



U.S. ARMY

# Forecast-Informed Reservoir Operations: USACE perspective on a Multi-Agency Research-to-Operations Effort

Cary Talbot, PhD, PE

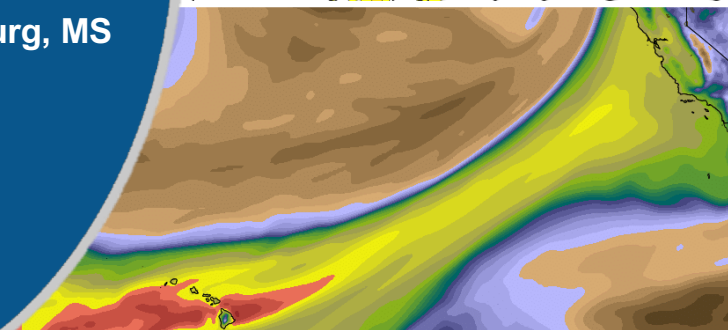
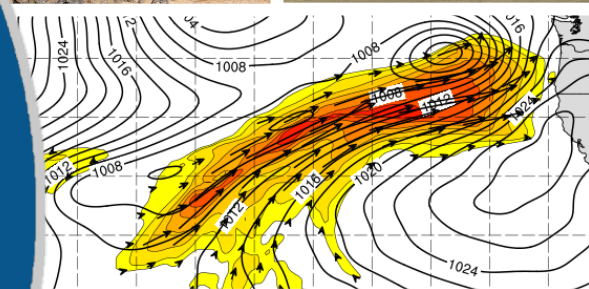
Coastal & Hydraulics Laboratory

US Army Engineer Research & Development Center (ERDC), Vicksburg, MS

Joint TWDB-UTA-NIDIS Workshop

Arlington, TX

12-13 September 2019



US Army Corps  
of Engineers



DISCOVER | DEVELOP | DELIVER

# Acknowledgements

**Sean Smith** – Principal Hydrologic & Hydraulic Engineer, US Army Corps of Engineers, Headquarters, Washington DC

**Cuong Ly** - Senior Hydrologic & Hydraulic and Water Management Engineer, US Army Corps of Engineers, South Pacific Division, San Francisco





# Importance of FIRO Effort to USACE

- **USACE Flood Risk Management Mission** is paramount in water operations decision-making
- **April 2015** – FIRO briefing to USACE & Assist. Secretary of the Army-Civil Works Senior Leaders
  - “We need this research effort to tell us A, B and C in order to make a policy decision” – Steve Stockton, Director of Civil Works
  - HQ liaison assigned to ensure R&D effort aligns with operational needs
- **HQ liaison and USACE South Pacific Division technical lead** actively engaged in FIRO steering committee meetings and workshops throughout course of FIRO effort
- **Pilot Projects** – Efforts at Lake Mendocino and others are pilot projects for the Corps in establishing pattern for safe and effective incorporation of forecast information in water management decision-making process

# May 2016 Update to Engineer Regulation (ER) 1110-2-240

## Water Control Management

### Section 3.3 Evacuation of Impounded Water.

Consistent with the authorized purposes of a project and affected interests in the project area, any water impounded in the flood control space defined by the plan of regulation shall be evacuated as rapidly as can be accomplished without causing downstream flows to exceed the controlling rates and not releasing more than peak inflow or in accordance with reservoir regulation schedules. That is, releases from reservoirs shall be restricted insofar as practicable to quantities that, in conjunction with uncontrolled runoff downstream of the dam, will not cause water levels to exceed the controlling maximum non-damaging stages currently in effect. **This implies making decisions based on the principle of water on the ground** which is observed precipitation or observed snowpack.

*Emphasis added*

# Lake Mendocino FIRO 5-Year Work Plan



- Created by Interagency, cross-disciplinary Steering Committee
- Work plan developed in 2014/15; finalized in Sep 2015



**TABLE OF CONTENTS**

Glossary of Terms  
Executive Summary

1. Introduction ..... 1-1
2. Project Background ..... 2-1
  - 2.1 Interagency Cooperation ..... 2-1
  - 2.2 Russian River Watershed ..... 2-5
  - 2.3 Water Management Challenges ..... 2-9
  - 2.4 Current Capabilities ..... 2-13
3. FIRO Viability Assessment Process ..... 3-1
  - 3.1 Approach ..... 3-1
4. Evaluation Framework, Scenarios and Criteria ..... 4-1
  - 4.1 Evaluation Framework ..... 4-1
  - 4.2 Evaluation Scenarios ..... 4-2
  - 4.3 Development of Evaluation Criteria ..... 4-2
  - 4.4 Envisioned Improvements to Facilitate FIRO ..... 4-3
5. Evaluate Model Results ..... 5-1
6. Assess Benefits ..... 6-1
  - 6.1 Identify Economic Benefits ..... 6-1
  - 6.2 Develop Logic Model ..... 6-2
  - 6.3 Establish Bookend Scenarios ..... 6-3
  - 6.4 Conduct Economic Analysis ..... 6-3
7. Implementation Strategies ..... 7-1
  - 7.1 Pathway to Implementation ..... 7-1
  - 7.2 Describe Lake Mendocino FIRO-Decision Support System (FIRO-DSS) ..... 7-1
  - 7.3 Implementation Timeline ..... 7-8
8. Technical and Scientific Programs Necessary to Support Lake Mendocino FIRO Viability Assessment and Potential Implementation of FIRO ..... 8-1

References/Citations  
Appendices

- A. FIRO Steering Committee
- B. FIRO Information Sheet
- C. Decision 1610
- D. Water Control Diagram
- E. Preliminary Considerations for Criteria Development
- F. Short Project Descriptions
- G. Evaluating Fisheries Benefits Associated with FIRO
- H. Communications and Outreach Plan

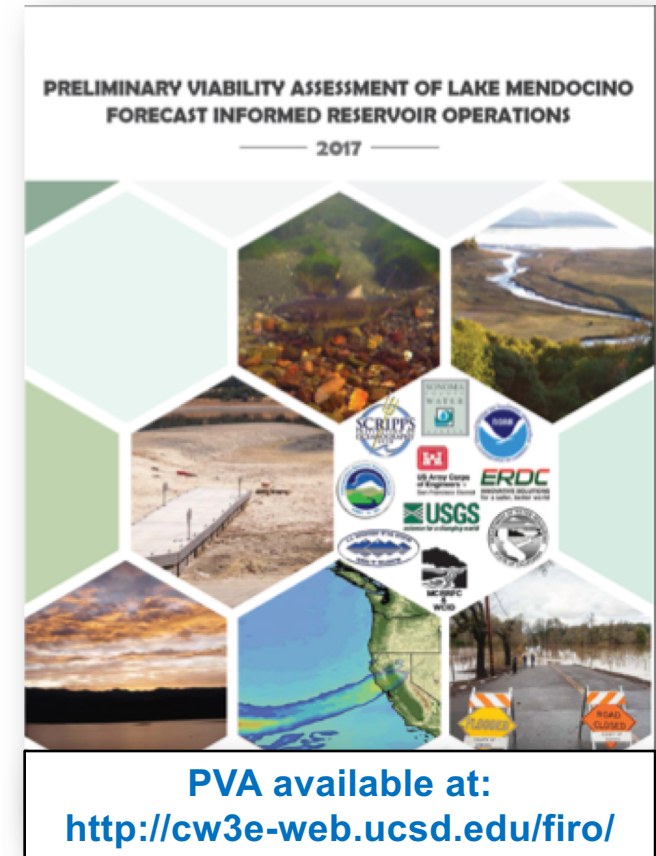
Provides Roadmap for execution of Interagency, cross-disciplinary effort

# Lake Mendocino FIRO Preliminary Viability Assessment

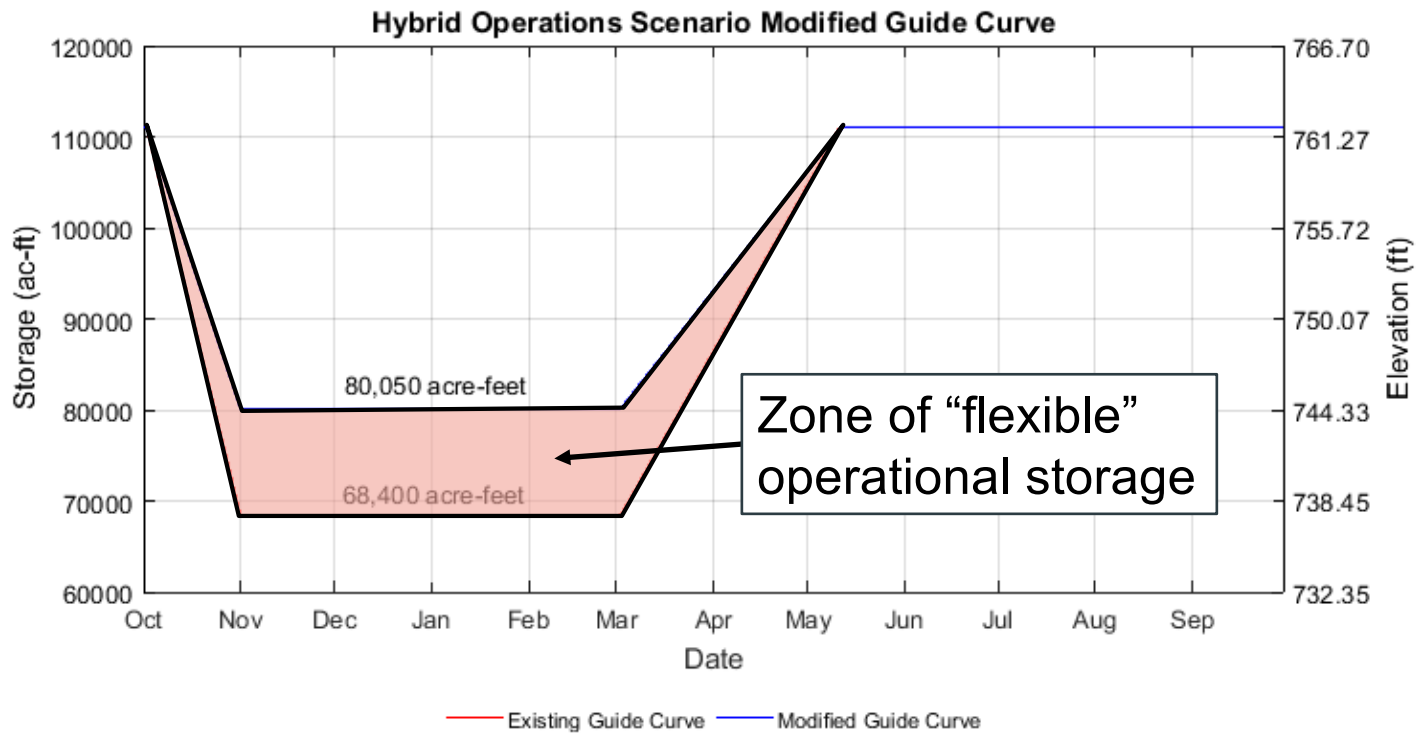
Peer-reviewed and published in Oct 2017

## PVA Tested Operation Scenarios

1. **Actual Operations** - In compliance with existing rule curve
2. **Ensemble Forecast Operations (EFO)**
  - No rule curve
  - Operations by FIRO based on 60-member ensemble forecasts of reservoir inflows from CNRFC (NWS)
3. **Hybrid Operations**
  - Combination of rule curve & FIRO
  - Zone or band of storage which is operated by FIRO using ensemble forecasts are used to inform operations
  - When storage outside of FIRO zone/band, operations by rule curve
4. **Perfect Forecast Operations**
  - We have a weather forecast crystal ball



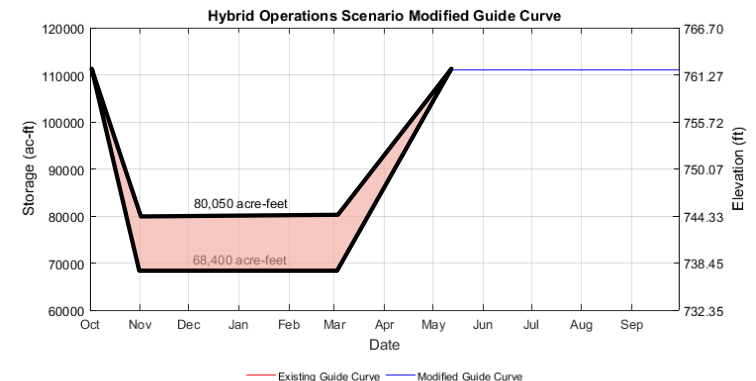
# Lake Mendocino FIRO FY19 Major Deviation





# Lake Mendocino FIRO Current Status

- **Lake Mendocino FIRO** - Use as a learning tool to explore prototype FIRO using new tools and systems
- **Major Deviation @ Lake Mendocino for Water Year 2019**
  - Request submitted by FIRO Steering Committee
  - Approved by SPD on 7 Nov 2018
  - Based on tested scenarios from Preliminary Viability Assessment
  - Opt-out at USACE discretion
- **2<sup>nd</sup> Major Deviation for WY 2020**
  - Request submitted in July 2019 by SC
  - Integrate experience/adjustments
- **Full Viability Assessment**
  - To be completed and published in FY20



# Transferring FIRO: Expanded Effort

- **Prado Dam**
  - Prado Dam FIRO Steering Committee formed and functioning
  - Work plan finalized: July 2019
- **Yuba-Feather Basins (New Bullards Bar Reservoir & Lake Oroville)**
  - Yuba-Feather FIRO Steering Committee formed, first meeting held Jun '19
- **Potential Additional Location**
  - Considering other candidate locations for an additional FIRO pilot
- **Screening-Level Assessments**
  - Develop and test process for FIRO screening-level assessments at potential reservoirs across the country

# USACE FIRO Benefits

- FIRO assessments setting important policy application precedent for USACE and other partner agencies
- Significant opportunity for policy and perspective **change** by combining **researchers, operators** and **regulators** focused collectively on improving water management strategies
  - Collaborative effort builds ***institutional trust*** between partners which leads to willingness to make accommodation for each other's objectives in operational decisions
- FIRO provides an effective means of increasing the efficiency and resiliency of existing water resources infrastructure – ***all without costly construction projects***