

## Forecast-Coordinated Operations Program Update

# California Cooperative Snow Surveys 60<sup>th</sup> Annual Meeting November 6, 2014

Boone Lek  
Reservoir Coordinated Operations Section

# Forecast-Coordinated Operations (F-CO) Program Update

- San Joaquin F-CO
- F-CO Grants
- Forecast-Inform Operations (F-IO)

# F-CO Program Partners

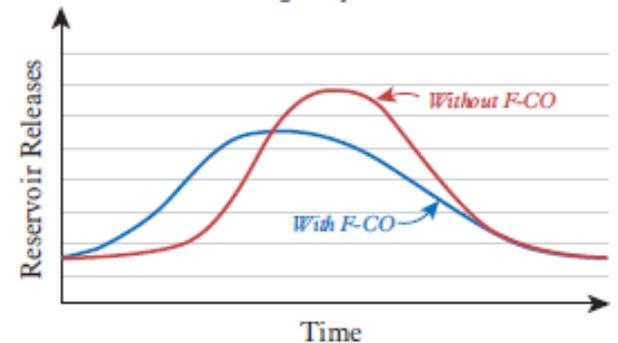


Goal: Improve flood protection  
w/o impacting water supply

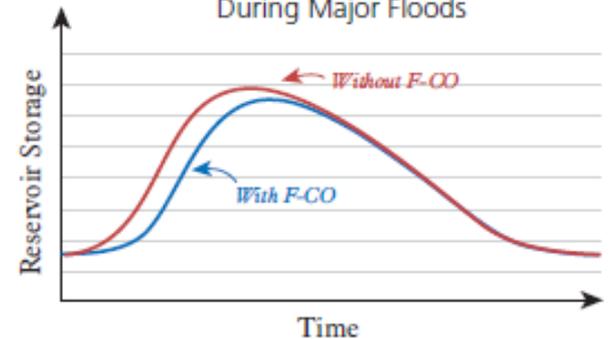
Objectives: Reduce d/s peak flood  
flows with improved

- Forecasting (reservoir inflows  
and river stages)
- Coordination of reservoir  
releases

Conceptual Reservoir Release Pattern with  
and without Forecast-Coordinated Operation  
During Major Floods

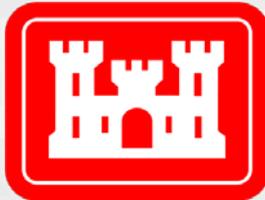


Conceptual Reservoir Storage Pattern with  
and without Forecast-Coordinated Operation  
During Major Floods





# F-CO Program Partners



# ➤ San Joaquin F-CO

➤ F-CO Grants

➤ Forecast-Inform Operations (F-IO)



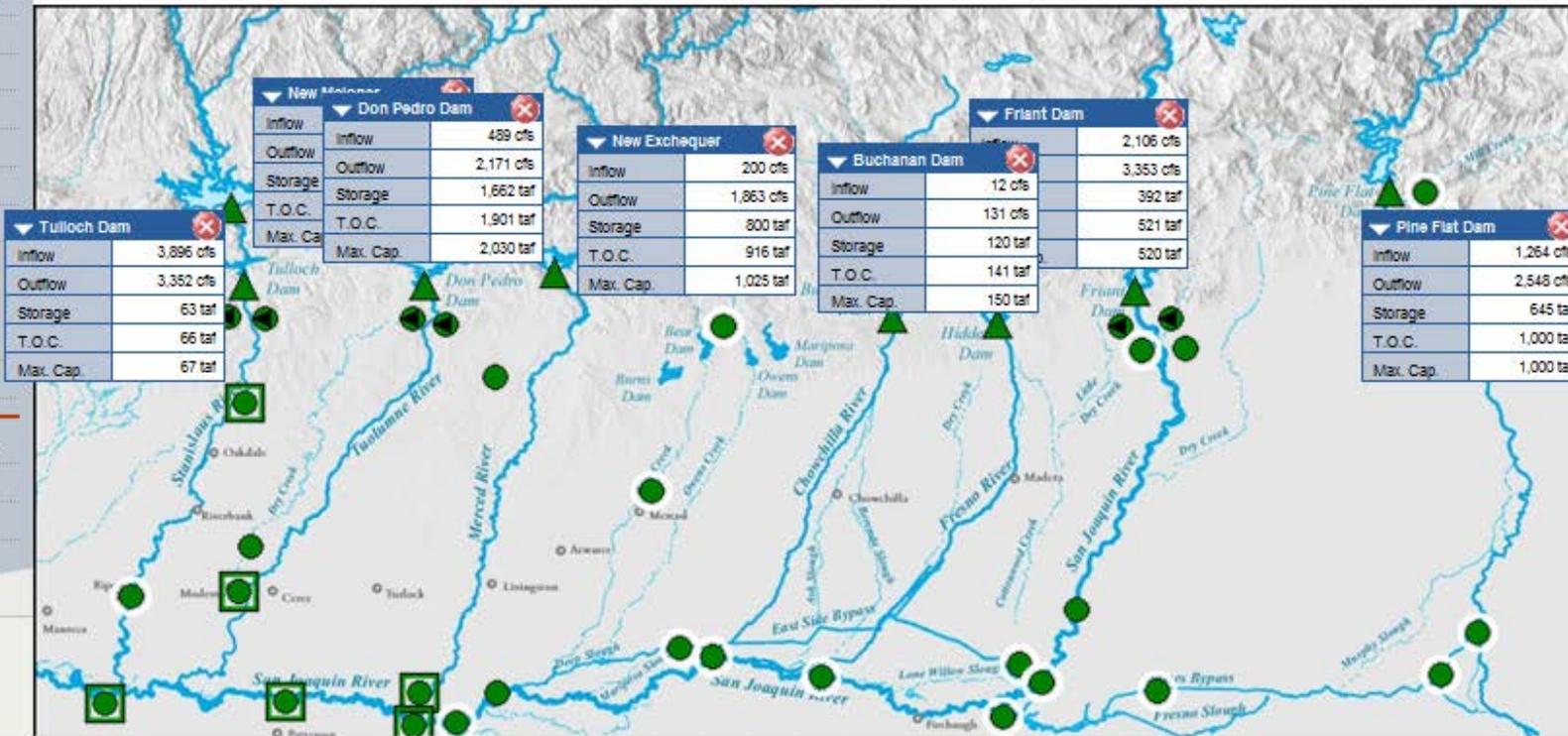
### SUB-MODELS

- New Melones Dam
- Don Pedro Dam
- New Exchequer
- Buchanan Dam
- Hidden Dam
- Friant Dam
- Pine Flat Dam

### QUICK LINKS

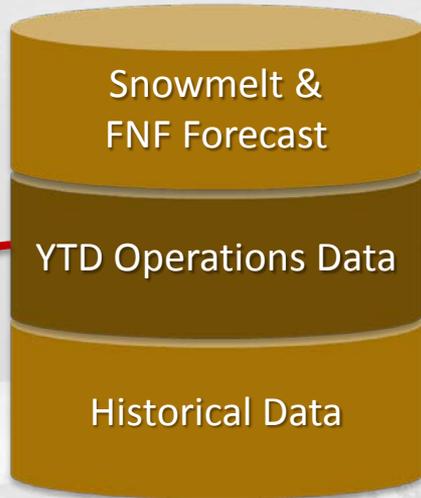
- Contact Us
- User Help
- CDEC TOC Charts
- USACE Res. Plots
- River Guidance

## San Joaquin River System F-CO Model



# Reservoir Simulation Model

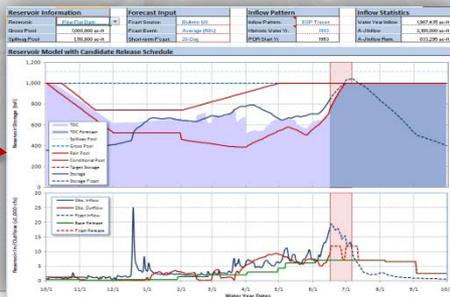
Database



Reservoir	A-J Low (50%)	A-J Avg (50%)	A-J High (50%)
New Tehachaq	1,070,000	1,130,000	1,180,000
Priest Dam	2,140,000	2,190,000	2,250,000
Pine Flat Dam	2,180,000	2,230,000	2,280,000
New Melones	1,230,000	1,240,000	1,240,000
Don Pedro Dam	2,050,000	2,100,000	2,160,000



Forecaster Application




PUBLIC SAFETY

ENVIRONMENTAL STEWARDSHIP

ECONOMIC STABILITY



➤ San Joaquin River Watershed F-CO

➤ **F-CO Grants**

➤ Forecast-Inform Operations (F-IO)

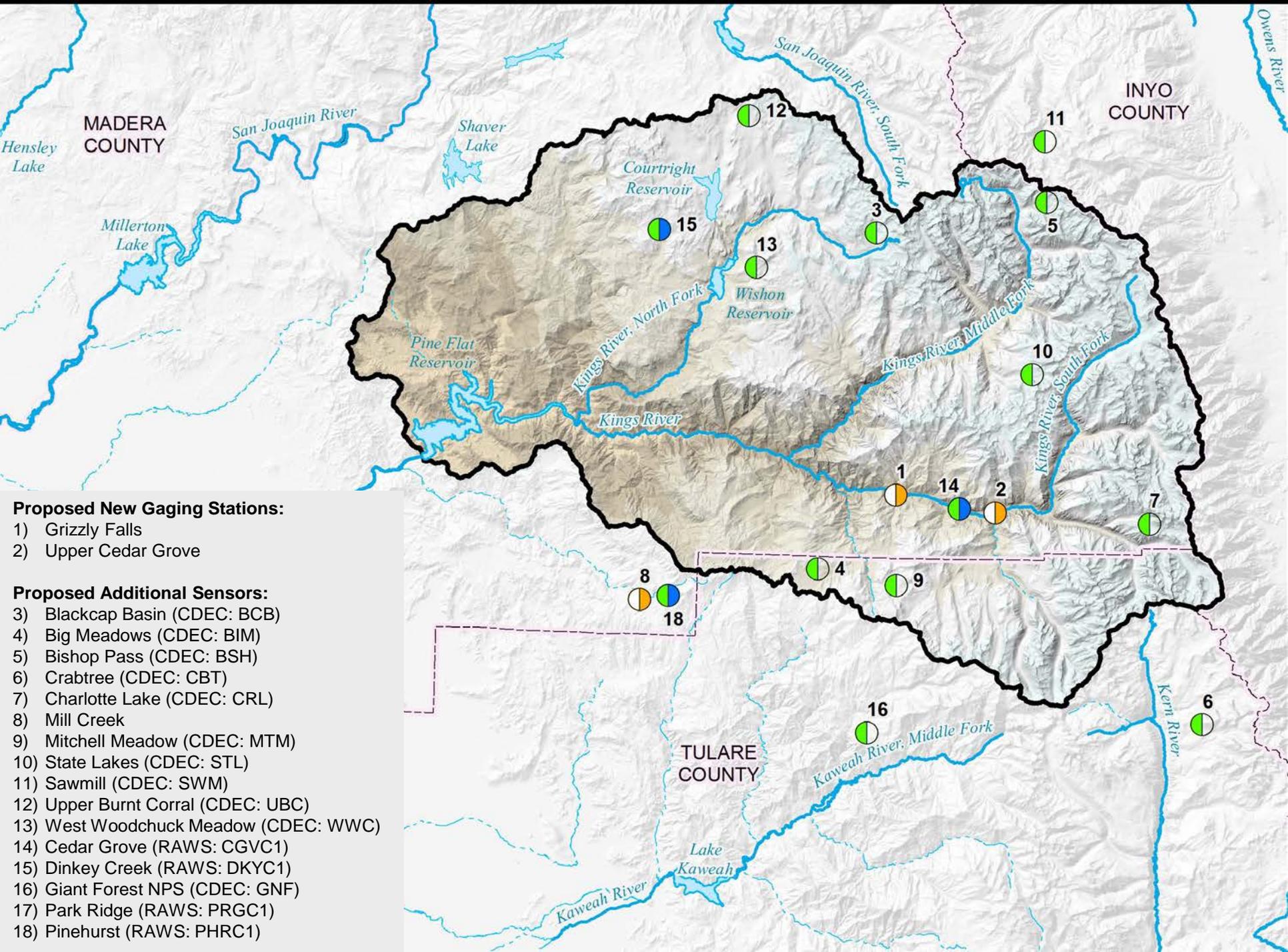
## Kings River F-CO Proposed Gaging Installation Sites

Station Name	Latitude	Longitude	Elevation (ft)	Existing Sensors	Proposed Additional Sensors	
<b>New Sites</b>						
1	Grizzly Falls	36.693	-119.054	4,200	None	F, S, Cableway
2	Upper Cedar Grove	36.787	-118.617	4,720	None	F, S (installed 9/30/2014)
<b>Sites For Additional Sensors</b>						
3	Blackcap Basin (CDEC: BCB)	37.067	-118.770	10,300	SnD, SWE, T	HTB, R, SM, WD, WS
4	Big Meadows (CDEC: BIM)	36.727	-118.834	7,600	P, R, SnD, SWE, T	HTB, SM, WD, WS
5	Bishop Pass (CDEC: BSH)	37.101	-118.559	11,200	SnD, SWE, T	HTB, R, SM, WD, WS
6	Crabtree Meadow (CDEC: CBT)	36.577	-118.357	10,700	P, R, SnD, SWE, T	HTB, SM, WD, WS
7	Cedar Grove (RAWS: CGVC1)	36.790	-118.661	4,734	P, RH, SnD, R, T, WT, WD, WS	HTB
8	Charlotte Lake (CDEC: CRL)	36.778	-118.426	10,400	P, SnD, SWE, T	HTB, R, SM, WD, WS
9	Dinkey (RAWS: DKYC1)	37.066	-119.039	5,662	P, RH, SnD, R, T, WT, WD, WS	HTB
10	Giant Forest (CDEC: GNF)	36.563	-118.770	6,693	P, SWE, T	HTB
11	Mill Creek	36.693	-119.054	3,023	F, S	HTB
12	Mitchell Meadow (CDEC: MTM)	36.712	-118.737	9,500	SWE, T	HTB, R, SnD, SM, WD, WS
13	Park Ridge (RAWS: PRGC1)	36.725	-118.943	7,540	P, RH, SnD, R, T, WT, WD, WS	HTB
14	Pinehurst (RAWS: PHRC1)	36.697	-119.019	4,056	P, Pr, RH, SnD, R, T, WT, WD, WS	HTB
15	State Lakes (CDEC: STL)	36.927	-118.574	10,300	SWE, T	HTB, R, SnD, SM, WD, WS
16	Sawmill (CDEC: SWM)	37.162	-118.563	10,200	SnD, SWE, T	HTB, R, SM, WD, WS
17	Upper Burnt Corral (CDEC:UBC)	37.183	-118.931	9,700	SnD, SWE, T	HTB, R, SM, WD, WS
18	West Woodchuck Meadow (CDEC: WWC)	37.030	-118.918	9,100	SnD, SWE, T	HTB, R, SM, WD, WS

F = Flow  
 NR = Net radiation  
 P = Precipitation  
 WD = Wind Direction  
 WS = Wind Speed  
 WT = Water Temperature

HTB = Heated Tipping Bucket  
 S = Stage  
 SM = Soil Moisture  
 Pr = Pressure  
 R = Radiation Short Wave  
 RH = Relative Humidity

SWE = Snow Water Content  
 T = Temperature  
 SG = Stream Gage  
 SnD = Snow Depth  
 ST = Soil Temperature



MADERA COUNTY

INYO COUNTY

TULARE COUNTY

**Proposed New Gaging Stations:**

- 1) Grizzly Falls
- 2) Upper Cedar Grove

**Proposed Additional Sensors:**

- 3) Blackcap Basin (CDEC: BCB)
- 4) Big Meadows (CDEC: BIM)
- 5) Bishop Pass (CDEC: BSH)
- 6) Crabtree (CDEC: CBT)
- 7) Charlotte Lake (CDEC: CRL)
- 8) Mill Creek
- 9) Mitchell Meadow (CDEC: MTM)
- 10) State Lakes (CDEC: STL)
- 11) Sawmill (CDEC: SWM)
- 12) Upper Burnt Corral (CDEC: UBC)
- 13) West Woodchuck Meadow (CDEC: WWC)
- 14) Cedar Grove (RAWS: CGVC1)
- 15) Dinkey Creek (RAWS: DKYC1)
- 16) Giant Forest NPS (CDEC: GNF)
- 17) Park Ridge (RAWS: PRGC1)
- 18) Pinehurst (RAWS: PHRC1)

## Merced River F-CO Proposed Gaging Installation Sites

Station Name	Elevation (ft)	Existing Sensors	Proposed Additional Sensors
<b>New Sites</b>			
1 Lake McClure / Exchequer Reservoir (DWR - HMT)	1,200	None	Vertical Pointing Radar
2 Upper Dry Creek basin (Snelling), along Highway 132 (MID)	230	None	P, RH, T, WD, WS
3 Upper Black Rascal Creek basin, along La Paloma Road	230	None	P, RH, T, WD, WS, S
4 <a href="#">Mariposa Grove (YNP, CDEC ID: MPG)</a>	6,400	P, RH, WD, WS	T, SWE, SnD, NR, SM, ST
5 <a href="#">Merced Lake (COOP, CDEC ID: MLK)</a>	7,300	NR, RH, S, SnD, T, WD, WS	P, SWE
6 <a href="#">Merced River at Happy Isles (USGS, CDEC ID: HIB)</a>	4,016	F, S	P(ETI), T, RH
7 <a href="#">Merced River at Cressy (DWR, CDEC ID: CRS)</a>	165	F, S, WT	P, T, RH
8 <a href="#">Ostrander Lake (DWR, CDEC ID:STR)</a>	8,200	R, RH, SWE, SnD, T, WD, WS	NR, P, ST, SM
9 <a href="#">Tenaya (DWR, CDEC ID:TNY)</a>	8,150	NR, P, RH, SnD, SWE, T, WD, WS	P(ETI), NR, SM, ST
10 <a href="#">Merced River at Briceburg Bridge</a>	1,200	None	P, RH, T, ST, WD, WS, F, S
11 <a href="#">Black Rascal Creek at Yosemite (USACE)</a>	183	F, S	P, SM, ST, T
12 <a href="#">CIMIS gage #C1148 near Merced (DWR - CIMIS)</a>	200	R, RH, P, ST, T, WD, WS	GOES radio
13 <a href="#">Lake Yosemite (MID)</a>	237	S	F, P, T
14 <a href="#">Merced River near HWY 59 Bridge Snelling (CDEC: M59)</a>	200	S, WT	DCP & GOES radio
15 <a href="#">Merced River between Highway 59 and Shaffer Bridge (1)</a>		F, S	DCP & GOES radio
16 <a href="#">Merced River between Highway 59 and Shaffer Bridge (2)</a>		F, S	DCP & GOES radio

F = Flow  
 NR = Net radiation  
 P = Precipitation  
 WD = Wind Direction  
 WS = Wind Speed  
 WT = Water Temperature

HTB = Heated Tipping Bucket  
 S = Stage  
 SM = Soil Moisture  
 Pr = Pressure  
 R = Radiation Short Wave  
 RH = Relative Humidity

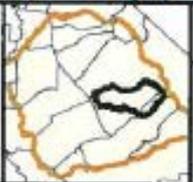
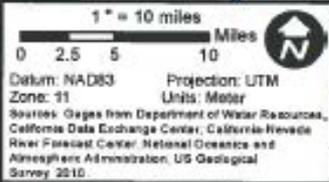
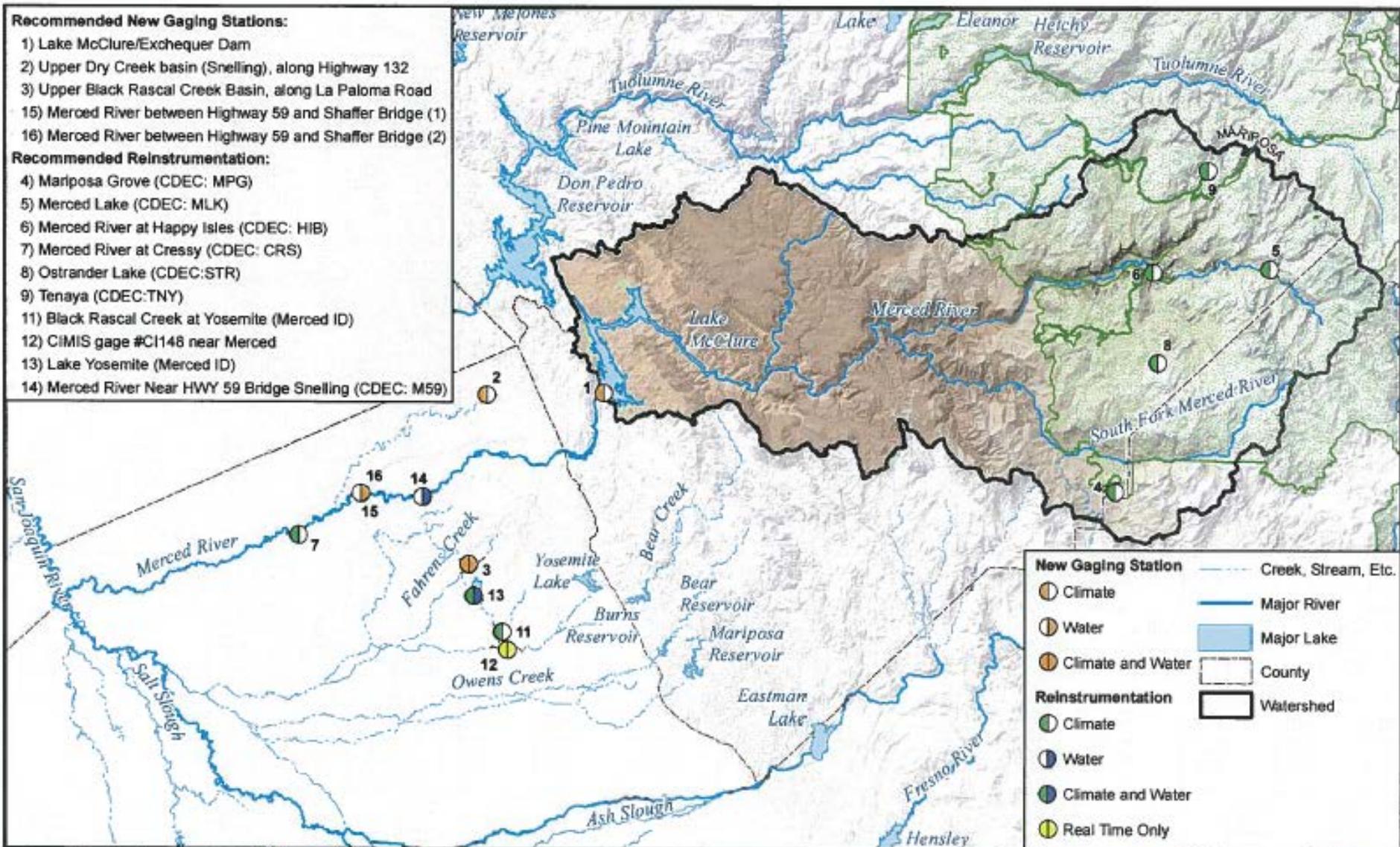
SWE = Snow Water Content  
 T = Temperature  
 SG = Stream Gage  
 SnD = Snow Depth  
 ST = Soil Temperature

**Recommended New Gaging Stations:**

- 1) Lake McClure/Exchequer Dam
- 2) Upper Dry Creek basin (Snelling), along Highway 132
- 3) Upper Black Rascal Creek Basin, along La Paloma Road
- 15) Merced River between Highway 59 and Shaffer Bridge (1)
- 16) Merced River between Highway 59 and Shaffer Bridge (2)

**Recommended Reinstrumentation:**

- 4) Mariposa Grove (CDEC: MPG)
- 5) Merced Lake (CDEC: MLK)
- 6) Merced River at Happy Isles (CDEC: HIB)
- 7) Merced River at Cressy (CDEC: CRS)
- 8) Ostrander Lake (CDEC: STR)
- 9) Tenaya (CDEC: TNY)
- 11) Black Rascal Creek at Yosemite (Merced ID)
- 12) CIMIS gage #C1148 near Merced
- 13) Lake Yosemite (Merced ID)
- 14) Merced River Near HWY 59 Bridge Snelling (CDEC: M59)



**San Joaquin F-CO Program**

**Proposed New Gaging Stations and Reinstrumentation  
In and Near the Merced River Watershed**



California State Water Project  
Real Time Emergency Response Program



Prepared By: S. Troedson	Figure: 1
Job No.: 087756/080352	Date: November 3, 2011

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➤ San Joaquin River Watershed F-CO

➤ F-CO Grants

➤ **Forecast-Informed Operations (F-IO)**

# Concept of Forecast-Informed Operation (F-IO)

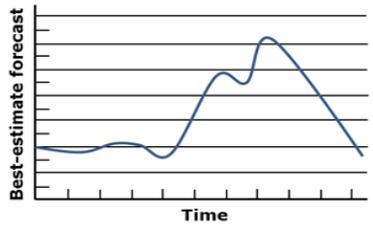
F-IO allows for pre-releasing or storing water in a reservoir in anticipation of future inflows that are forecasted, considering the uncertainty of the forecasted inflows and the associated risks of releases and water supply deficits. Such operations may require changes in the reservoir flood control diagram.

# Concept of Forecast-Informed Operation (F-IO)

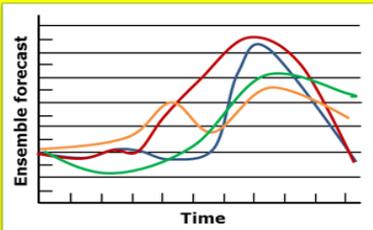
The F-IO phase of the project involves:

- Development and use of ensembles in forecasting.
- Proactive reservoir management policies, guidelines, and rules whose use may reduce flood damages associated with extreme events and improve water management operations.
- Possible changes to the flood control diagram

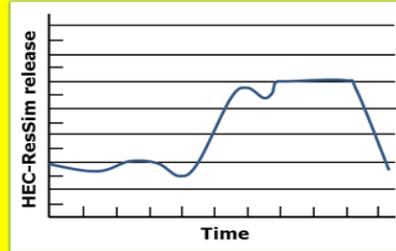
1. CNRFC provides *best estimate* forecast of reservoir inflows and uncontrolled local flows, using current state + QPF.



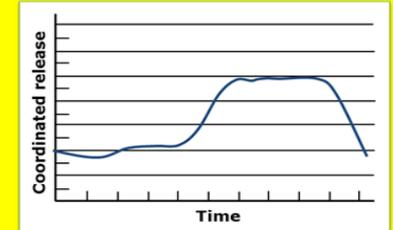
CNRFC also provides ensemble of forecasts of reservoir inflows and uncontrolled local flows. Some forecasts greater and some smaller than best estimate.



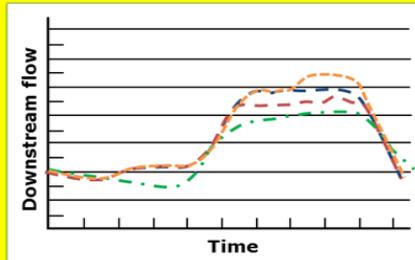
2. Operators run HEC-ResSim (through F-CO DSS interface) with best estimate forecast to identify recommended release schedule with strict interpretation of rules.



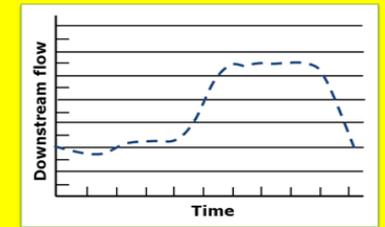
3. Operators review HEC-ResSim results, coordinate, collaborate to select *coordinated release schedule*.



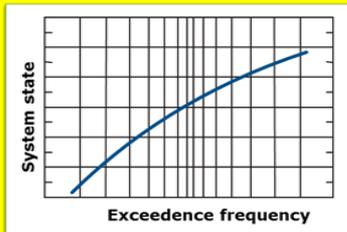
5. For each ensemble member, HEC-ResSim computes system states with coordinated release schedule from Step 3



4. Downstream conditions computed with HEC-ResSim, using coordinated release schedule.



6. Frequency of exceedence of critical system states analyzed and reported. If hazard deemed unacceptable, process is repeated starting with Step 3.



## Next year...

- Preliminary results of the F-IO analyses
- San Joaquin F-CO Application
- Implementation of F-CO funded sensors

# QUESTIONS?

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