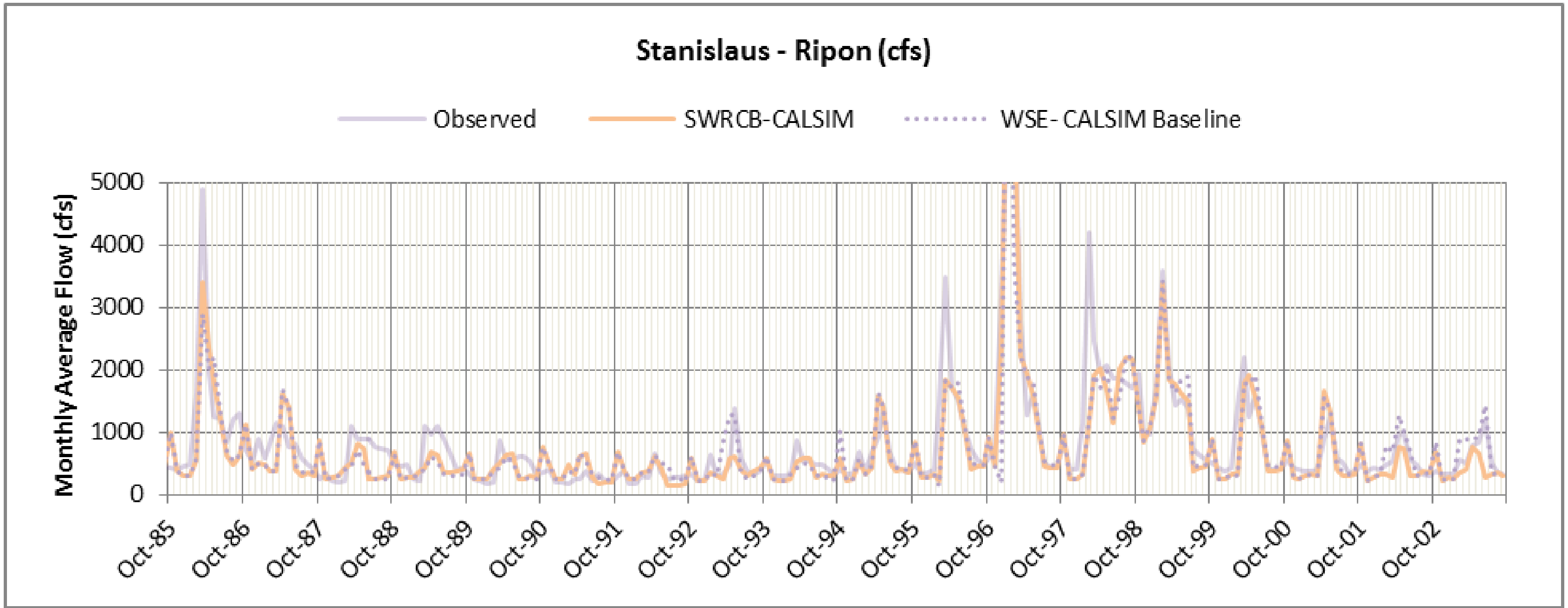
   Minimum(Available, Demand, Max)

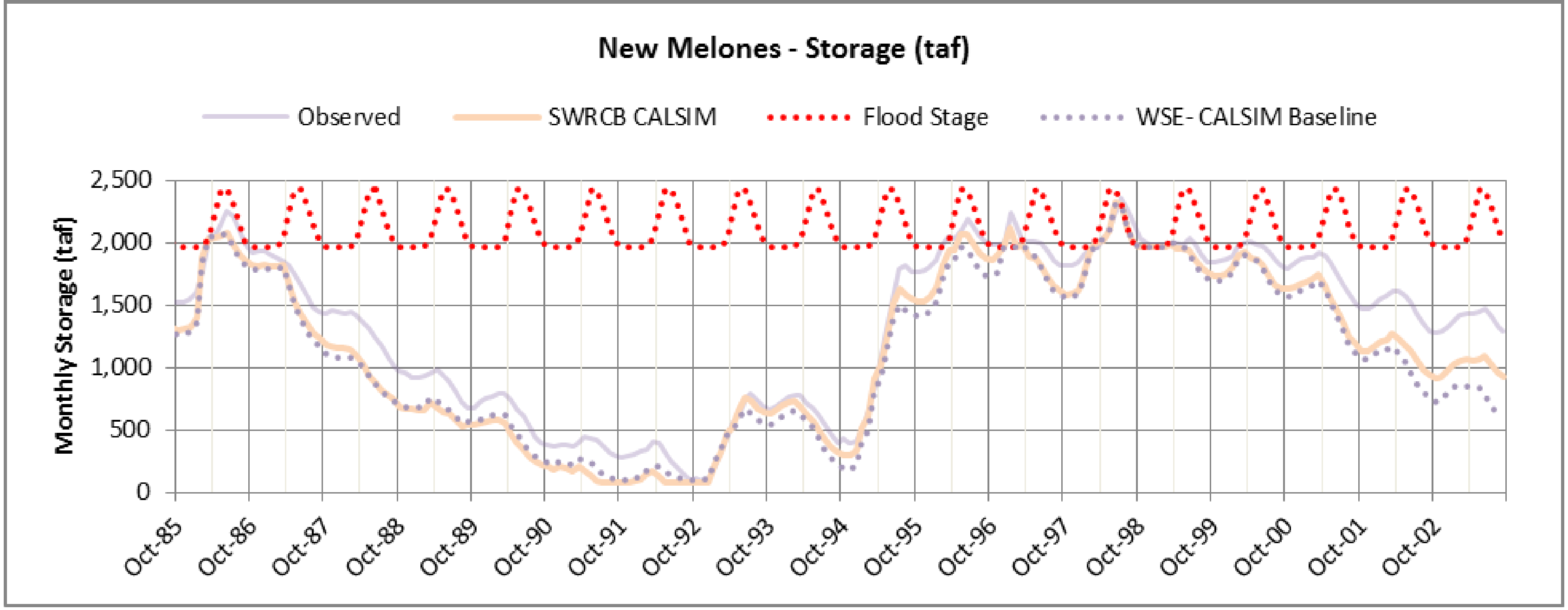
Tuolumne Supply and Demand

Up to 3500 TAF



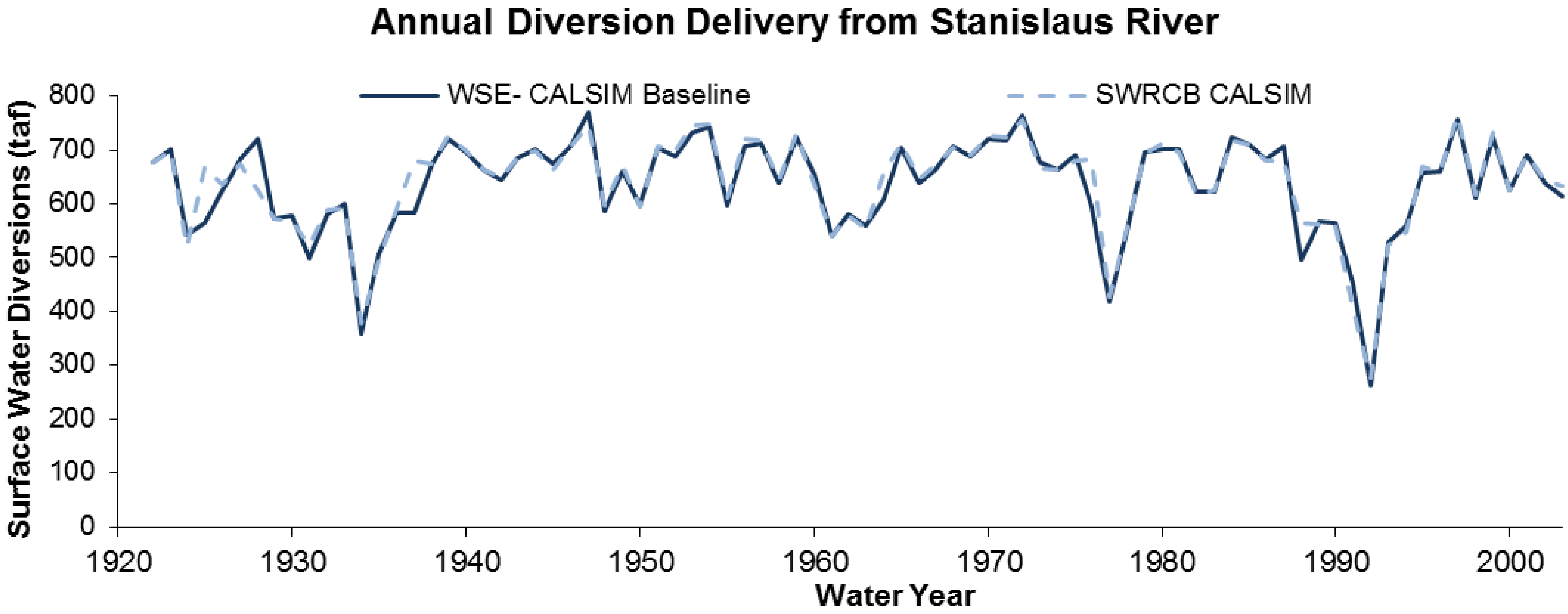
Baseline Results:



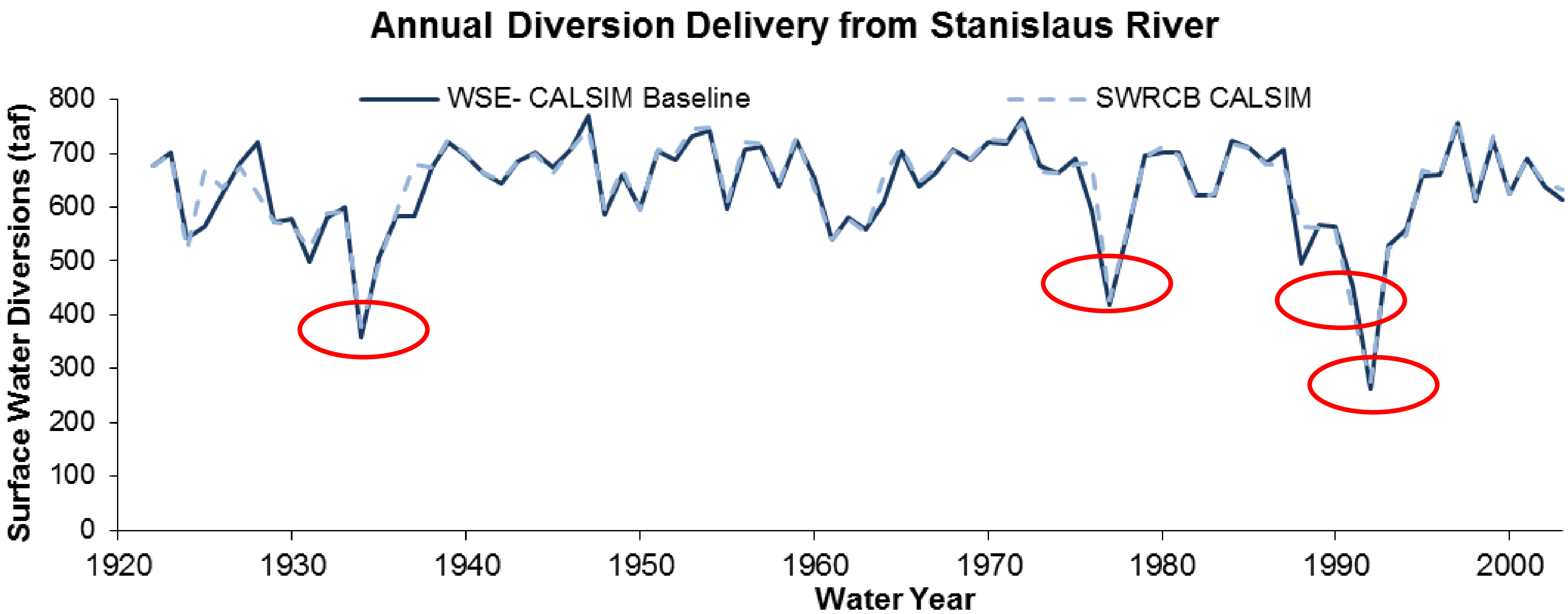


CALIFORNIA Water Boards

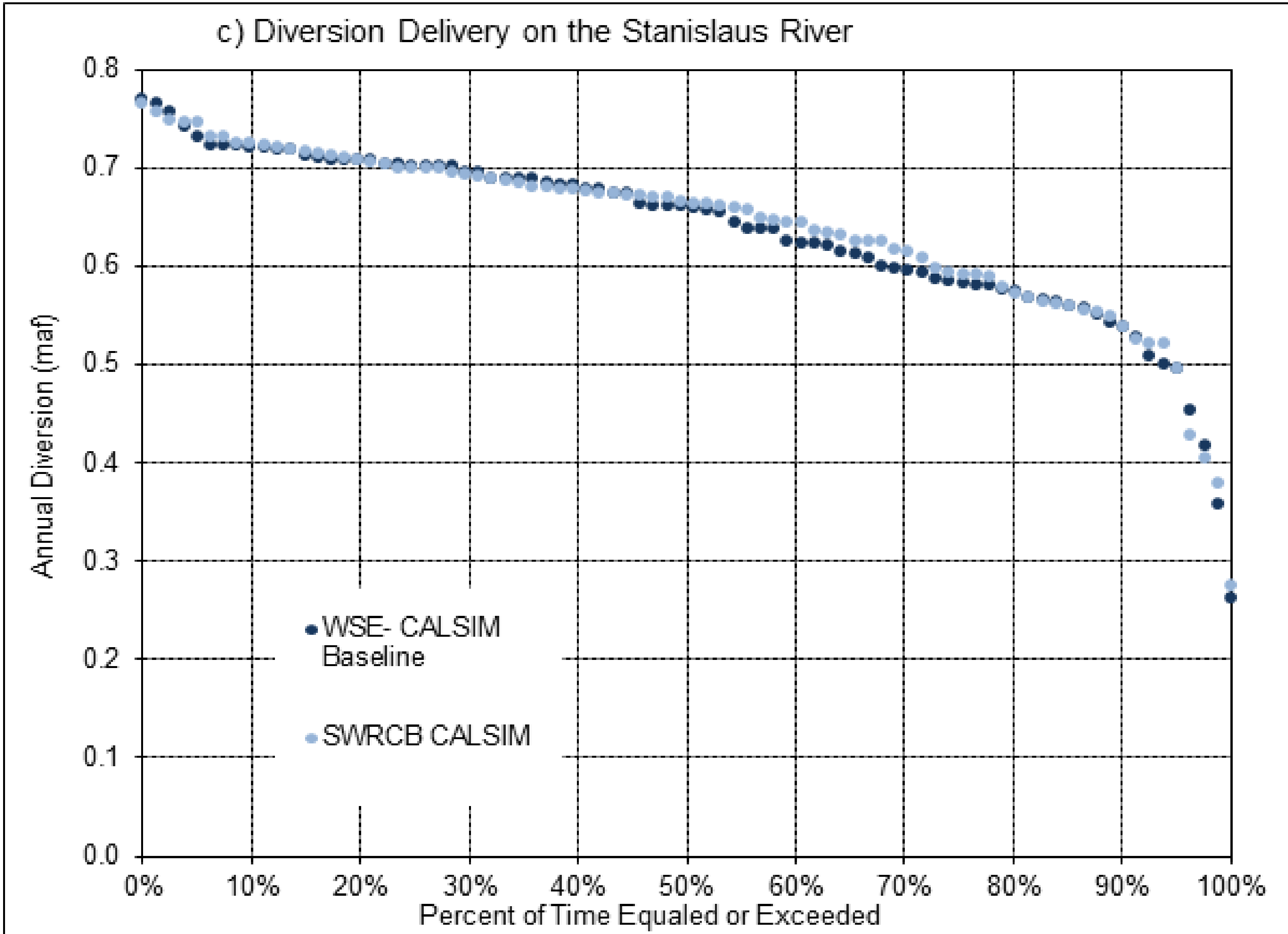
82-yr Diversion Calibration



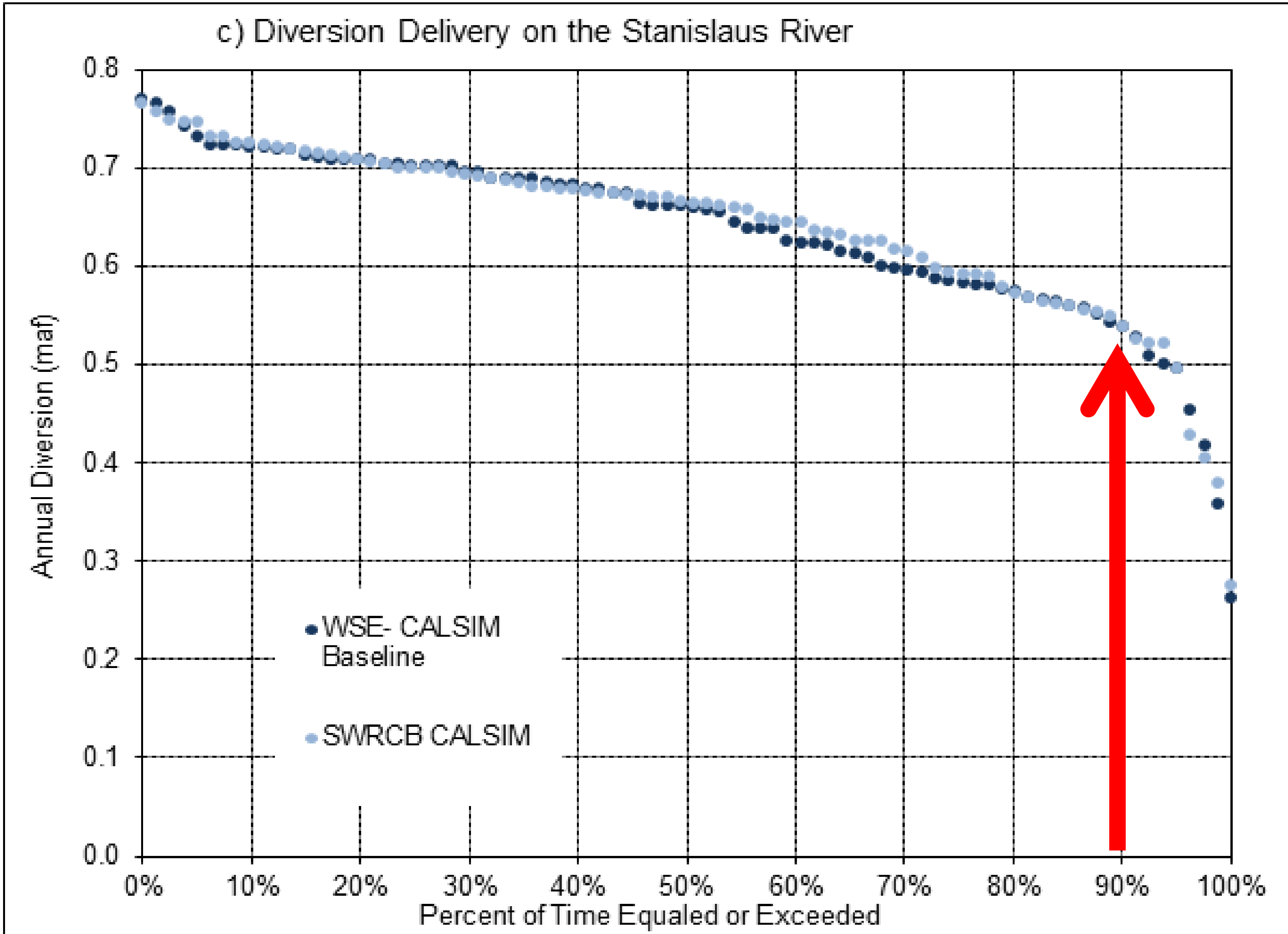
82-yr Diversion Calibration



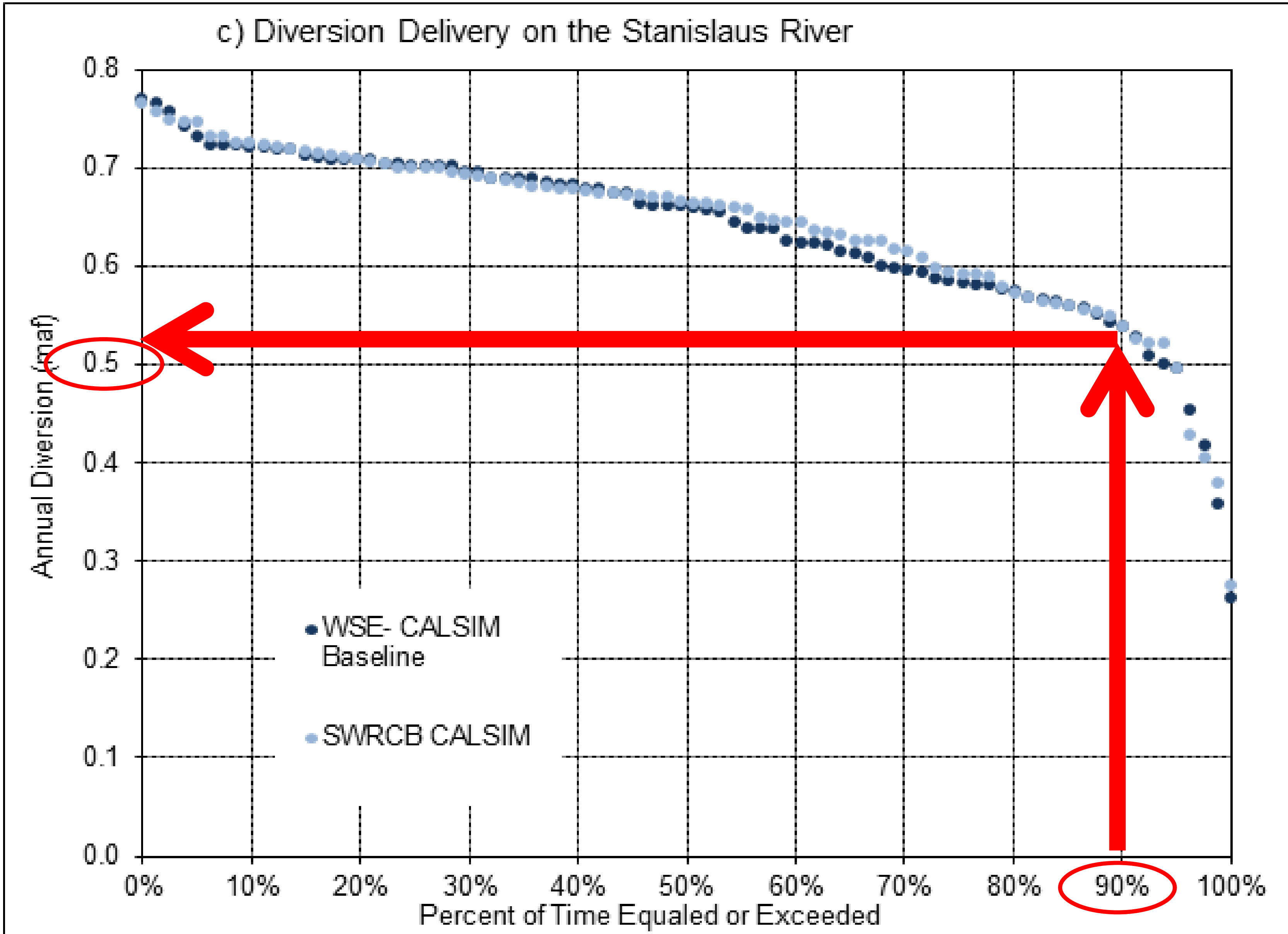
Percent Exceedance of Diversion Delivery

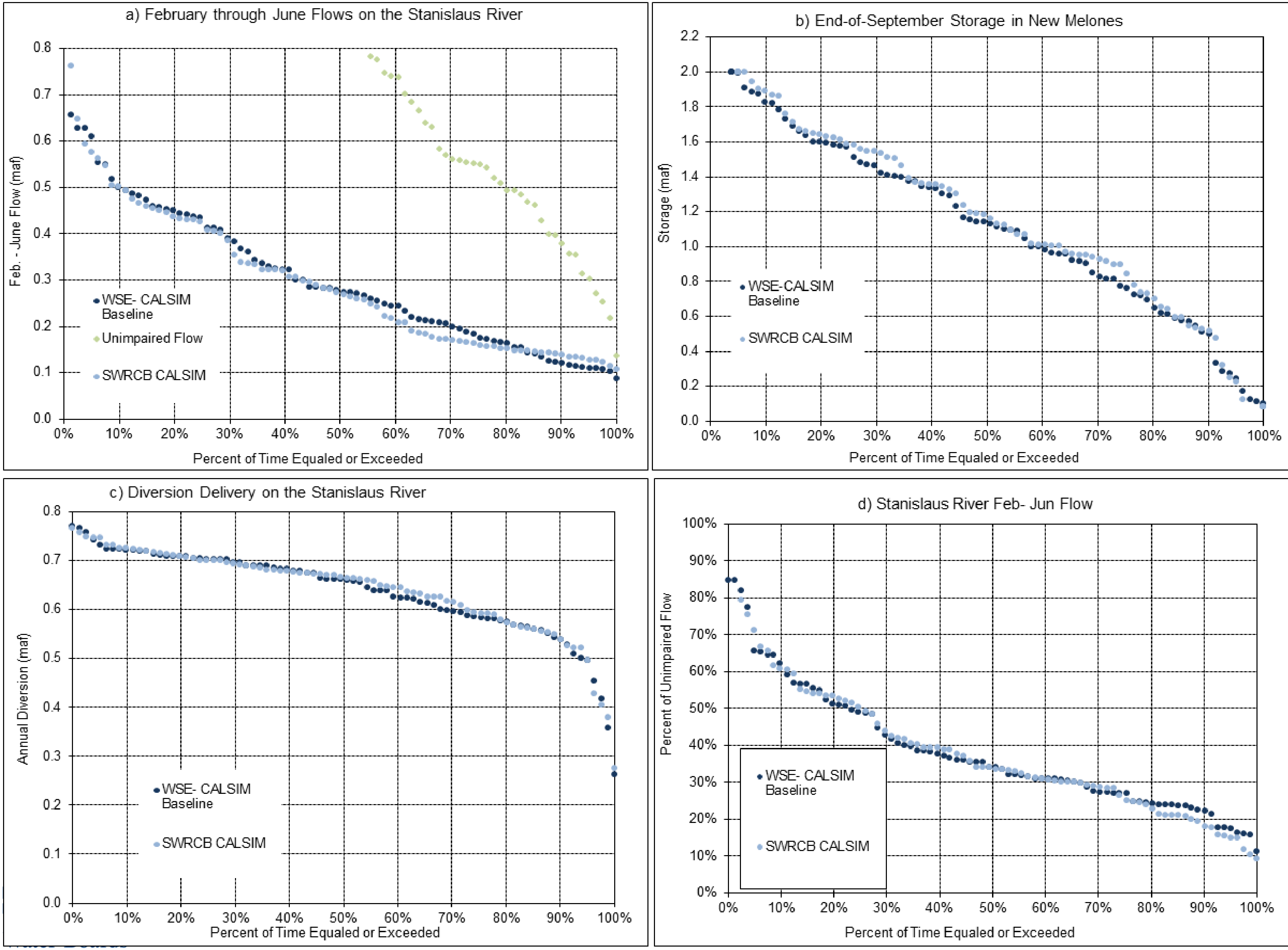


Exceedence Plots



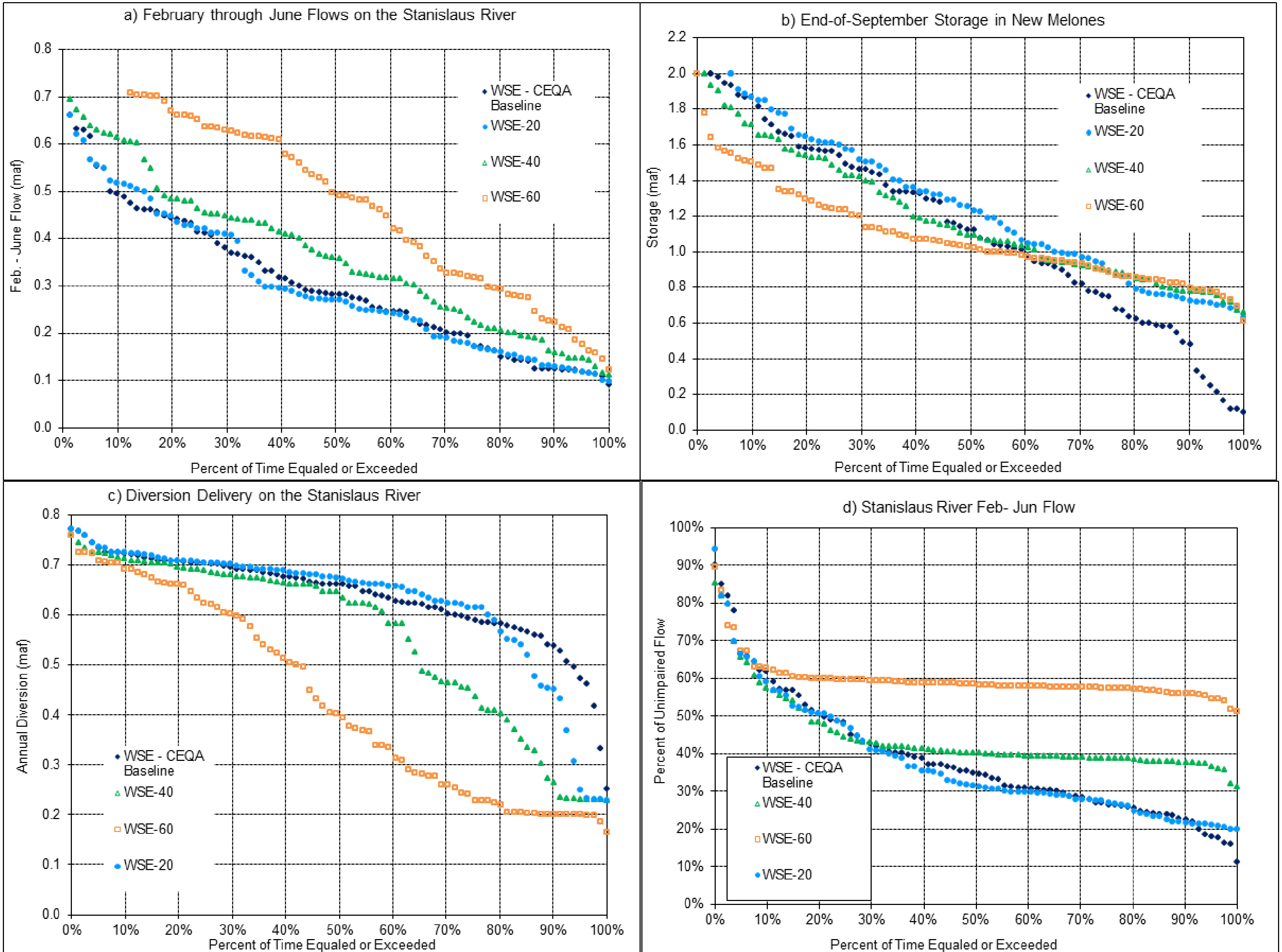
Exceedence Plots



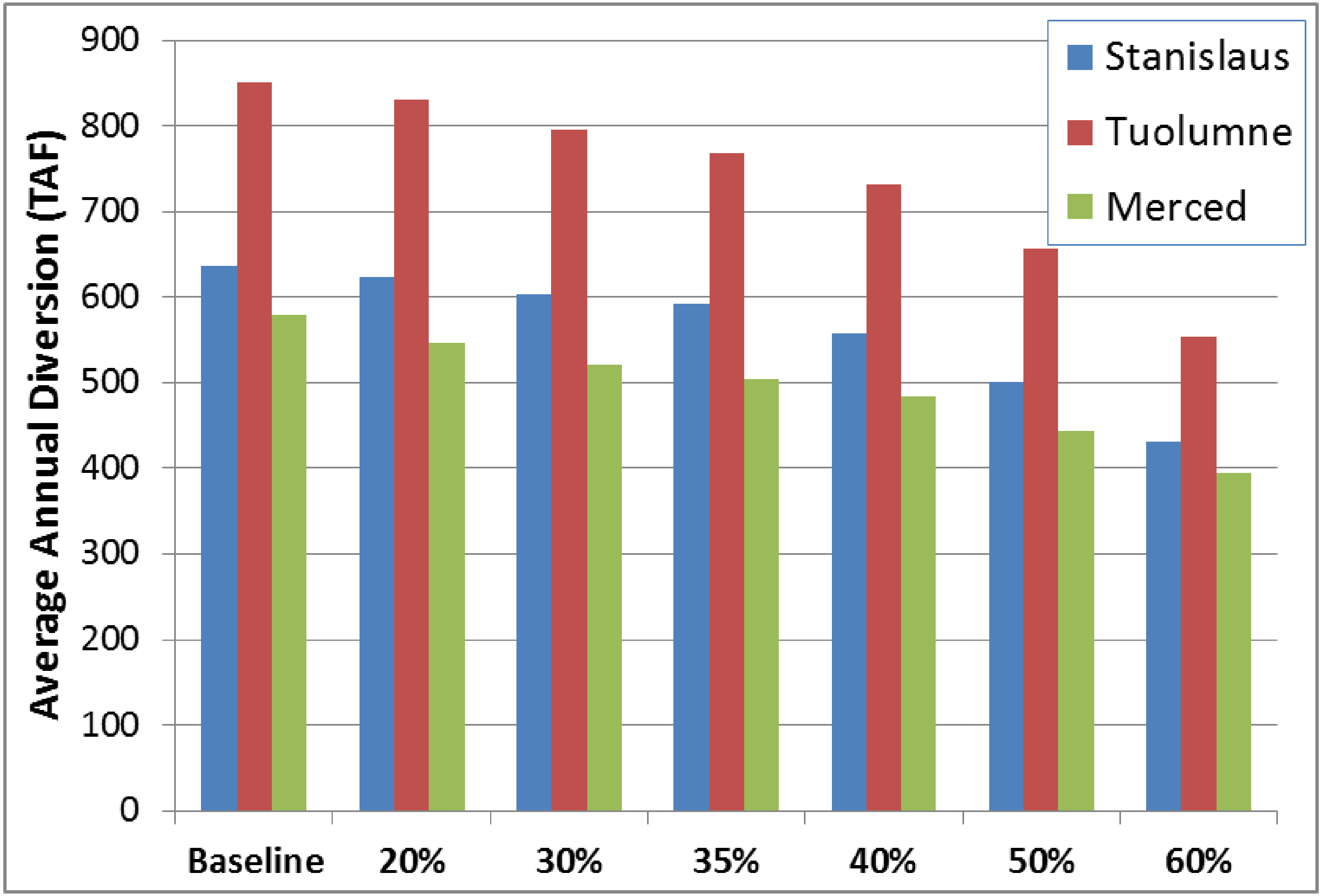

a) February through June Flows on the Stanislaus River
Feb. - June Flow (maf)
Percent of Time Equaled or Exceeded
WSE- CALSIM Baseline
Unimpaired Flow
SWRCB CALSIM
b) End-of-September Storage in New Melones
Storage (maf)
Percent of Time Equaled or Exceeded
WSE-CALSIM Baseline
SWRCB CALSIM
c) Diversion Delivery on the Stanislaus River
Annual Diversion (maf)
Percent of Time Equaled or Exceeded
WSE- CALSIM Baseline
SWRCB CALSIM
d) Stanislaus River Feb- Jun Flow
Percent of Unimpaired Flow
Percent of Time Equaled or Exceeded
WSE- CALSIM Baseline
SWRCB CALSIM

Alternatives Results

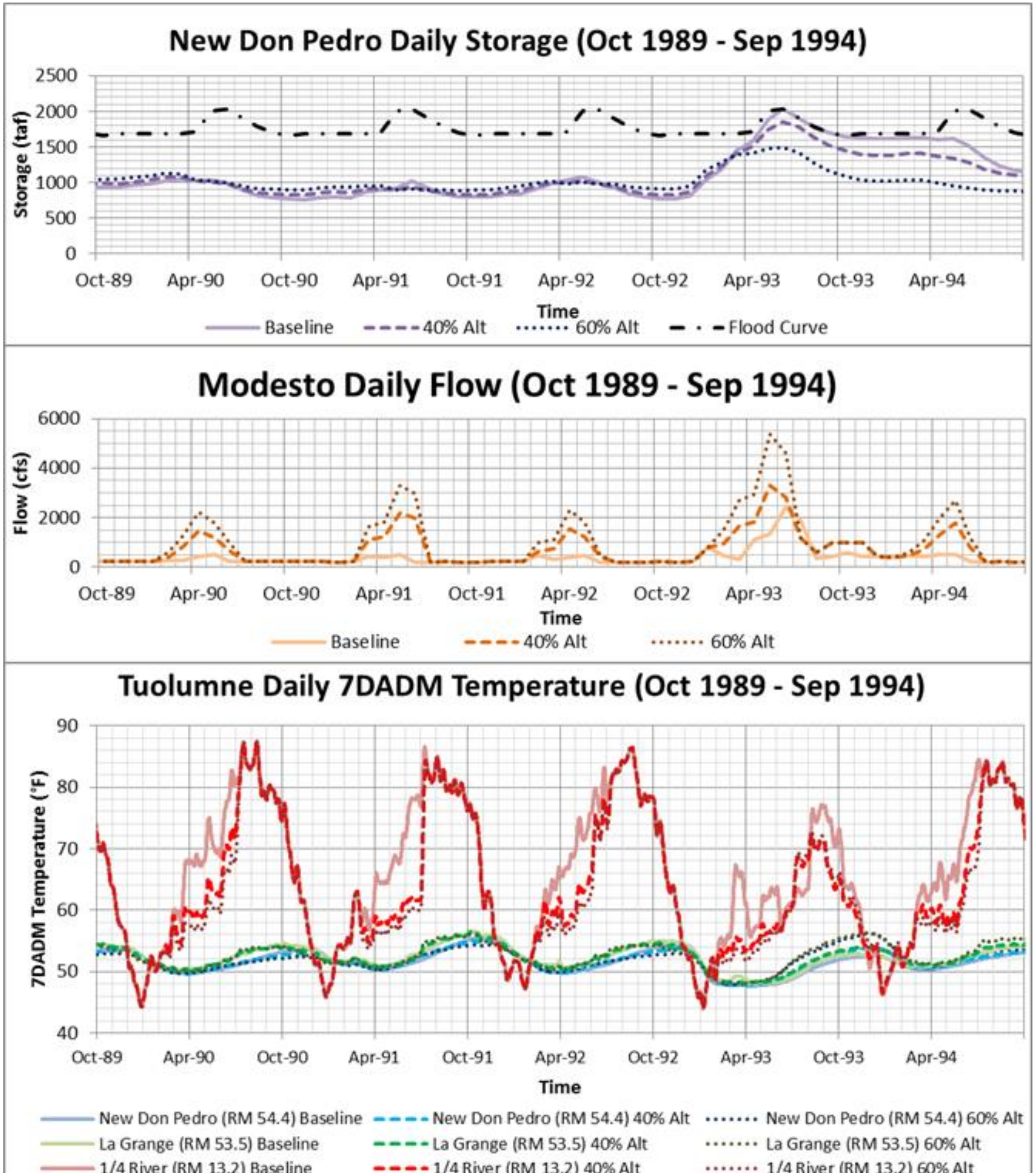
Alternatives Results



WSE Impacts Summary: Reductions in Available Diversions



Temperature Results



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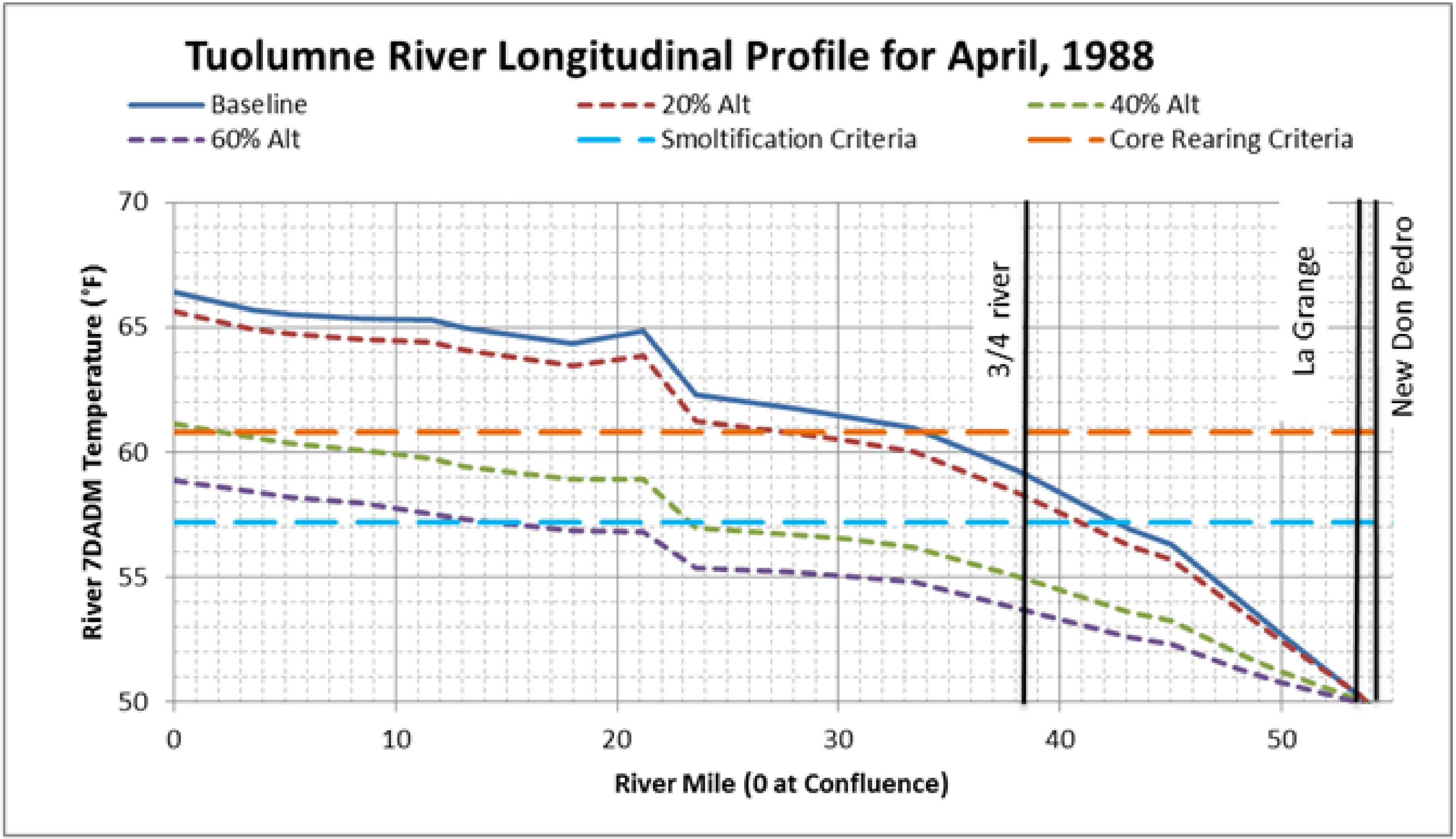
Tuolumne Avg. 7DADM April

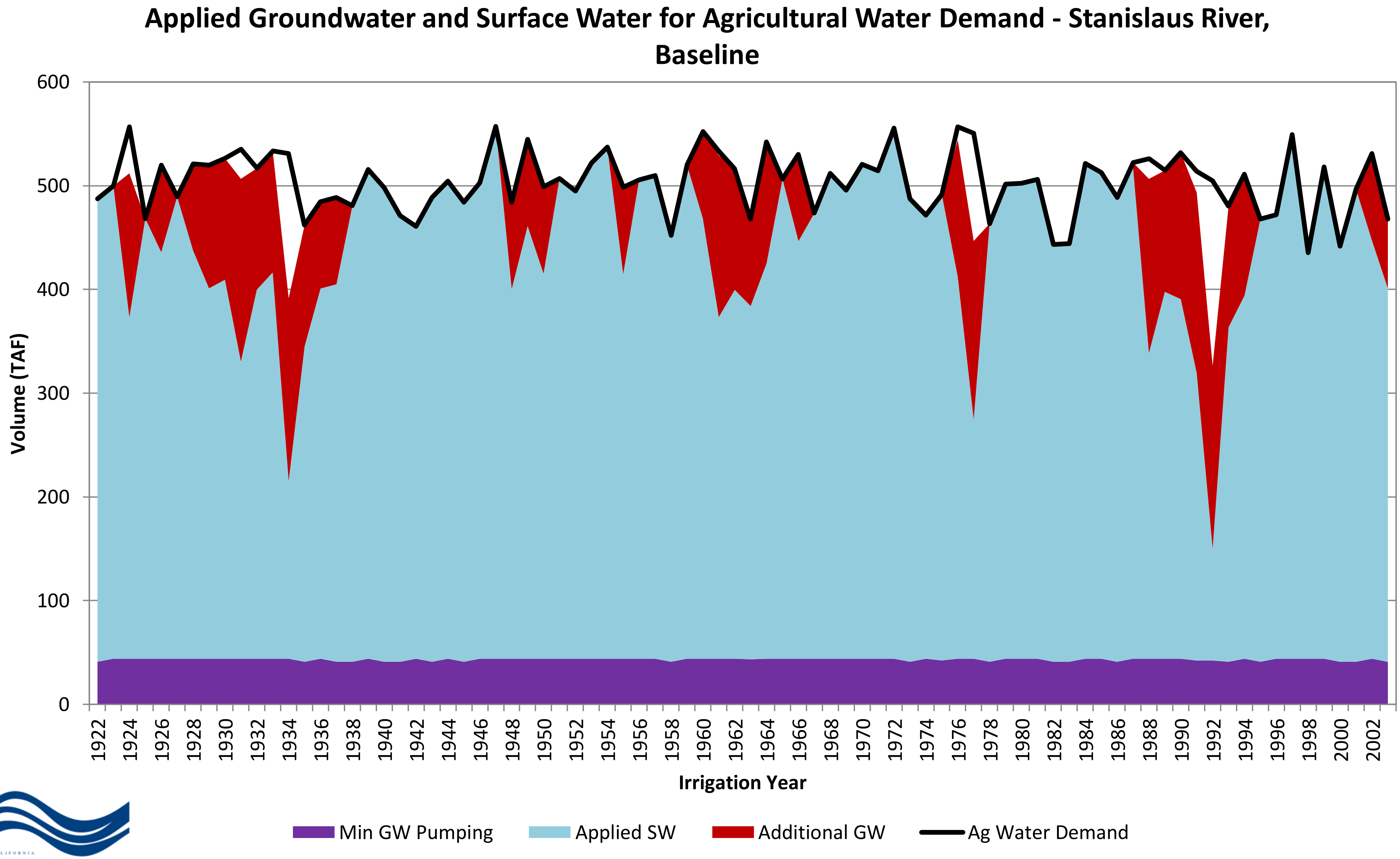


CALIFORNIA Water Boards

Groundwater analysis

- Shortage is applied primarily to field demand (CUAW + Deep Percolation) for each district.
- To alleviate some of this affect additional groundwater pumping can be pumped up to a district maximum.
- Additional groundwater pumping is applied directly at the farm gate

Surface Water Agricultural Demand and Water Supply Stanislaus Baseline



California Water Boards
State Water Resources Control Board
Regional Water Quality Control Boards

Things to Remember

- SED describes CEQA Impacts Analysis
  - Basin Plan Amendment is not self-implementing
  - Board has not picked an alternative
  - %UF may include adaptive implementation range
    - Can optimize benefits / minimize impacts
  - Requires Water Rights Proceedings/Due Process
    - Aka “Phase 3” of the Bay-Delta Plan Update