# OROVILLE DAM CITIZENS ADVISORY COMMISSION

## Hosted by the California Natural Resources Agency

CALIFORNIA natural resources AGENCY

# ITEM 1: WELCOME AND INTRODUCTIONS

# ITEM 2: NOVEMBER MEETING RECAP AND UPDATES

# ITEM 3: U.S. ARMY CORP OF ENGINEERS BRIEFING

# USACE ROLE IN NORTHERN CA FLOOD CONTROL OPERATIONS

**Oroville Dam Citizens Advisory Commission**
**Southside Oroville Community Center**
**Oroville, CA**
**February 21, 2020**

**Joe Forbis, P.E.**
**Chief, Water Management Section**
**Sacramento District, U.S. Army Corps of Engineers**

*"The views, opinions and findings contained in this report are those of the authors(s) and should not be construed as an official Department of the Army position, policy or decision, unless so designated by other official documentation."*

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# AGENDA

- USACE Sacramento District Overview
- Authorities, Roles, and Responsibilities
- Water Control Manuals – Folsom Example
- Pilot Project - FIRO

*Spillway Fuse Gates at Terminus Dam*

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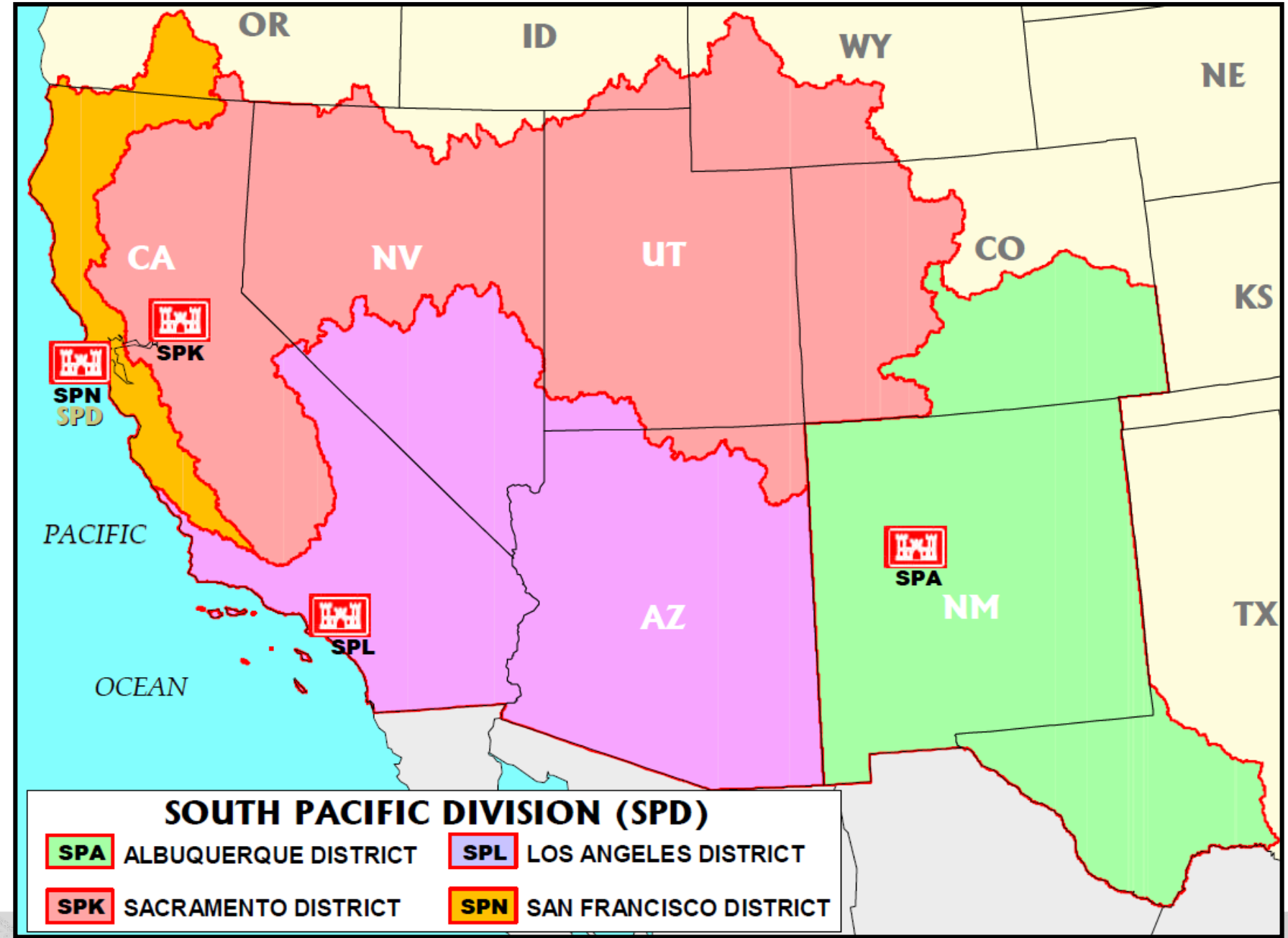
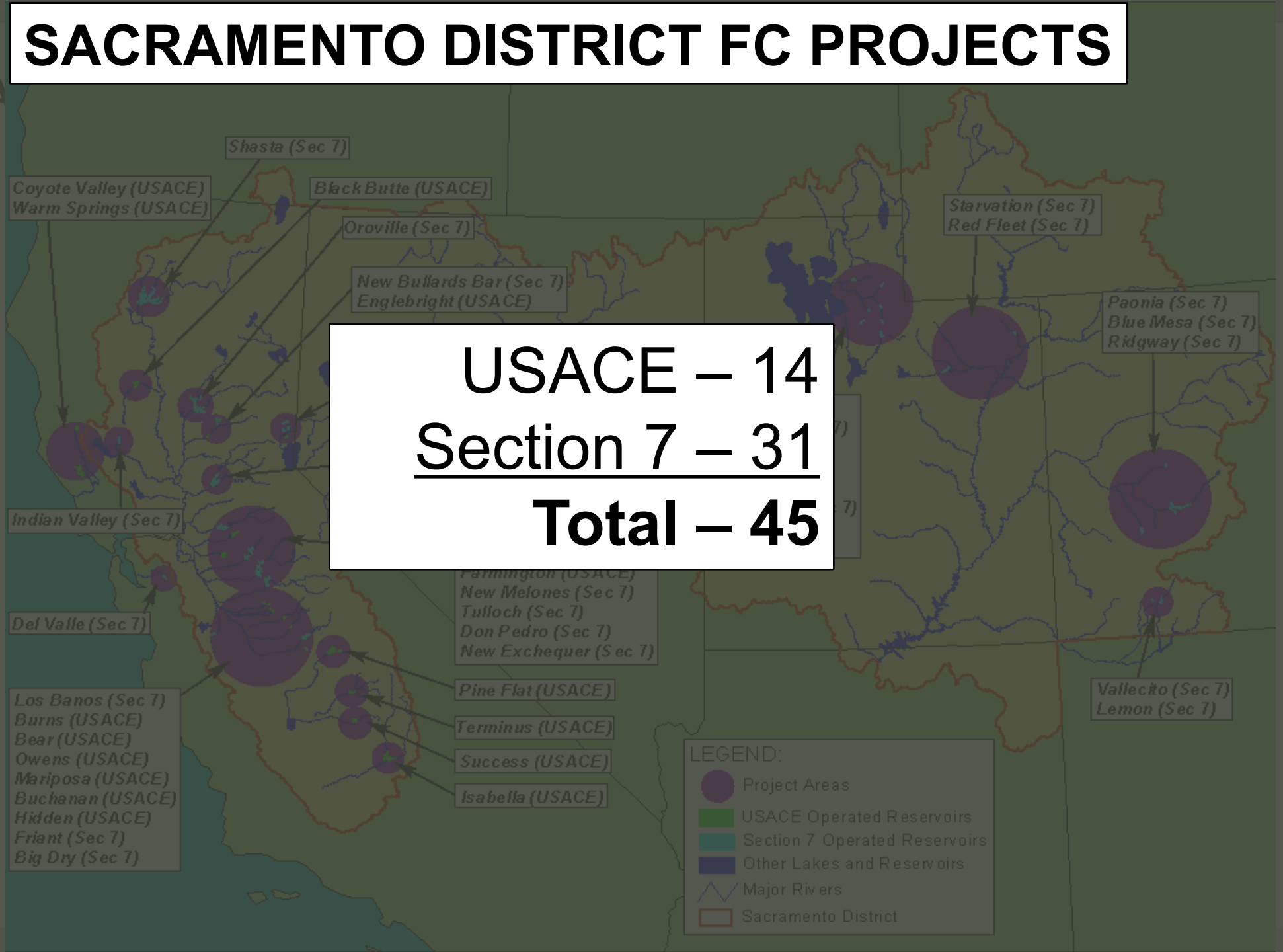
# SOUTH PACIFIC DIVISION



# SACRAMENTO DISTRICT FC PROJECTS

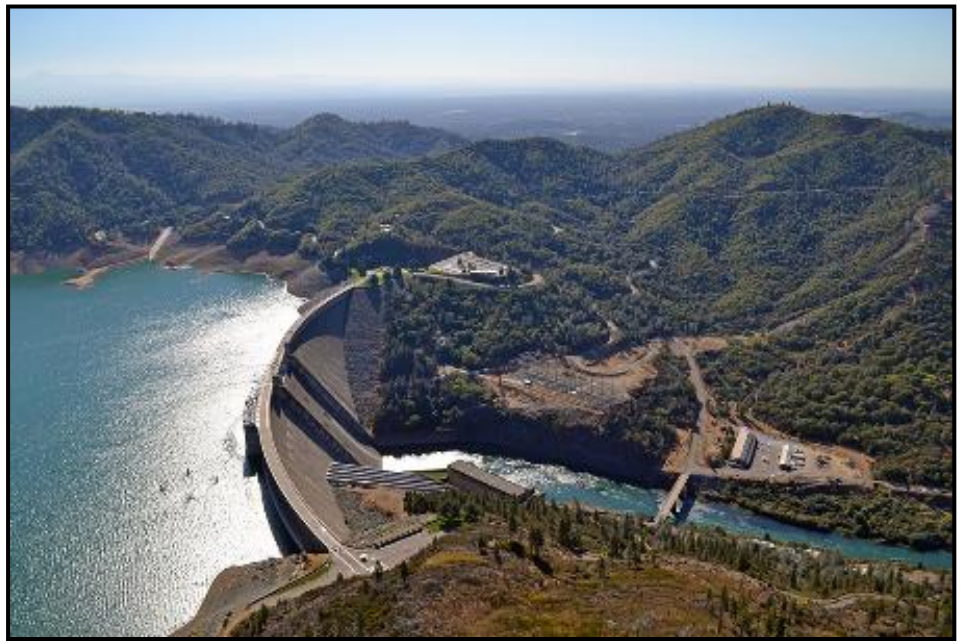



USACE – 14

Section 7 – 31

**Total – 45**

# SPK RESERVOIR EXAMPLES



Largest Reservoir
Shasta Dam and Lake
4,500,000 acre-feet

Smallest Reservoir
Mountain Dell Dam and Reservoir
3,200 acre-feet

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# FLOOD OPS PARTNERS

- Irrigation Districts
  - Stockton East Water District
- Flood Control Districts
  - Fresno Metro Flood Control District
- Federal Water Masters
  - Truckee River Basin Reservoirs
- Water Storage Districts
  - Tulare Lakebed
- Government Agencies
  - DWR
  - USBR

*Black Butte Dam*

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# USACE AUTHORITY FOR FLOOD OPS

- Section 7 of the Flood Control Act of 1944 (58 Stat. 890, 33 U.S.C. 709)
- Prescribe flood control rules and regulations for all reservoirs where:
  - Flood control is an authorized purpose
  - Reservoir was constructed using Federal funds



of the electric facilities of the projects) of the cost of producing and transmitting such electric energy, including the amortization of the capital investment allocated to power over a reasonable period of years. Preference in the sale of such power and energy shall be given to public bodies and cooperatives. The Secretary of the Interior is authorized, from funds to be appropriated by the Congress, to construct or acquire, by purchase or other agreement, only such transmission lines and related facilities as may be necessary in order to make the power and energy generated at said projects available in wholesale quantities for sale on fair and reasonable terms and conditions to facilities owned by the Federal Government, public bodies, cooperatives, and privately owned companies. All moneys received from such sales shall be deposited in the Treasury of the United States as miscellaneous receipts.

SEC. 6. That the Secretary of War is authorized to make contracts with States, municipalities, private concerns, or individuals, at such prices and on such terms as he may deem reasonable, for domestic and industrial uses for surplus water that may be available at any reservoir under the control of the War Department: Provided, That no contracts for such water shall adversely affect then existing lawful uses of such water. All moneys received from such contracts shall be deposited in the Treasury of the United States as miscellaneous receipts.

SEC. 7. Hereafter, it shall be the duty of the Secretary of War to prescribe regulations for the use of storage allocated for flood control or navigation at all reservoirs constructed wholly or in part with Federal funds provided on the basis of such purposes, and the operation of any such project shall be in accordance with such regulations: Provided, That this section shall not apply to the Tennessee Valley Authority, except that in case of danger from floods on the Lower Ohio and Mississippi Rivers the Tennessee Valley Authority is directed to regulate the release of water from the Tennessee River into the Ohio River in accordance with such instructions as may be issued by the War Department.

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# OROVILLE – FLOOD SPACE ALLOCATION

2. AUTHORIZATION FOR FLOOD CONTROL ALLOCATION

a. A monetary contribution by the Federal Government toward the construction cost of Oroville Dam and Reservoir in the interest of flood control was authorized by the Flood Control Act of 1958 (Public Law 85-500, 3 July 1958, 85th Congress, 2nd Session). Based on the flood control benefits to be derived, 22 percent of the construction cost of the dam and reservoir, exclusive of power and recreational facilities, was allocated to flood control with total sum not to exceed $85 million. The cost allocation was approved by the President on 10 January 1962.

- Contract between US Gov't (USACE) and State of California (DWR)
- Executed March 1962
- Among terms of contract, reserves up to 750,000 ac-ft of storage space for flood control

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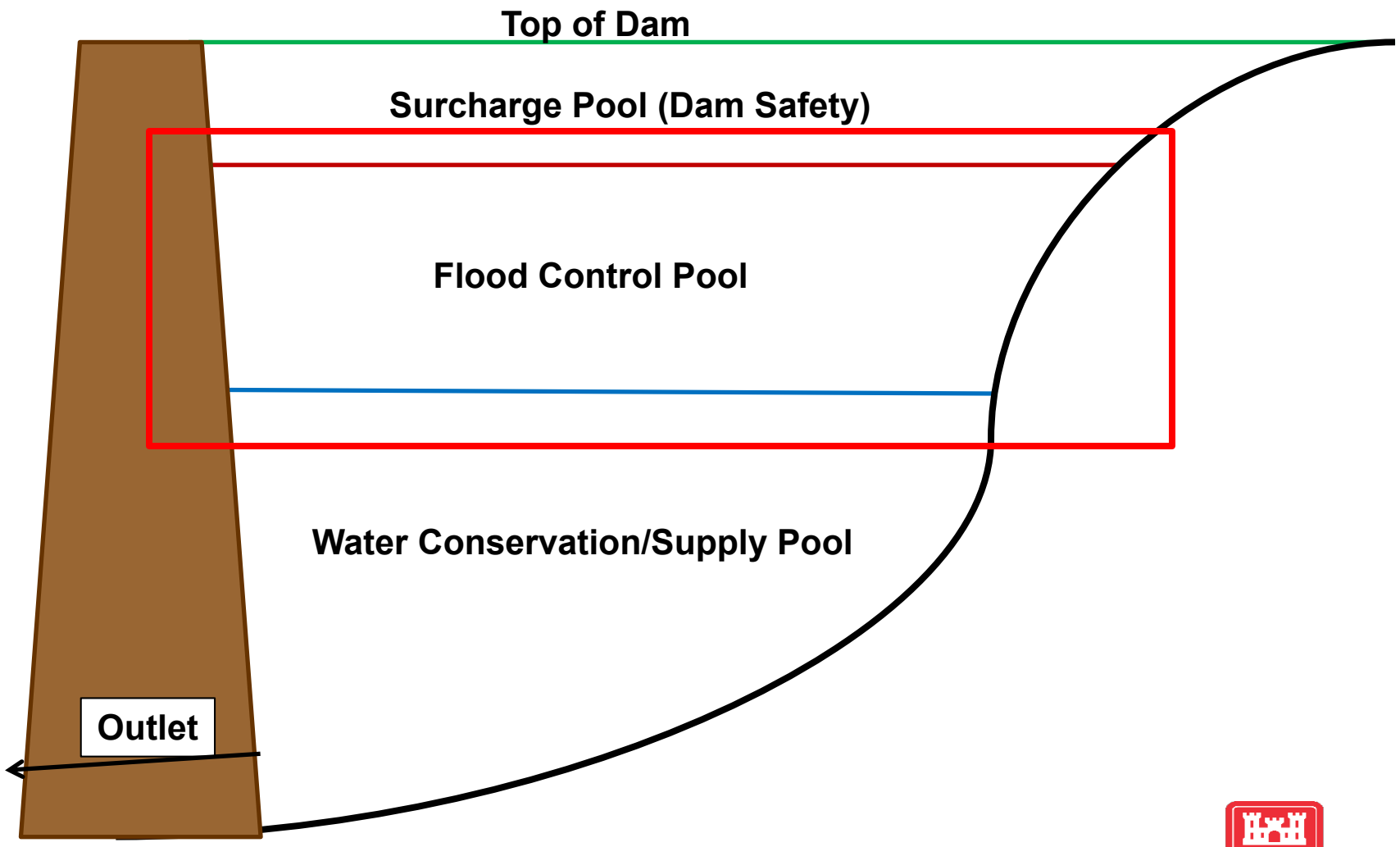


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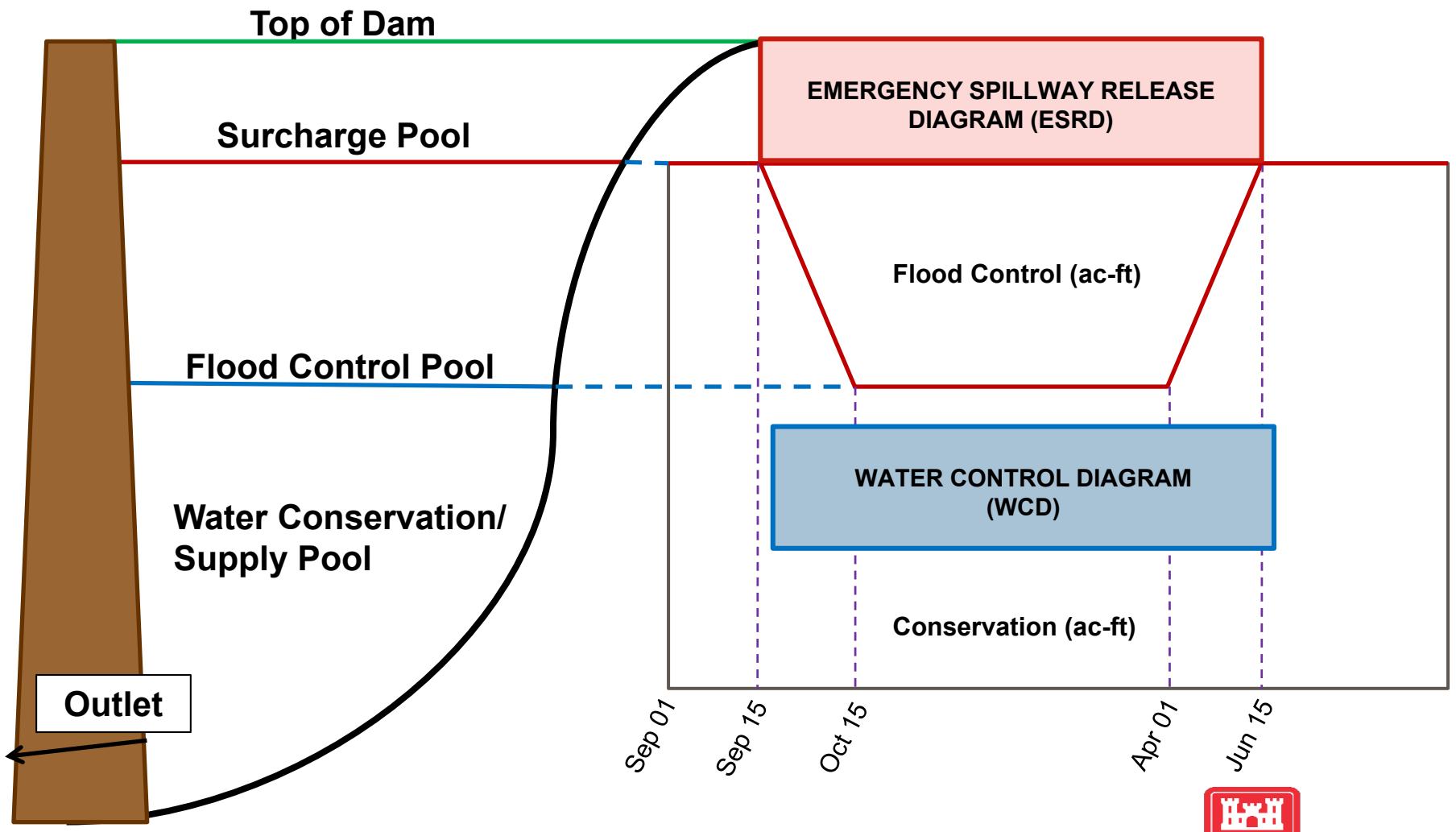
# RESERVOIR TO WCD/ESRD

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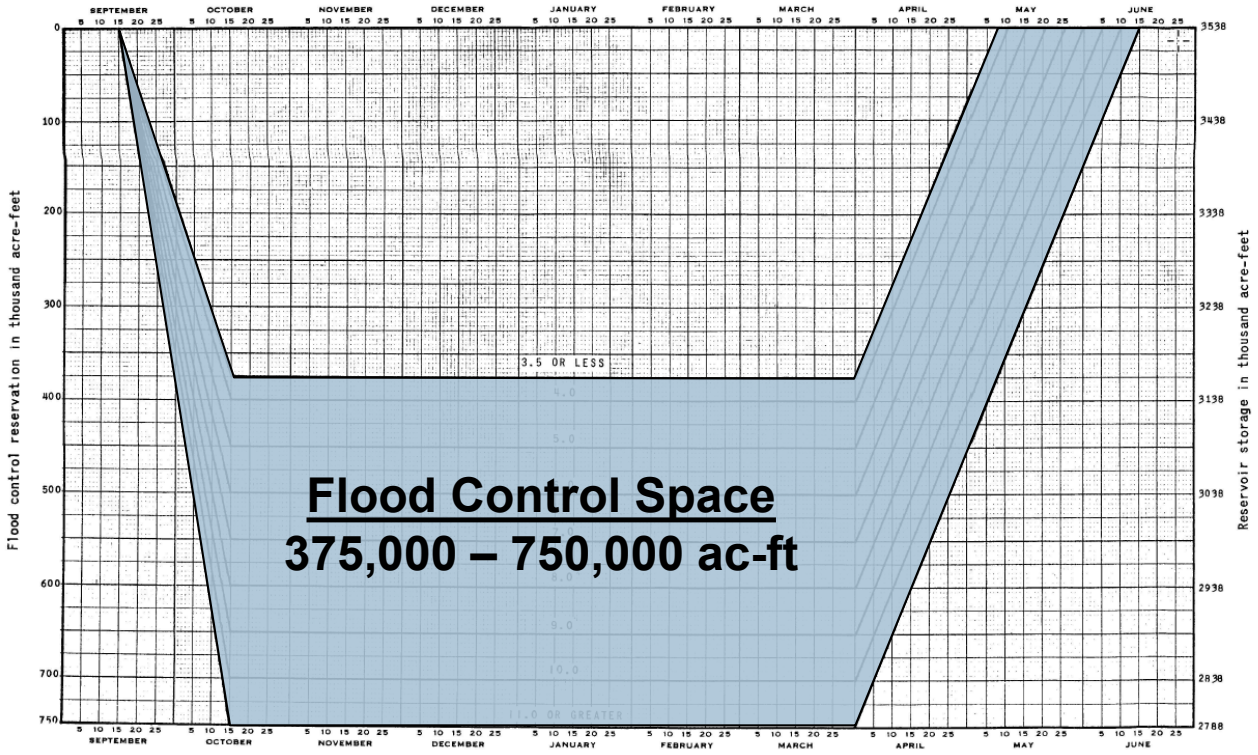
# OROVILLE – WCD




USE OF DIAGRAM

1. Parameters are computed daily from the weighted accumulation of seasonal basin mean precipitation by multiplying the preceding day's parameter by 0.97 and adding the current day's precipitation in inches.

2. Except when releases are governed by the emergency spillway release diagram currently in force (File No. 4-13-586), water stored in the flood control reservation, defined hereon, shall be released as rapidly as possible, subject to the following conditions:

   a. That releases are made according to the release schedule hereon.

   b. That flows in Feather River above Yuba River do not exceed 180,000 c.f.s.

   c. That flows in Feather River below Yuba River do not exceed 300,000 c.f.s.

   d. That flows in Feather River below Bear River do not exceed 320,000 c.f.s. insofar as possible.

   e. That releases are not increased more than 10,000 c.f.s. or decreased more than 5,000 c.f.s. in any 2 hour period.

RELEASE SCHEDULE

| ACTUAL OR FORECAST INFLOW (WHICHEVER IS GREATER) | FLOOD CONTROL SPACE USED | REQUIRED RELEASES |
|---|---|---|
| c.f.s. | ac-ft | c.f.s. |
| 0 - 15,000 | 0 - 5,000 | Power Demand |
| 0 - 15,000 | Greater Than 5,000 | Inflow |
| 15,000 - 30,000 | 0 - 30,000 | Lesser of 15,000 or maximum inflow |
| 0 - 30,000 | Greater Than 30,000 | Maximum inflow for flood |
| 30,000 - 120,000 | - - - - - - - - | Lesser of maximum inflow or 60,000 c.f.s. |
| 120,000 - 175,000 | - - - - - - - - | Lesser of maximum inflow or 100,000 c.f.s. |
| Greater Than - 175,000 | - - - - - - - - | Lesser of maximum inflow or 150,000 c.f.s. |

OROVILLE DAM AND RESERVOIR
FEATHER RIVER, CALIFORNIA

FLOOD CONTROL DIAGRAM

Prepared Pursuant to Flood Control Regulations
For Oroville Dam and Reservoir

APPROVED: F P Koisch
Major General, USA, Director of Civil Works

APPROVED: [illegible]
Director, Department of Water Resources

Effective Date: [illegible] File No.: 4-13-585

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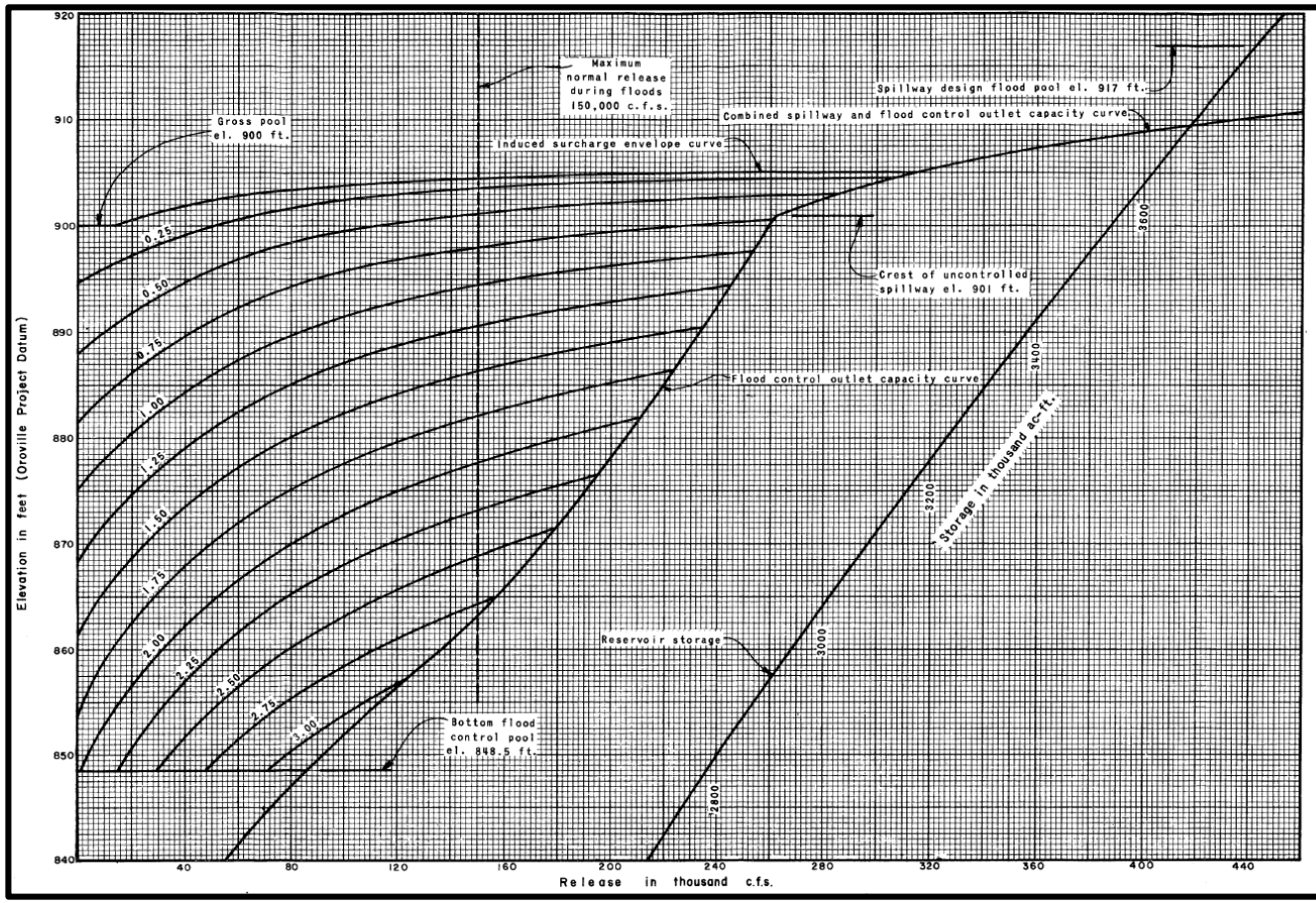
# OROVILLE – ESRD




OPERATING INSTRUCTIONS

1. Follow regular flood control regulation schedule until larger releases are required by this schedule.
2. Adjust the spillway outflow each hour on the basis of the rate of rise of reservoir elevation in feet for the preceding hour and the current reservoir elevation as indicated by the curves.
3. After the reservoir elevation starts to fall, maintain current gate openings until the flow has been reduced to 150,000 c.f.s.
4. Once operation in accordance with the emergency spillway release diagram is initiated, gate changes shall be made only in accordance with the above criteria.

NOTES:

1. Parameter values are the rate of rise in reservoir elevation in feet during preceding hour.
2. Sill of the flood control outlet is at elevation 813.6 feet. Ungated spillway crest is at elevation 901 feet.
3. Discharge through the flood control outlet is controlled by eight 17.6' x 33.0' gates with an additional 1730 feet of uncontrolled spillway above elevation 901 feet.

OROVILLE DAM AND RESERVOIR
Feather River, California

EMERGENCY SPILLWAY RELEASE DIAGRAM
Prepared Pursuant to Flood Control Regulations
for Oroville Dam and Reservoir

APPROVED: L P Koisch
Major General, U.S.A., Director of Civil Works

APPROVED: W H Gianelli
Director, Department of Water Resources

Effective Date: 13 Sep 71 File No: 4-13-586

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# WATER MANAGEMENT ACTIVITIES

- Oversee flood operations
- Establish operating rules for flood control
- Update water control manuals
- Aid in re-operation studies
- Train dam operators
- Assist with planning studies
  - New projects
  - Modification of existing projects
- Assist with dam safety studies
- Prepare deviation packages

*New Exchequer Dam/ Lake McClure*

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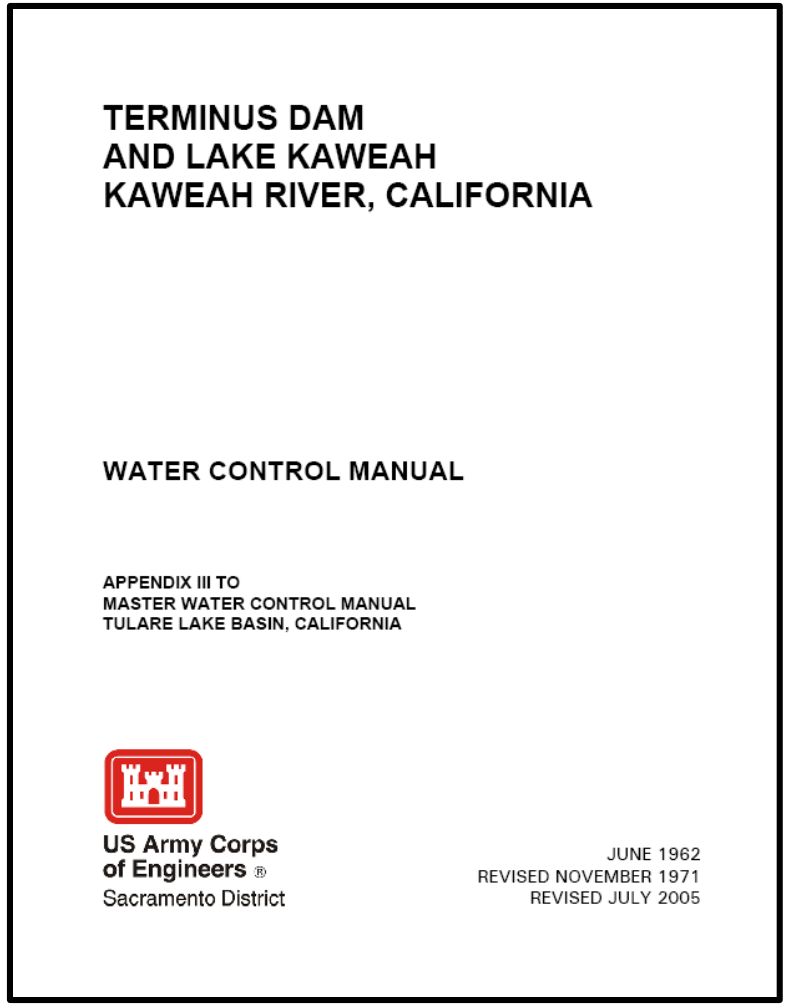
# WATER CONTROL MANUALS



TERMINUS DAM
AND LAKE KAWEAH
KAWEAH RIVER, CALIFORNIA

WATER CONTROL MANUAL

APPENDIX III TO
MASTER WATER CONTROL MANUAL
TULARE LAKE BASIN, CALIFORNIA

US Army Corps
of Engineers ®
Sacramento District

JUNE 1962
REVISED NOVEMBER 1971
REVISED JULY 2005

Provides guidance and instruction for project personnel

Includes info related to all water management activities such as:

- Description of physical components
- Operating procedures
- Historical facts
- Other pertinent data

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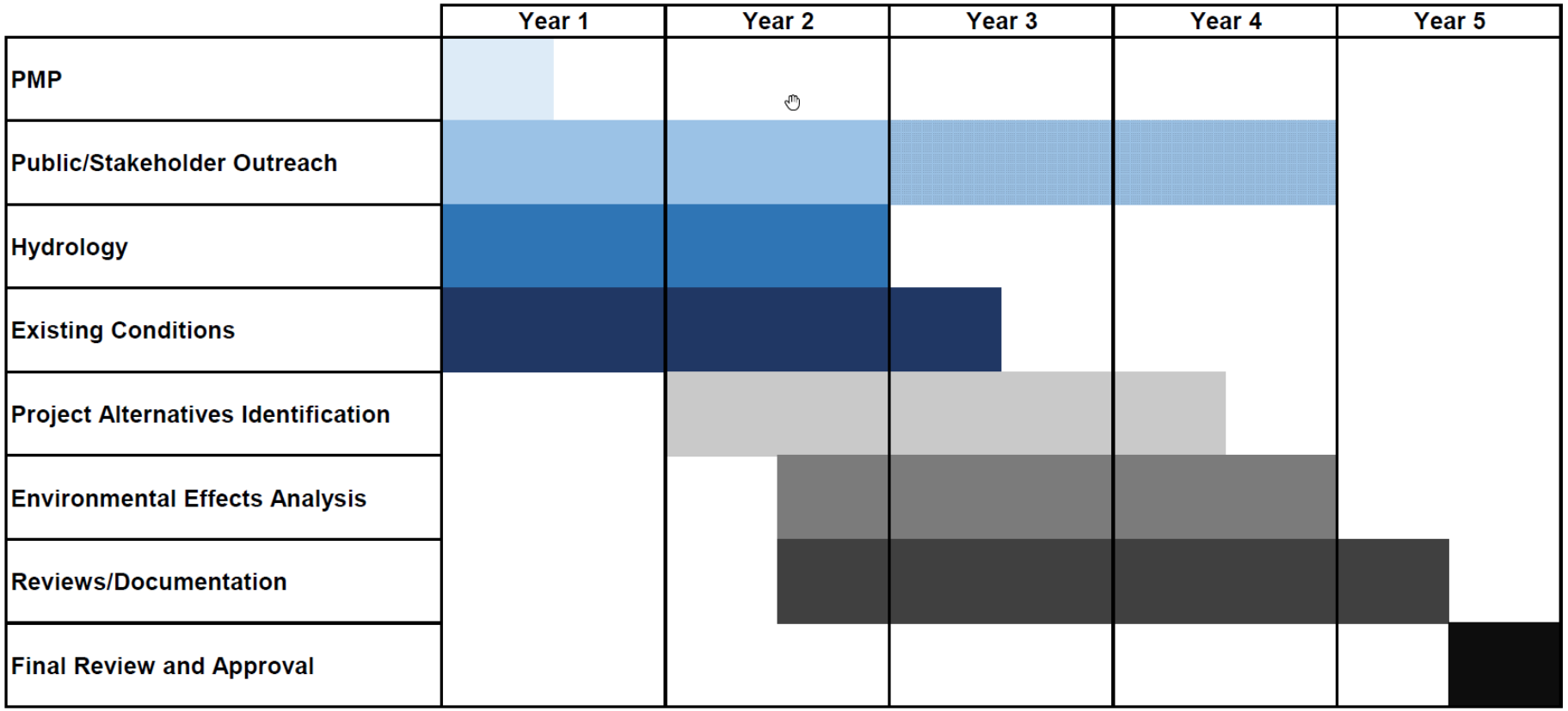
# SIMPLIFIED WCM UPDATE PROCESS

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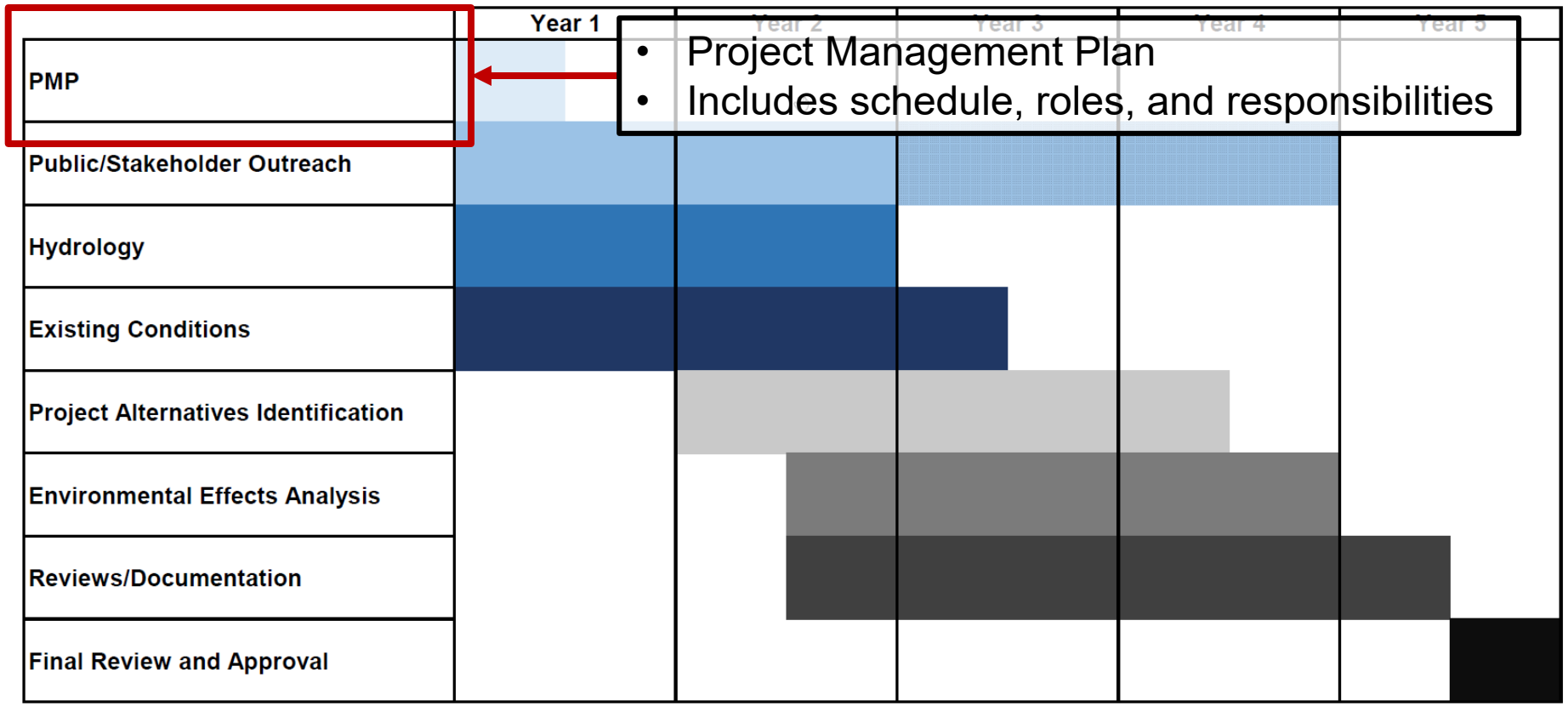
# SIMPLIFIED WCM UPDATE PROCESS




- Project Management Plan
- Includes schedule, roles, and responsibilities

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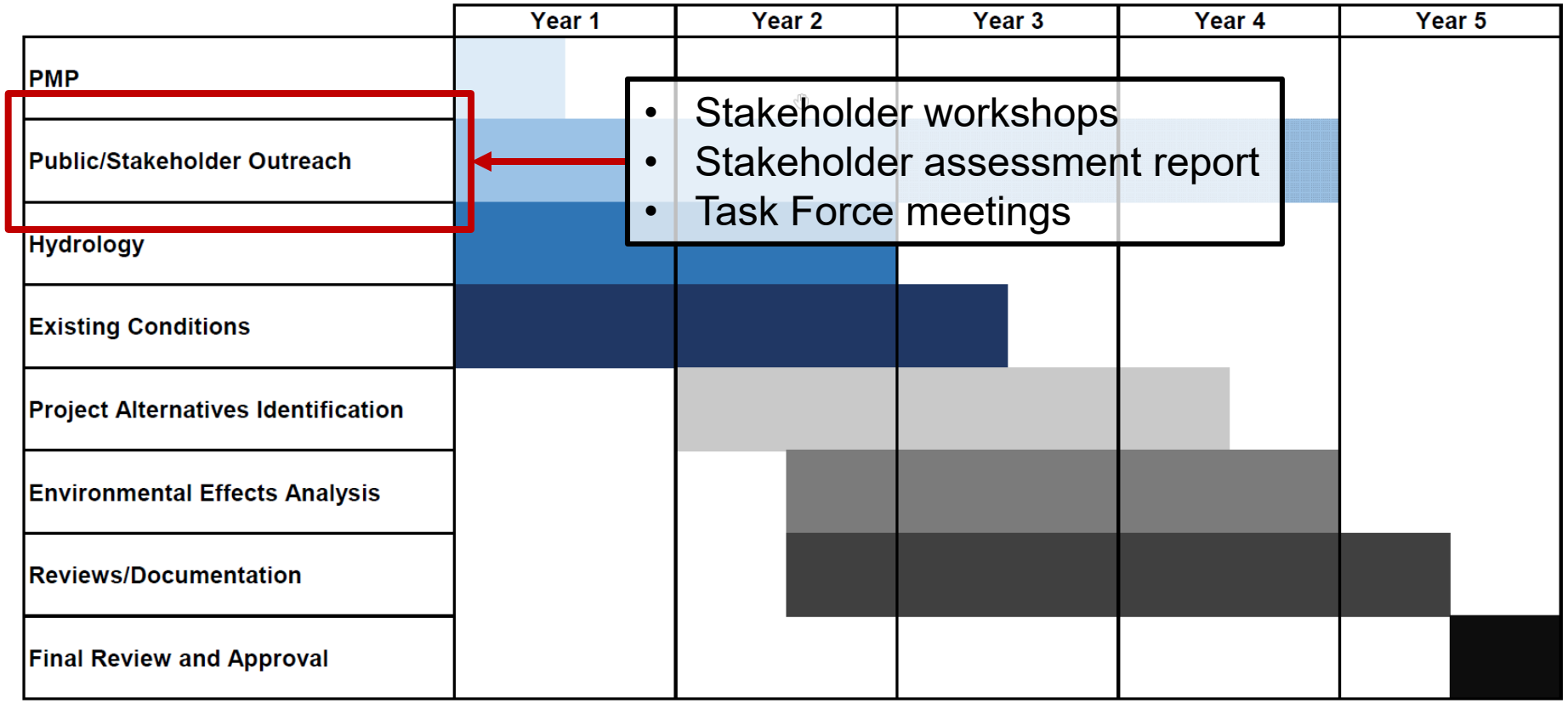
# SIMPLIFIED WCM UPDATE PROCESS

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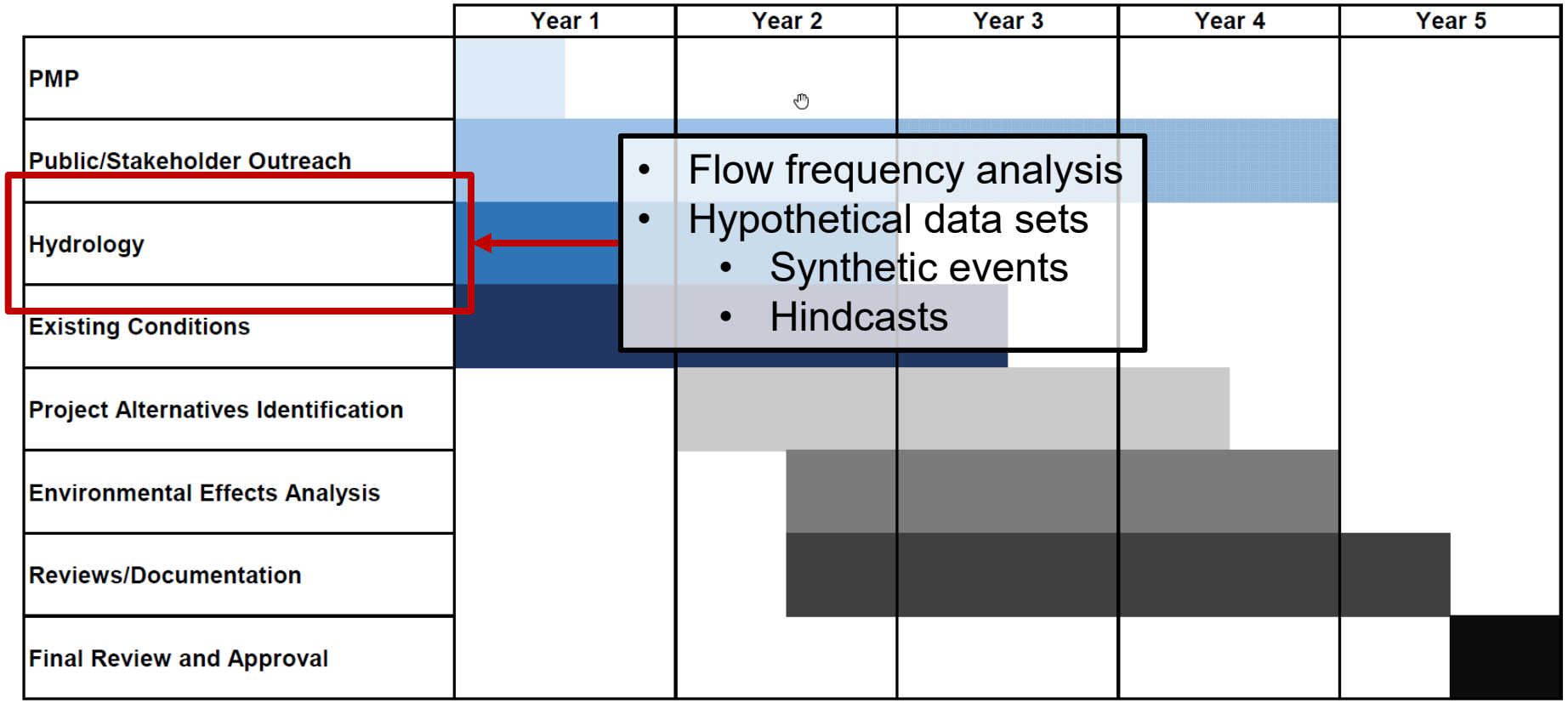


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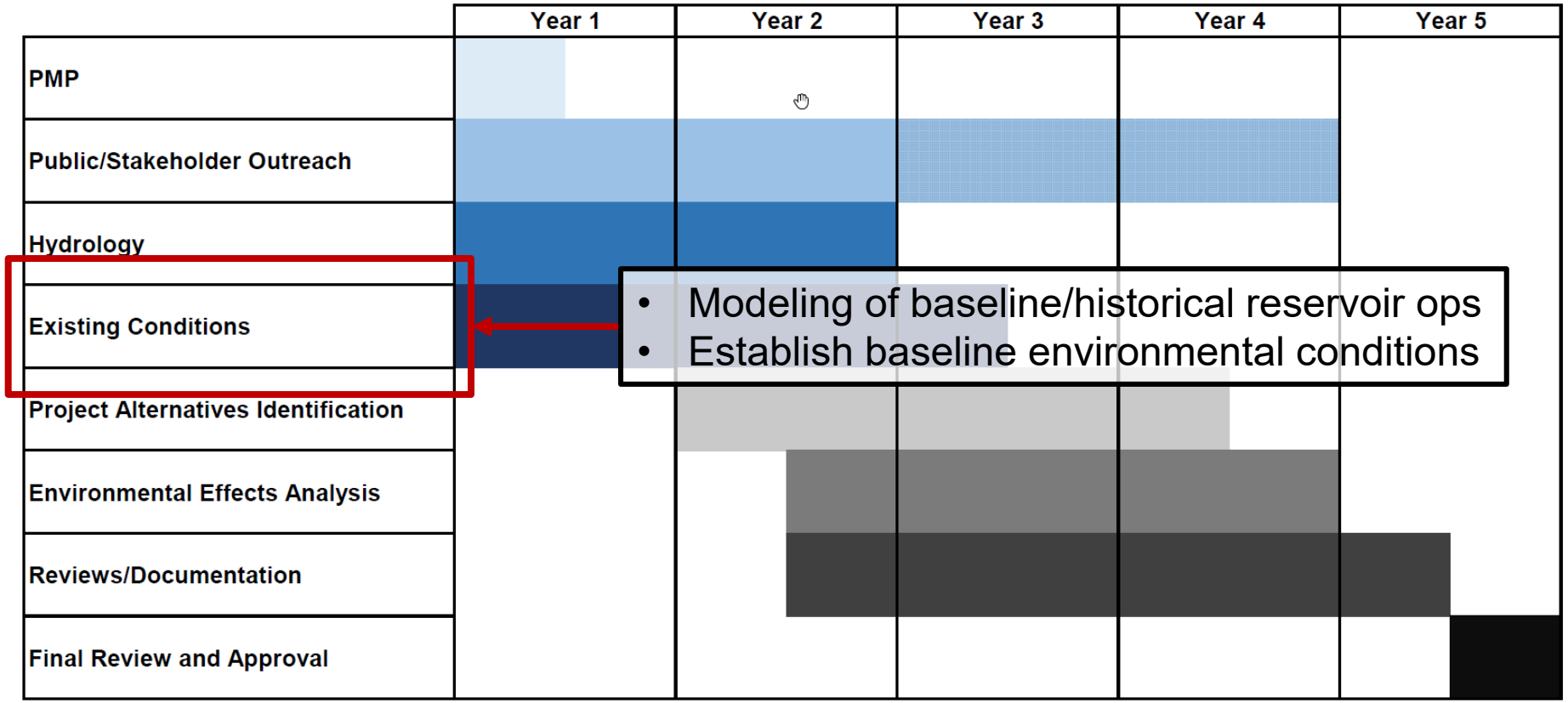


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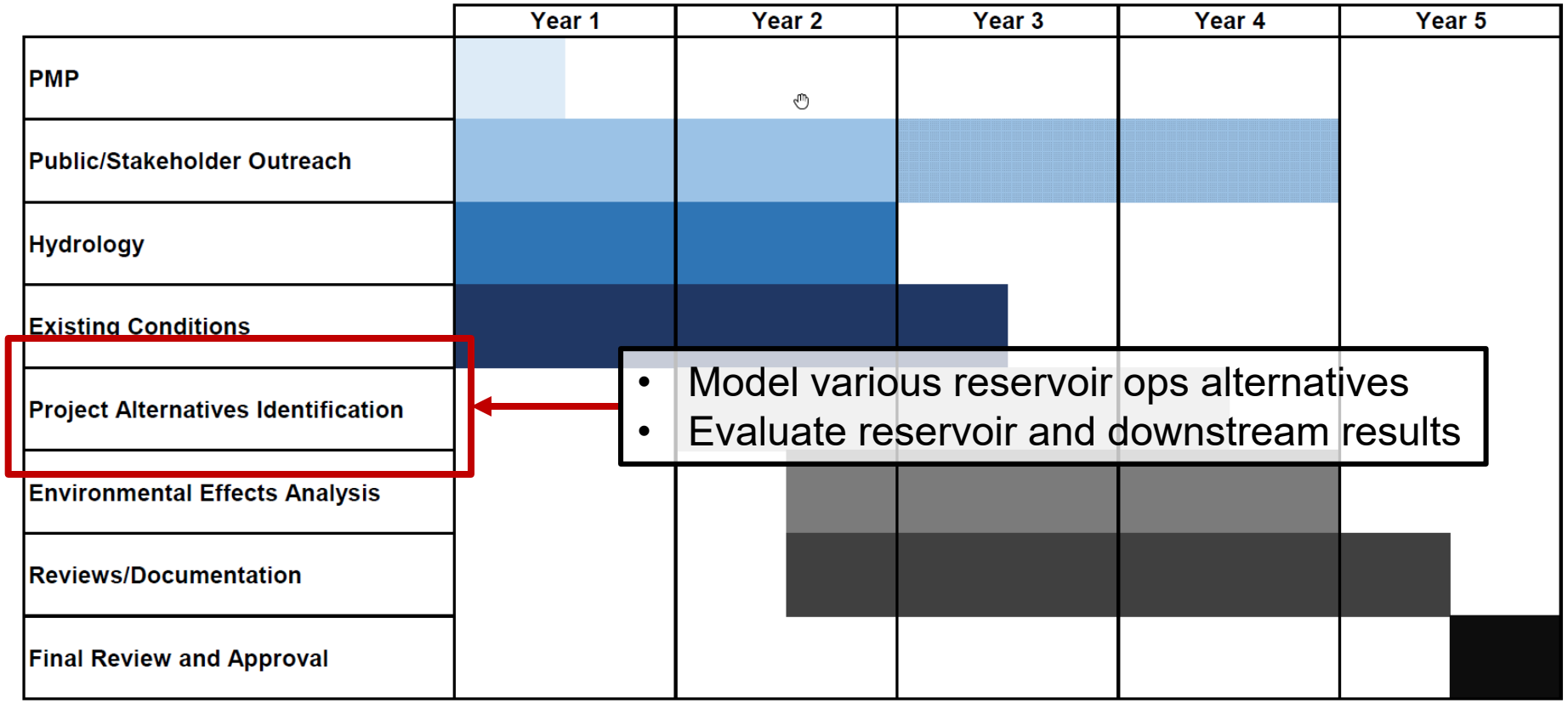


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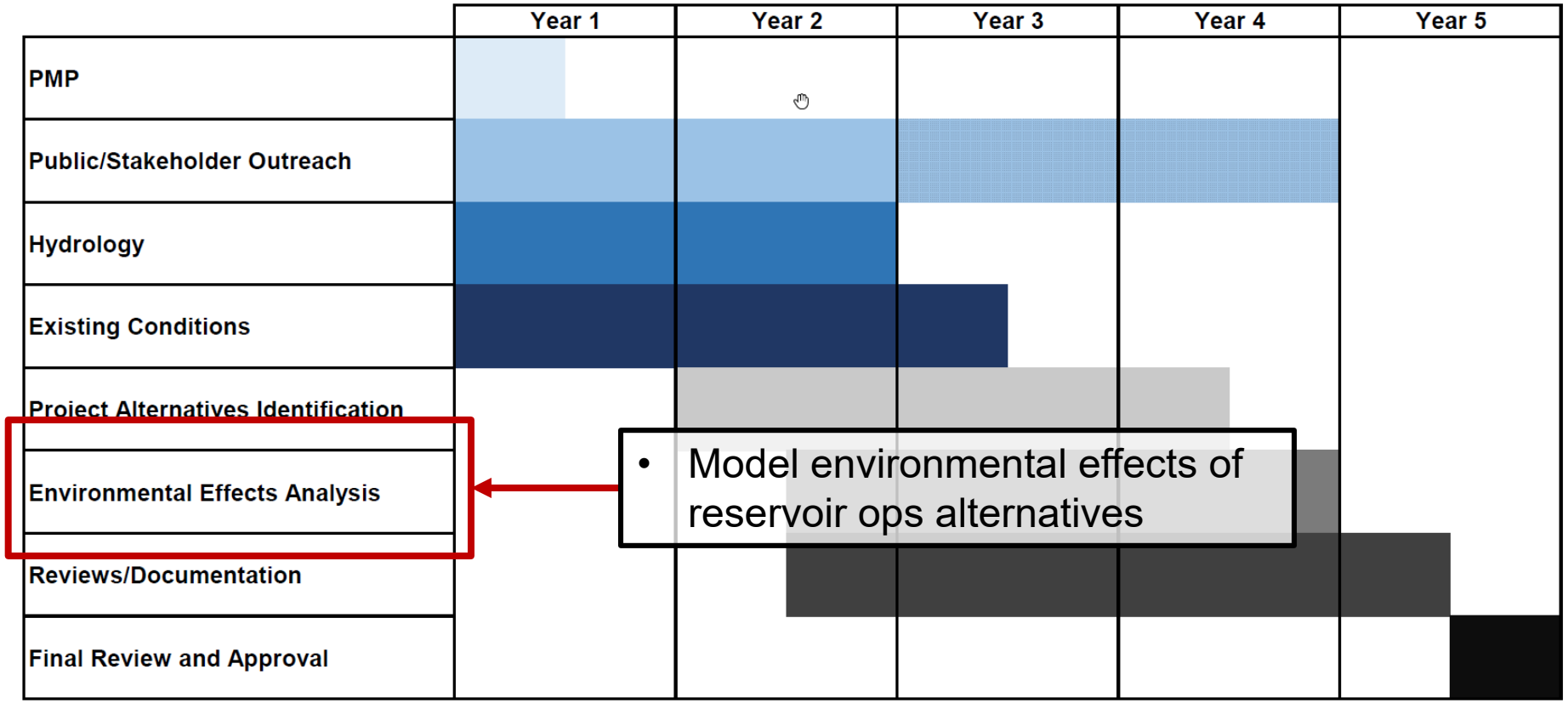
# SIMPLIFIED WCM UPDATE PROCESS




- Model environmental effects of reservoir ops alternatives

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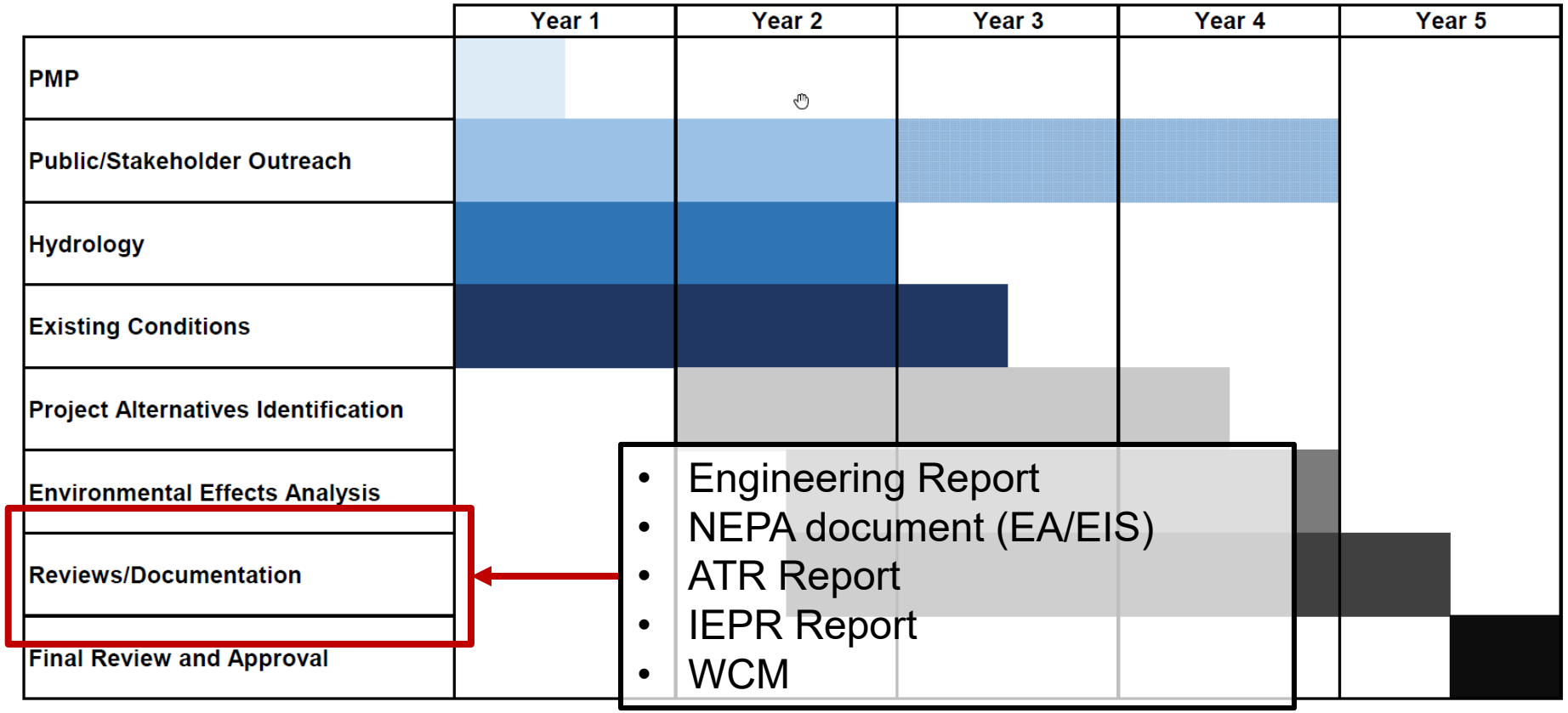
# SIMPLIFIED WCM UPDATE PROCESS

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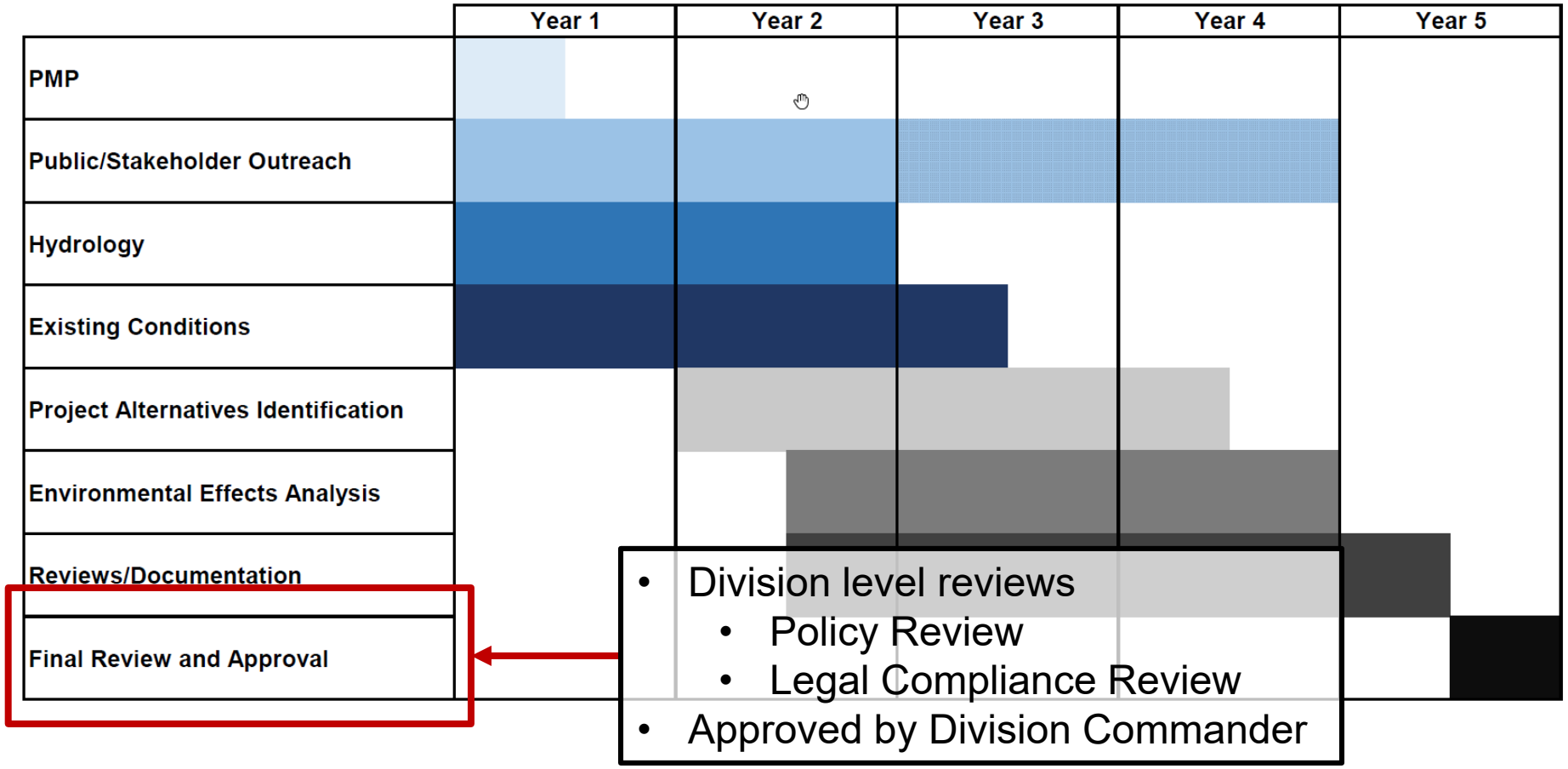
# SIMPLIFIED WCM UPDATE PROCESS

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# HOW WCM PROCESS CAN BE EXPEDITED

- Items that will show progress or (potentially) be complete prior to when WCM update process would normally start:
  - Hydrology
  - Existing conditions
  - Project alternatives identification

- USACE will receive $4M to update WCMs for ORO and NBB

> The Committee recommends not less than $4,000,000 of the additional funds recommended in the Scheduling of Reservoir Operations line be for a water control manual update for a non-Corps owned high hazard dam where: (1) the Corps has a responsibility for flood control operations under section 7 of the Flood Control Act of 1944; (2) the dam requires coordination of water releases with one or more other high-hazard dams for flood control purposes; and (3) the dam owner is actively investigating the feasibility of applying forecast informed reservoir operations technology. Of the addi-

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# WCM UPDATE CASE STUDY – FOLSOM

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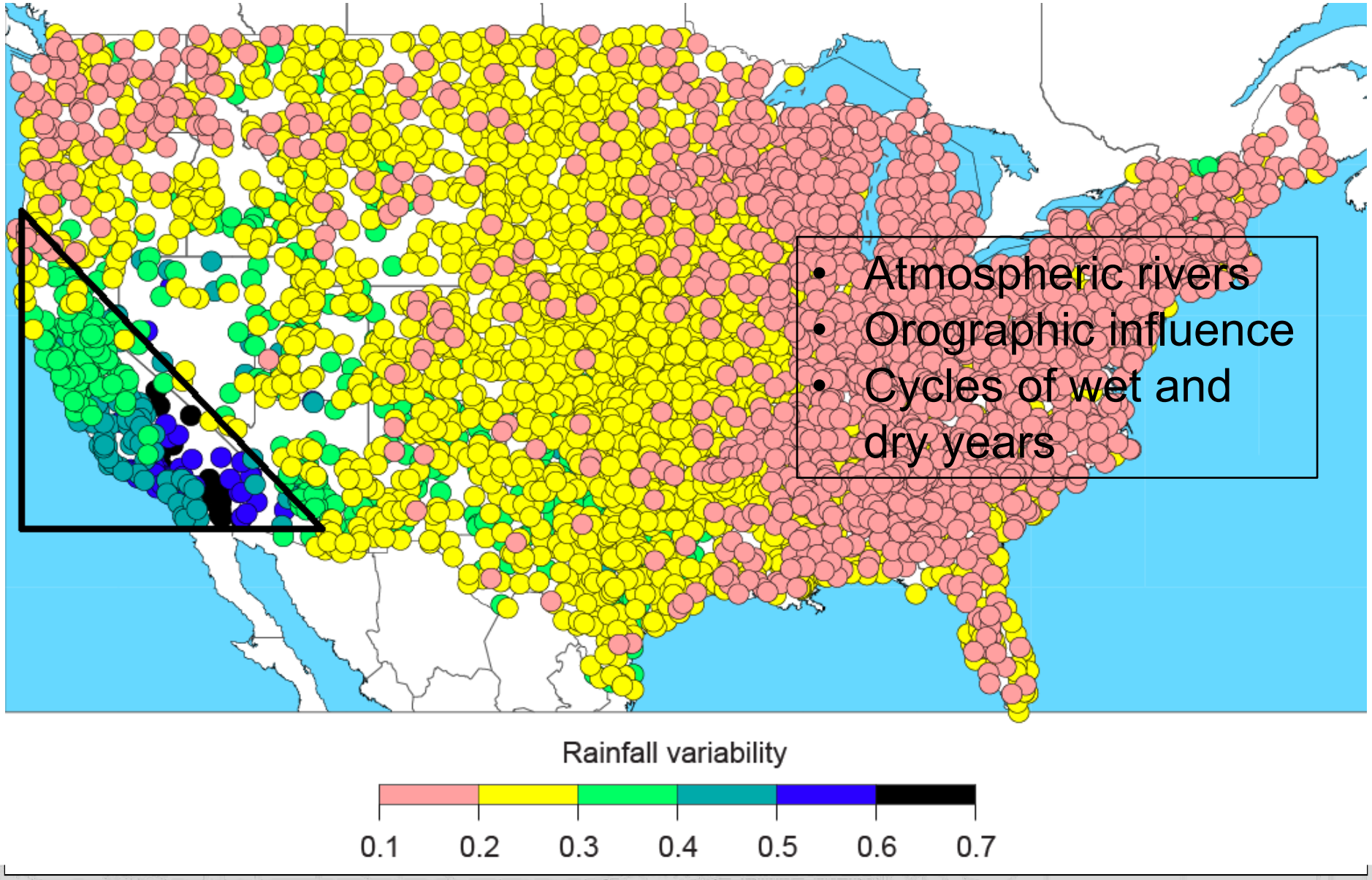
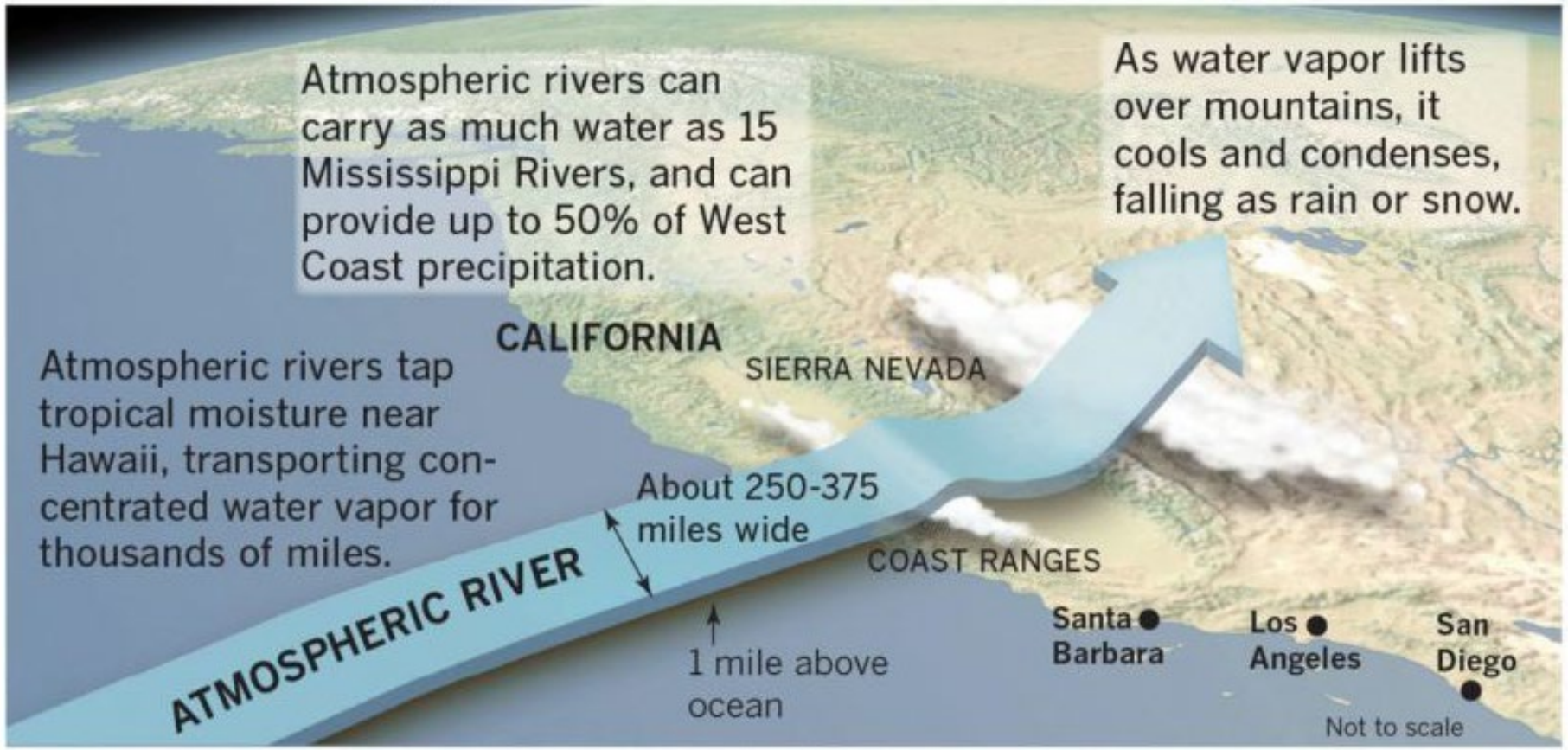
# CALIFORNIA WEATHER AND HYDROLOGY




- Atmospheric rivers
- Orographic influence
- Cycles of wet and dry years

# ATMOSPHERIC RIVERS




Sources: National Weather Service, Scientific American

@latimesgraphics

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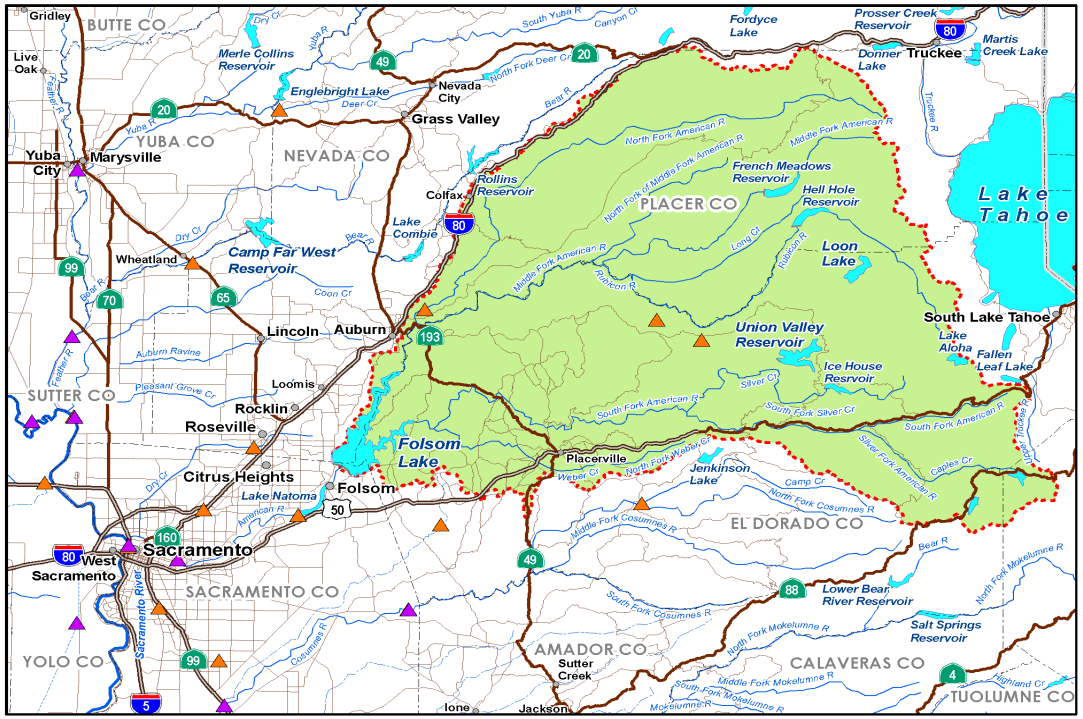
# AMERICAN RIVER HYDROLOGY

- Steep watershed
- Rain-on-snow potential
- Winter snowpack

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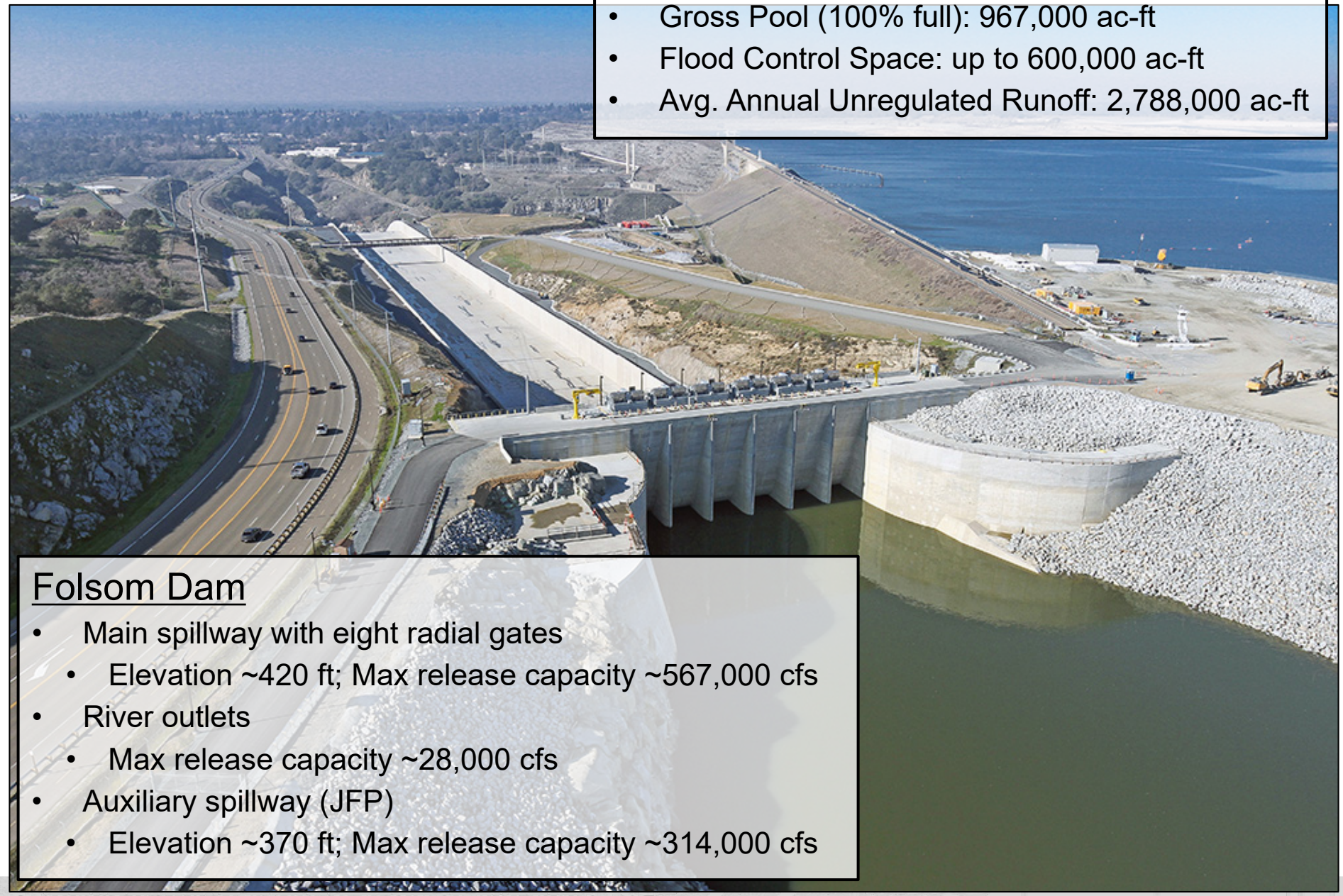
# FOLSOM DAM



## Folsom Lake

- Gross Pool (100% full): 967,000 ac-ft
- Flood Control Space: up to 600,000 ac-ft
- Avg. Annual Unregulated Runoff: 2,788,000 ac-ft

## Folsom Dam

- Main spillway with eight radial gates
  - Elevation ~420 ft; Max release capacity ~567,000 cfs
- River outlets
  - Max release capacity ~28,000 cfs
- Auxiliary spillway (JFP)
  - Elevation ~370 ft; Max release capacity ~314,000 cfs

# FOLSOM DAM FLOOD HISTORY

- 1944 – Folsom Dam authorized; Designed to provide 500-year level of flood protection

- 1951 – Record Flood
- 1956 – Record Flood
- 1964 – Record Flood; New level of protection is 120-year
- 1986 – Record Flood; New level of protection is 60-year
- 1997 – Record Flood

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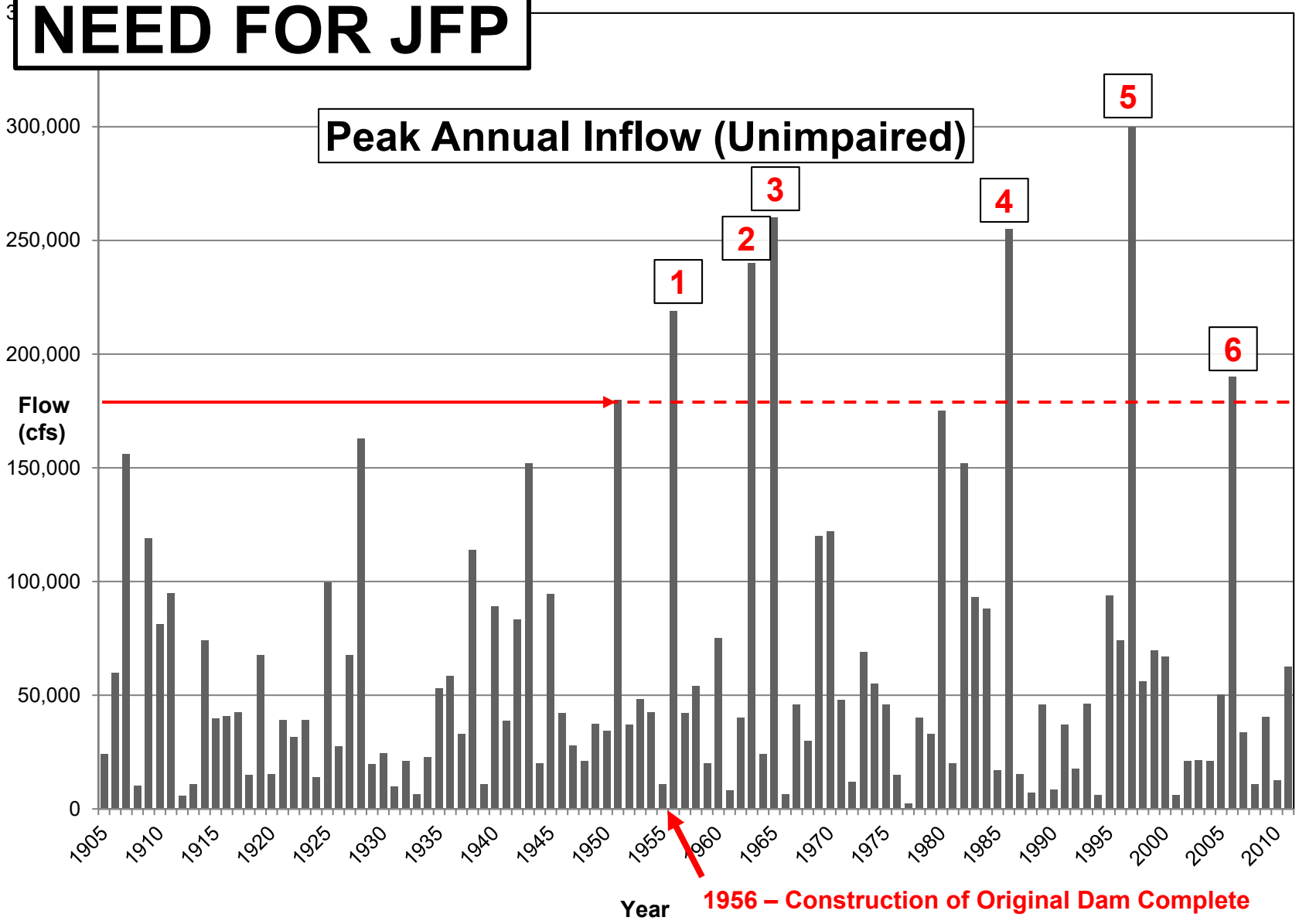
# NEED FOR JFP

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# NEED FOR JFP

- Problems with the existing dam:
  - Only 400,000 acre-feet of authorized flood storage (wasn't sized to include largest storms)
  - Can't pass the Probable Maximum Flood without overtopping
  - 30% of flood storage used when downstream objective release (115,000 cfs) can be achieved

- Proposed solutions:
  - Additional upstream flood storage
  - Expansion of existing outlets
  - Auxiliary spillway, additional 200,000 ac-ft of variable flood storage, and forecast-based operations potential

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# JFP – WCM UPDATE

- Joint Federal Project (JFP)

**WRDA 1999: ”The Secretary…shall update the flood management plan for Folsom Dam…to reflect the operational capabilities created by the modification authorized in subparagraph (A) and improved weather forecasts based on the Advanced Hydrologic Prediction System of the National Weather Service.”**

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# FORECAST-BASED OPERATIONS

- Theory: foreknowledge of runoff volume and timing enables optimal use of storage and release decisions

- Concerns: forecast uncertainty generates risk
  - Insufficient releases (increased flood risk)
  - Excessive releases (increased water supply risk)

- Challenges:
  - Limited forecast data record
  - Never been done before

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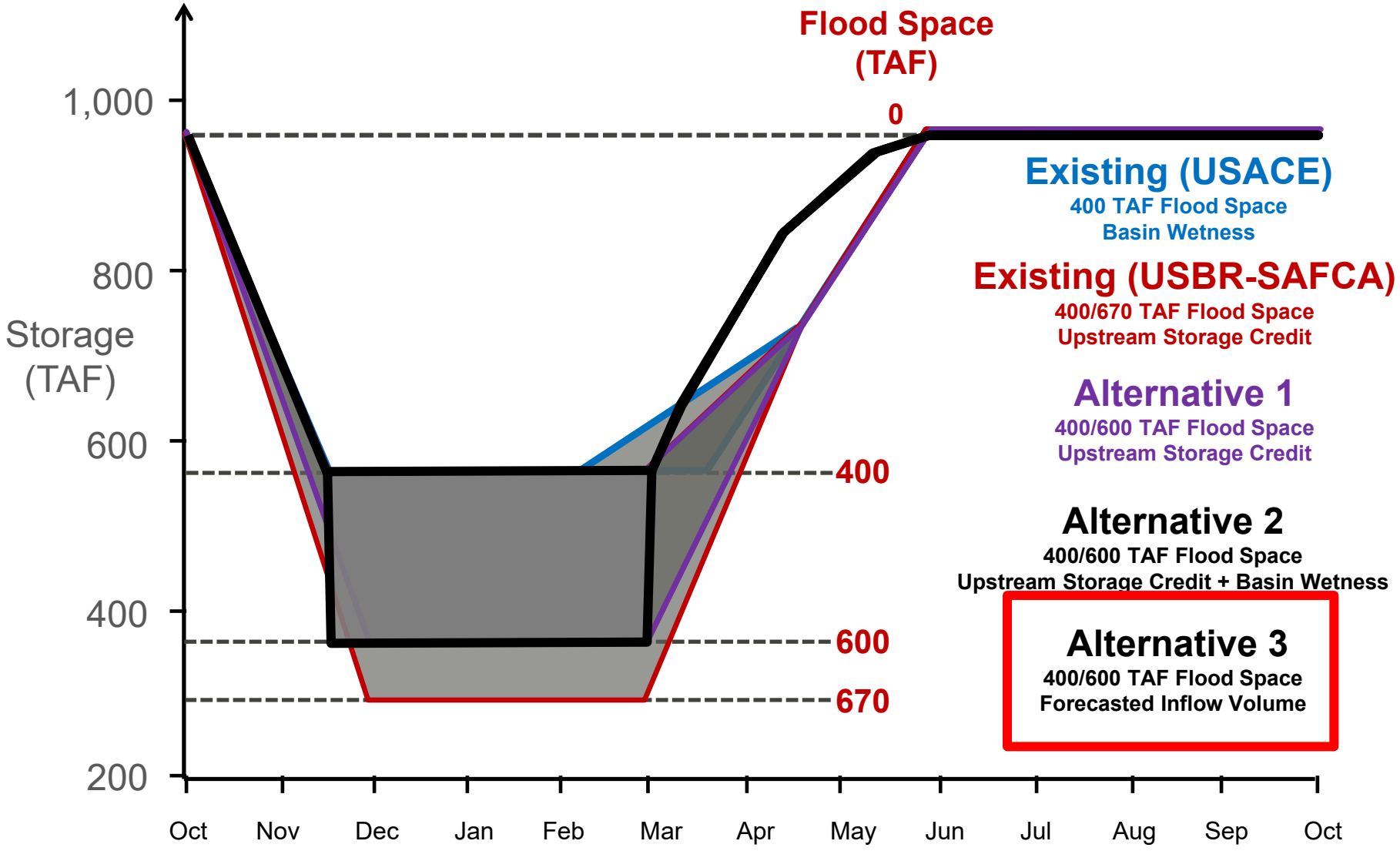
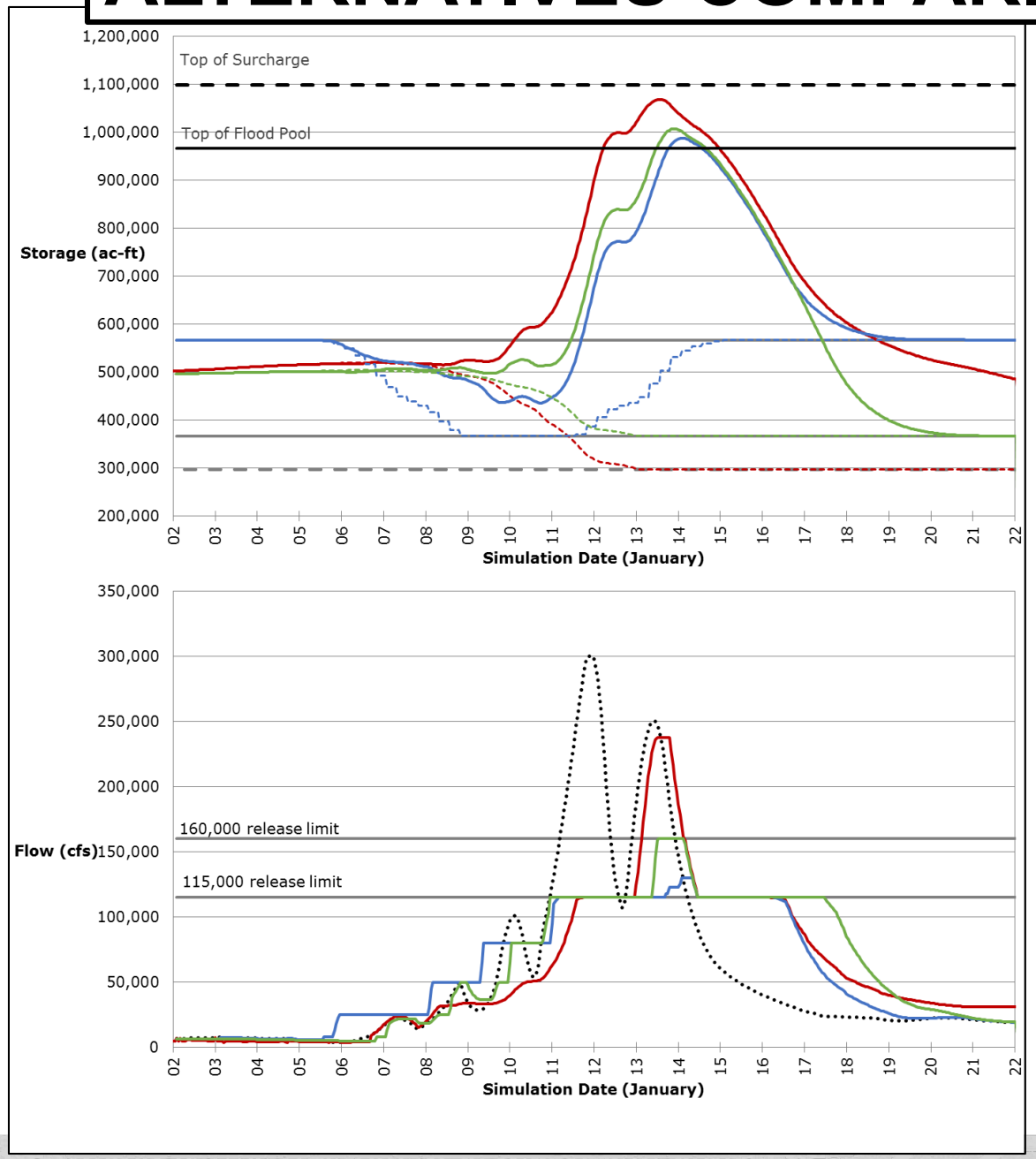
# TWO BASELINES/THREE ALTERNATIVES



# ALTERNATIVES COMPARISON




- 1986 event pattern (observed) scaled to 200-year event
- Forecast operation reflects perfect forecast

**Existing (BOR/SAFCA)**

**JFP + US credit**

**JFP + Forecast-based**

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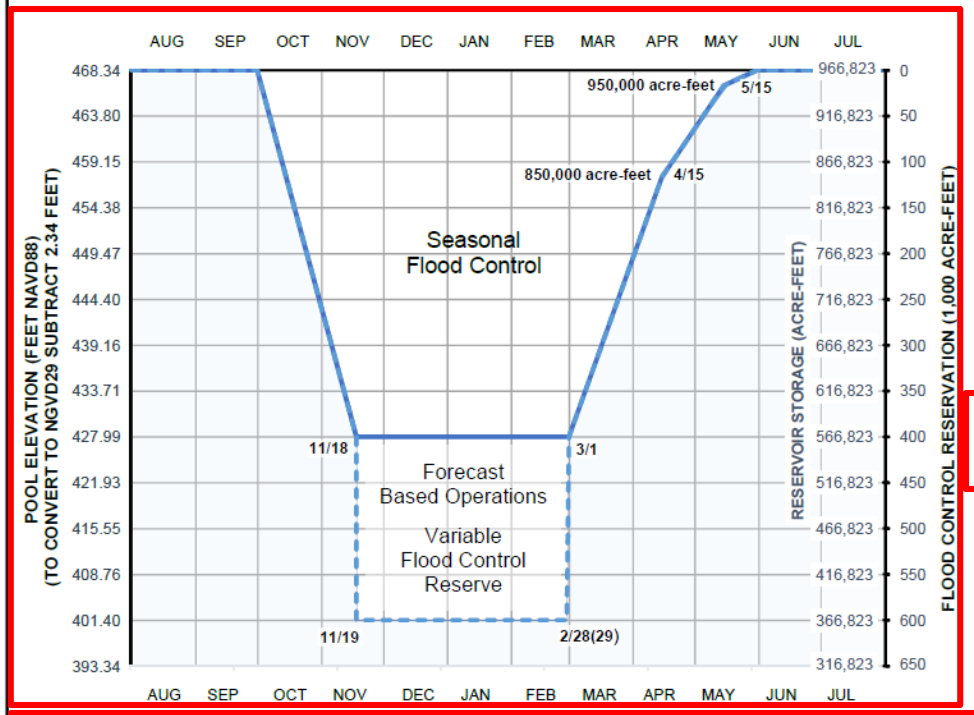
# NEW FOLSOM WCD




## USE OF WATER CONTROL DIAGRAM

Folsom Dam and Lake shall be operated for flood control in accordance with the Water Control Diagram and the accompanying Emergency Spillway Release Diagram (ESRD). Water stored within the Flood Control Reserve (FCR) space shall be released as rapidly as possible subject to the ***Release Schedule***, except when releases greater than 115,000 cfs are required by the ESRD. The Corps of Engineers may direct flood releases to be increased or decreased from the prescribed release when warranted by existing conditions or by high confidence forecast information provided by NWS-CNRFC.

### RELEASE SCHEDULE

***(Releases shall not exceed 115,000 cfs unless specified by the ESRD)***

**SEASONAL RELEASES**
***(EFFECTIVE MAR 1 THRU NOV 18)***

Release peak inflow for current event.

**FORECAST-BASED RELEASES**
***(EFFECTIVE NOV 19 THRU FEB 28/29)***

1. If FCR = 400,000 acre-feet, release peak inflow
2. If FCR < 500,000 acre-feet, Table A Release.
3. If FCR ≥ 500,000 acre-feet, release the greater of peak inflow for the current event or Table A Release.

TABLE A

| FORECASTED INFLOW VOLUME | RELEASE |
|---|---|
| 120-HR > 300,000 ACRE-FEET | 25,000 CFS |
| 72-HR > 300,000 ACRE-FEET | 50,000 CFS |
| 48-HR > 300,000 ACRE-FEET | 80,000 CFS |
| 24-HR > 300,000 ACRE-FEET AND INFLOW ≥ 115,000 CFS | 115,000 CFS |

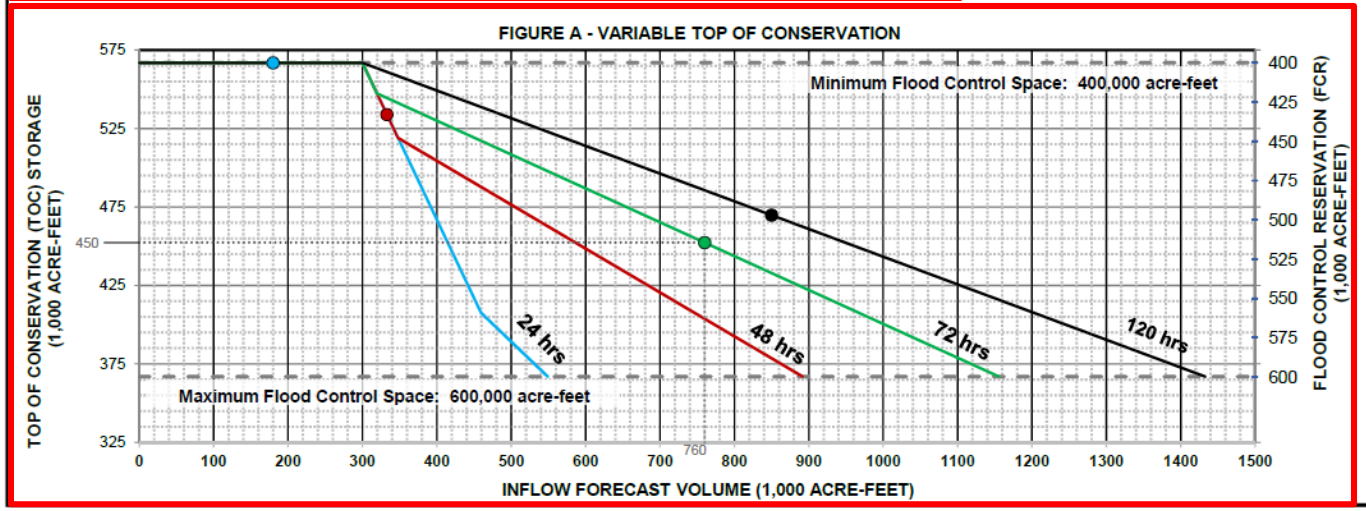
RAMPING RATES:
Releases between 8,000 cfs and 30,000 cfs will not be increased by more than 10,000 cfs during any 2-hour period.
Releases between 30,000 cfs and 115,000 cfs will not be increased by more than 30,000 cfs during any 2-hour period.
Releases between 8,000 cfs and 115,000 cfs will not be decreased by more than 10,000 cfs during any 2-hour period.

## COMPUTATION OF VARIABLE TOP OF CONSERVATION

From Nov. 19 to Feb. 28/29 the Top of Conservation (TOC) storage will vary based on forecasted inflow volumes. These are developed by the NWS-CNRFC for the purpose of supporting Folsom Dam flood operations, will reflect forecasted inflows over the next 24, 48, 72, and 120 hours, and will reflect a value of non-exceedence probability (NEP) specified by the Corps. Volumes will be provided once per day during normal operations, and every six hours once the 120-hour volume exceeds 300,000 acre-feet. Figure A provides relationships relating inflow forecast volume to variable TOC storage for each duration.

**FIGURE A INSTRUCTIONS:** Locate each of the four forecast volumes on the horizontal axis. Place the four forecast volumes on the respective duration curves. For each forecast volume, identify the corresponding candidate TOC storage value on the vertical axis. Of the four candidate TOC storage values, the lowest value is the adopted variable TOC storage value. The corresponding FCR value is given by: FCR = Gross Pool (966,823 acre-feet) - variable TOC storage.

**FIGURE A EXAMPLE:** Inflow forecast volumes of 180, 330, 760 and 850 thousand acre-feet are provided, corresponding to 24, 48, 72, and 120 hours, respectively. As shown in Figure A, the volumes are located on the horizontal axis and placed on the corresponding curves (indicated by large dots). Corresponding candidate TOC storage values are read from the vertical axis. The lowest value is given by the 72-hour volume. This value (450,000 acre-feet) is therefore the adopted variable TOC storage value. The corresponding FCR value is:
FCR = 966,823 ac-ft - 450,000 ac-ft = 516,823 ac-ft.




**FOLSOM DAM AND LAKE**
American River, California

**WATER CONTROL DIAGRAM**

Prepared pursuant to Flood Control Regulations for Folsom Dam and Lake in accordance with the Code of Federal Regulations Title 33 Part 208.11

APPROVED KIMBERLY M. COLLOTON
Brigadier General, Division Commander
South Pacific Division, USACE

APPROVED
Regional Director, Mid-Pacific Region
USBR

EFFECTIVE DATE 6-12-19 FILE NO. AM-1-26-586

Revised June 2019 PLATE A-9

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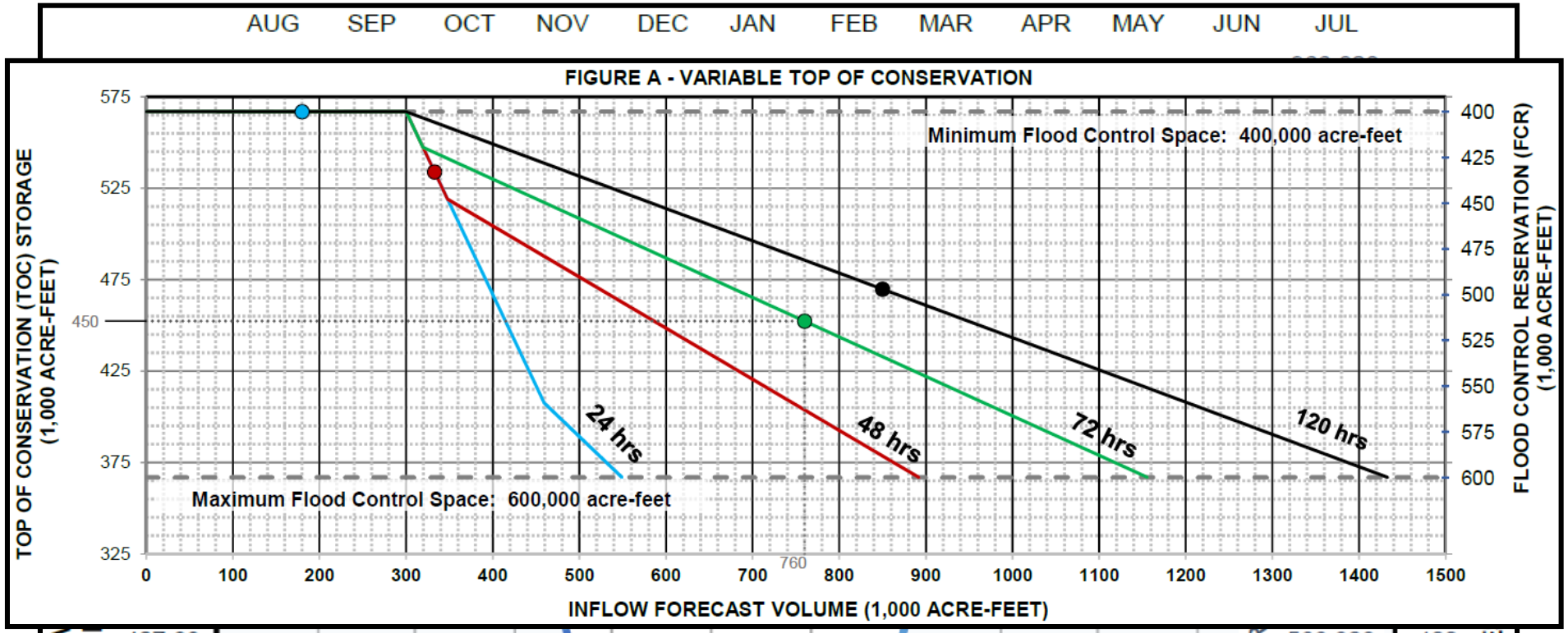
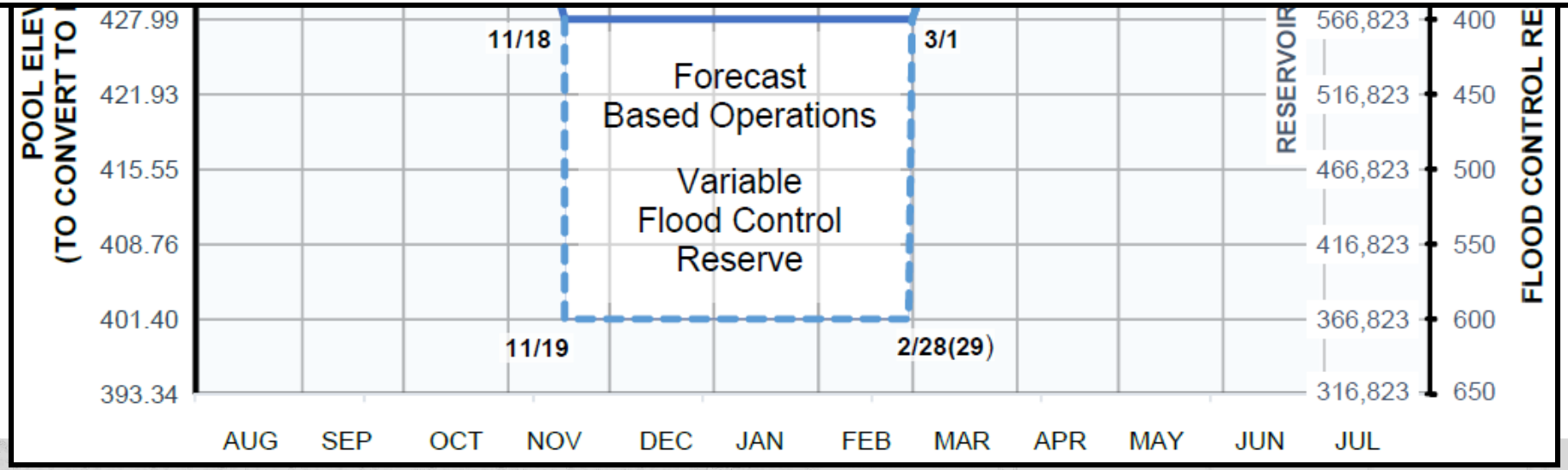
# NEW FOLSOM WCD



# ENSEMBLE FORECAST

- Forecast product from NWS (CNRFC)
  - Captures uncertainty of forecasts unlike deterministic
  - Starts with today's current watershed conditions like deterministic forecast
  - Incorporates calibration information from previous water years (currently 68)
  - Precipitation and temperature "traces" convert to 68 hydrographs considered equally likely to occur
  - Days 1-15 uses short-term forecast information
  - Days 16+ are solely climatological (no forecast skill)

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# ENSEMBLE FORECAST

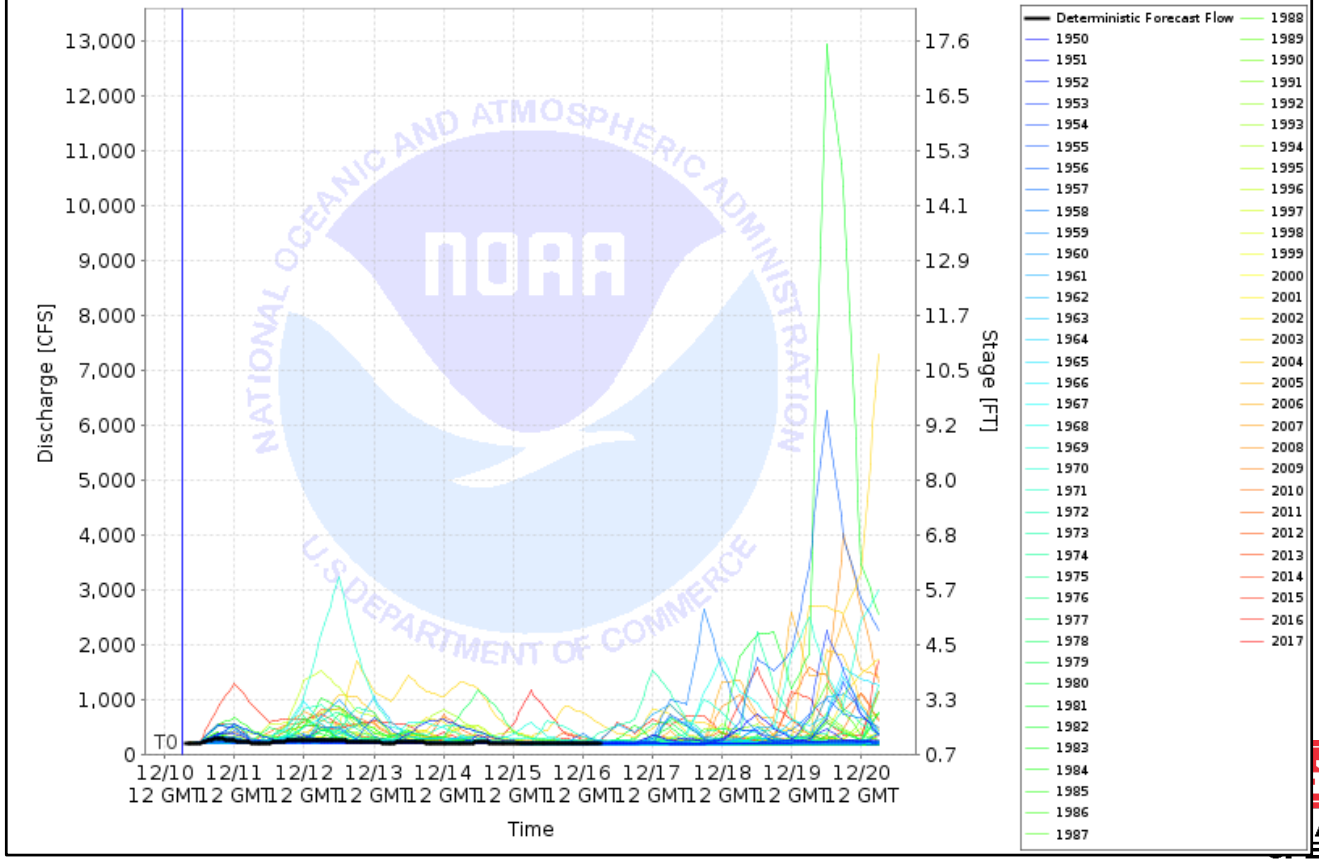
## EAST FORK RUSSIAN RIVER - LAKE MENDOCINO (LAMC1)

**Latitude: 39.20° N** **Longitude: 123.19° W** **Elevation: 670 Feet**
**Location: Mendocino County in California** **River Group: Russian Napa**

**Issuance Time:** Dec 10 2019 at 1:51 PM PST

***10-Day Traces Plot*** **CSV Ensemble File Download: LAMC1**

MEFP-based Traces with Deterministic Forecast for EF RUSSIAN - COYOTE DAM
Latitude: 39.20028 Longitude: -123.186386
Forecast for the period 12/10/2019 - 12/20/2019
This is a conditional simulation based on the current conditions as of 12/10/2019
*(src=D)*

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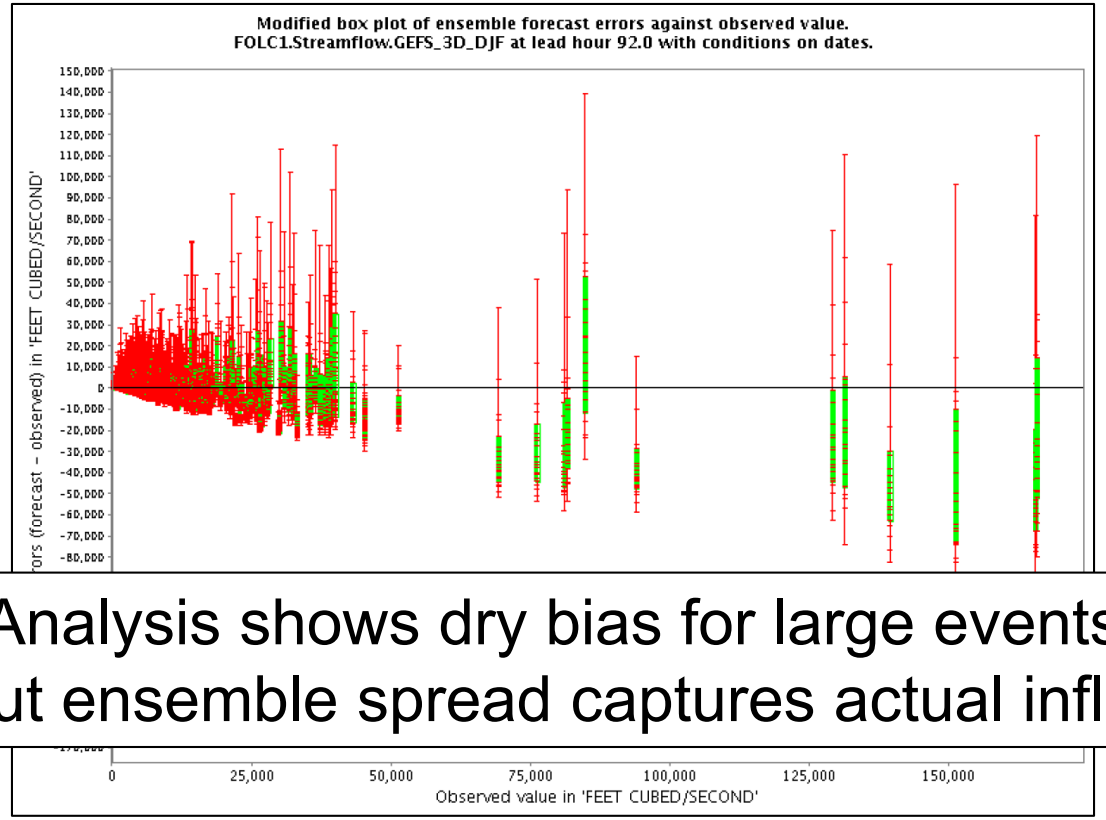
# FORECAST QUALITY AND RELIABILITY

- Use “hindcasts” to assess forecast quality and reliability
  - Created by CNRFC
  - “Hindcast” – what forecasts would have been in past years if today’s forecast skill was available




Analysis shows dry bias for large events, but ensemble spread captures actual inflow

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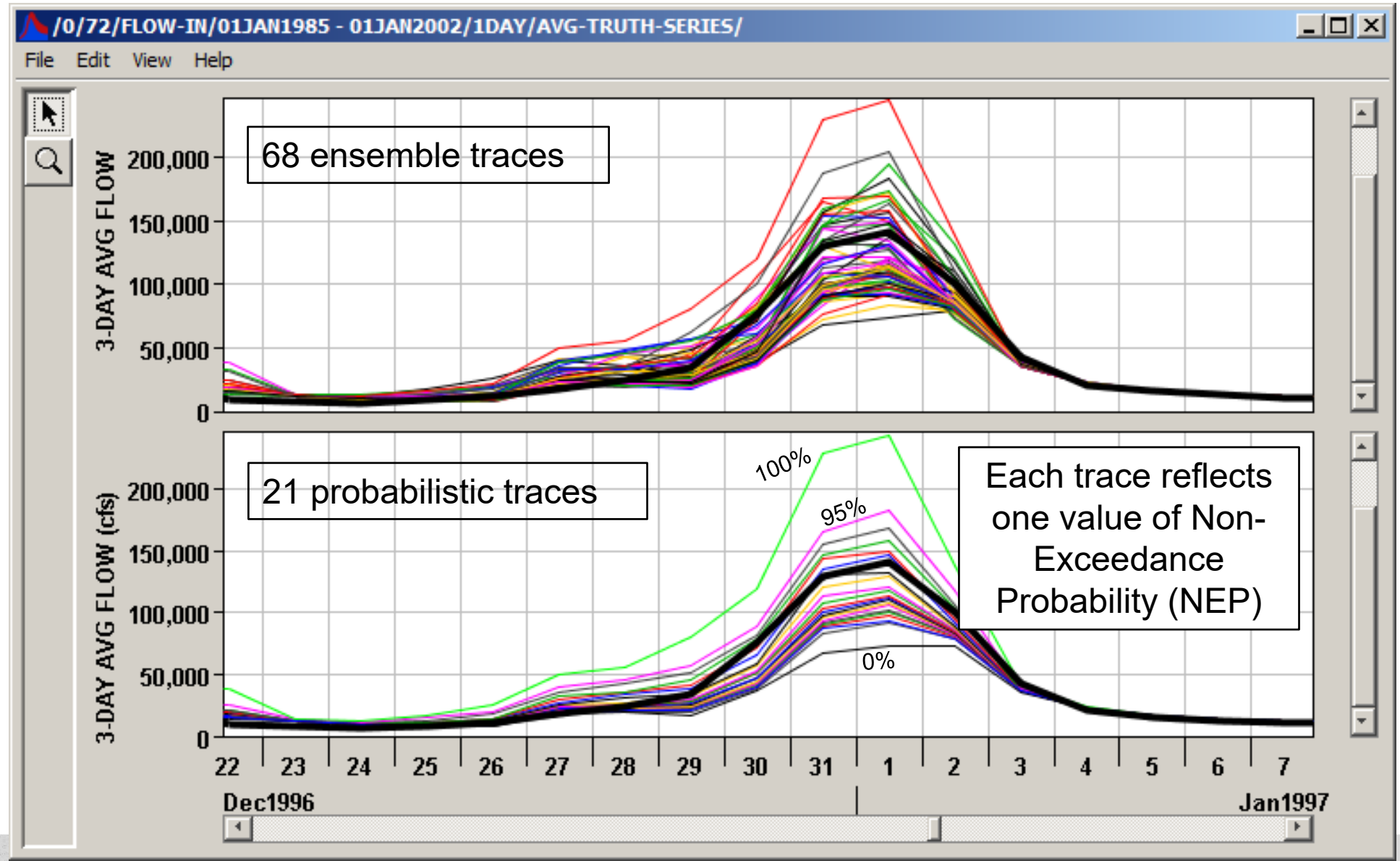
# FORECAST INFLOW VOLUMES



# ROBUSTNESS TESTING

To determine which NEP volume set was the most appropriate to use, robustness testing was performed.

NEPs were identified for various objectives, such as:

- Smallest NEP that routes design event at target release.
- Smallest NEP that routes design event given 24-hour time shift in forecasted inflow volumes.
- Greatest NEP that does not result in drawdowns that do not refill (false positives).

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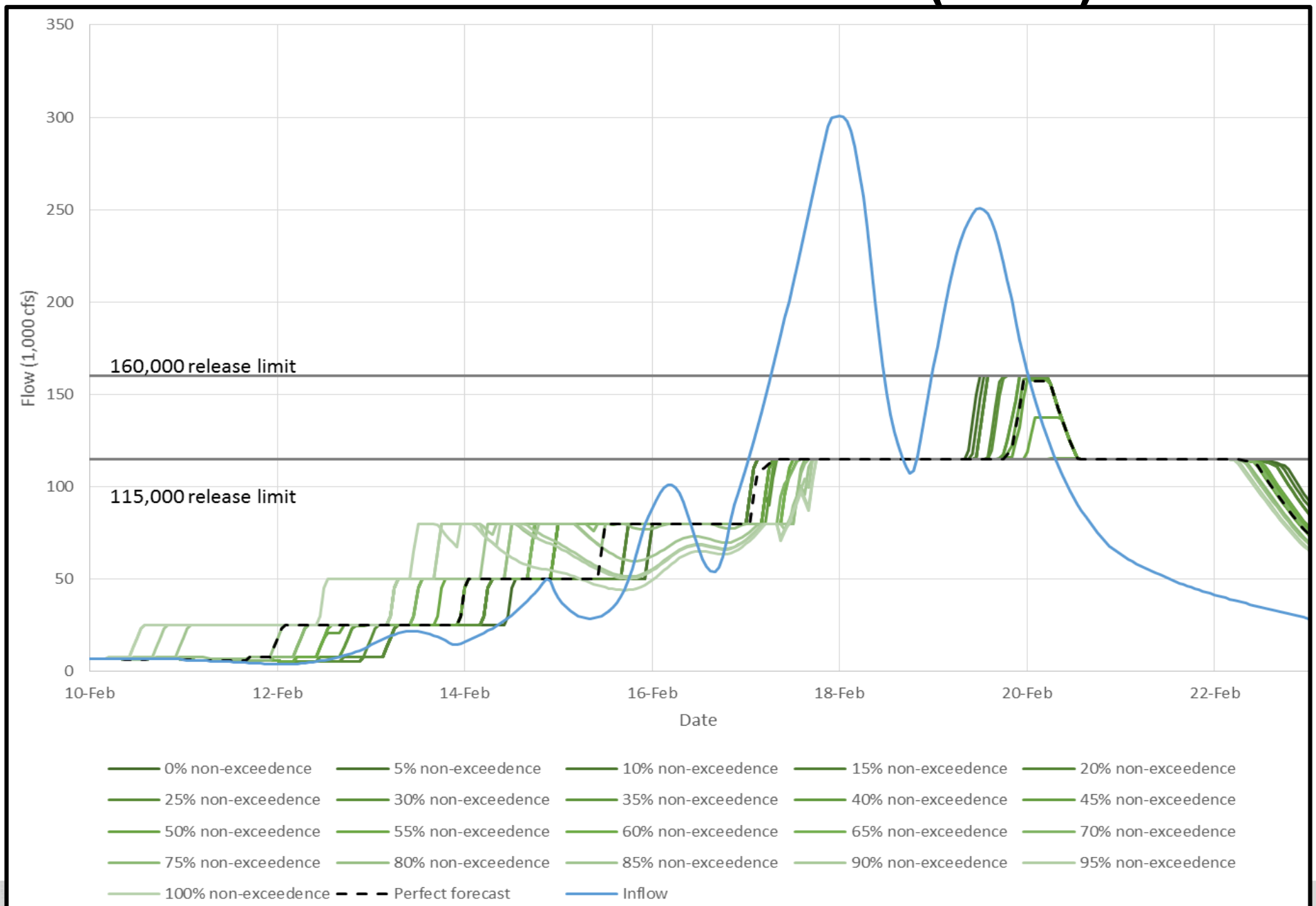
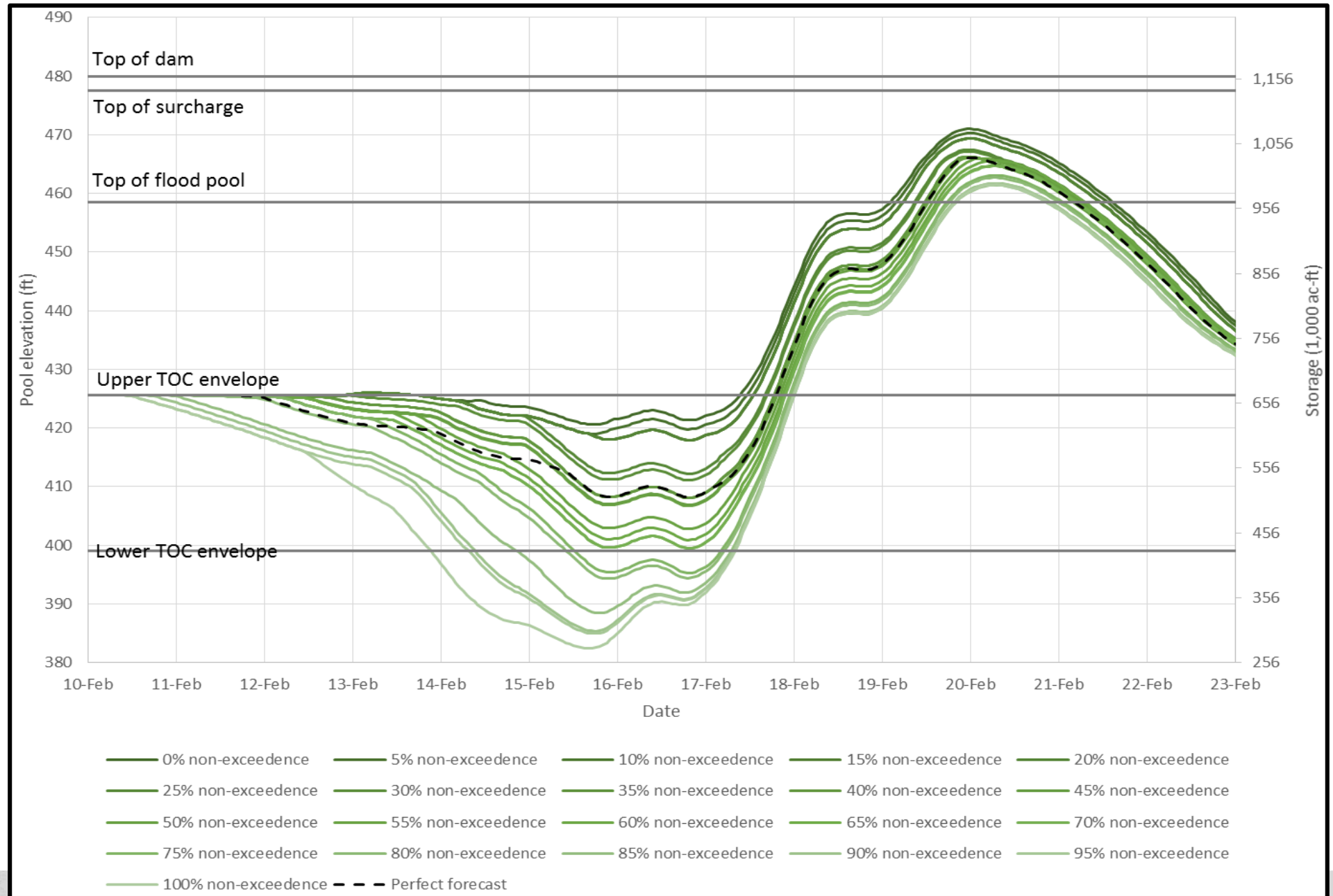
# ROBUSTNESS – 1/200 EVENT (1986)



# ROBUSTNESS – 1/200 EVENT (1986)



# ROBUSTNESS RESULTS

| | |
|---|---|
| 1/100 1986 pattern, 115 kcfs | **35%** |
| 1/100 1997 pattern, 115 kcfs | **5%** |
| 1/200 1986 pattern, 160 kcfs | **35%** |
| 1/200 1997 pattern, 160 kcfs | **5%** |

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# SENSITIVITY ANALYSIS RESULTS

- Evaluated susceptibility of the forecast-based operation not refilling in the short-term

- Modeled response of drastically overestimated inflow forecast when much lower inflow “actually” occurred

| | | |
|---|---|---|
| 1986 pattern | **1/130** | 1/2 |
| 1997 pattern | **1/100** | 1/2 |

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# FOLSOM WCM LESSONS LEARNED

- Maintain consistency in key leadership roles
- Keep open lines of communication with partners and stakeholders
- Develop comprehensive hydrologic dataset
- Ensure modeling and WCM stay aligned throughout
- Determine sufficiently narrow scope before starting NEPA process

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# FUTURE BENEFITS TO WCM – FIRO

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# YUBA-FEATHER FIRO

- **Vision** – FIRO will help increase flexibility in reservoir operations for the purpose of optimizing flood control, water supply, and habitat management.

- **Mission** – Provide guidance in a highly collaborative engagement process to ensure that the deliverables reflect interdisciplinary perspectives and inter-agency input.

- **Goal** – Develop clear pathways for assessing the viability of FIRO at New Bullards Bar and Oroville dams.

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# Y-F FIRO STEERING COMMITTEE

- Co-Chairs
  - F. Martin Ralph – CW3E
  - Curt Aikens – YWA
  - John Leahigh – DWR

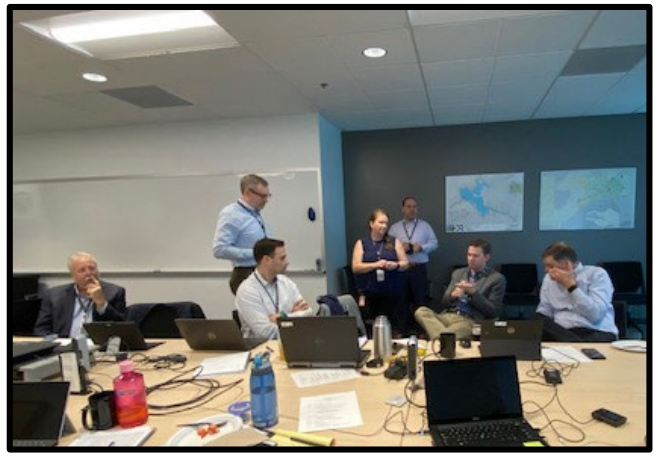
- Members
  - Jay Jasperse – SWA
  - Michael Anderson – DWR
  - Carl Talbot – USACE/ERDC
  - Alan Haynes – NOAA/CNRFC
  - Joe Forbis – USACE/SPK
  - Molly White – DWR
  - John James – YWA
  - Steven Lindley – NOAA/Fisheries

# STATUS UPDATE ON Y-F FIRO

- First Steering Committee meeting held in June 2019
  - Latest meeting was late-January 2020

- Work plan being developed
  - Outlines tasks, roles, schedule, and requirements for assessing FIRO viability
  - Subgroups formed to focus on portions of work plan
  - Final work plan complete by end of 2020

- Next meeting – late-April 2020



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# ITEM 4: DEPARTMENT OF WATER RESOURCES OPERATIONS COMMUNICATIONS UPDATE

# Stay in the Know about Oroville with the California Department of Water Resources

Published: February 20, 2020

An aerial view of Bidwell Bar Bridge at Lake Oroville. DWR/2018

The California Department of Water Resources (DWR) owns and operates the Oroville Dam facilities for a number of purposes, including flood control, water supply, environmental and water quality needs, and recreation. DWR is working to proactively share information on Oroville Dam operations in a variety of

## Tags

Oroville State Water Project ...

## Related Blogs

- Lake Oroville Community Update: January 24
- Lake Oroville Community Update: Jan. 31

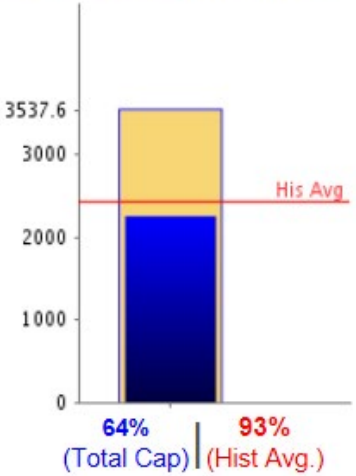
## Dates

+ 2017

Department of Water Resources
CALIFORNIA DATA EXCHANGE CENTER



## OROVILLE - STORAGE CONDITIONS AS OF FEBRUARY 19, 2020

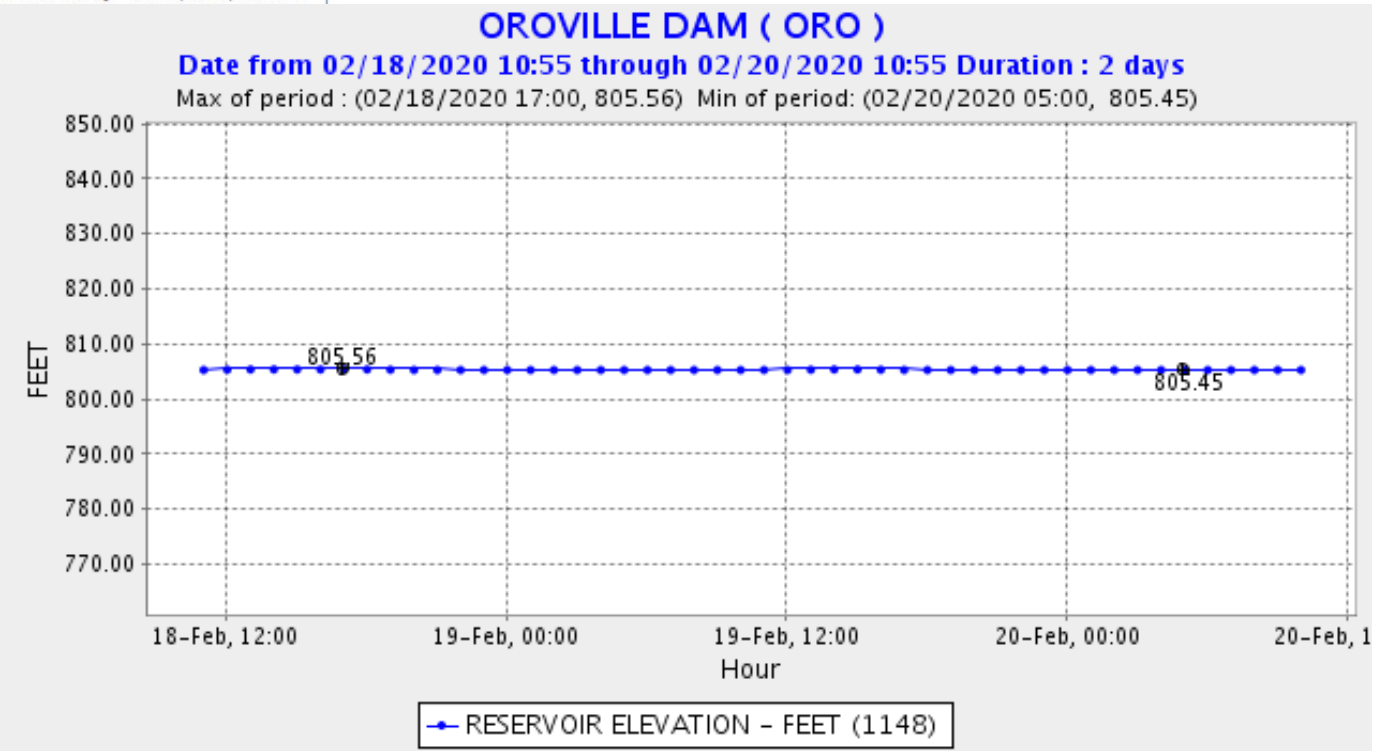



Data as of Midnight: February 19, 2020

- Storage: 2,253,954 AF
- Reservoir Elevation: 805.46 FT
- 64% of Total Capacity
- 93% of Historical Avg. For This Date
- Total Capacity: 3,537,577 AF
- Avg. Stor. for February 19: 2,418,100 AF

Change Dat

Major Reservoir Current Conditions Graphs



# ITEM 5: PUBLIC COMMENT

**The Oroville Dam Citizens Advisory Commission will now take public comment.**

**We appreciate your input.**

# ITEM 6: ADJOURN

**Thank you all for joining us today, our next Oroville Dam Citizens Advisory Commission meeting will be on Friday, June 26th.**

CALIFORNIA natural resources AGENCY