BUREAU OF RECLAMATION

Central Valley Project

Operations and Temperature Management

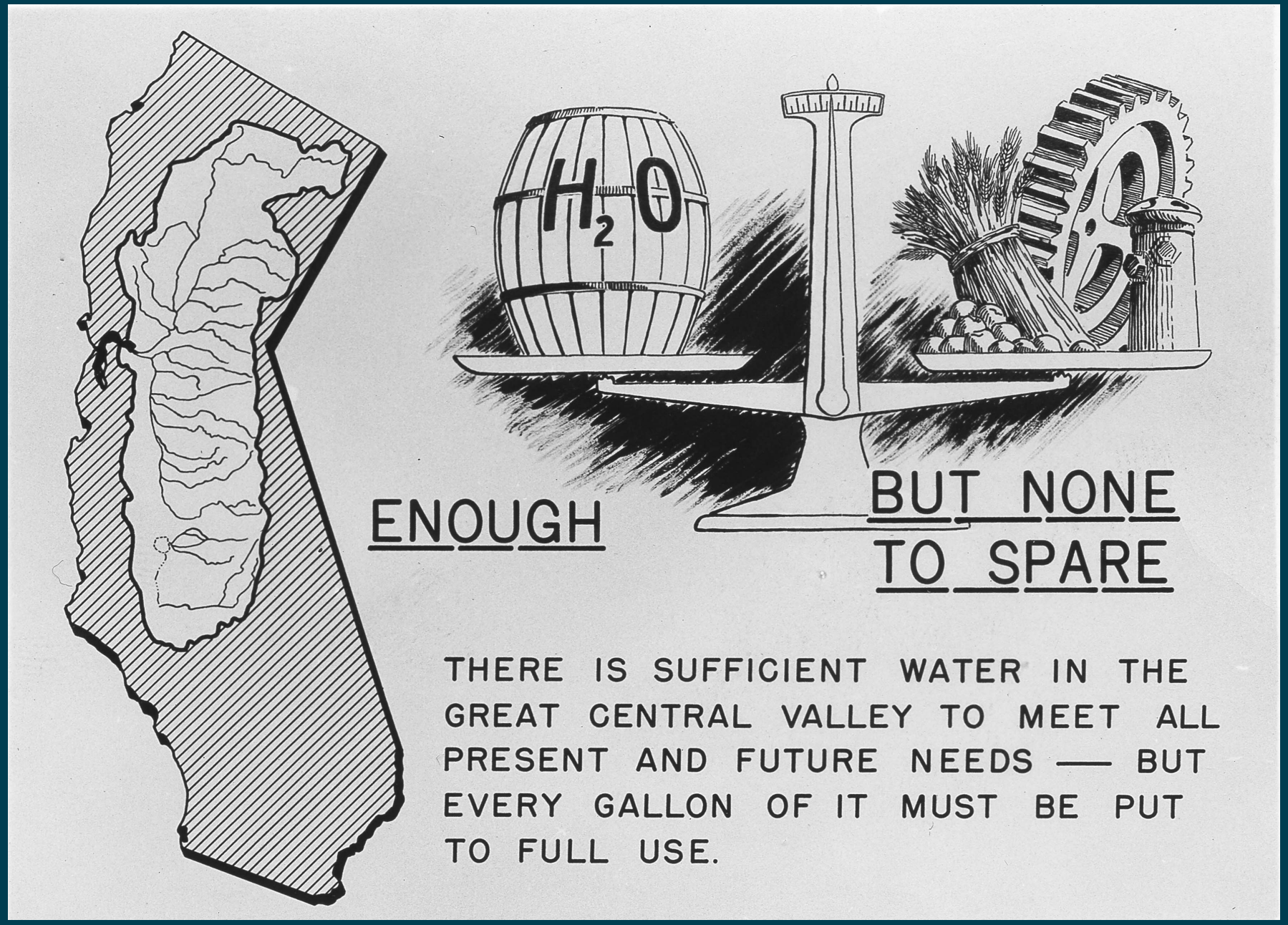
June 2022

Bureau of Reclamation

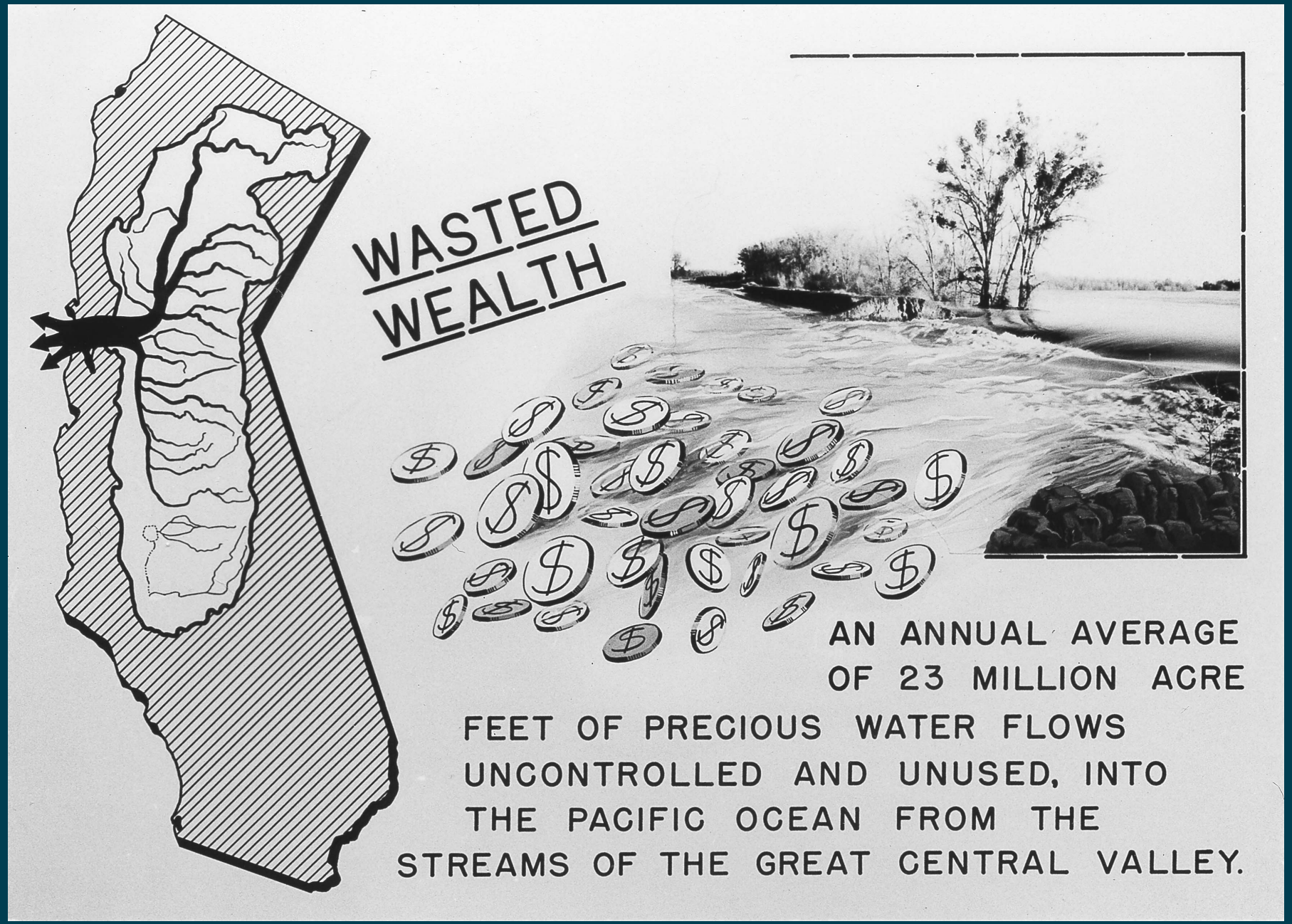
- 348 reservoirs, 479 dams and a total storage capacity of 245 million acre-feet
- Largest wholesaler of water in U.S.
- 31 million people served (10 trillion gallons)
- 1/3 of western irrigated agriculture (10 million acres)
- 1 in 5 western farmers (140,000)
- 60% nation's vegetables
- 25% nation's fruits and nuts
- 40 billion kilowatt hours electricity annually (~3.5 million homes)

Central Valley Project

1940's publication of the Central Valley Project



1940's publication of the Central Valley Project



1940's publication of the Central Valley Project

Central Valley Project

The CVP is one of the largest water storage and transport systems in the world:

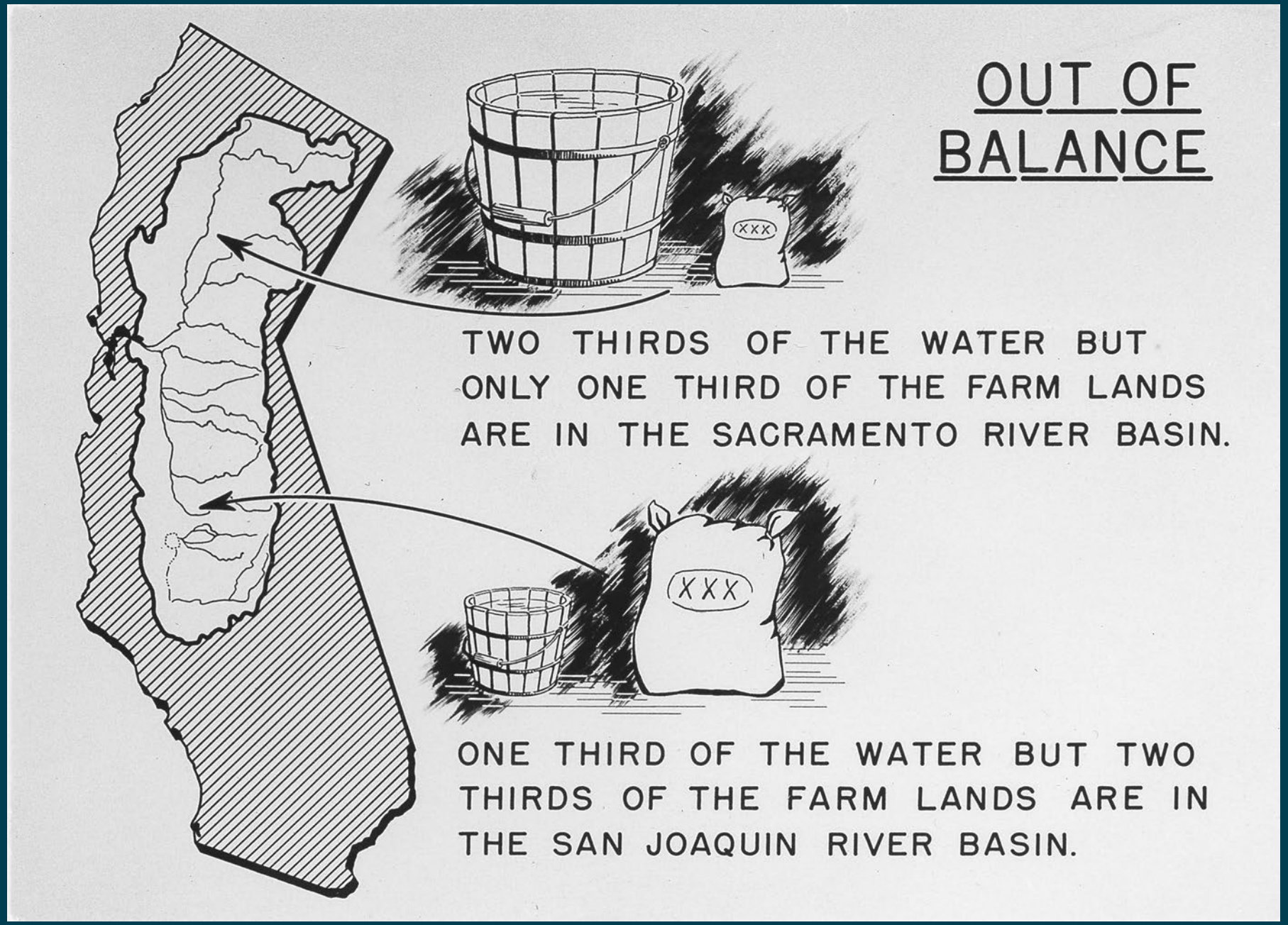
- 20 reservoirs and more than 500 miles of canals.
- The project provides water used to irrigate more than 3 million acres of agricultural land

Authorized purposes:

- flood control, fish and wildlife, municipal and agricultural water supply, power generation, and recreation

Central Valley Project

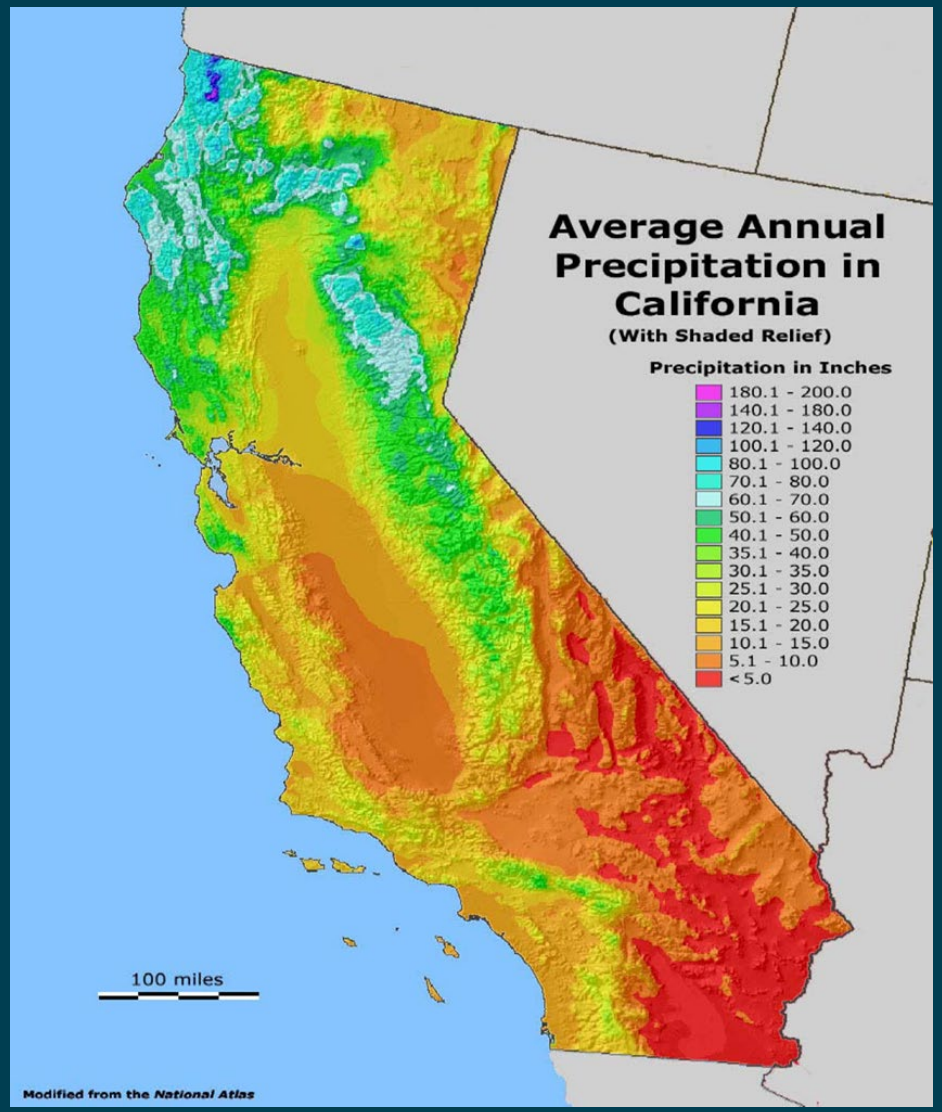
- Over 270 Contracts/Agreements
- Water Deliveries to 29 of 58 California counties
- 20% of Water Supply (~7 million acre-feet)
  - 30% of California Agricultural (~3 million acres of farmland)
  - 13% of Municipal & Industrial (~2 million people served)
  - 19 Wildlife Refuges
- 2.8 billion Kilowatt-Hours of Surplus Power (to ~650,000 people served)
- Coordination with the State Water Project and Local Systems



1940's publication of the Central Valley Project

California Water

- Most precipitation falls in the north; most water demand is in the south
- The wet season is winter and spring; water is needed more in the summer and fall
- Precipitation varies from year to year; demands don’t vary much



Major CVP Facilities

1940s– Shasta Dam, Friant Dam, Jones Pumping Plant, and Related Canals

1956– Folsom Dam

1961– Trinity Division added to import water into the CVP

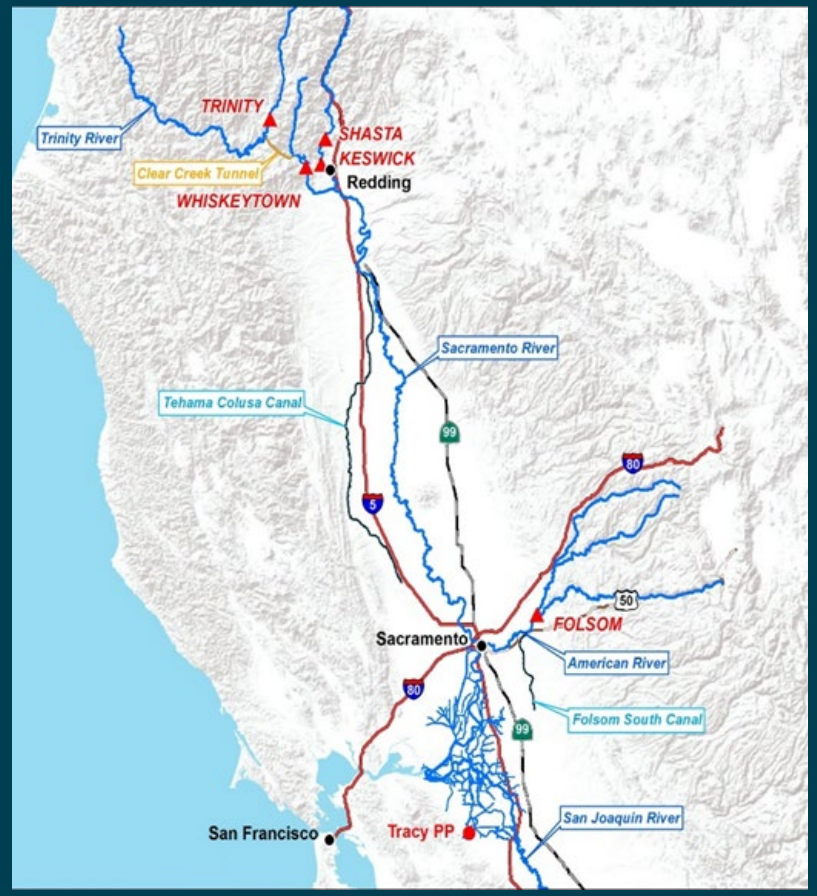
1967– San Luis Unit/State Water Project

1968– San Felipe Unit

1979– New Melones Dam

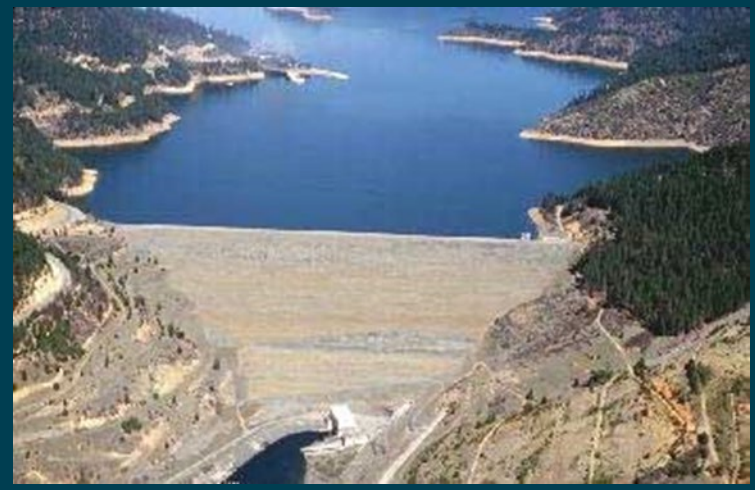
Shasta Dam

- Sacramento River
- 11 miles north of Redding
- Stands among the world's largest dams
- Flood control, water supplies, temperature management, power generation, and water quality benefits
- Capacity: 4.5 MAF

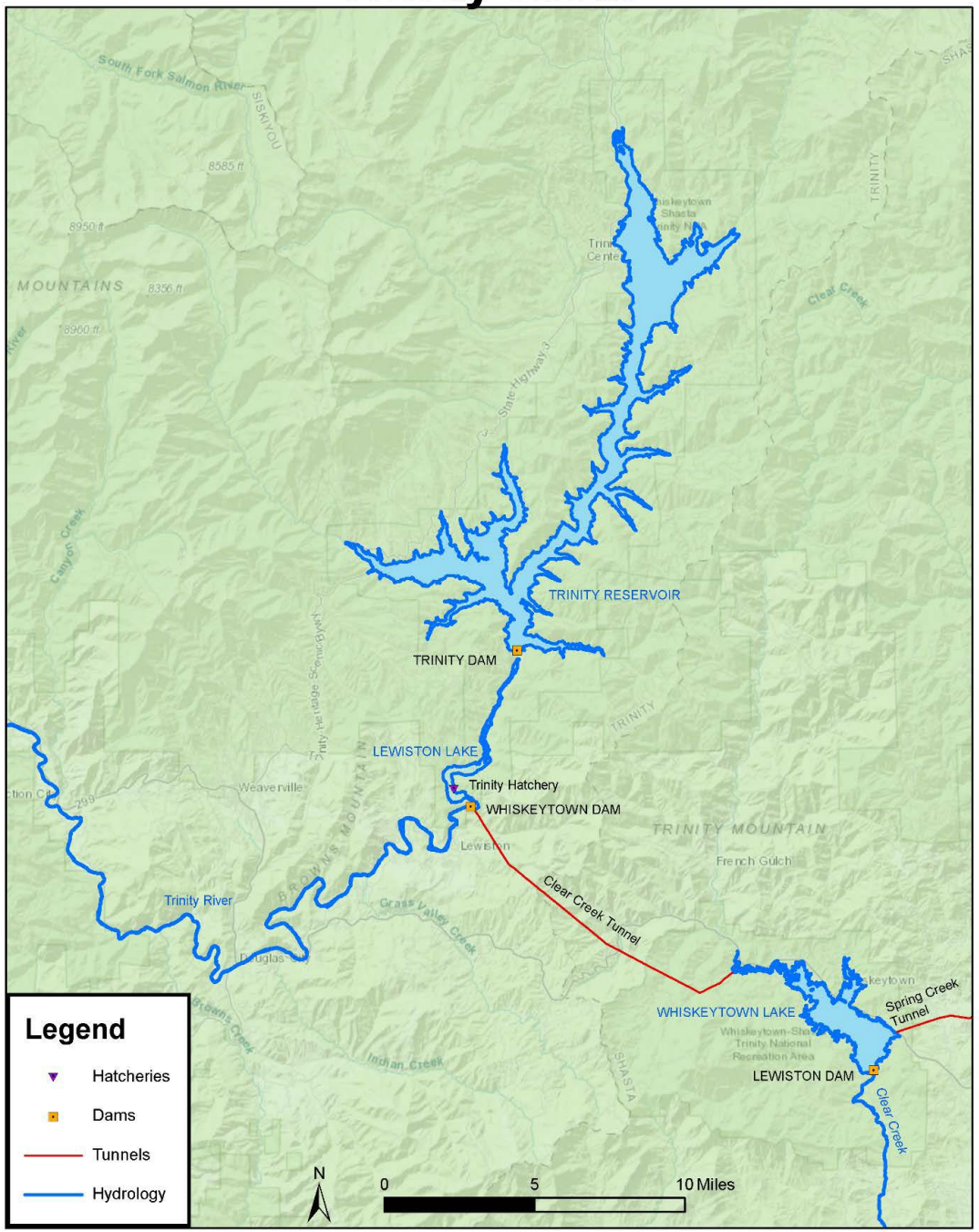


Trinity Dam

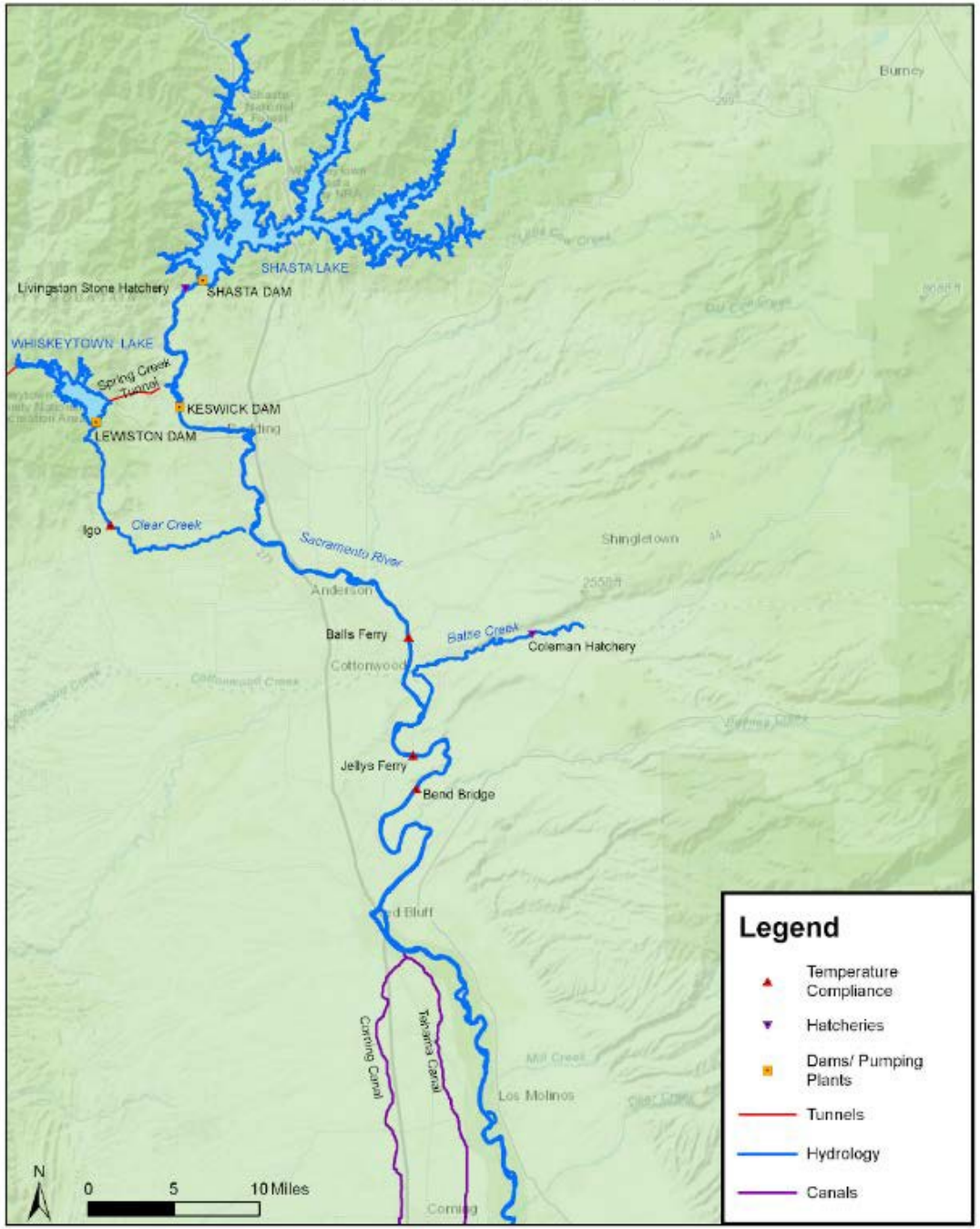
- Trinity River
- 7 miles northeast of Weaverville
- Stores water on in the Trinity River in the Klamath River basin partly for exporting to the Sacramento River
- Water supply in the Sacramento system
- Regulatory requirements both in the Sacramento and Trinity/Klamath systems
- Hydropower
- Capacity: 2.4 MAF



Trinity River

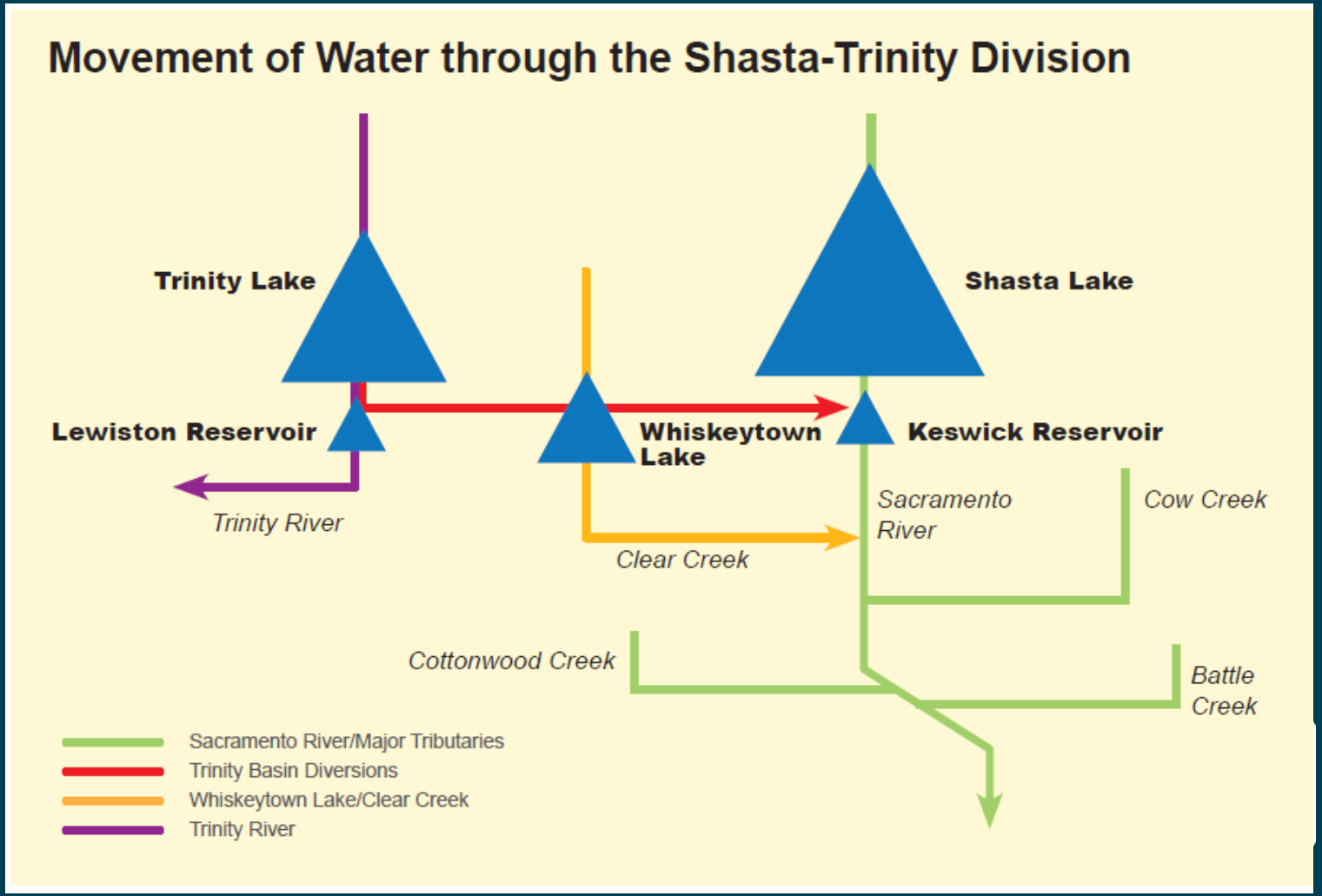


Sacramento River



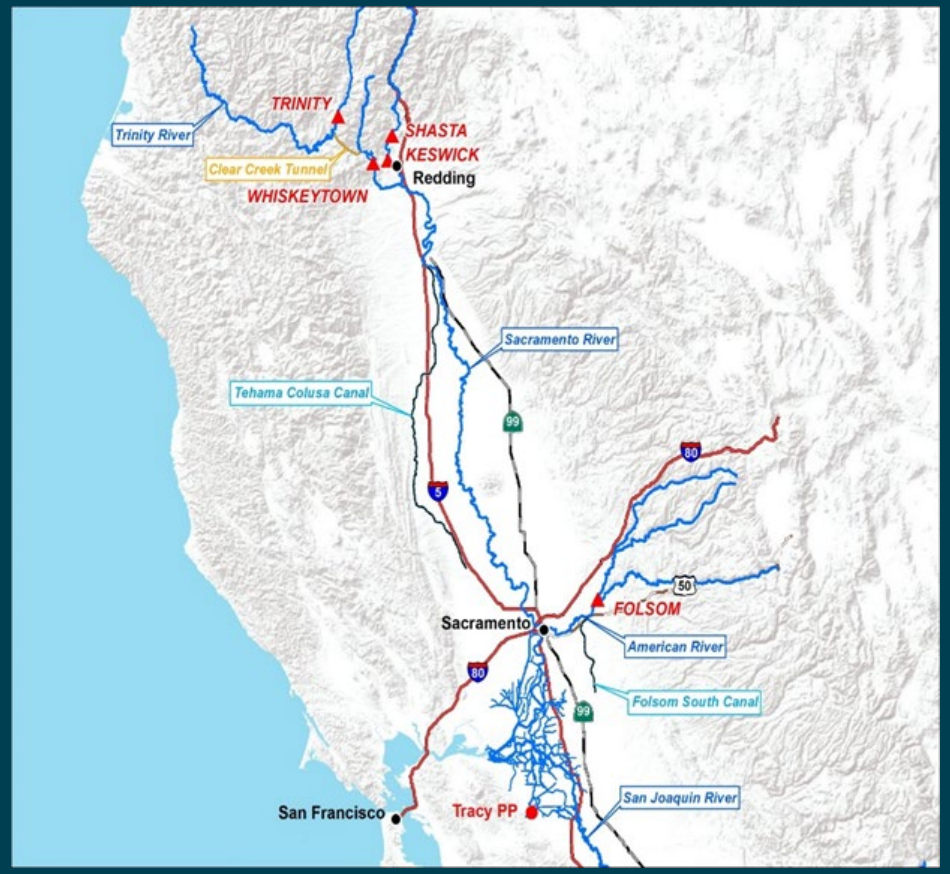
Whiskeytown Dam and Lake

Photo: Reclamation



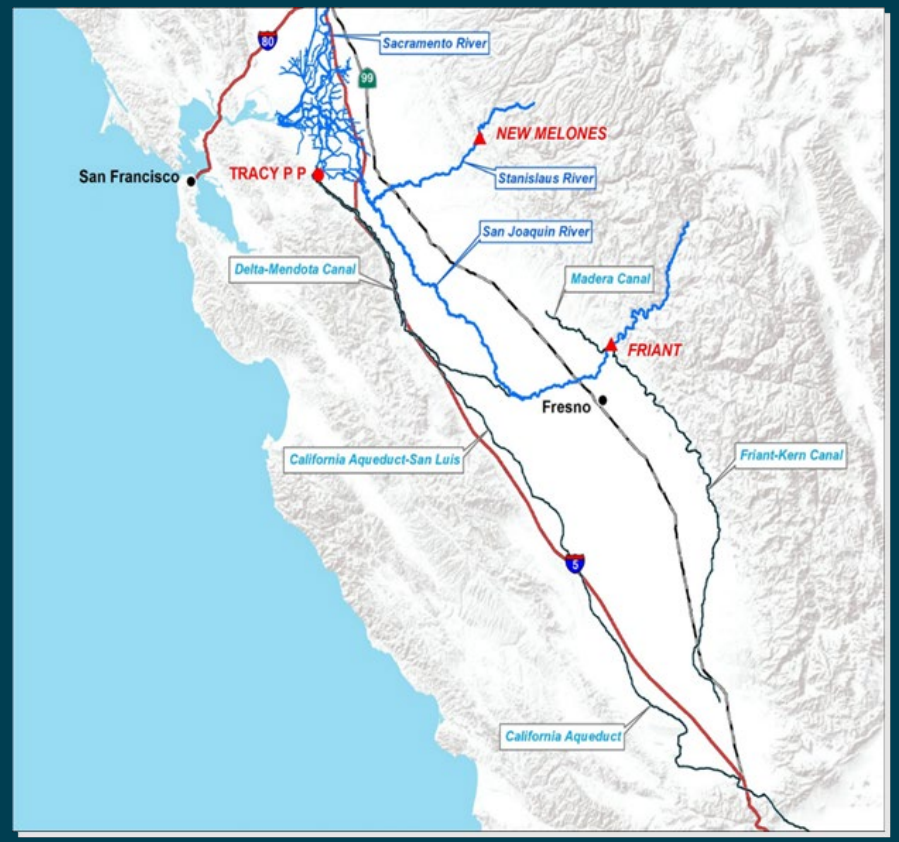
Folsom Dam

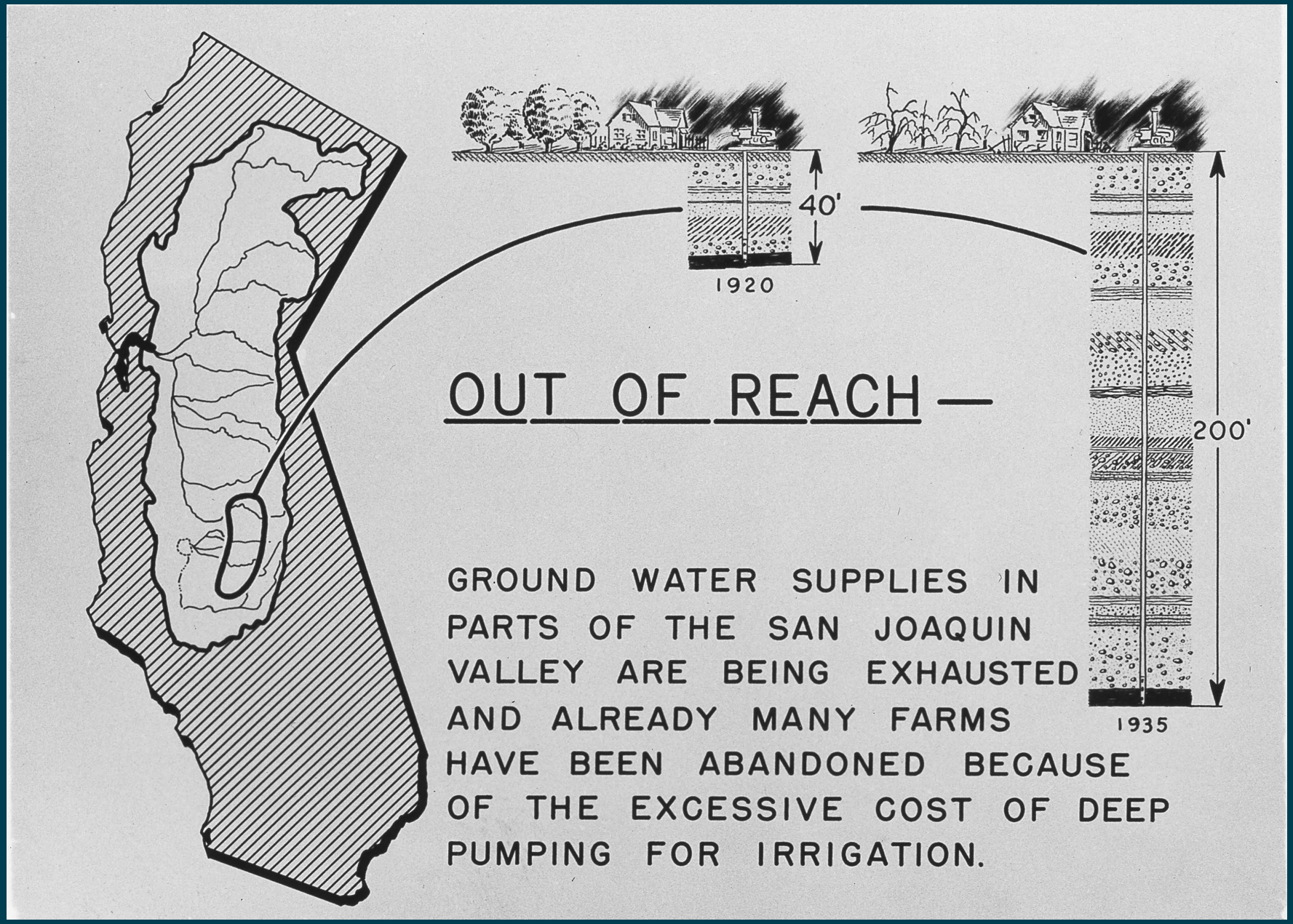
- American River
- 20 miles northeast of Sacramento
- Flood control, water supplies, temperature management power generation, and water quality
- High refill potential
- Capacity: 967 TAF



New Melones Dam

- Stanislaus River
- Sierra-Nevada foothills - 40 miles east of Stockton
- Fishery requirements, water quality, water rights, agricultural, municipal, and industrial water
- Capacity: 2.4 MAF





1940's publication of the Central Valley Project

Friant Dam

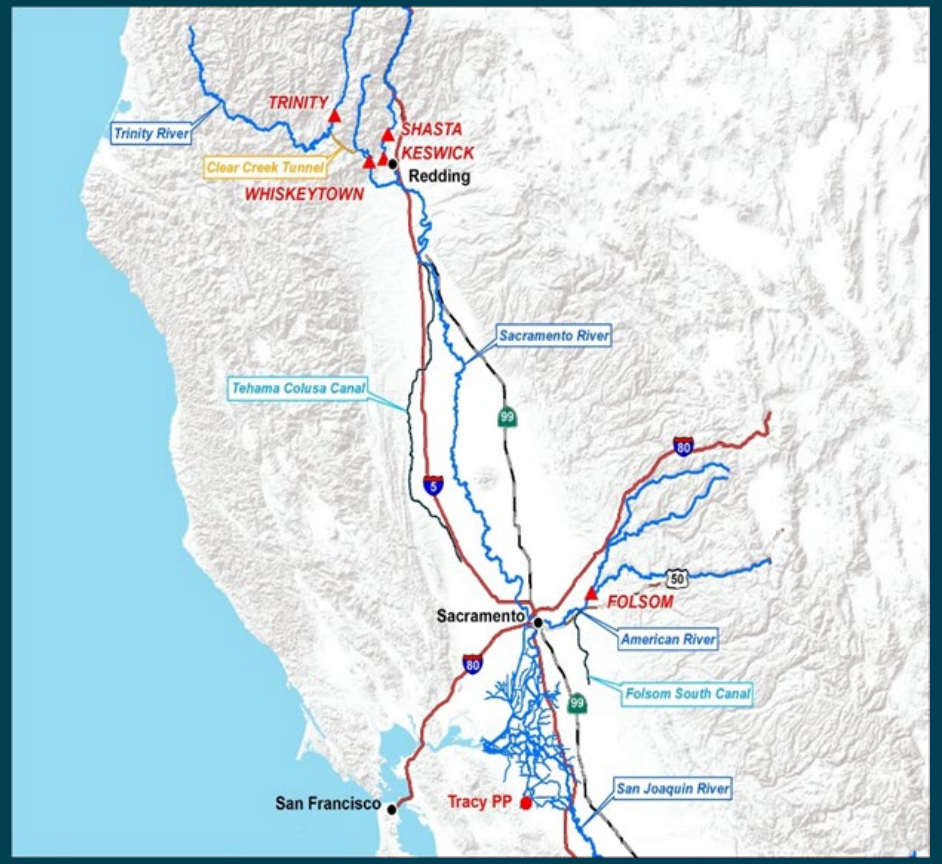
- San Joaquin River
- Foothills of the Sierra Nevada Mountains 20 miles north of Fresno
- Diverts into two canals for irrigators on the east side of the San Joaquin Valley
- San Joaquin River Restoration Program
- Millerton Reservoir Capacity: 520 TAF

San Luis Reservoir

- Stores water diverted from the Bay-Delta
- Reclamation (48%) and the State of California (52%) constructed and operate this unit jointly
- The Federal portion of the dam furnishes water to the western portion of the San Joaquin Valley
- Capacity: 2 MAF

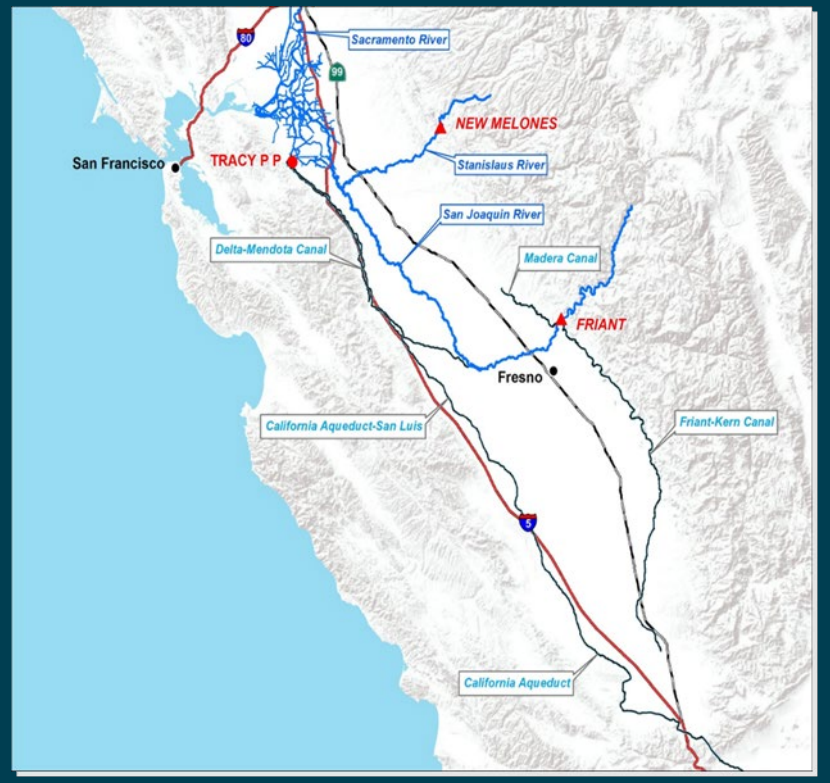
Tracy Pumping Plant

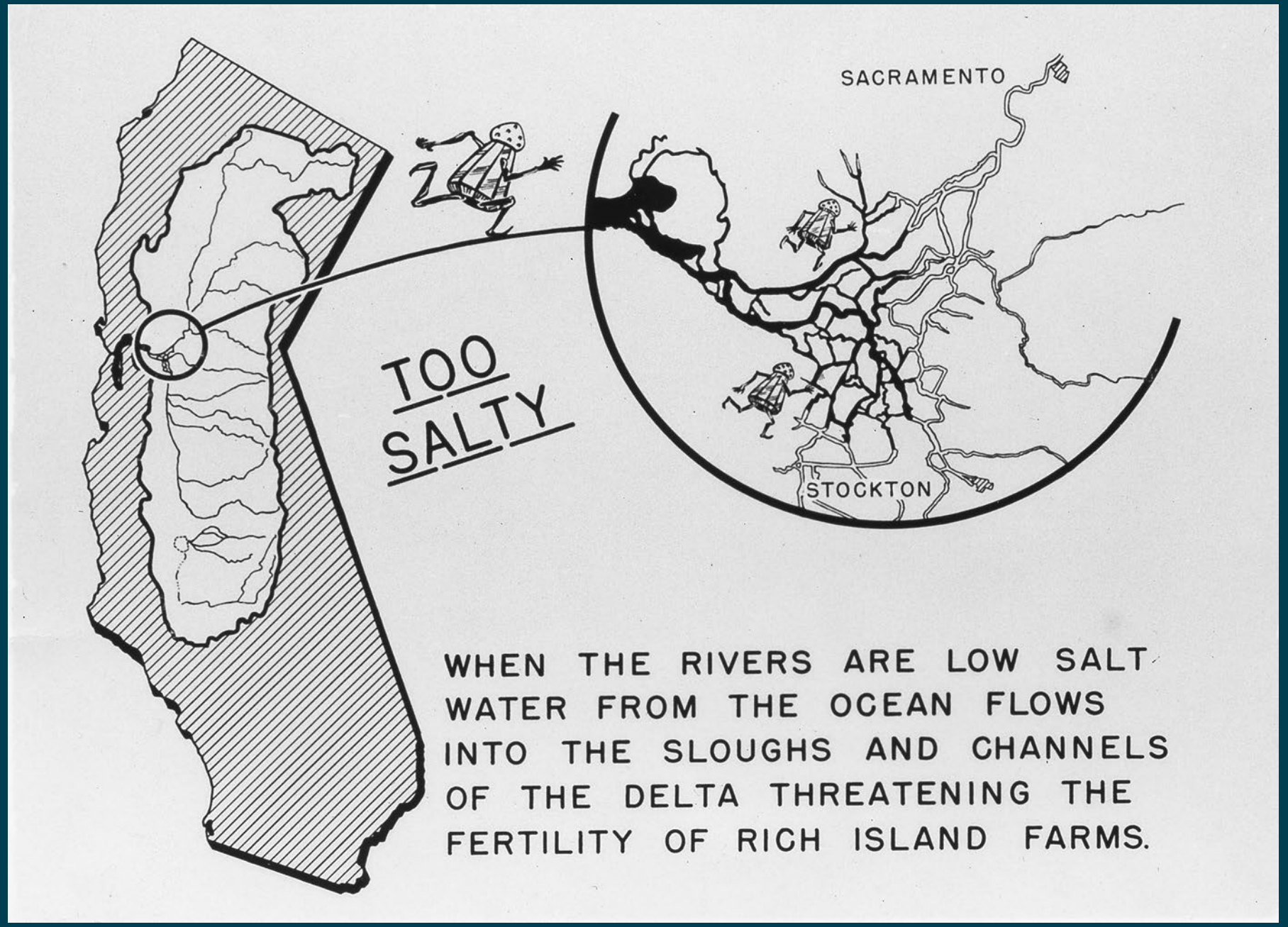
- The Tracy Pumping Plant consists of an inlet channel, pumping plant, and discharge pipes
- The Tracy Pumping Plant lifts water from the Bay-Delta 200 feet into the Delta-Mendota Canal
- CVP water right permits and license allow Reclamation to pump 4,600 cfs



Delta Mendota Canal

- Carries water southeasterly from the Tracy Pumping Plant along the west side of the San Joaquin Valley
- Irrigation supply
- 116 miles long and ends at the Mendota Pool, about 30 miles west of Fresno

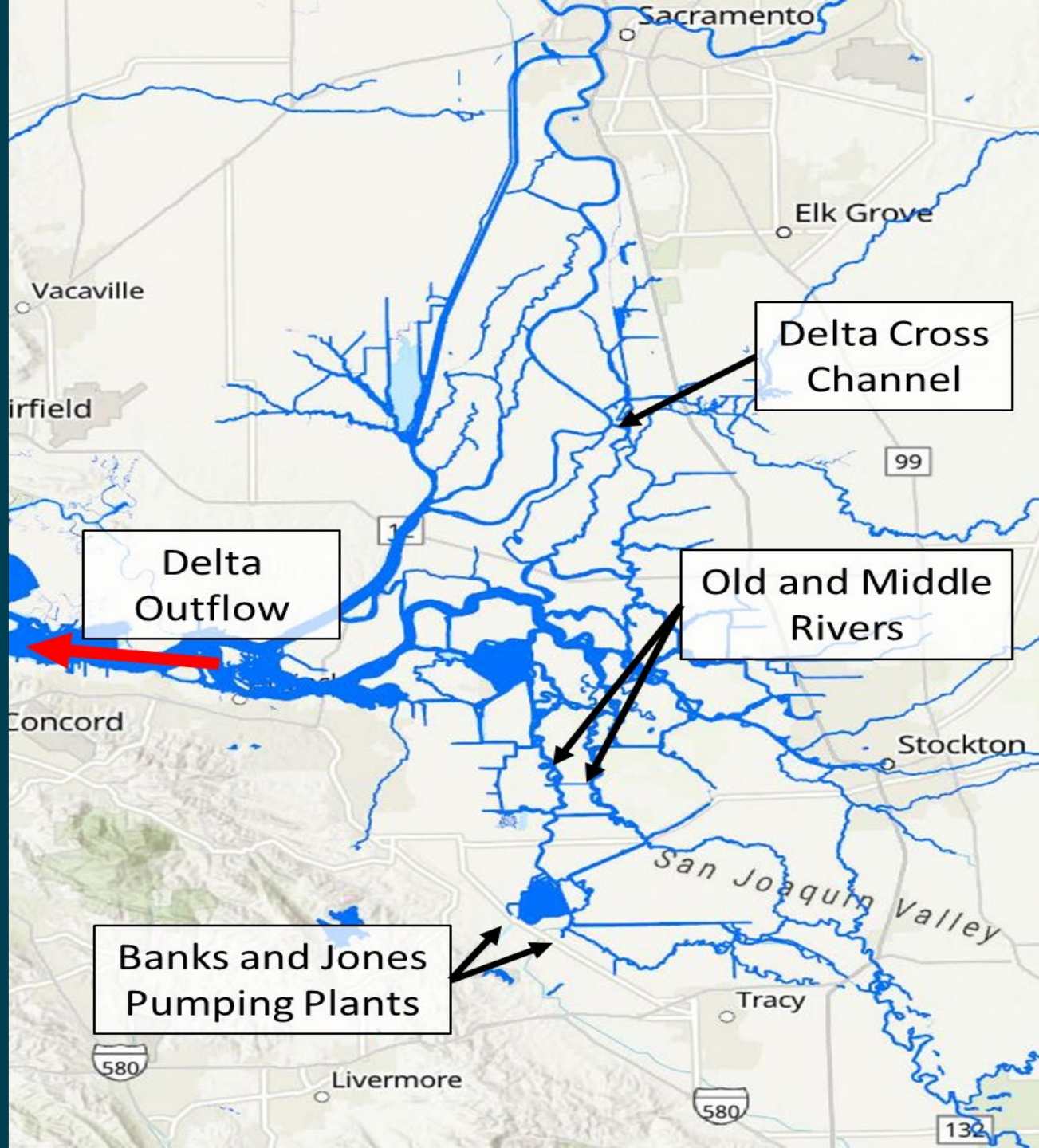


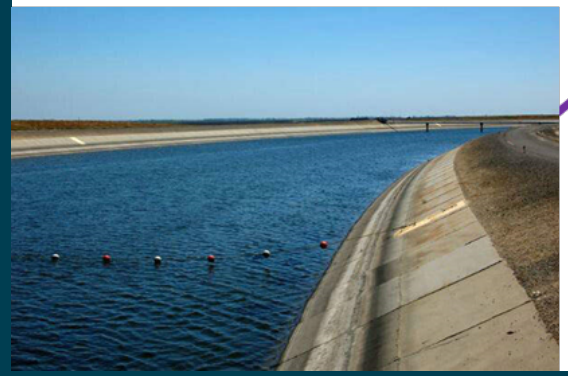


1940's publication of the Central Valley Project

Delta Operations

- Salinity Management
- Delta Cross Channel Gate
- Old and Middle River Reverse Flows
- Salvage before the Pumping Plants
- Facility limitations





Bay-Delta Standards

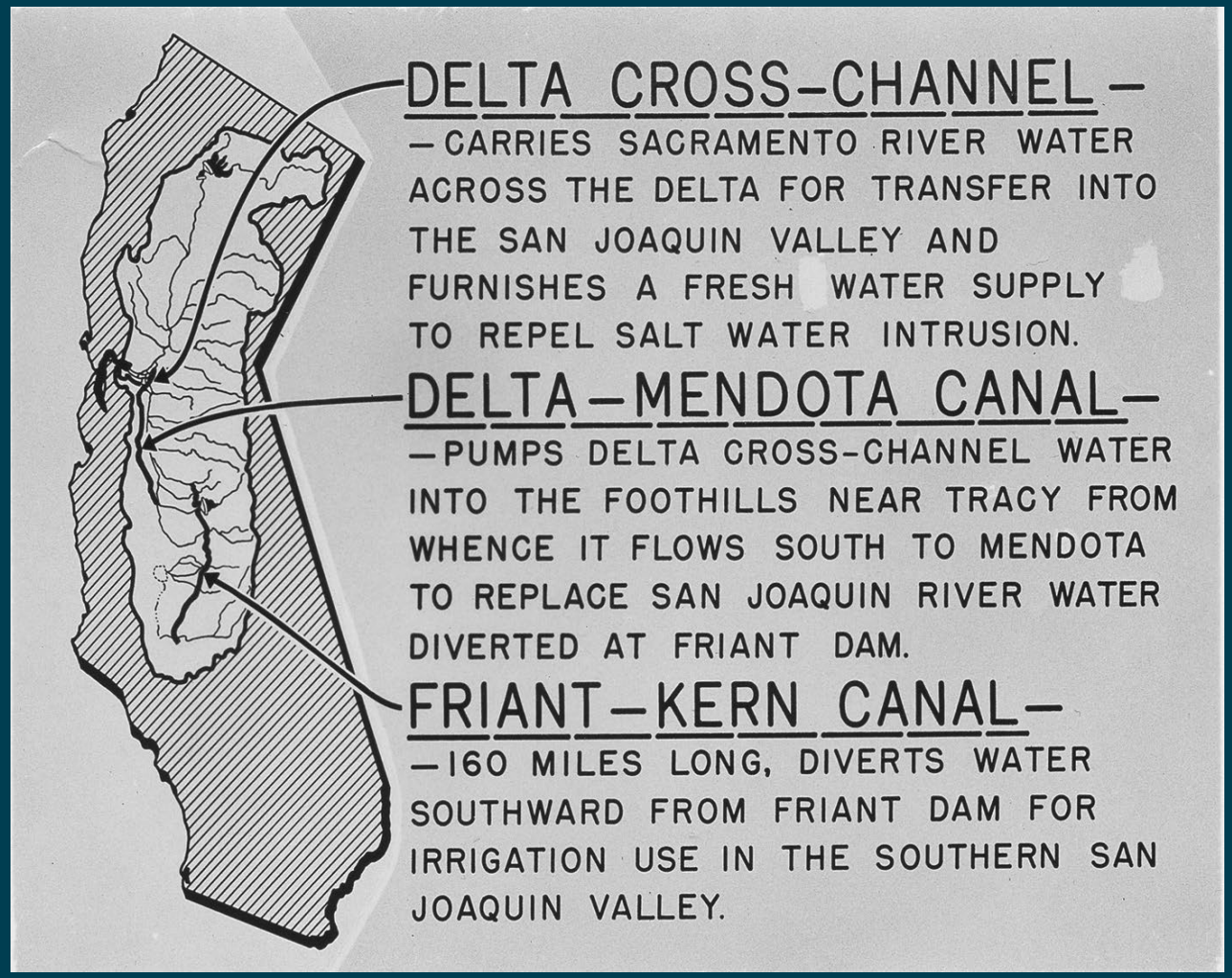
DRAFT

Contained in D-1641

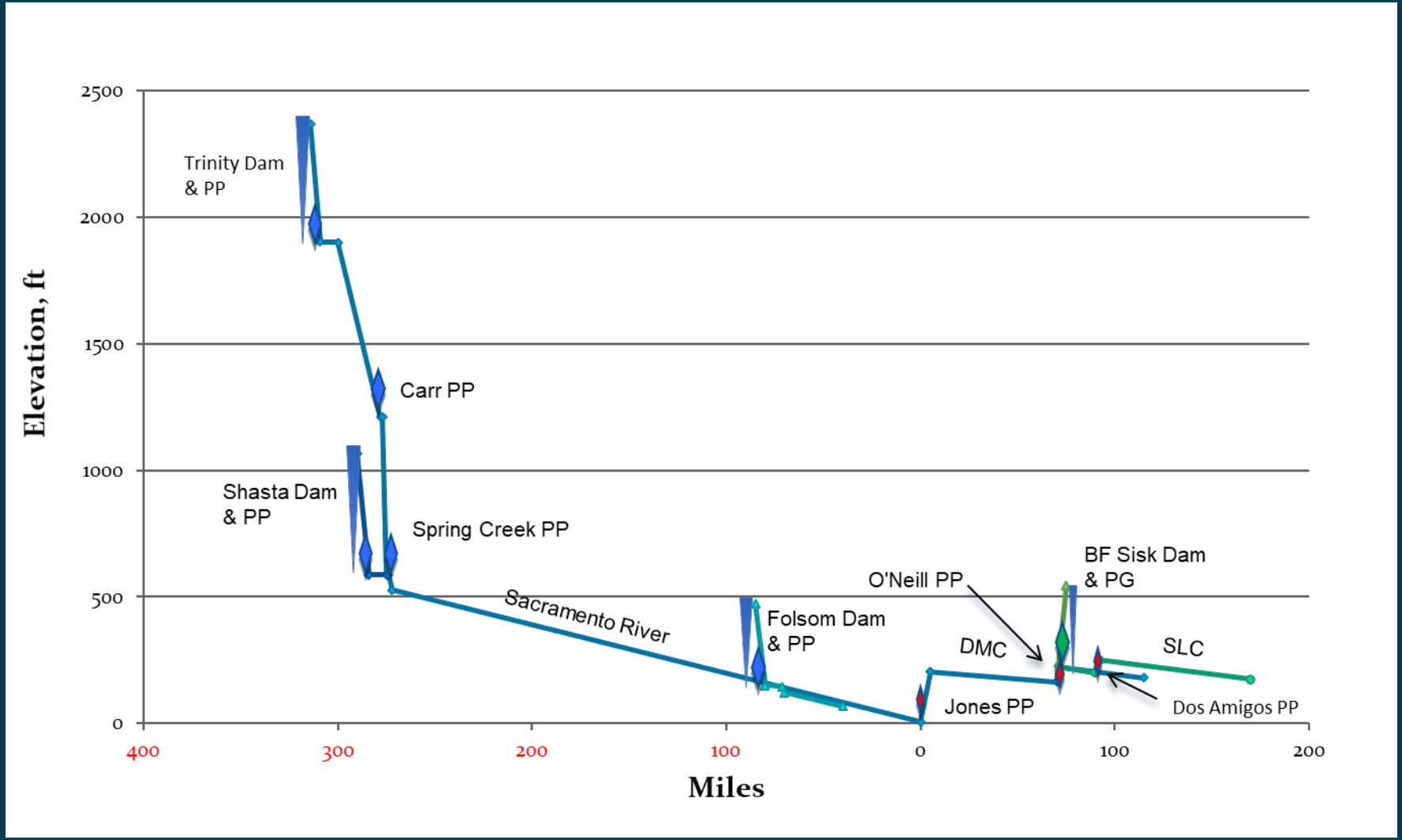
CRITERIA	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
FLOW/OPERATIONAL												
• Fish and Wildlife												
SWP/CVP Export Limits				1,500cfs [1]								
Export/Inflow Ratio [2]	65%	35% of Delta Inflow [3]					65% of Delta Inflow					
Minimum Delta Outflow	[4]						3,000 - 8,000 cfs [4]					
Habitat Protection Outflow			7,100 - 29,200 cfs [5]									
Salinity Starting Condition [6]		[6]										
River Flows:												
@ Rio Vista										3,000 - 4,500 cfs [7]		
@ Vernalis - Base		710 - 3,420 cfs [8]				[8]						
- Pulse				[9]						+28TAF		
Delta Cross Channel Gates	[10]		Closed		[11]						Conditional [10]	
WATER QUALITY STANDARDS												
• Municipal and Industrial												
All Export Locations	≤ 250 mg/l Cl											
Contra Costa Canal	150 mg/l Cl for the required number of days [12]											
• Agriculture												
Western/Interior Delta	Max 14-day average EC mmhos/cm [13]											
Southern Delta [14]	1.0 mS		30 day running avg EC 0.7 mS						1.0 mS			
• Fish and Wildlife												
San Joaquin River Salinity [15]	14-day avg; 0.44 EC											
Suisun Marsh Salinity [16]	12.5 EC	8.0 EC		11.0 EC						19.0 EC	[17]	15.5 EC

Delta Cross Channel Gates

1940’s publication of the Central Valley Project



CVP Hydropower Profile



CVP Allocations

- Total Contracted Quantity for Senior Water Rights and Refuges:
  - 4 million acre-feet (55% of Total)
- Total Contracted Quantity for Water Service (Not Including Friant):
  - 3.2 million acre-feet (45% of Total)

Key Operating Agreements and Standards of CVP and SWP

- SWRCB Permits and Conditions - Instream Flow and Delta Standards, Water Rights Decision 1641
- U.S. Fish and Wildlife Service Biological Opinion (2019)
- N.O.A.A. Fisheries (NMFS) Biological Opinion (2019)
- CDFW Incidental Take Permit (2019)
- Coordinated Operations Agreement – In-basin Demand Responsibilities
- Central Valley Improvement Act – Section 3406 b(1), b(2), b(3)
- U.S. Army Corps of Engineers – Flood Control Criteria
- California Department of Fish and Wildlife Agreements
- Federal Energy Regulatory Commission
- San Luis Joint Use Facilities Operating Agreement
- San Joaquin River Restoration Act
- Water Infrastructure Improvements for the Nation Act (WIIN)
- Water supply contracts and agreements

Coordination

- State Department of Water Resources : Project Operator
- State Water Resources Control Board : Regulator
- U. S. Fish and Wildlife Service : Regulator
- State Department of Fish and Wildlife: Regulator
- National Marine Fisheries Service : Regulator
- U. S. Army Corps of Engineers : Project Operator/Regulator
- Western Area Power Administration : Transmission and Power Marketing
- Local System Operators: Project Operators
- Various Stakeholders

CVP Operational Schedule

- Monthly
  - Seasonal runoff forecast with short-term and long-term forecasts
  - Operational forecast (Releases, storage and diversions/exports)
  - Watershed technical team meetings on monthly operations and fishery conditions
- Weekly
  - Salmon and smelt technical team meetings on weekly operations and fishery conditions
  - Review relevant regulations and agreements
  - Forecast changes 3-5 days out given regulations and forecasts
- Daily
  - Operators discuss current conditions
  - Flow, Export and Temperature adjustments as needed
  - Coordinate with the State Water Project operators
- Allocations
  - Initial in February
  - Monthly updates March through June as needed

CVP Challenges

- Flood Control
- River Regulation (Navigation)
- Fish and Wildlife*
- Water Supply
- Power Generation
- Recreation**

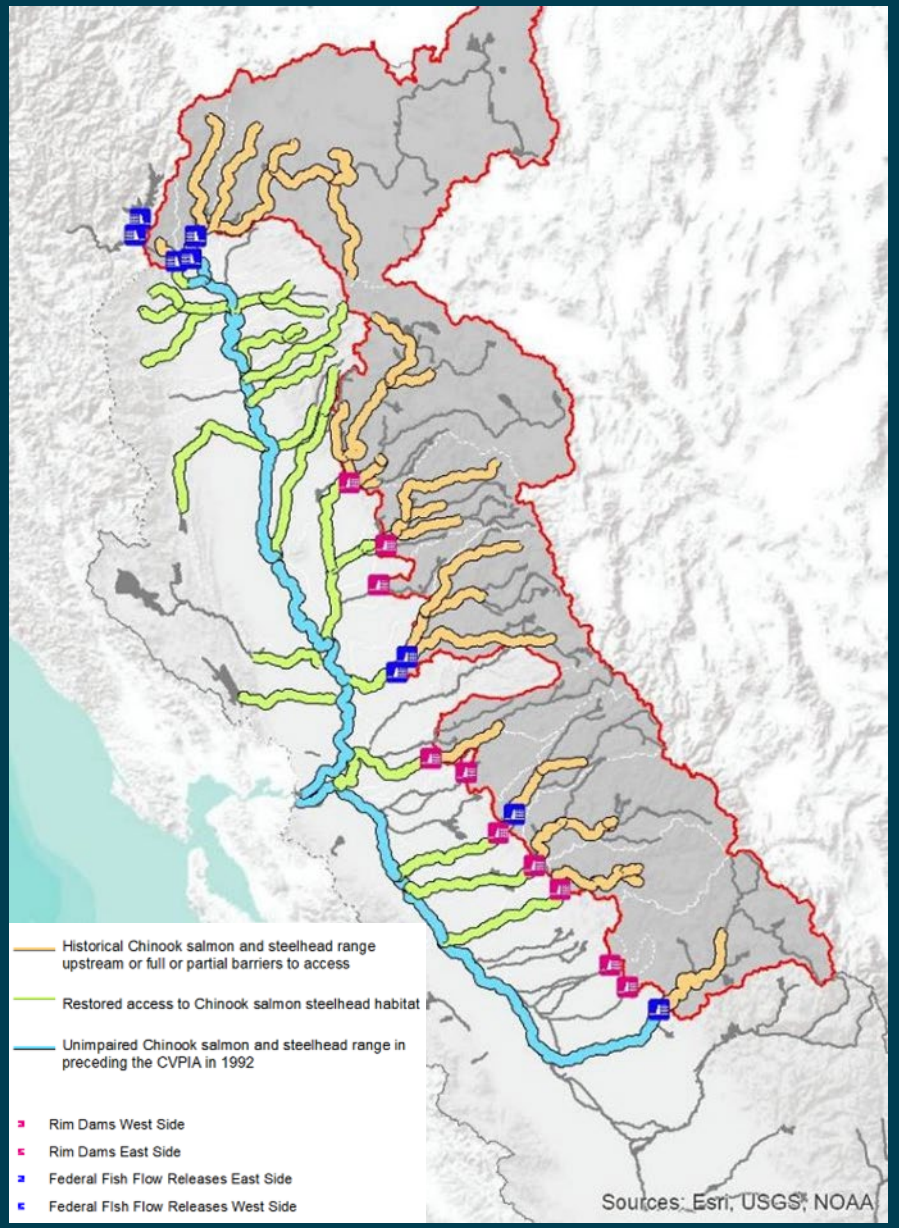
*Prioritized in 1992 by the Central Valley Project Improvement Act

**Project Recreation Act, 1965

- Droughts and Floods
- Climate Change
- Aging Infrastructure
- Growing Populations
- Changing Hydropower Markets
- Groundwater and Subsidence
- Invasive Species
- Regulations and Coordination
- Water Quality Compliance
- Endangered Species

Central Valley Habitat

- Dams around the rim of the valley floor isolate salmon from historical habitats
- Warm water conditions challenge spawning, incubation, and rearing
- Levees isolate fish from historical floodplain habitat
- Diversions impair passage for returning adults and may entrain juveniles
- Exports alter the hydrodynamics of the Delta

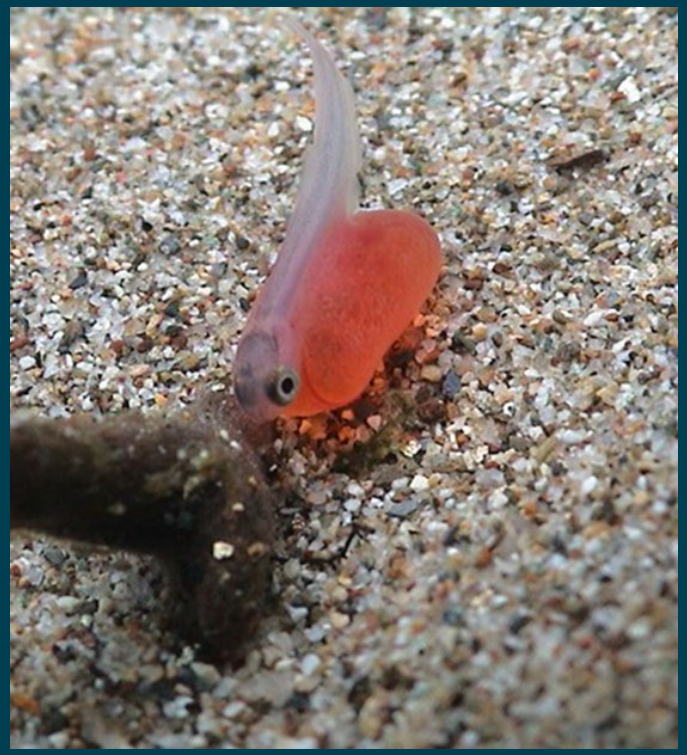


Temperature Management

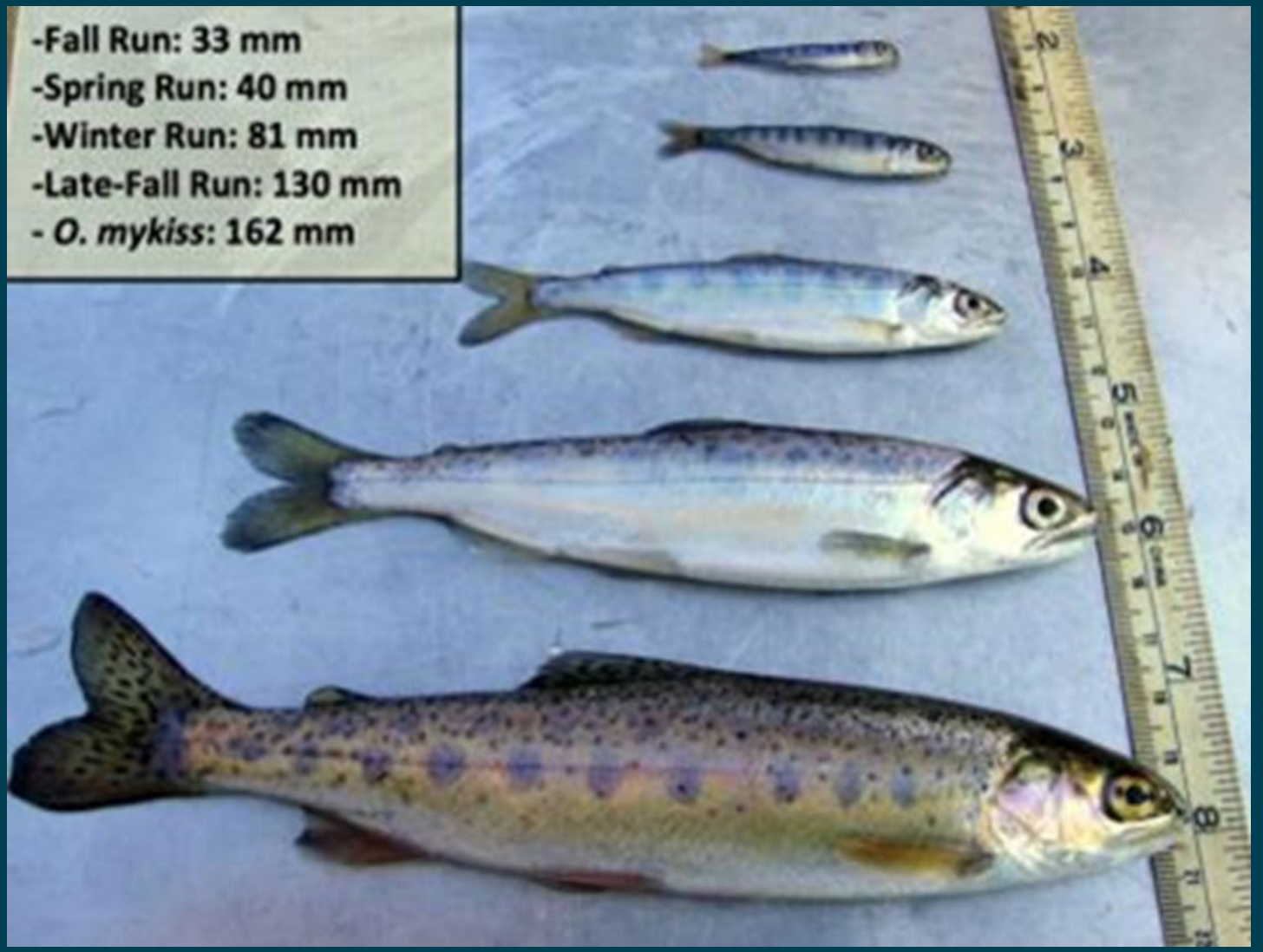
Background

- 1987: Court Order to protect winter run Chinook salmon
- 1990 and 1991: State Water Board modified Reclamation's Water Rights
- Incorporate temperature control objectives in the Upper Sacramento River

Salmonids

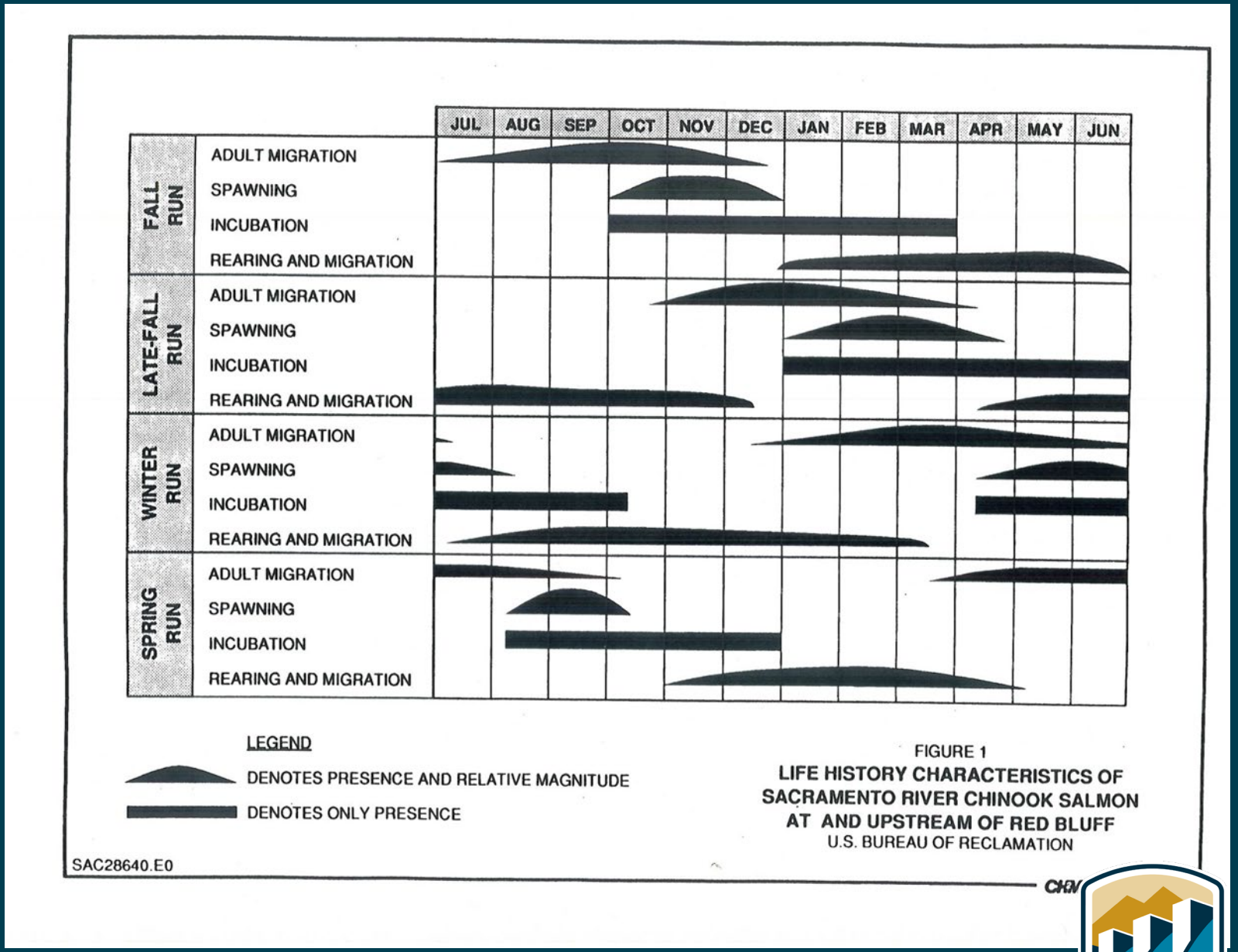


CDFW



USFWS

Fish Presence



Sacramento River Winter Run Spawning Area

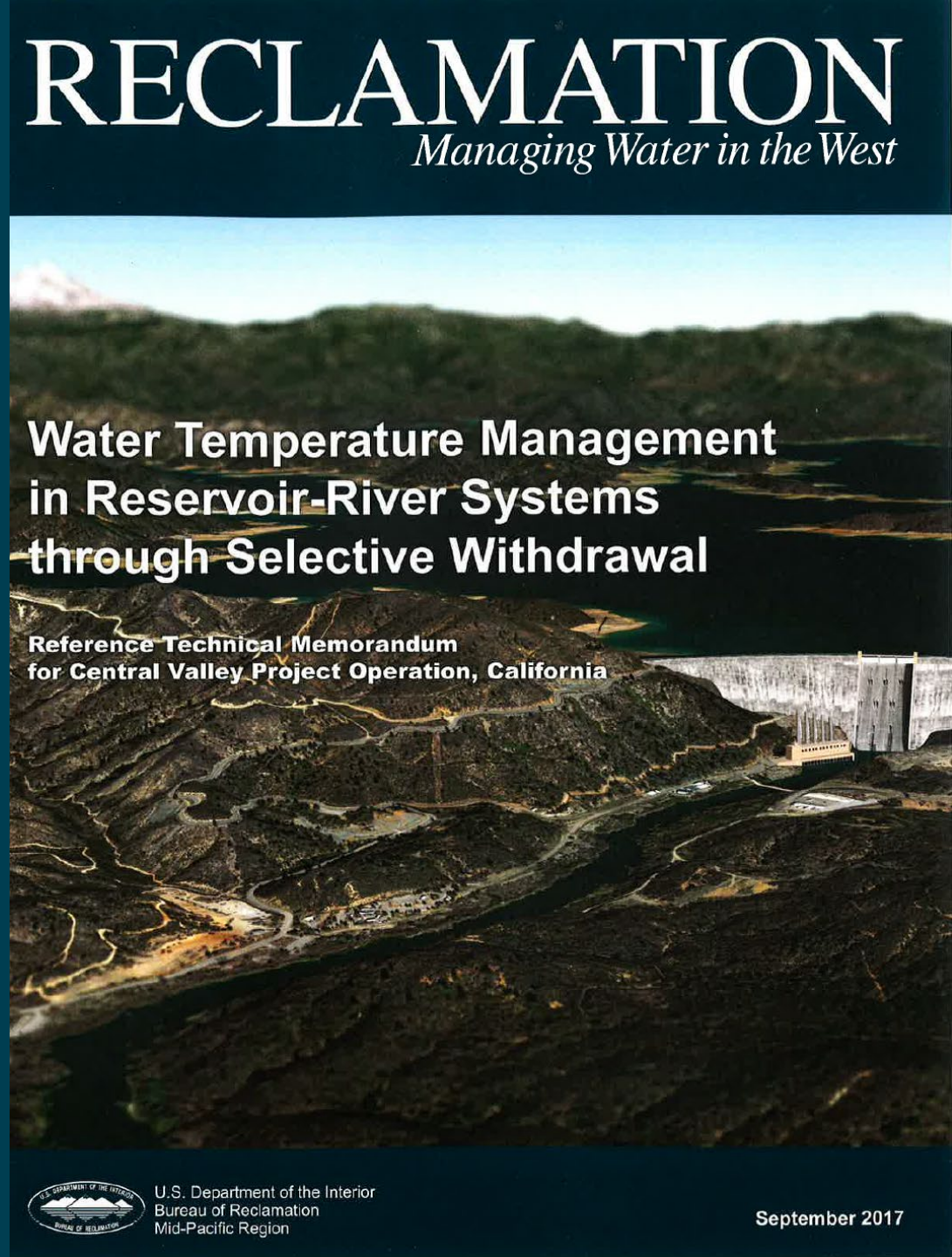
Photo: John Hannon

Temperature Management

Reference Technical Memorandum 2017

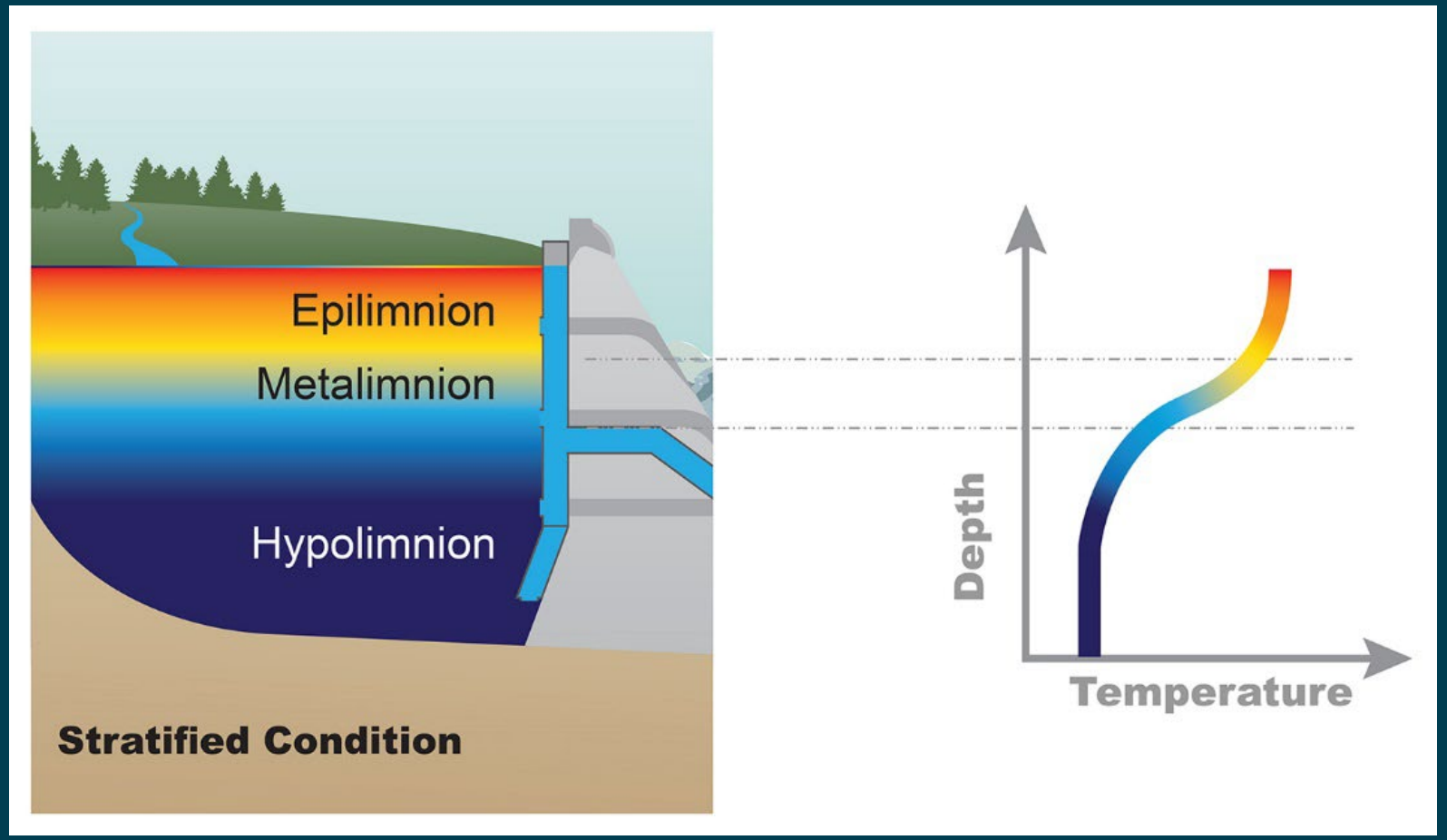
Web Link - See Additional References:

https://www.usbr.gov/mp/bdo/cvp-wtmp.html

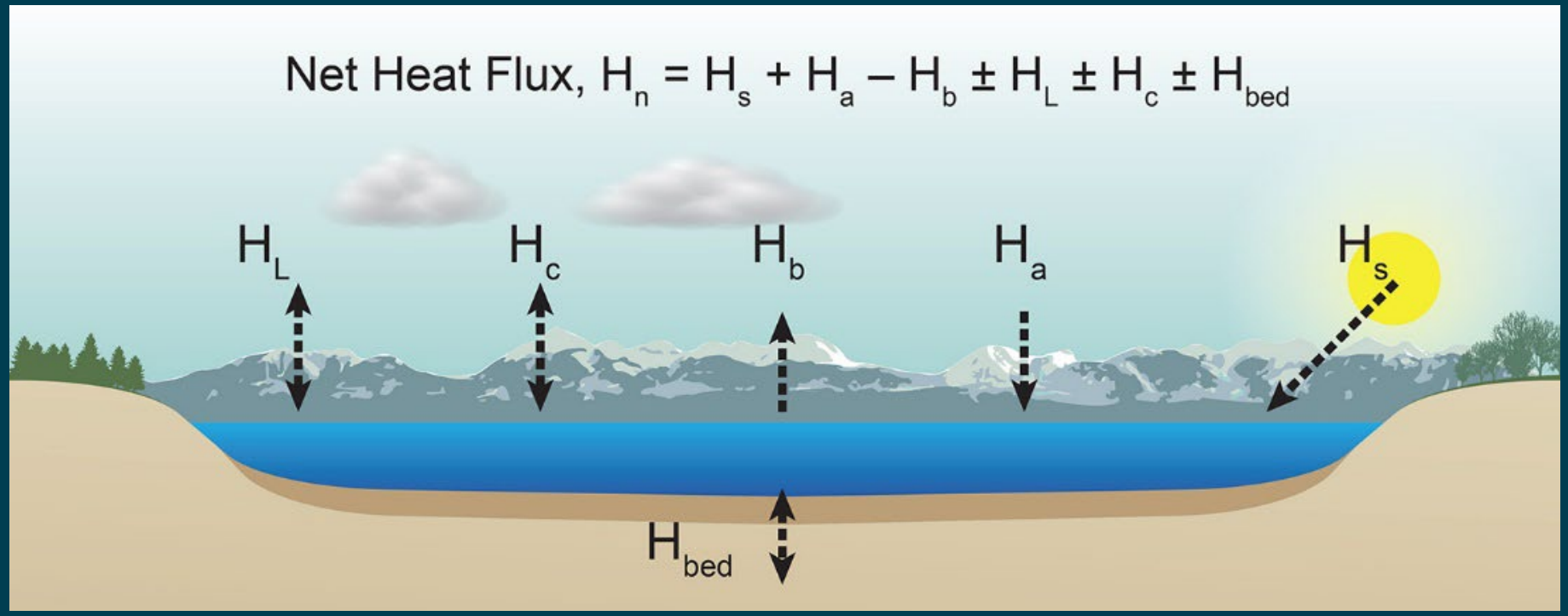


Temperature Management Fundamentals

Lake Stratification

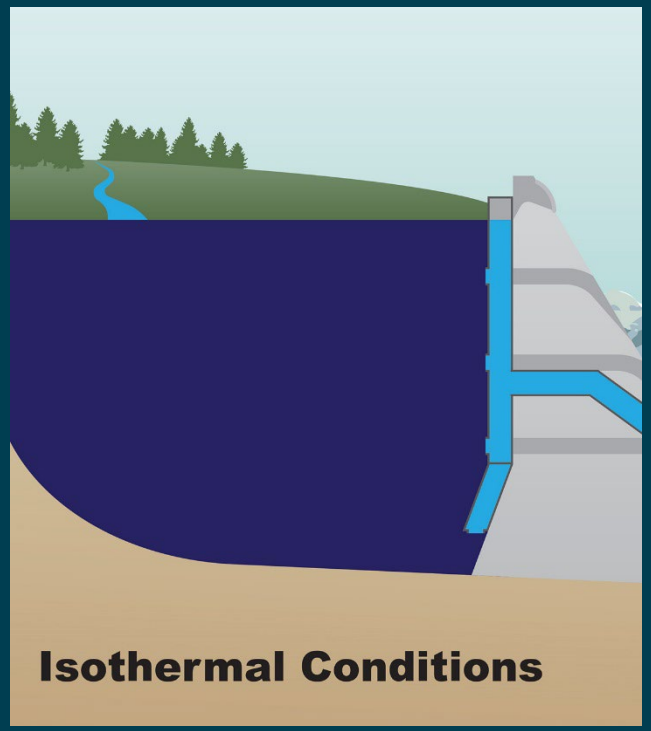


Thermal Heat Flux

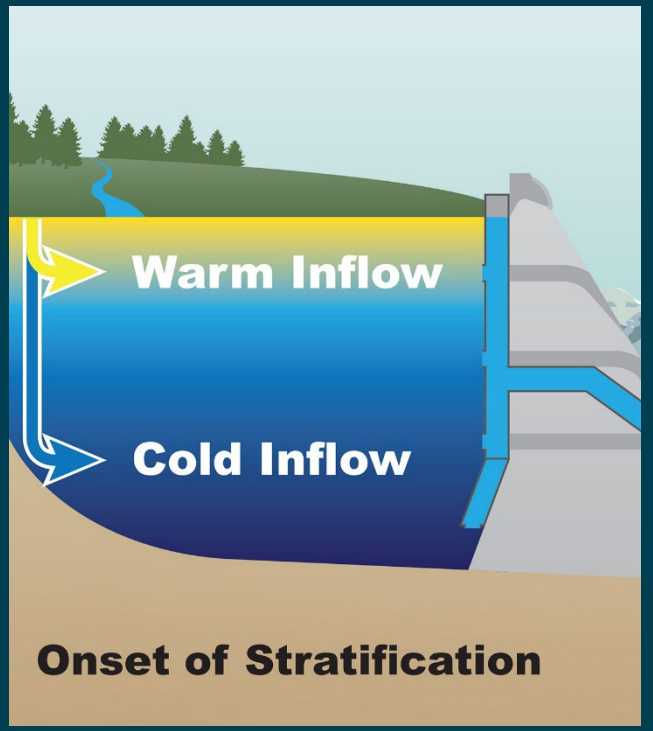


Seasonal Lake Characteristics

Winter

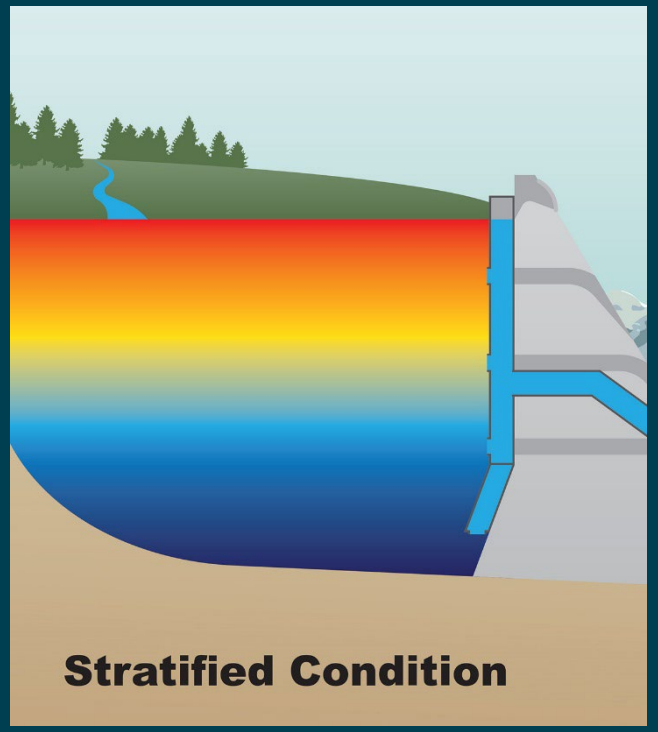


Spring

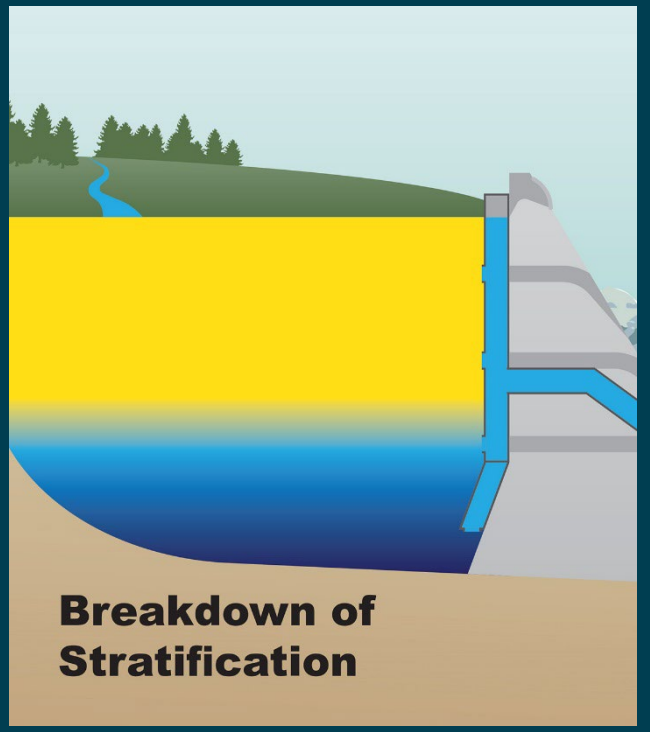


Seasonal Lake Characteristics

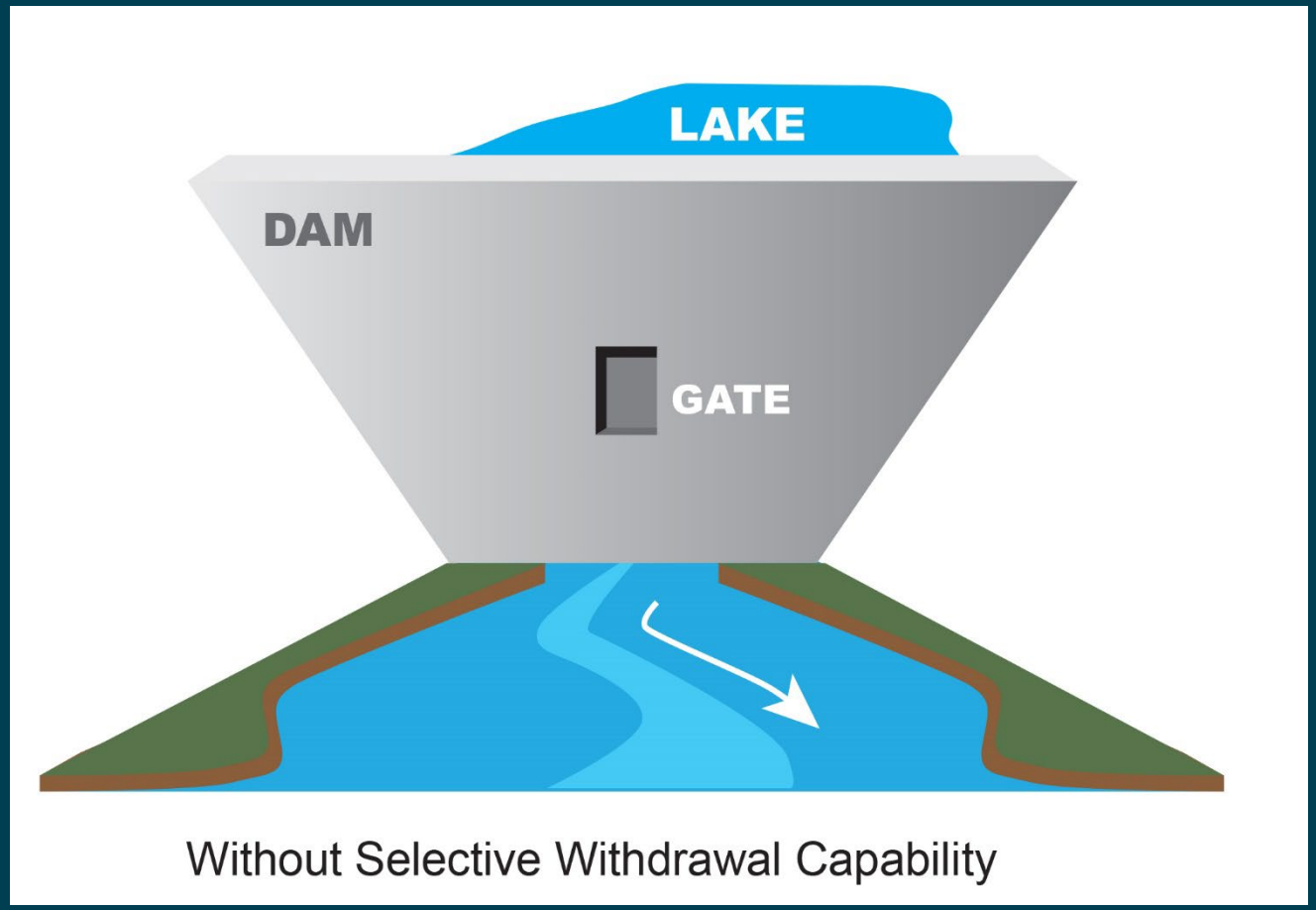
Summer



Fall

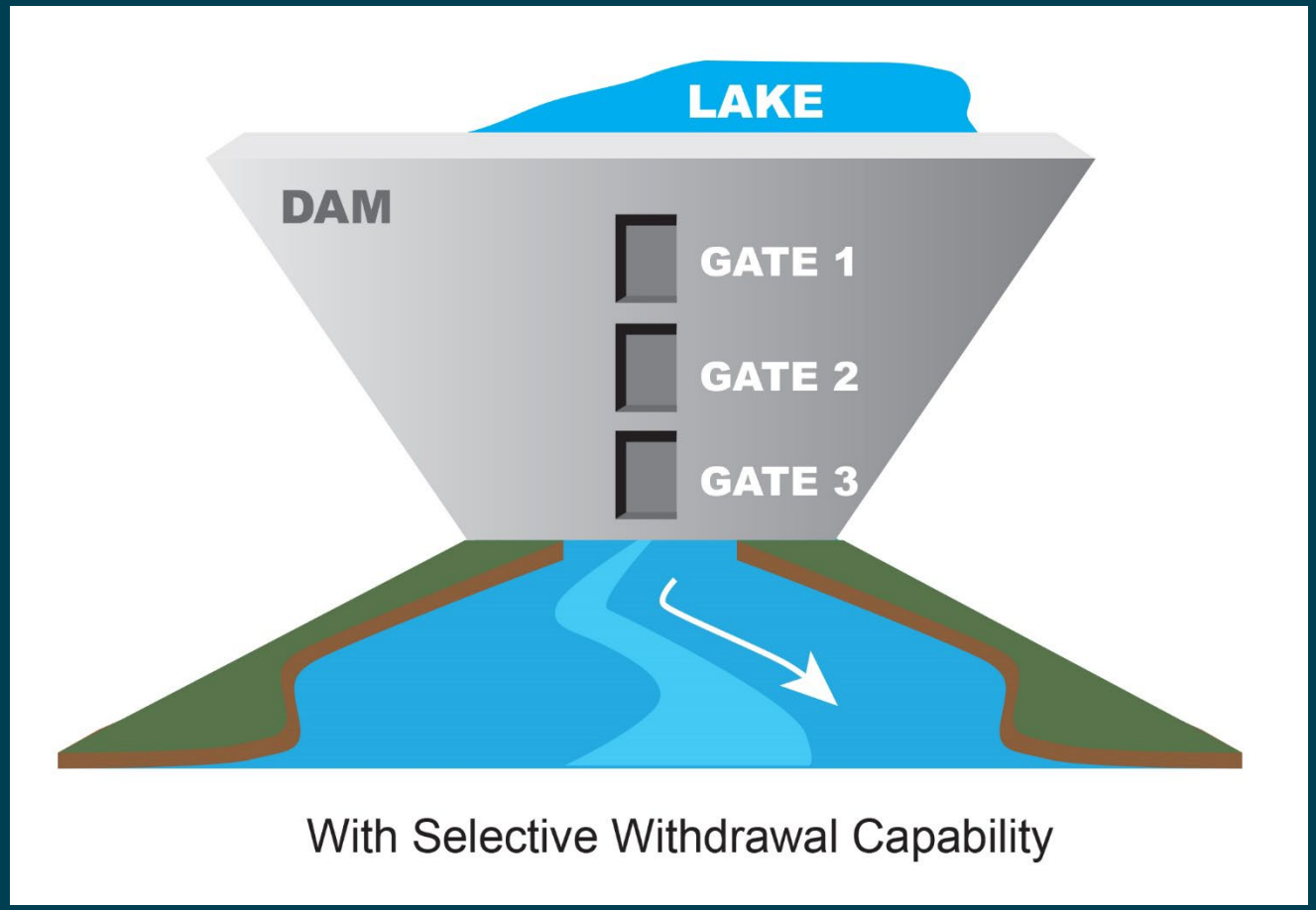


No Selective Withdrawal



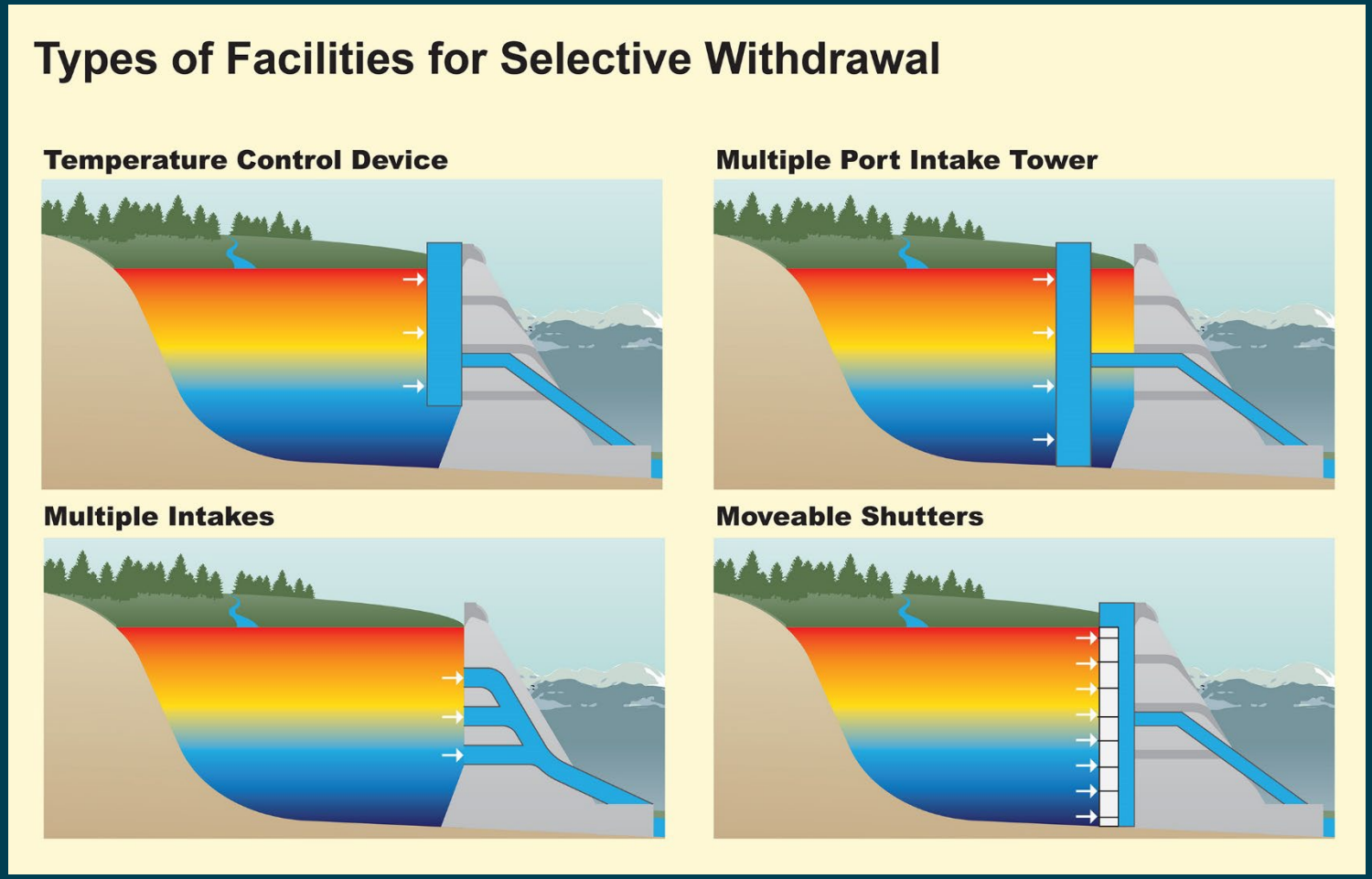
Without Selective Withdrawal Capability

Selective Withdrawal



With Selective Withdrawal Capability

Temperature Management Infrastructure



Temperature Control Device System

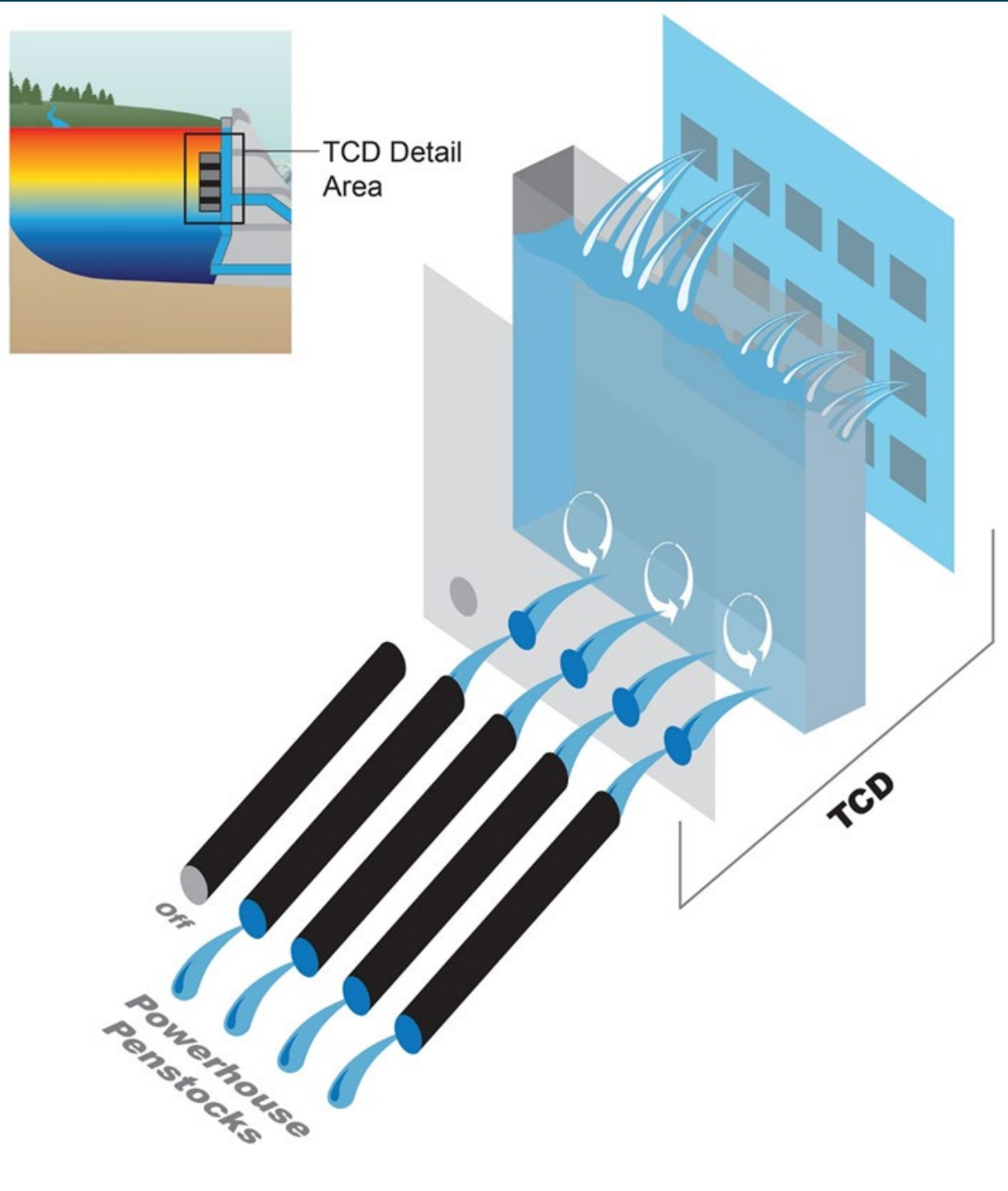
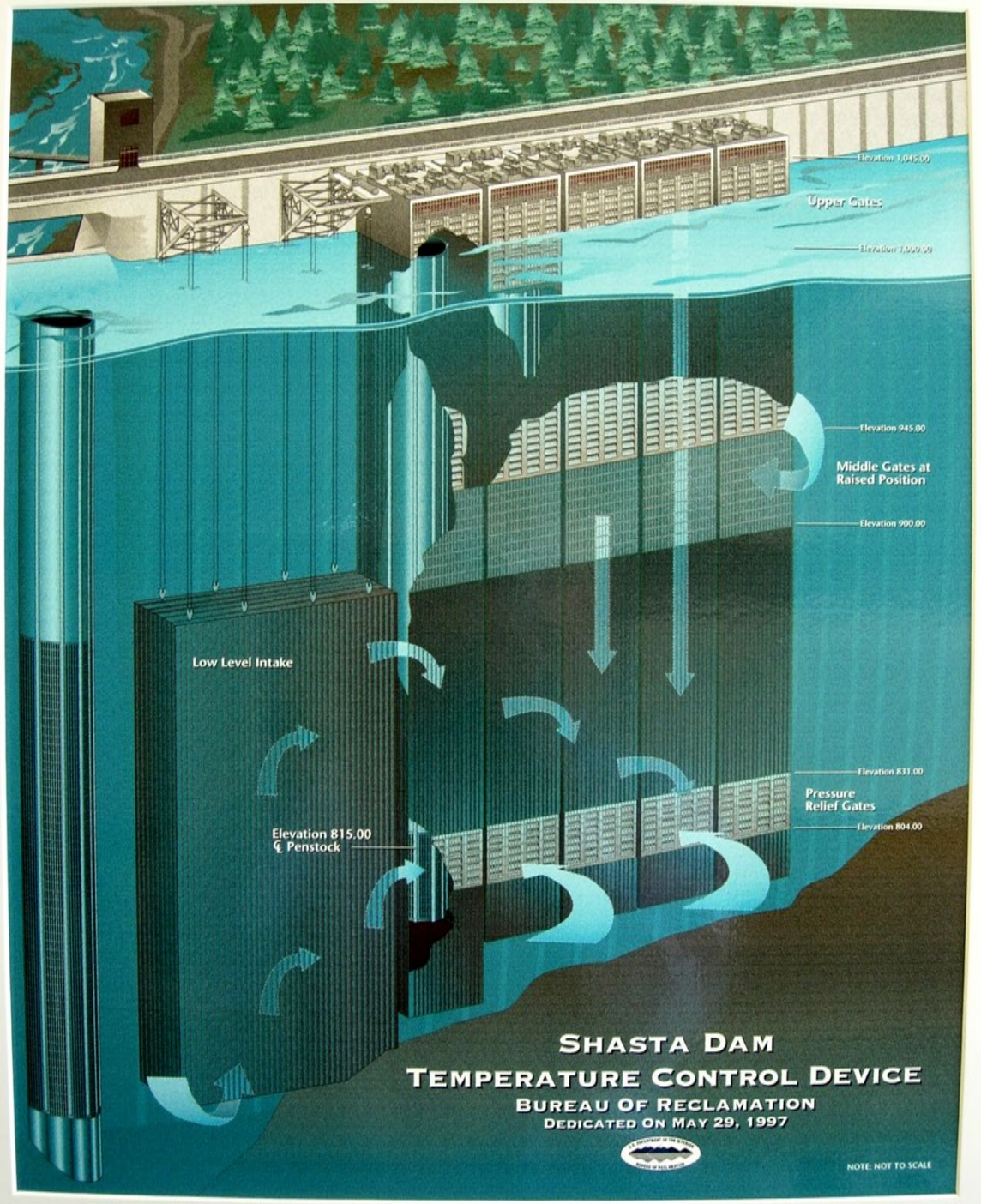


Photo: Reclamation

Shasta Temperature Control Device

Completed 1997



Construction 1990's

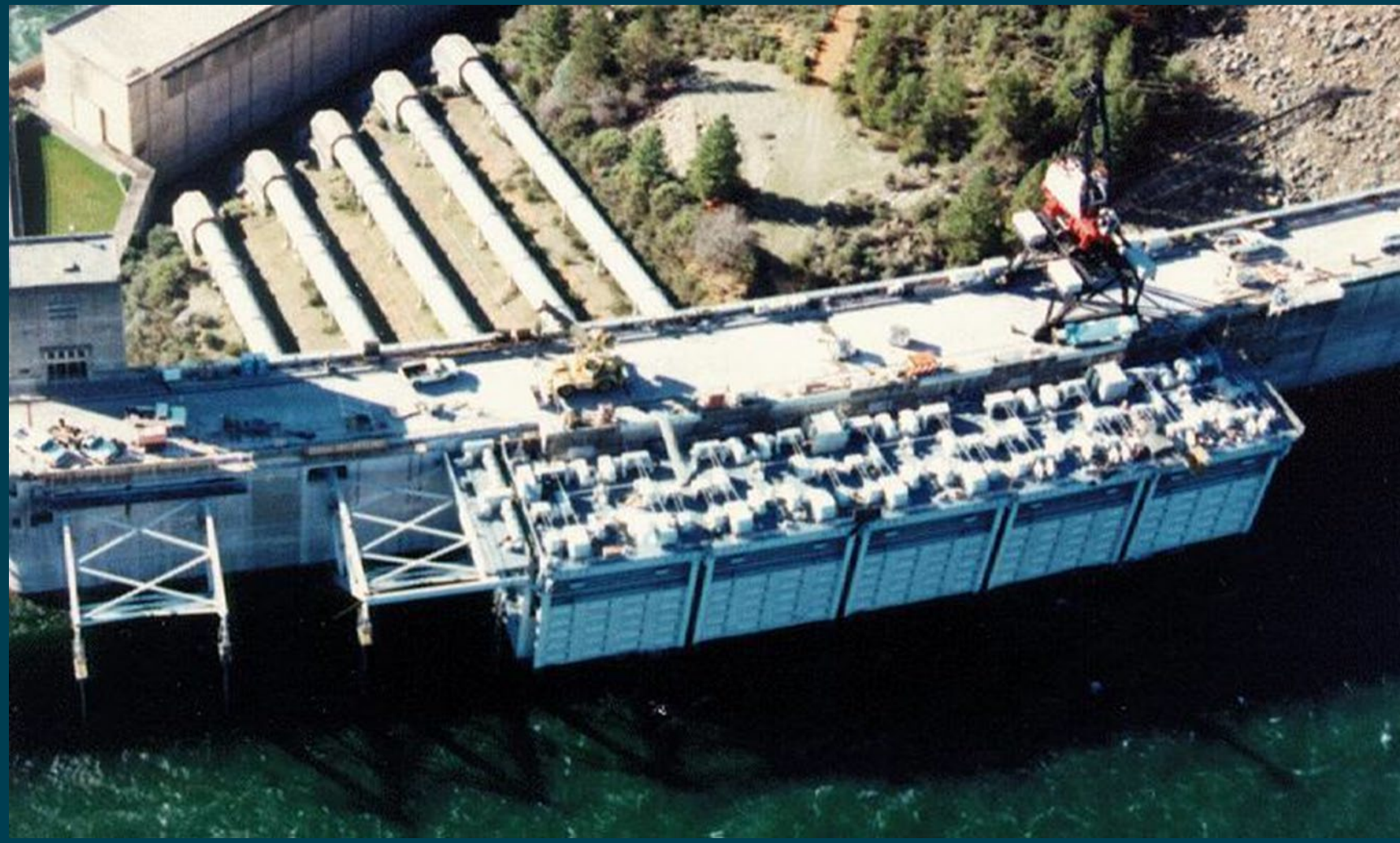


Photo: Reclamation

Shasta TCD

2019

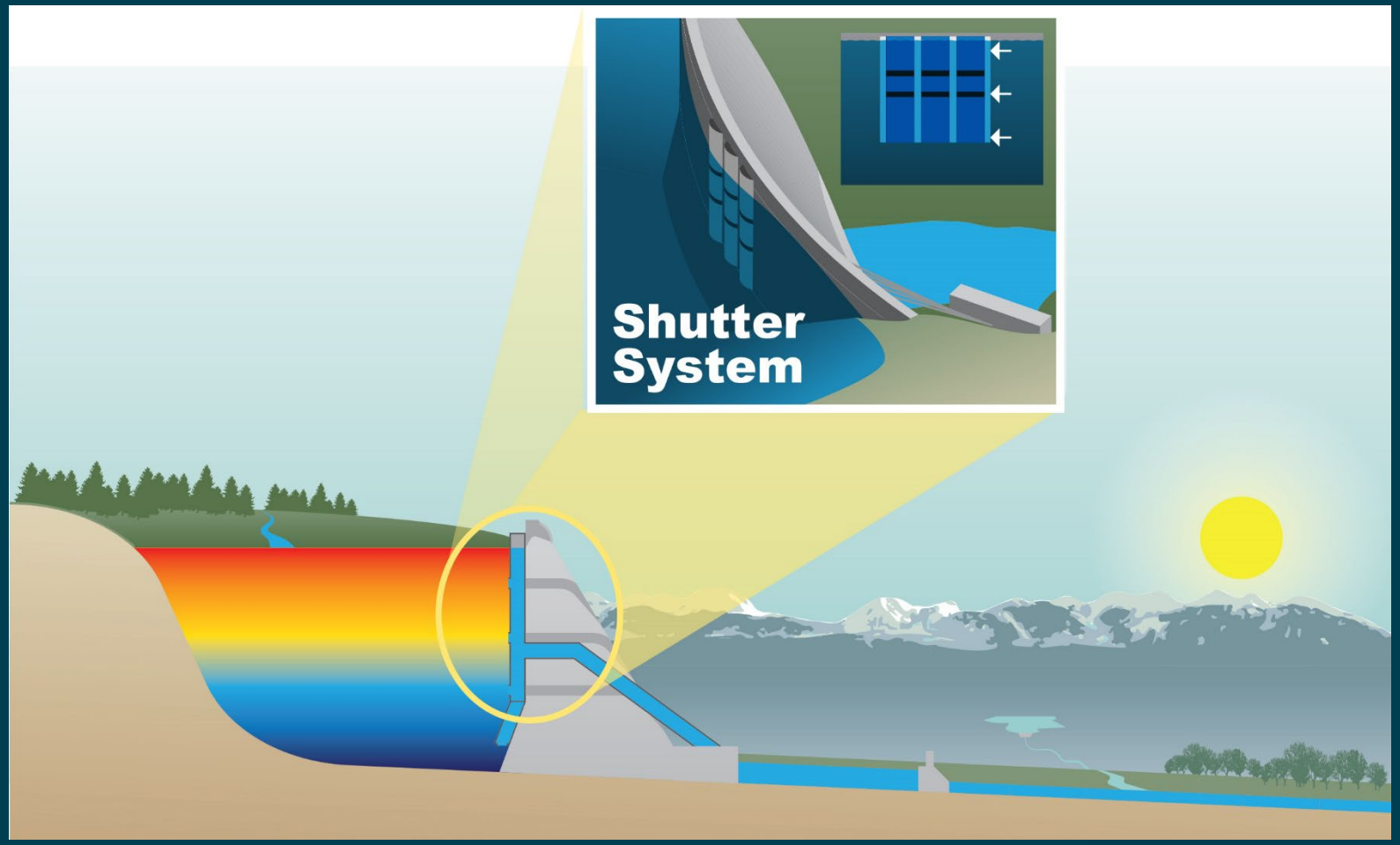
Photo: Watercourse Engineering, Inc.

Shasta TCD

2015
Middle Gate Curtain

Photo: Reclamation

Shutter System



Folsom Dam

Photo: Reclamation

Folsom Dam Outlets

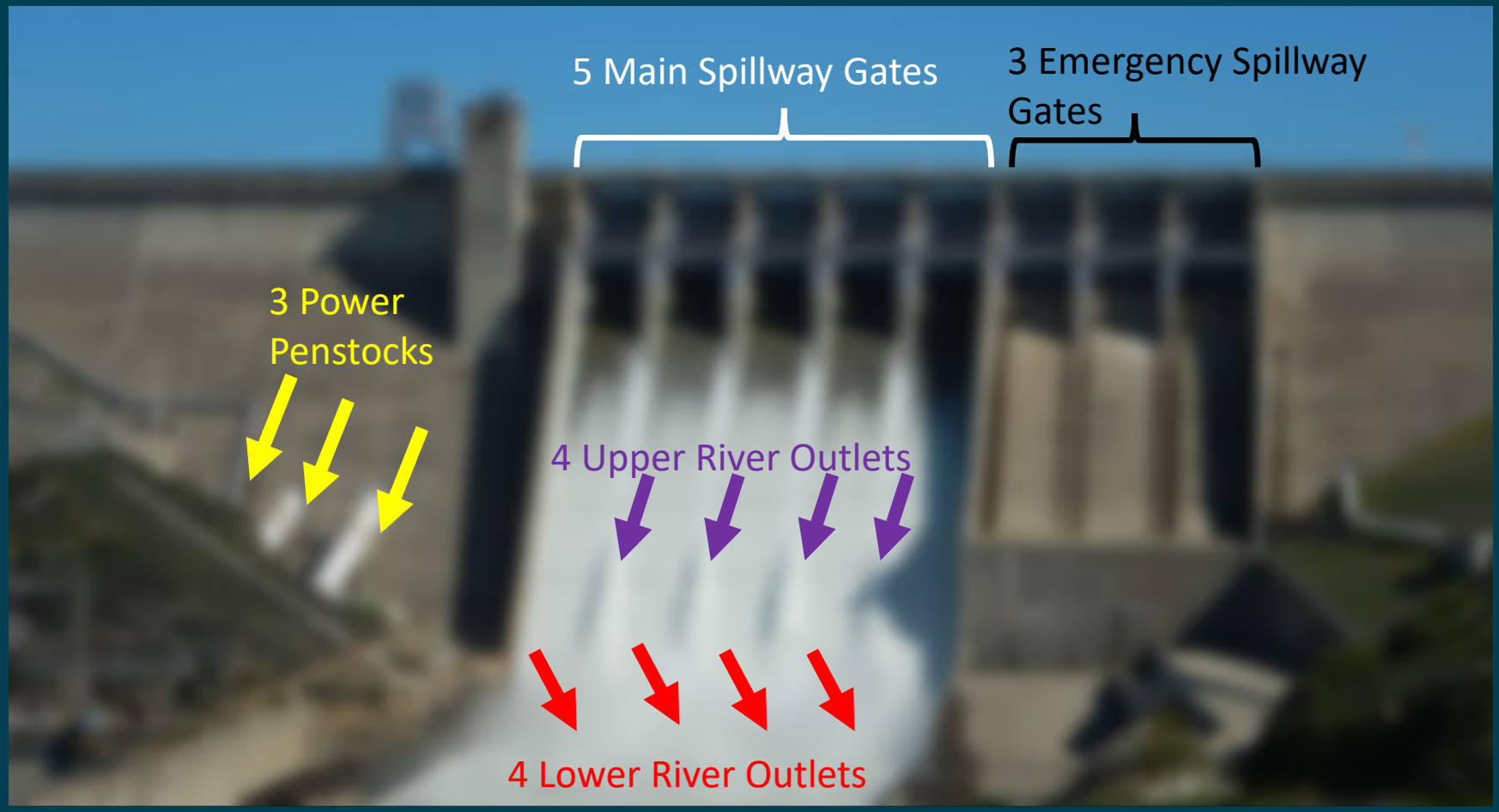


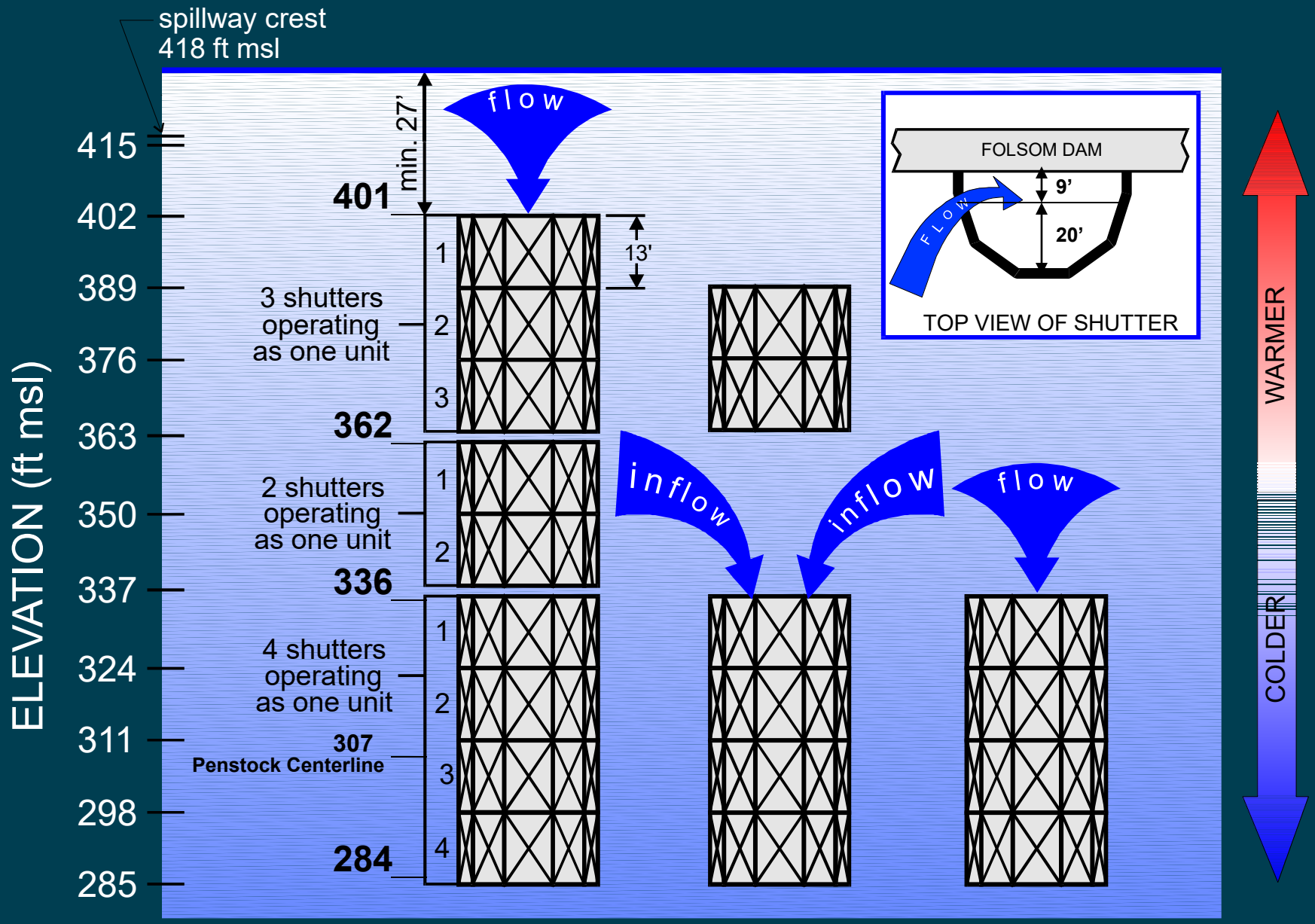
Photo: Reclamation

Folsom Dam

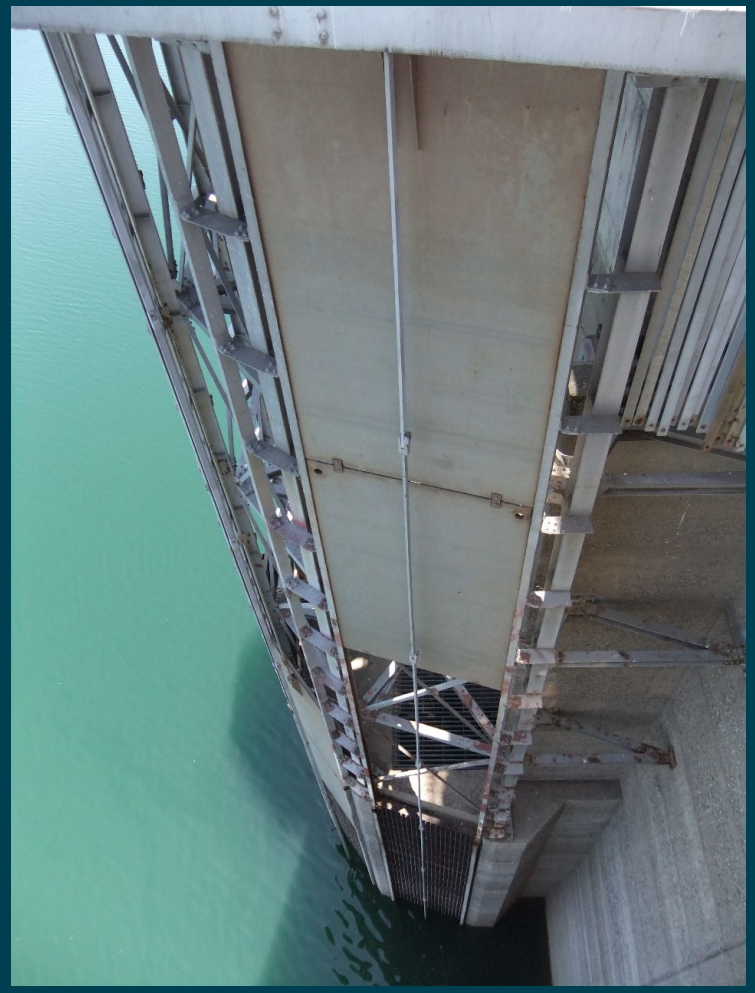
2015

Photo: Reclamation

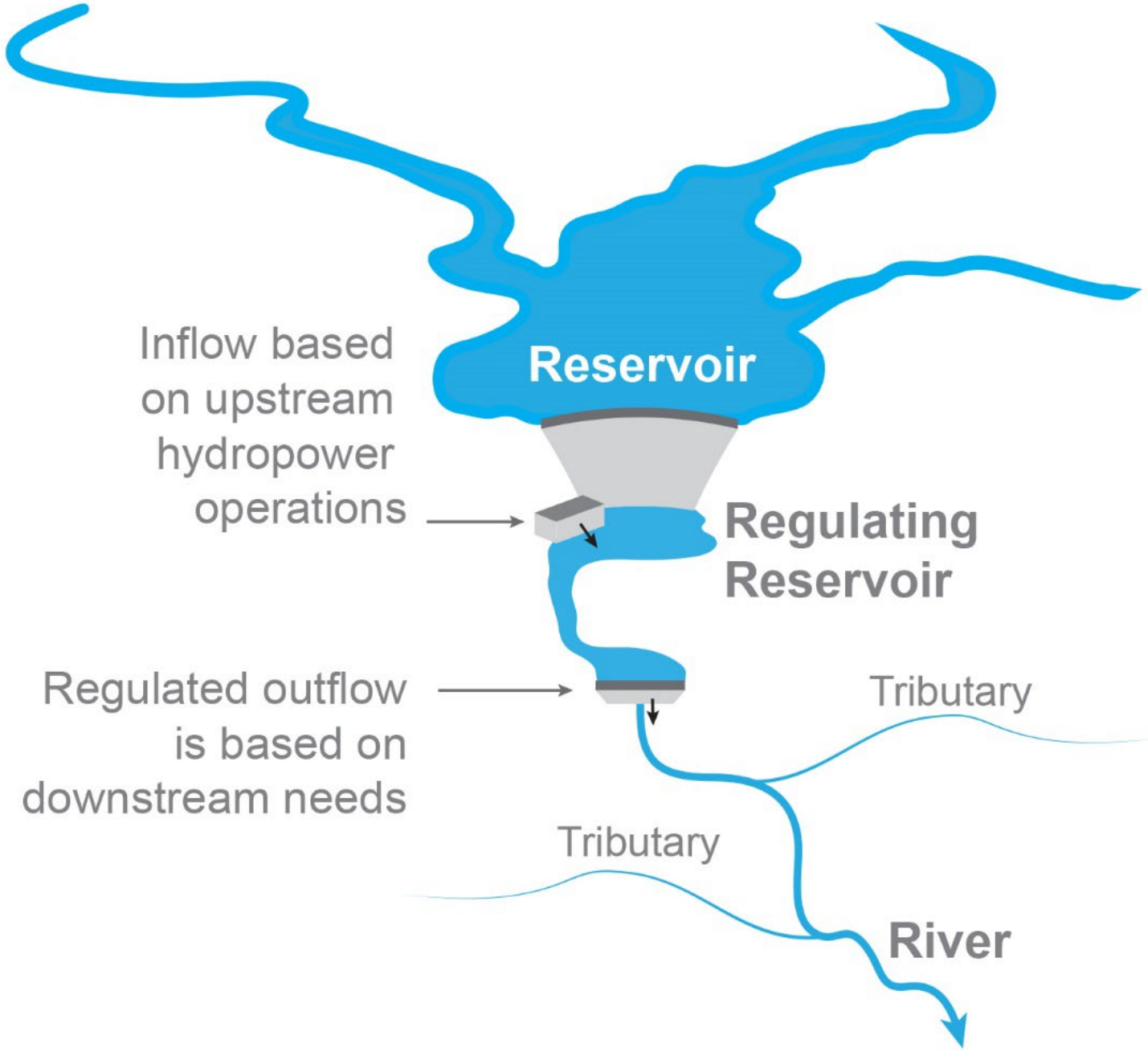
Folsom Dam Shutters



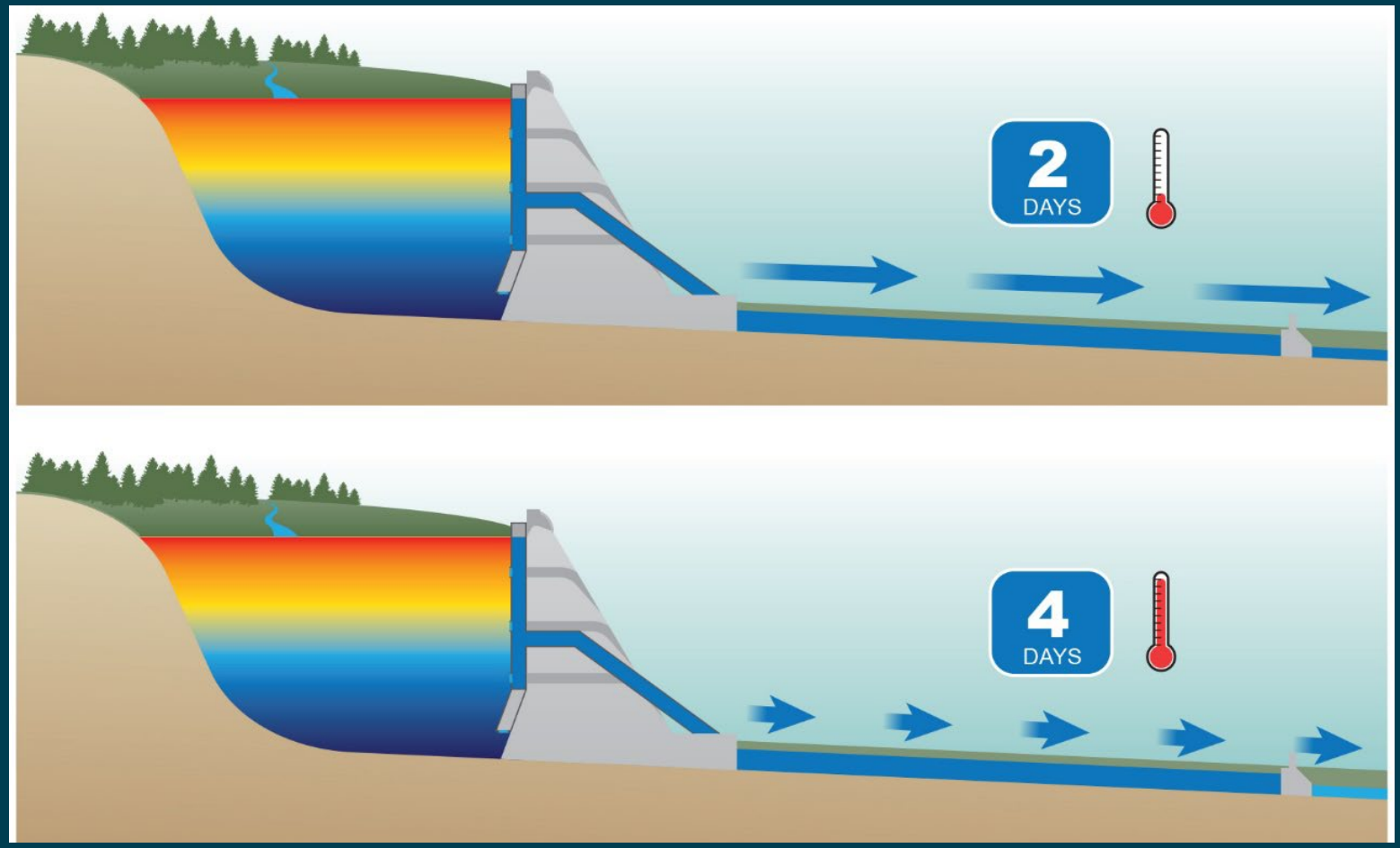
Folsom Dam Shutter De-Ganging



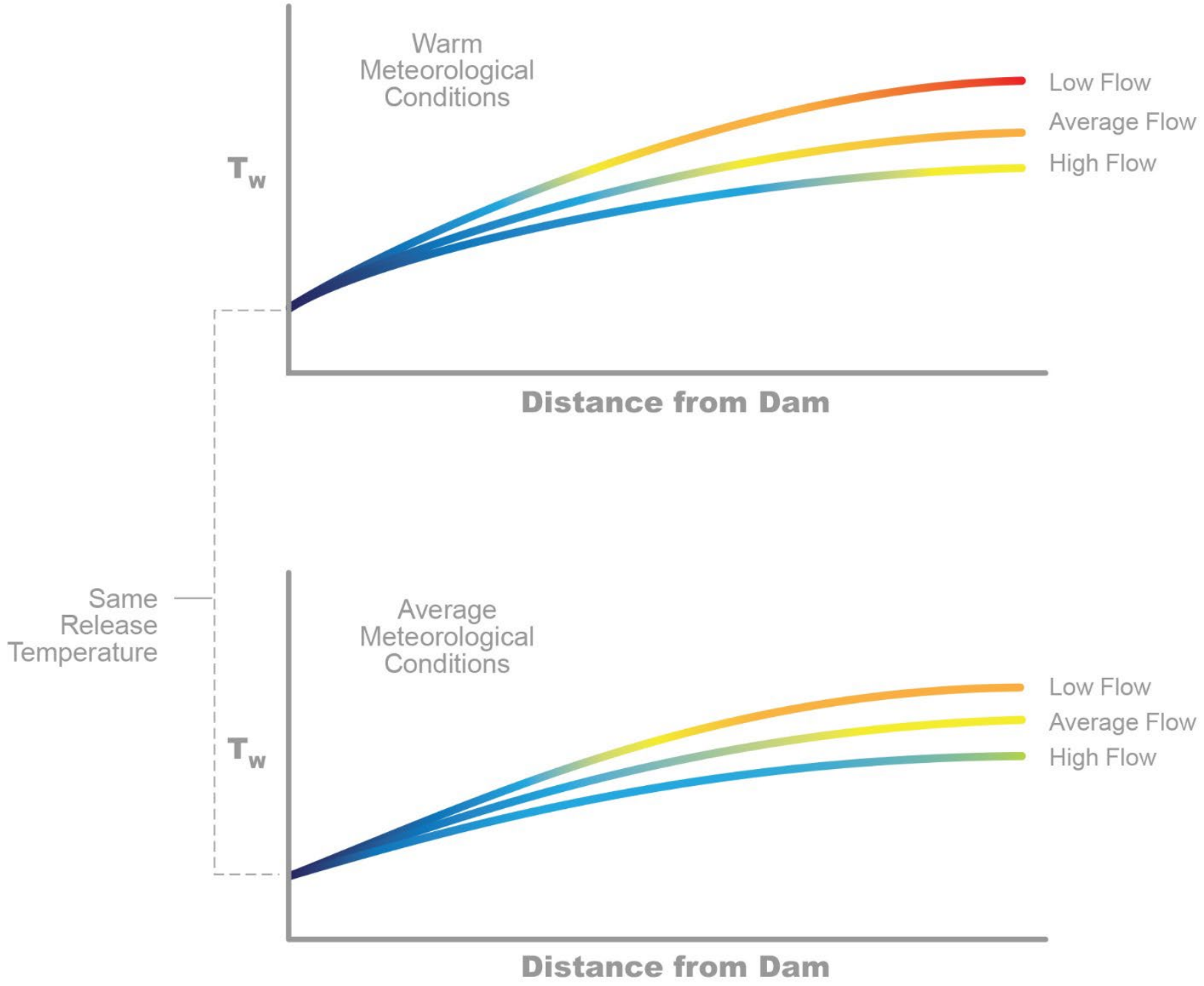
Reservoir and Regulating Reservoir



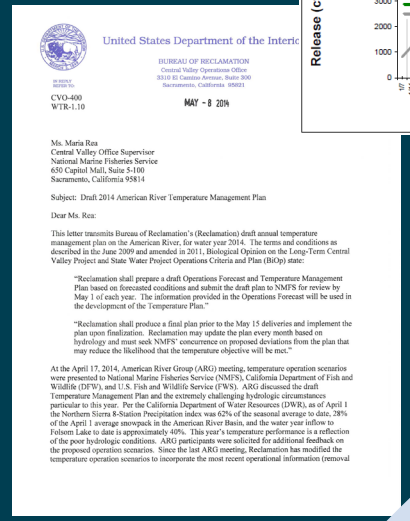
Regulating Reservoir Residence Time



River Flow Heat Gain



Temperature Management Process



United States Department of the Interio

BUREAU OF RECLAMATION
Central Valley Operations Office
3310 El Camino Avenue, Suite 300
Sacramento, California 95821

CVO-400
WTR-1.10

MAY - 8 2014

Ms. Maria Rea
Central Valley Office Supervisor
National Marine Fisheries Service
650 Capitol Mall, Suite 5-100
Sacramento, California 95814

Subject: Draft 2014 American River Temperature Management Plan

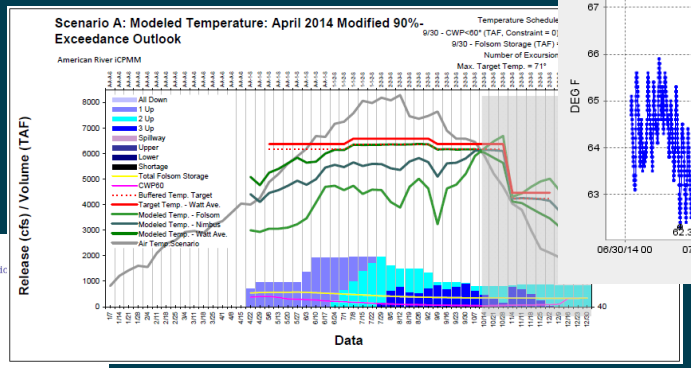
Dear Ms. Rea:

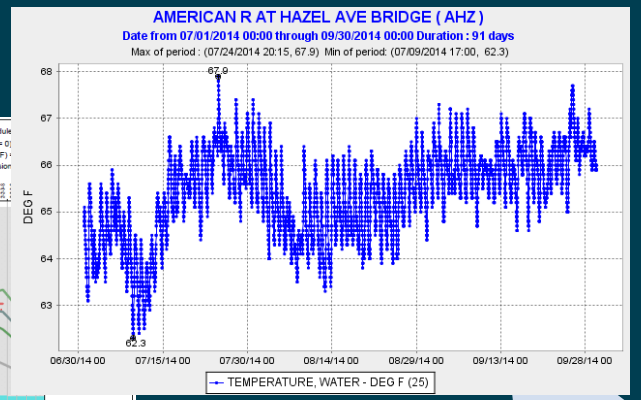
This letter transmits Bureau of Reclamation's (Reclamation) draft annual temperature management plan on the American River, for water year 2014. The terms and conditions as described in the June 2009 and amended in 2011, Biological Opinion on the Long-Term Central Valley Project and State Water Project Operations Criteria and Plan (BiOp) state:

"Reclamation shall prepare a draft Operations Forecast and Temperature Management Plan based on forecasted conditions and submit the draft plan to NMFS for review by May 1 of each year. The information provided in the Operations Forecast will be used in the development of the Temperature Plan."

"Reclamation shall produce a final plan prior to the May 15 deliveries and implement the plan upon finalization. Reclamation may update the plan every month based on hydrology and must seek NMFS' concurrence on proposed deviations from the plan that may reduce the likelihood that the temperature objective will be met."

At the April 17, 2014, American River Group (ARG) meeting, temperature operation scenarios were presented to National Marine Fisheries Service (NMFS), California Department of Fish and Wildlife (DFW), and U.S. Fish and Wildlife Service (FWS). ARG discussed the draft Temperature Management Plan and the extremely challenging hydrologic circumstances particular to this year. Per the California Department of Water Resources (DWR), as of April 1 the Northern Sierra 8-Station Precipitation index was 62% of the seasonal average to date, 28% of the April 1 average snowpack in the American River Basin, and the water year inflow to Folsom Lake to date is approximately 40%. This year's temperature performance is a reflection of the poor hydrologic conditions. ARG participants were solicited for additional feedback on the proposed operation scenarios. Since the last ARG meeting, Reclamation has modified the temperature operation scenarios to incorporate the most recent operational information (removal





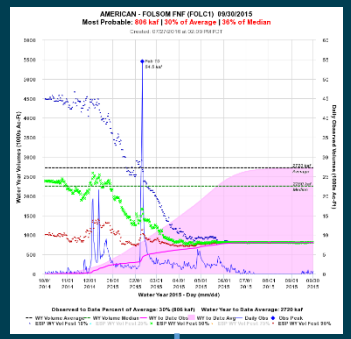
1. May: Temperature Management Plan

2. Update Plan Monthly

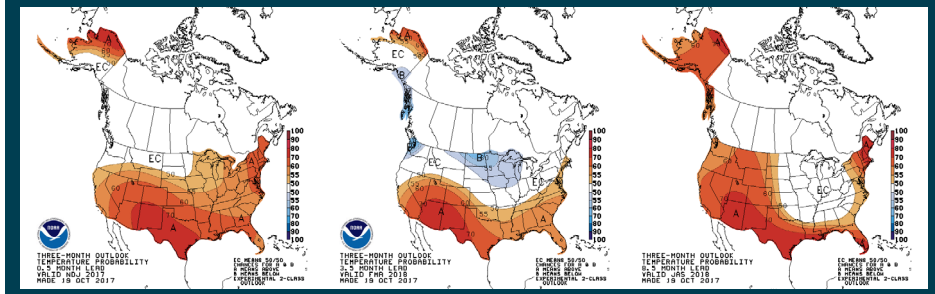
3. November: Complete Season

Temperature Modeling – Seasonal Plan

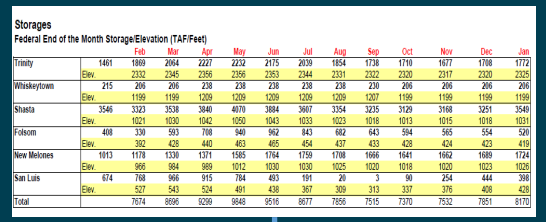
Hydrology Forecasts



Long-Term Meteorology Forecasts



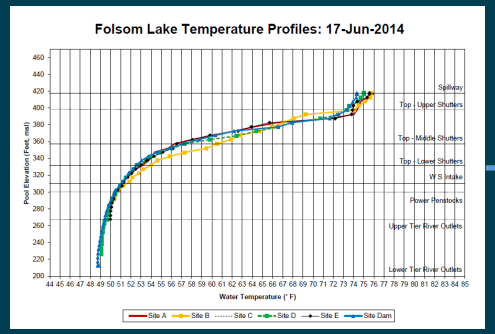
Operation Outlook

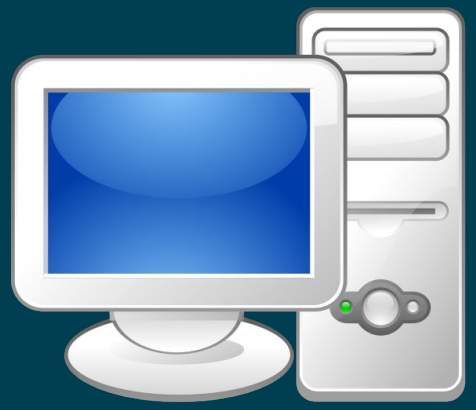


Storages
Federal End of the Month Storage/Elevation (TAF/Feet)

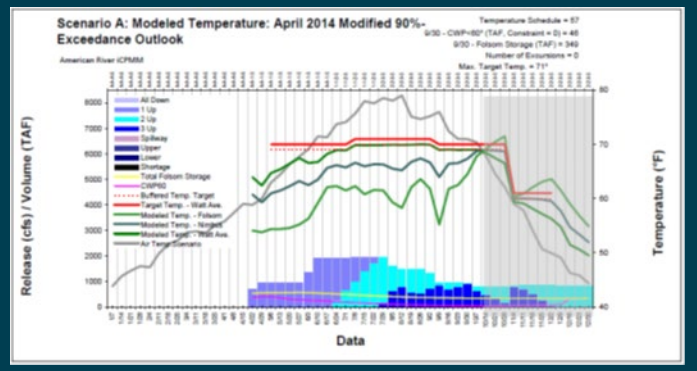
		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Trinity	1461	1869	2064	2227	2232	2175	2039	1854	1738	1710	1677	1708	1772
	Elev.	2332	2345	2356	2356	2353	2344	2331	2322	2320	2317	2320	2325
Whiskeytown	215	206	206	238	238	238	238	238	230	206	206	206	206
	Elev.	1199	1199	1209	1209	1209	1209	1209	1207	1199	1199	1199	1199
Shasta	3546	3323	3538	3840	4070	3884	3667	3354	3235	3129	3168	3251	3540
	Elev.	1021	1030	1042	1050	1043	1033	1023	1018	1013	1015	1018	1031
Folsom	408	330	593	708	940	962	843	682	643	594	565	554	526
	Elev.	392	426	440	463	465	454	437	433	428	424	423	419
New Melones	1013	1178	1330	1371	1585	1764	1759	1708	1666	1641	1662	1689	1724
	Elev.	966	984	989	1012	1030	1030	1025	1020	1018	1020	1023	1026
San Luis	674	768	966	915	784	493	191	20	3	90	254	444	398
	Elev.	527	543	524	491	438	367	309	313	337	376	408	428
Total		7674	8696	9299	9848	9516	8677	7856	7515	7370	7532	7851	8170

Initial Conditions



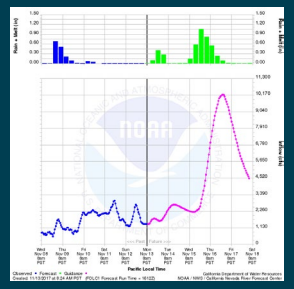


Temperature Performance



Temperature Modeling – Real-Time

Hydrology Forecasts



Short-Term Meteorology Forecasts

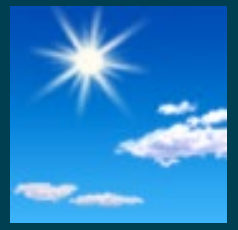
Friday

Mostly Sunny
High: 80 °F

Saturday

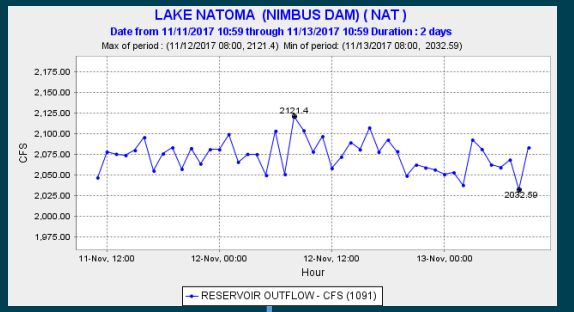
Partly Sunny
High: 72 °F

Sunday

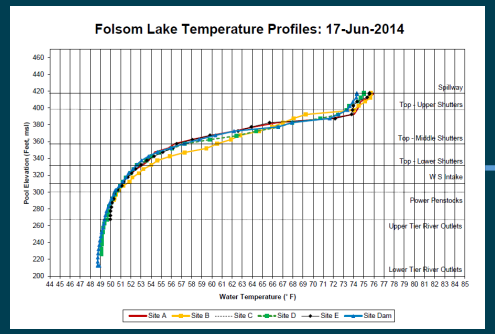


Sunny
High: 88 °F

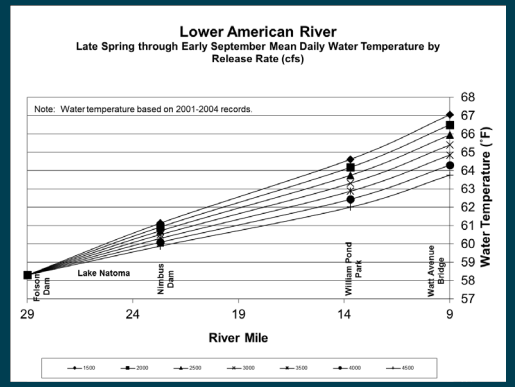
Short-Term Operation



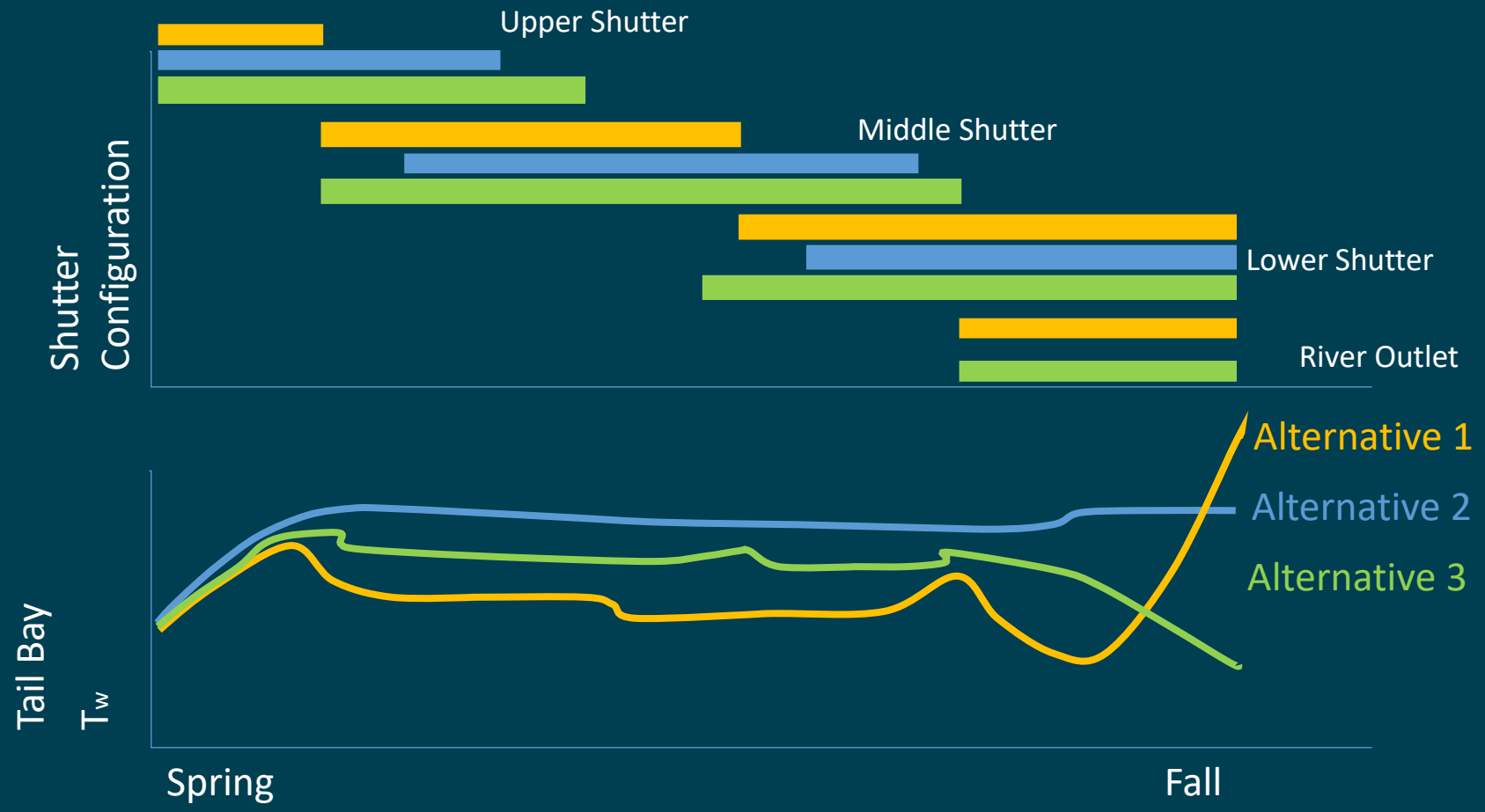
Initial Conditions



Temperature Performance



Operational Tradeoffs

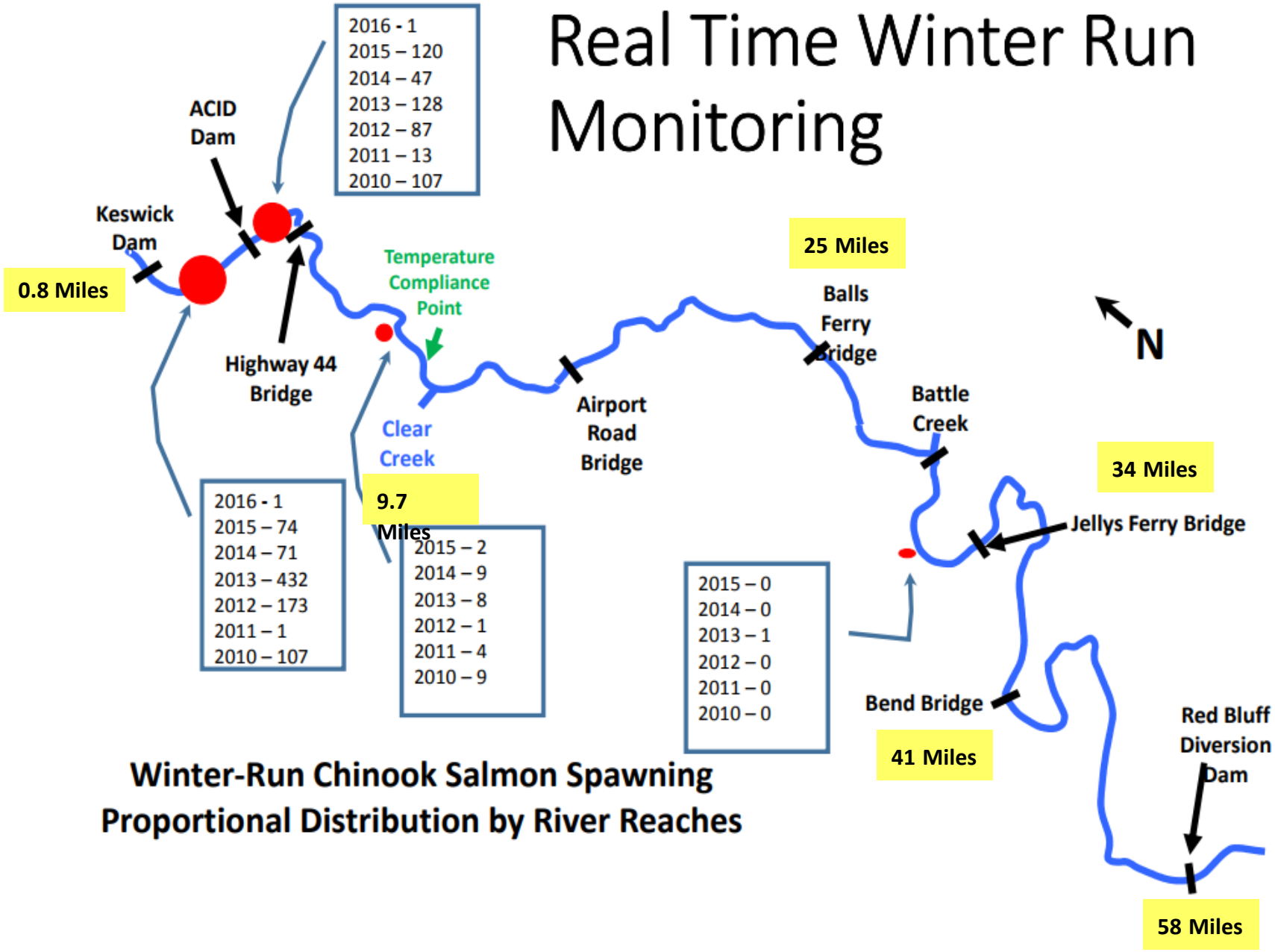


Sacramento River Temperature Compliance

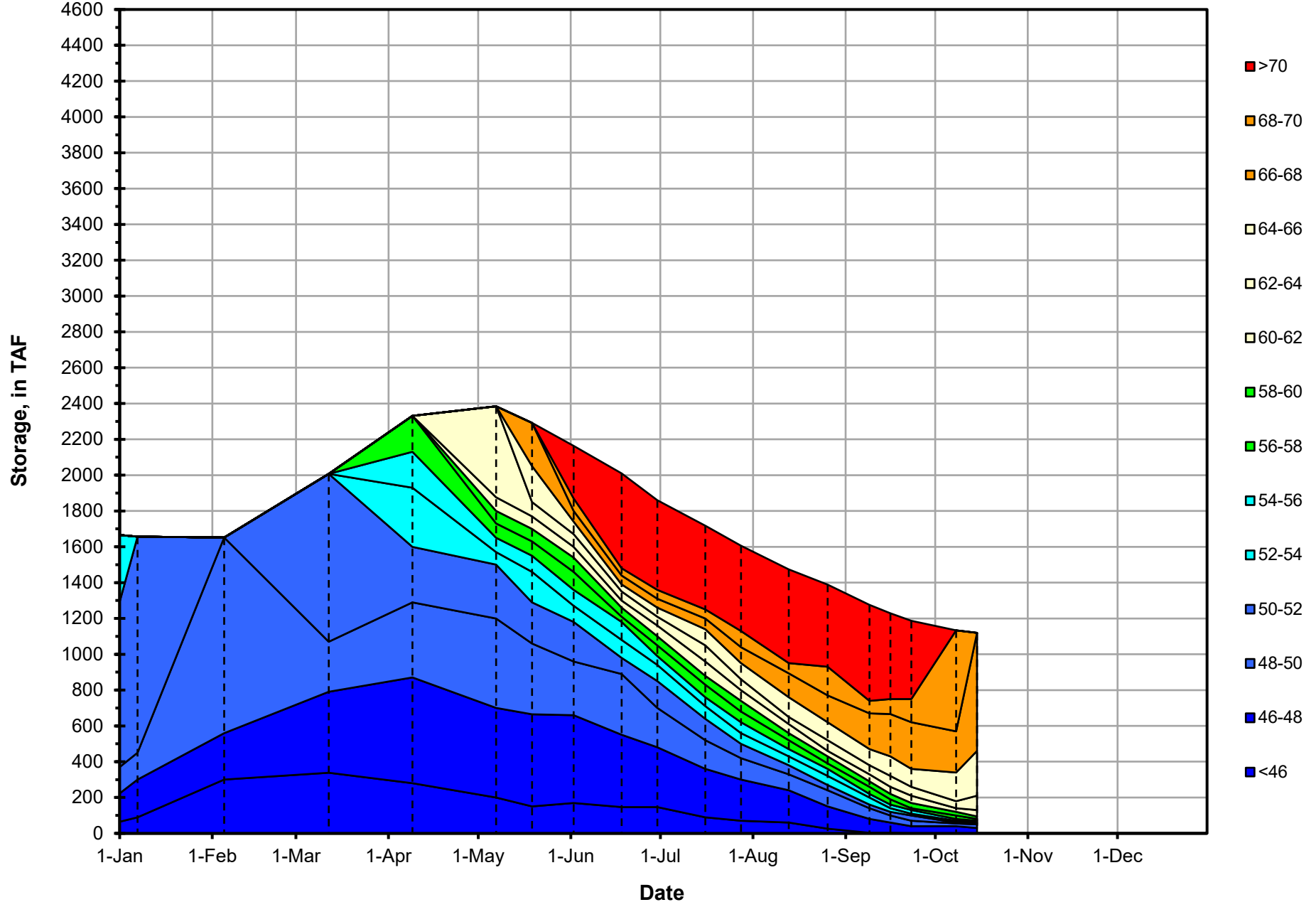
Ideal Temperatures at Variable Locations:

Water Right Order: 56°F

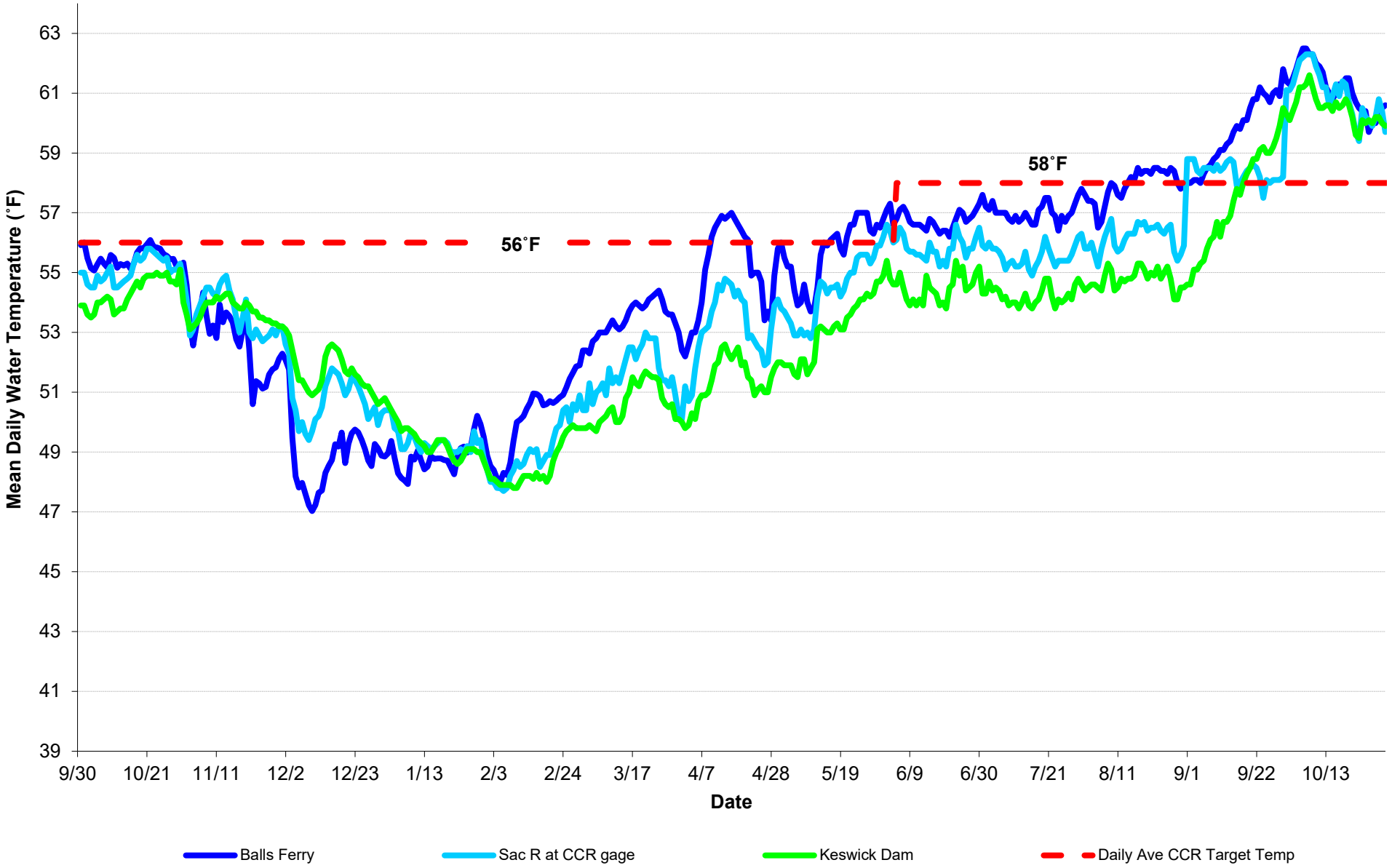
BiOp: 53.5°F - 56 °F

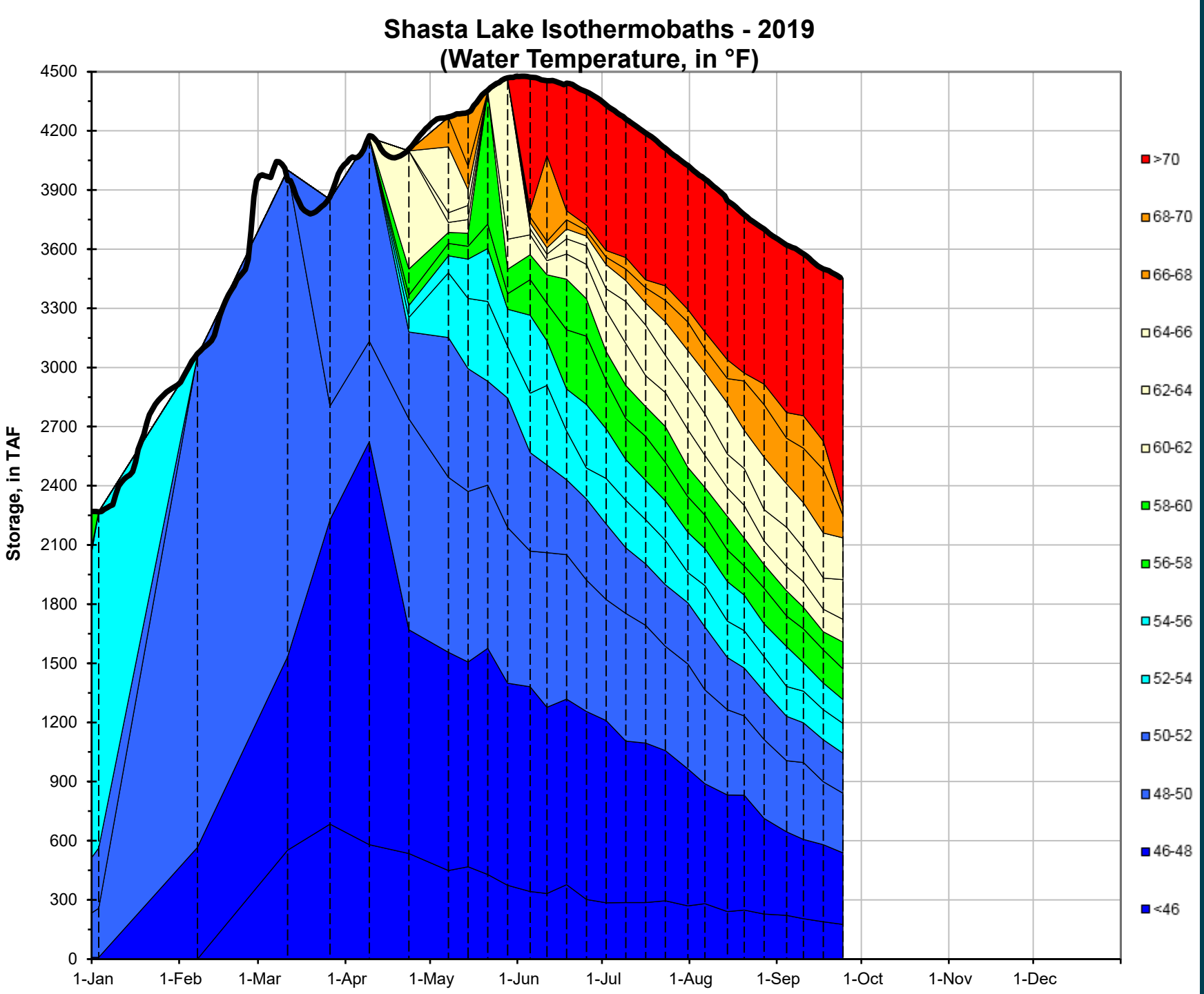


Shasta Lake Isothermobaths - 2014
(Water Temperature, in °F)

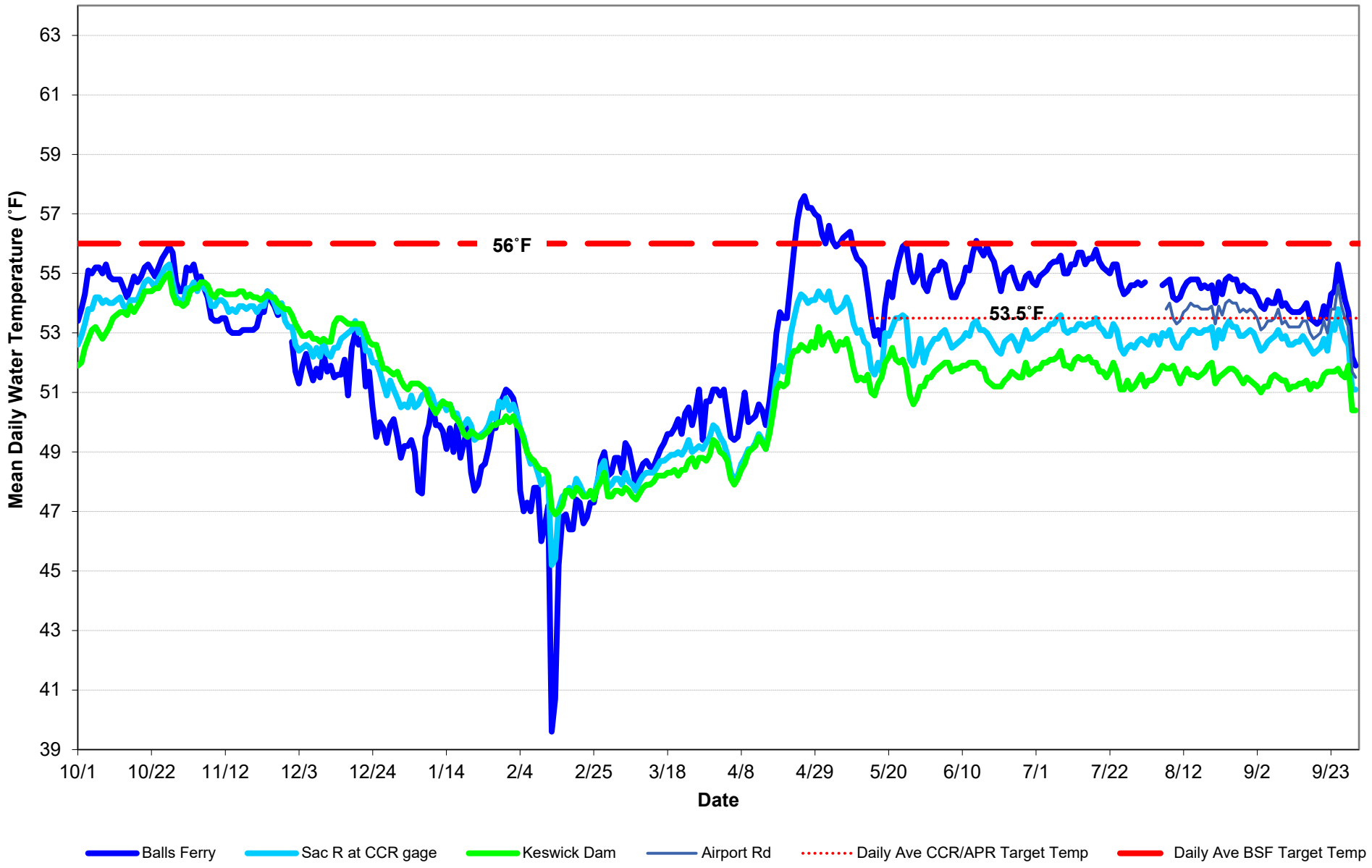


Sacramento River Temperature
WY 2014

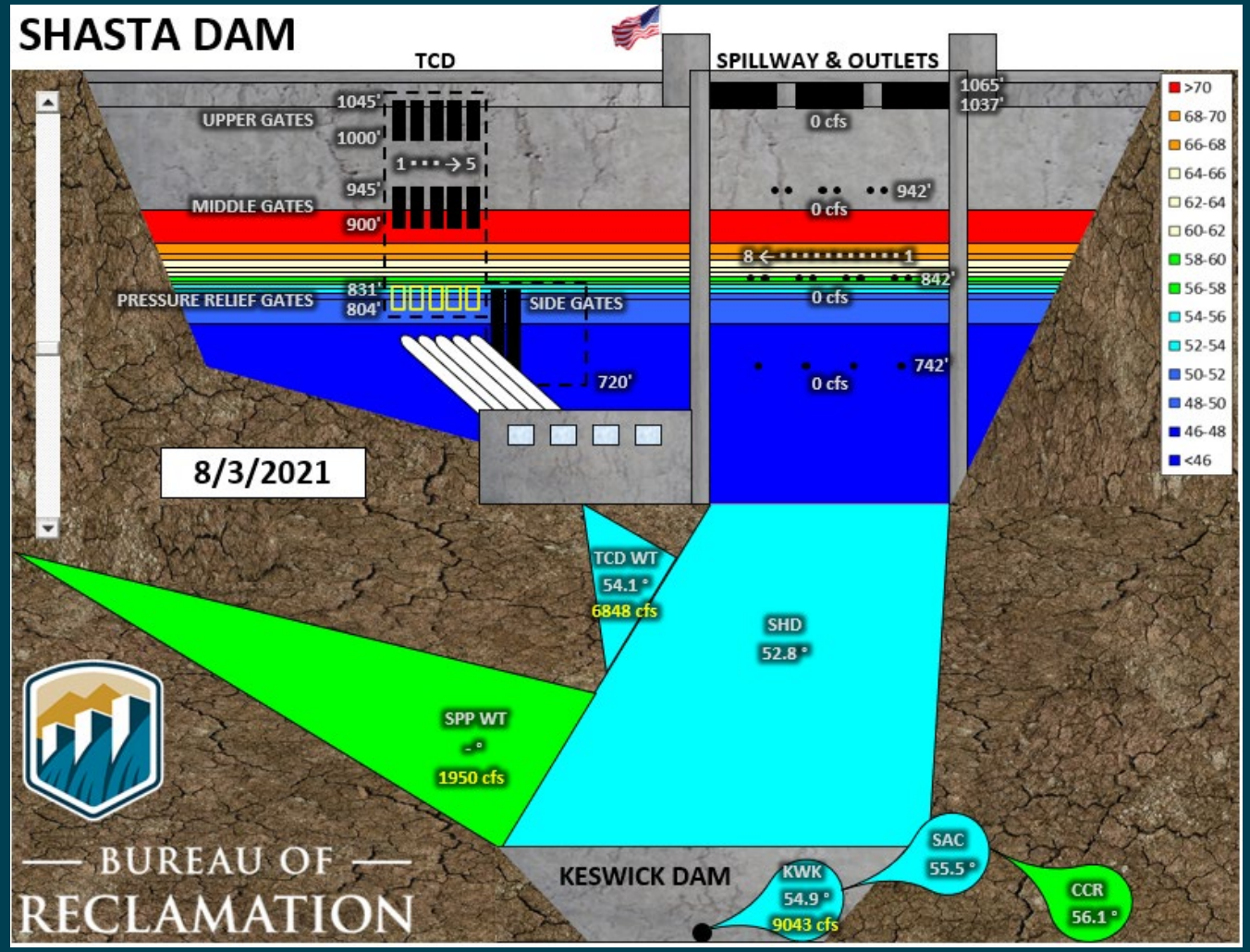



Shasta Lake Isothermobaths - 2019
(Water Temperature, in °F)
Storage, in TAF
4500
4200
3900
3600
3300
3000
2700
2400
2100
1800
1500
1200
900
600
300
0
1-Jan
1-Feb
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
1-Nov
1-Dec
>70
68-70
66-68
64-66
62-64
60-62
58-60
56-58
54-56
52-54
50-52
48-50
46-48
<46

Sacramento River Temperature
WY 2019



Shasta Dam August 2021



American River Temperature Compliance

Target Species:

Central Valley Steelhead (O. mykiss)

Target Life stage:

Over-summering Juvenile

Months:

May 15 – October 31

Ideal Temperature:

65°F Daily Average

American River Temperature Compliance

Target Species:

Fall-run Chinook (O. tshawytscha)

Target Life stage:

Pre-spawning and Spawning

Months:

November

Ideal Temperature:

< 60°F

Folsom Dam July 2015