



— BUREAU OF —
RECLAMATION

Central Valley Project Water Temperature Modeling Platform Project

Mid-Term Independent Peer Review

July 19, 2022

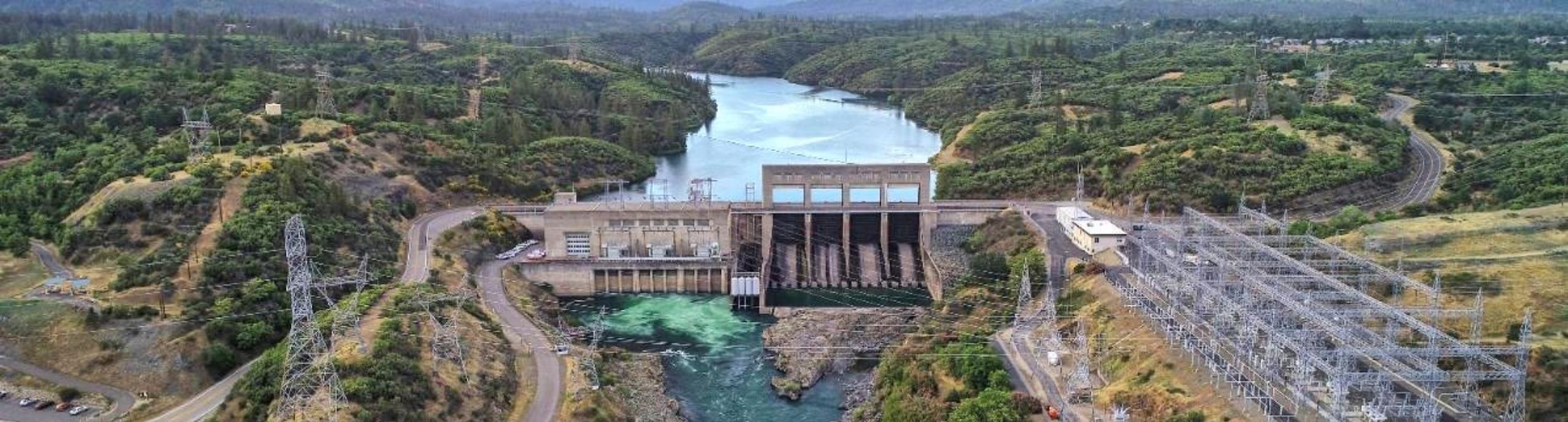


Photo credit: John Hannon, Reclamation

WTMP Project Overview

Randi Field, Hydrologic Engineer

Reclamation, Central Valley Operations Office



Outline

- Central Valley Project Overview
- Temperature Management
- Needs of the WTMP Project
- Project Plan/Schedule
- Highlighted project details



Central Valley Project

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



Salmonids

- Fall Run: 33 mm
- Spring Run: 40 mm
- Winter Run: 81 mm
- Late-Fall Run: 130 mm
- *O. mykiss*: 162 mm



Photo credit: USFWS

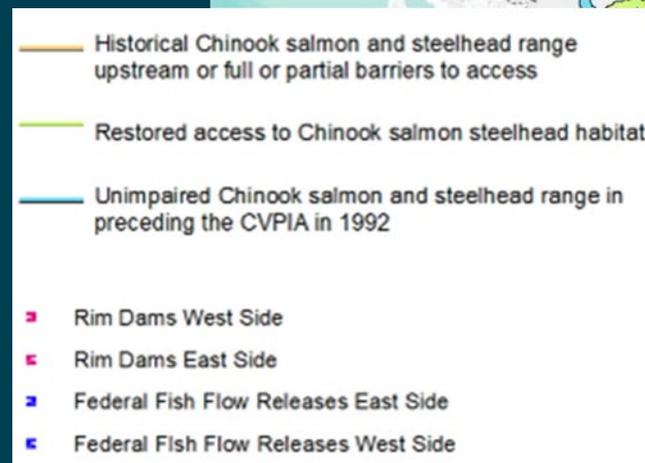
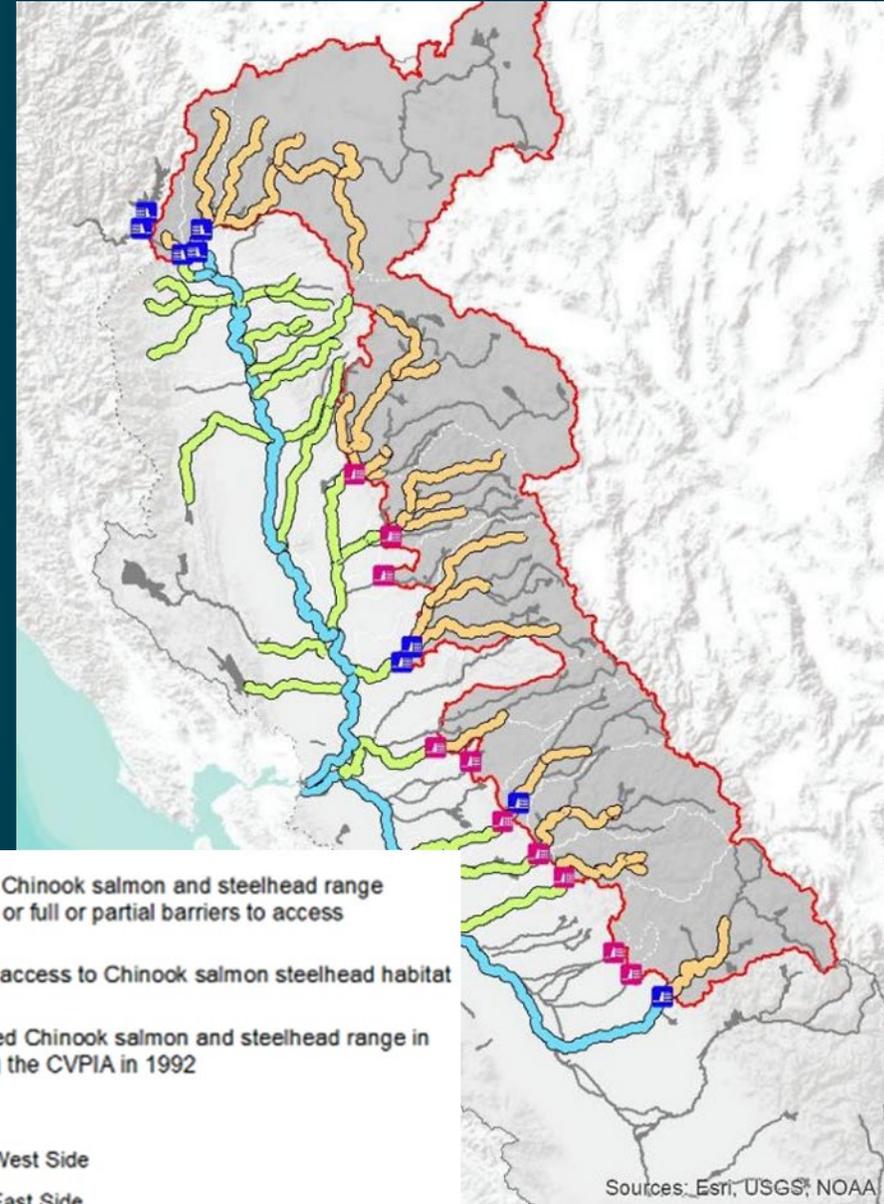


Photo credit: CDFW



Central Valley Habitat

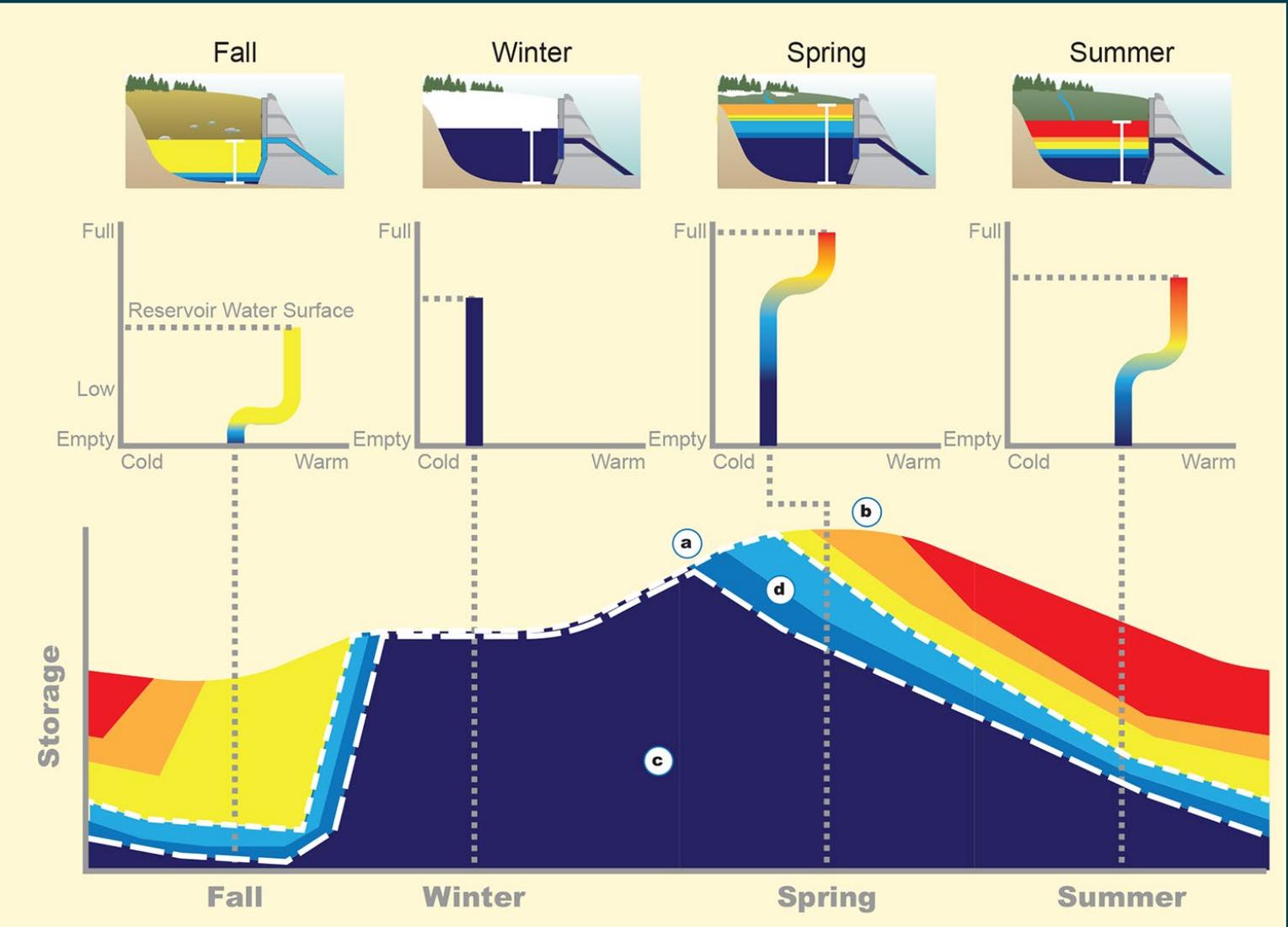
- Dams around the rim of the valley floor isolate salmon from historical habitats
- Warm water conditions challenge spawning, incubation, and rearing
- Levees isolate fish from historical floodplain habitat
- Diversions impair passage for returning adults and may entrain juveniles
- Exports alter the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



Sources: Esri, USGS, NOAA



Water Temperature Management



Elements of Temperature Management

The Why



1. Environmental Objectives: Defining management criteria (e.g., target species' seasonal temperature requirements and their distribution in downstream river reaches).

The Resources



2. Total Reservoir Storage: Defining cold water volume through reservoir storage.



3. Reservoir Water Temperature Profile: Defining cold water volume through thermal profile characterization.

The Means



4. Selective Withdrawal: Assessing selective withdrawal facilities and strategies.



5. Tail Bay Water Temperature Management: Determining reservoir tail bay temperatures.

The Factors



6. Meteorological Conditions: Determining heat gain from the reservoir to downstream river management locations to inform decision-making processes.



7. Major Tributary Inflow: Determining thermal conditions of tributaries.



8. Regulating Reservoirs: Characterizing re-regulating reservoir conditions and river release temperatures.

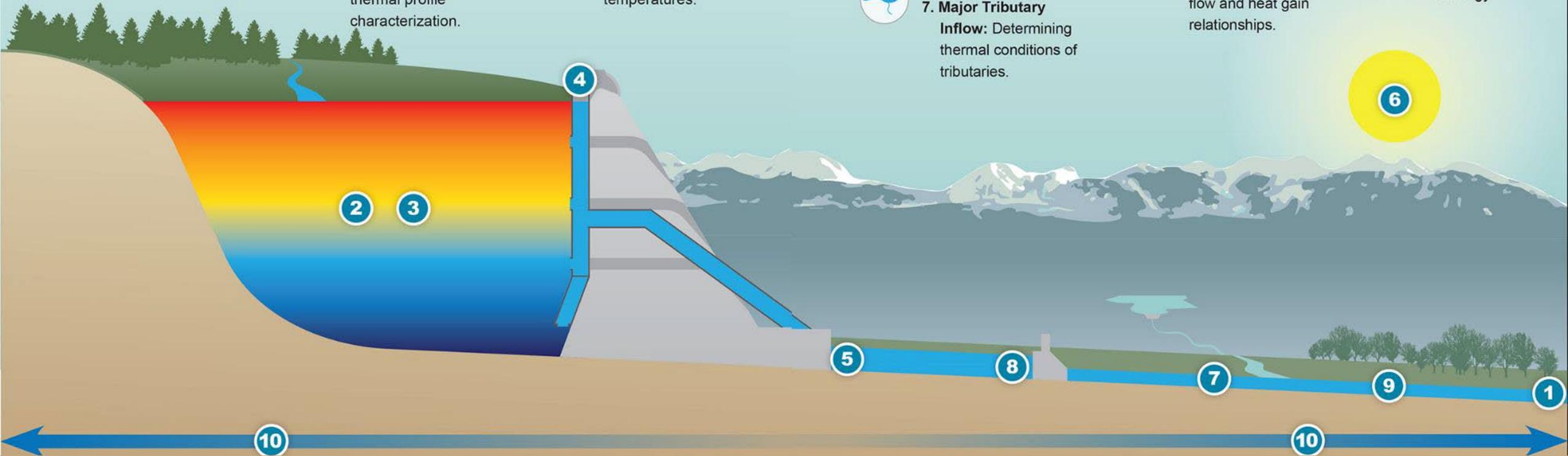


9. River Flow Heat Gain Relationship: Employing river flow and heat gain relationships.

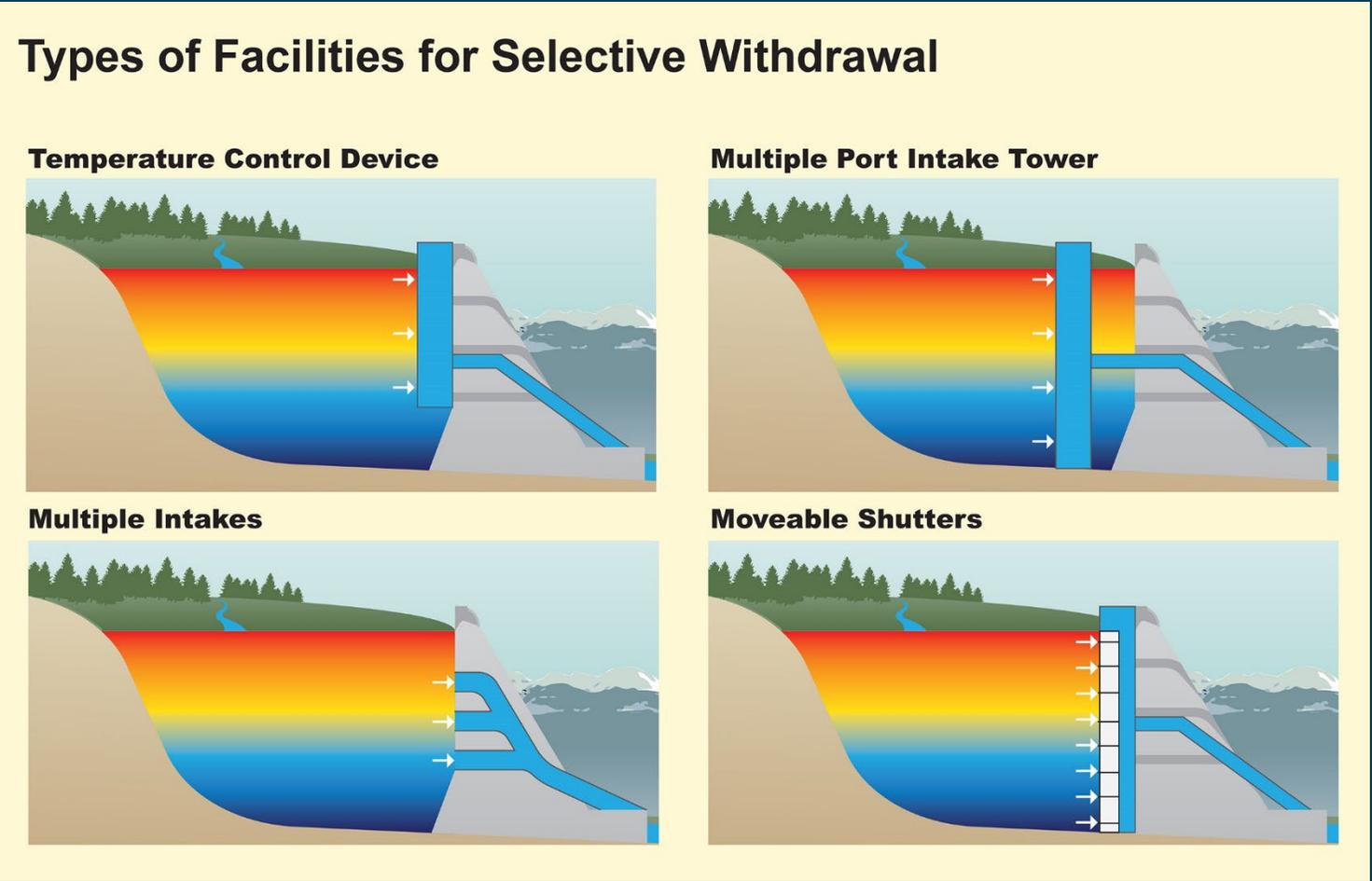
The Methods



10. Monitoring: Using system-wide monitoring network information to assess conditions and adapt the selective withdrawal strategy.



Temperature Management Infrastructure



Shasta TCD

2015

Middle Gate Curtain



Photo credit: Reclamation

Folsom Dam

2015

De-ganging Shutters



Photo credit: Reclamation



Multi-Agency Temperature Management Process


United States Department of the Interior
 BUREAU OF RECLAMATION
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 Sacramento, California 95831
 CVO-400
 WTR-1.10
 MAY - 8 2014

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

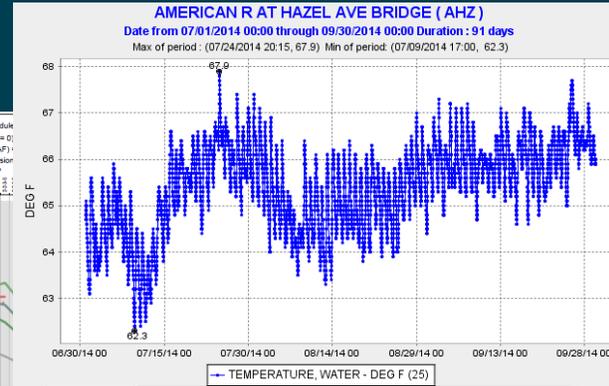
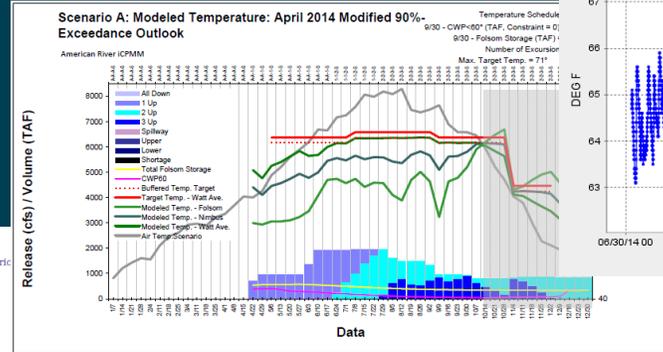
Subject: Draft 2014 American River Temperature Management Plan
 Dear Ms. Rza:

This letter transmits Bureau of Reclamation's (Reclamation) draft annual temperature management plan for the American River for water year 2014. The terms and conditions are 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 (BOP) 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 deliverables 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 (CDFW), 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 (CDWR) 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

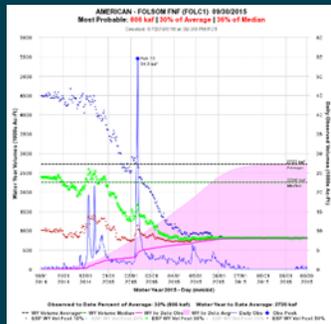
**2. Update
 Plan
 Monthly**

**3. November:
 Complete
 Season**

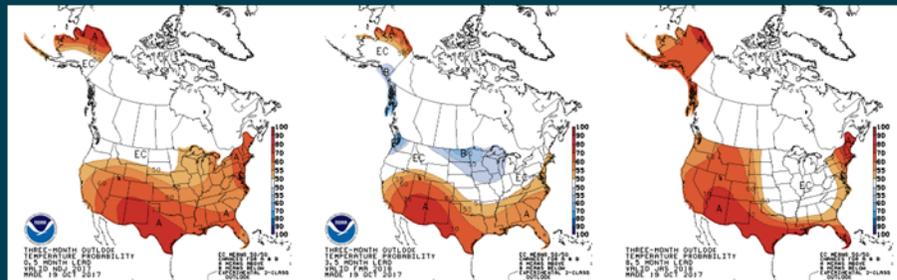


Temperature Modeling – Seasonal Plan

Hydrology Forecast



Long-Term Meteorology Forecast

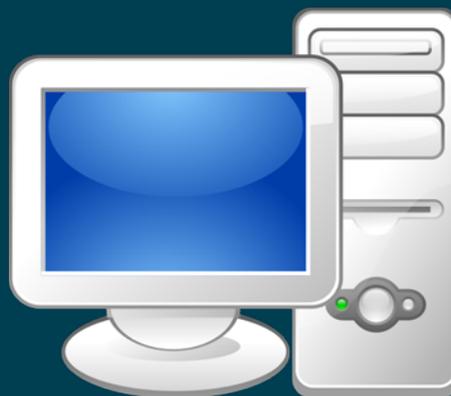
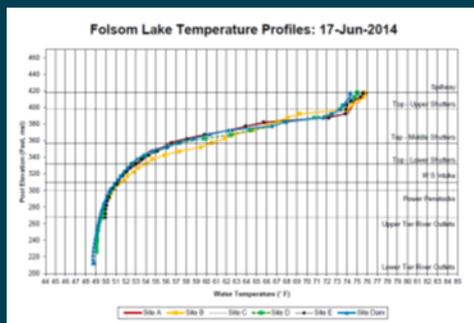


Operation Outlook

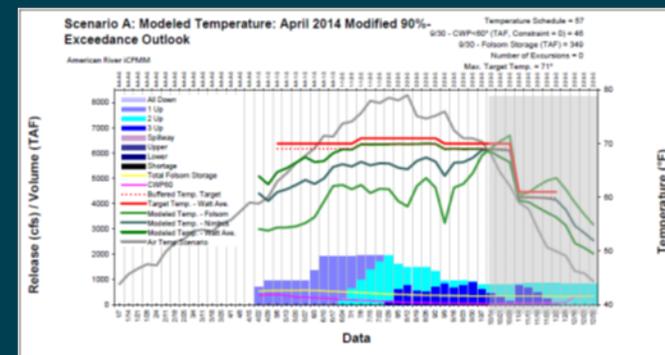
Storages
 Federal End of the Month Storage/Elevation (TAF/Feet)

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	
Trinity	Elev 1461	1869	2664	2227	2232	2175	2639	1854	1738	1716	1677	1708	1772
Whiskeytown	Elev 215	296	296	238	238	238	238	238	238	296	296	296	2325
Shasta	Elev 3546	3323	3538	3848	4078	3884	3687	3354	3235	3129	3168	3251	3548
Folsom	Elev 488	330	593	798	948	962	843	682	643	584	565	554	528
New Melones	Elev 1013	1178	1338	1374	1585	1764	1759	1708	1666	1641	1662	1689	1724
San Luis	Elev 674	768	866	915	784	483	191	20	3	90	254	444	398
Total	Elev 7674	8696	9299	9948	9516	8677	7856	7515	7370	7532	7951	8170	

Boundary/Initial Conditions



Temperature Performance



Modernize Business Practice to Support the CVP Operations

- Expect high quality
- Build trust and confidence
- Optimize flexibility
- Design for compatibilities/efficiencies
- Plan for long-term horizon
- Enhance within agency expertise



Need High Quality

- Objective: Set High Standards
- Requirements:
 - Documentation: Robust - Transparent
 - Assumptions: Explicit
 - Demonstrate Performance: Continuous Testing – How well does the model perform?



Need **Confidence and Trust** - Tools add value and are useful

- Objective: Open process
- <https://www.usbr.gov/mp/bdo/cvp-wtmp.html>
- Requirements:
 - Access: Transparent – Share information
 - Clarify Limitations: Informed consumer/user
 - New Data: Continual Improvements
 - Collaborative Forum: Modeling Technical Committee
 - Demonstrate Performance: Testing
 - Peer Review: Independent evaluation



Need **Flexibility** to respond

- Objective: Design for change
- Requirements:
 - Accessible Model: Modify code and adapt to change
 - Modeling Modes: Address both real-time, seasonal and long-term planning
 - Risk and Uncertainty Assessment: New capabilities



Need **Compatibility and Efficiency** for practical applications

- Objective: Leverage technology
- Requirements:
 - Framework: Robust structural organization/compatibility
 - Model Setup and Organization: Consistency
 - Data Management: Essential
 - Streamline Procedures: Ease of use and error reduction
 - Apply time saving techniques: Automate tasks when appropriate
 - Modeling Modes: Address both real-time, seasonal and long-term planning



Need to Build Tools for **Longer-term Use** with Stable Support

- Objective: Adapt to current funding and contracting constraints
- Requirements:
 - Design for Change: Anticipate future needs
 - Build Institutional Knowledge: Empower staff



Need to develop **Expertise**

- Objective: Broaden knowledge and technical capability
- Requirements:
 - Communication: Share information
 - Investment: Build knowledge base
 - Organization capacity building: Empower staff



Vision for WTMP Project

Goal: Deliver quality products to support Reclamation's mission – predict water temperature to support CVP operations and planning studies

- Modernize Systemwide Water Temperature Modeling and Analytics
- Develop to Professional Standards – foster transparency
- Consistency cross uses: Real-Time, Seasonal, and Long-term Planning
- Accommodate technological advancements



WTMP Team

- Reclamation staff:
 - Bay Delta Office
 - Central Valley Operations Office
- Contracted services:
 - Watercourse, RMA, Cardno now part of Stantec, Eyasco, Camara, and Stantec
- Modeling Technical Committee (MTC):
 - Interested Agencies, Stakeholders, and Individuals

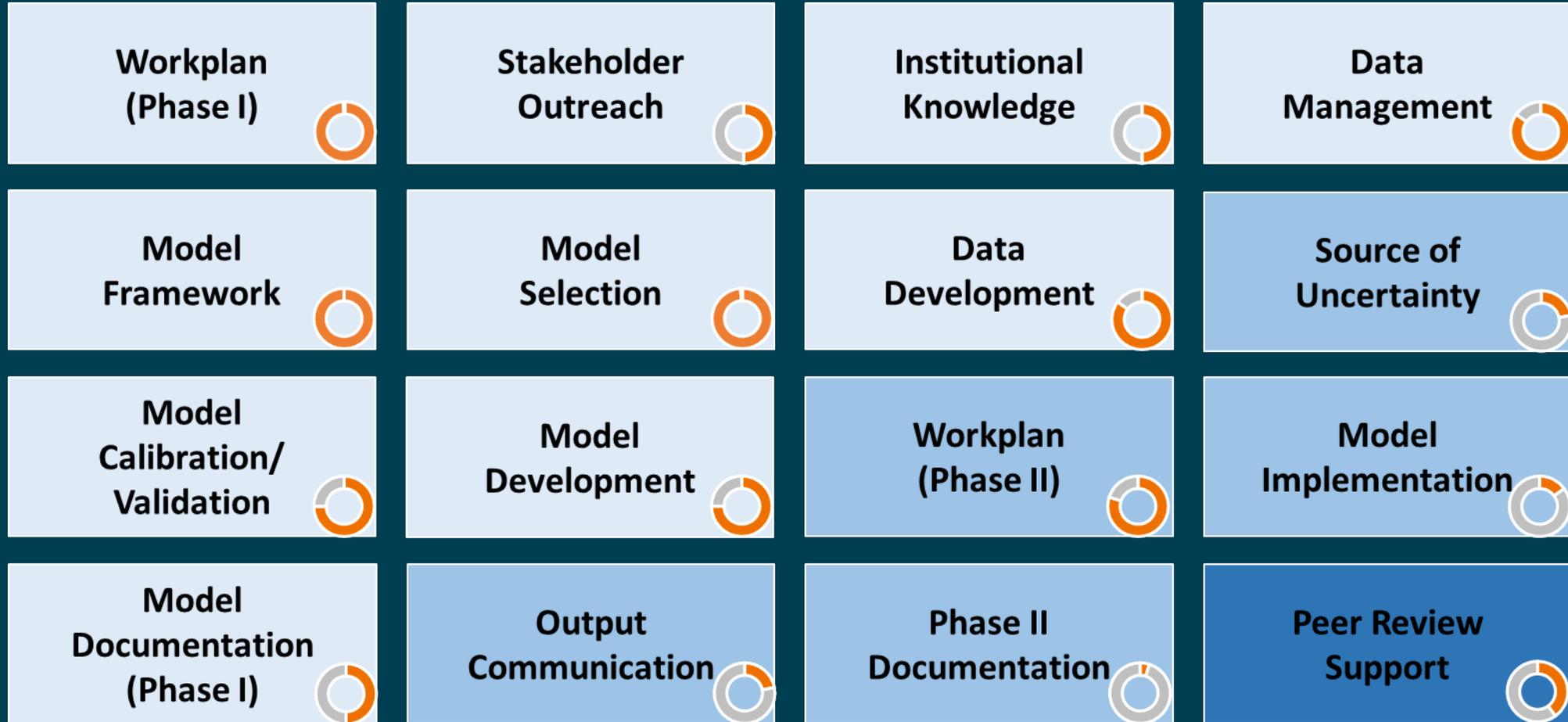


Collaborative Model Development Approach

- Working hypothesis - Approach fosters:
 - Confidence
 - Transparency and trust
 - Problem solving synergy
 - A better model application
- Modeling Technical Committee (MTC):
 - Consistent "open forum" engagement
 - Timely project product review as available (Quarterly meetings)
 - Sub-group breakout meetings
 - Constructive input and comments
 - Future technical user group



Project Tasks



Phase I

Phase II

Peer Review



Phase I Activities

Task	Objective
Task 1. Project Workplan	Develop workplan and schedule for the overall modeling project with emphasis on Phase I – Task 1 through Task 10
Task 2. Stakeholder Involvement and Outreach	Outreach activities
Task 3. Develop Reclamation's Institutional Knowledge	Technology transfer
Task 4. Data Management	Develop data management plan for Phases I and II of project
Task 5. Model Framework Design and Refinement.	Develop a system-wide model framework for use throughout project area
Task 6. Model Selection/Design	Select models for each of the elements of the framework
Task 7. Data Development	Identify necessary input data to models and obtain necessary data
Task 8. Model Development	Develop and revised or refined models
Task 9. Calibration, Validation, and Sensitivity	Calibrate and validate models
Task 10. Documentation Phase I	Documentation of Phase I model development



Phase II Activities

Task	Objective
Task 11: Phase II Workplan	Develop a detailed workplan and schedule for Phase II – Task 11 through Task 17
Task 12: Implementation	Determine schedule for downstream/in-river simulation, real time/seasonal, and planning applications
Task 13: Estimation of Uncertainty – Sources	Develop and communicate <u>sources</u> of uncertainty in estimates of water temperature downstream of regulating reservoirs.
Task 14: Estimation of Uncertainty – Protocols	Develop and communicate <u>protocols</u> for estimating uncertainty bounds in estimates of water temperature downstream of regulating reservoirs. Task 14 will be combined with Task 13
Task 15. Output Communication	Develop output communication/visualization tools and data presentation approaches
Task 16: Documentation – Phase II	Documentation of Phase II activities
Task 17. Peer Review	Provide support for peer review of model components and overall framework.



WTMP Schedule

Topic	7/21	10/21	1/22	4/22	7/22	10/22	1/23	4/23	7/23	10/23
MTC Orientation	●	-	-	-	-	-	-	-	-	-
Project Purposes, Goals, Anticipated Outcomes	●	●	-	-	-	-	-	-	-	-
Modeling Framework Selection	●	●	●	●	●	-	-	-	-	-
Water Temperature Model Selection	●	●	●	-	-	-	-	-	-	-
Consistency between System Model and Detailed Models	-	●	●	●	-	-	-	-	-	-
Common Model Preparation and Considerations	-	●	●	-	-	-	-	-	-	-
Sacramento/Trinity River Water Temperature Model	-	-	●	●	●	●	-	-	-	-
American River Water Temperature Model	-	-	-	●	●	●	●	-	-	-
Stanislaus River Water Temperature Model	-	-	-	-	●	●	●	●	-	-
Modeling Framework Implementation	●	-	●	-	-	●	-	-	-	-
Phase II Activities	-	-	-	-	●	●	●	●	●	●
Peer Review	-	-	-	-	●	-	-	-	●	-

Project and Peer Review Philosophy

- **WTMP Project:**
 - Modernization of existing tools improves process workflow, reduce error, and afford enhanced communications for better decision making
 - Collaboration will build trust through development
 - Leverage the advantages of a using a Framework
 - Evaluating uncertainty better informs interpretation of results
 - Broad expertise promotes confidence and sustainability
- **Independent Peer Reviews:**
 - Strengthen confidence and enhance products with Mid-Term and Final reviews



Project Process Documentation

- Water Temperature Modeling Platform Project Workplan

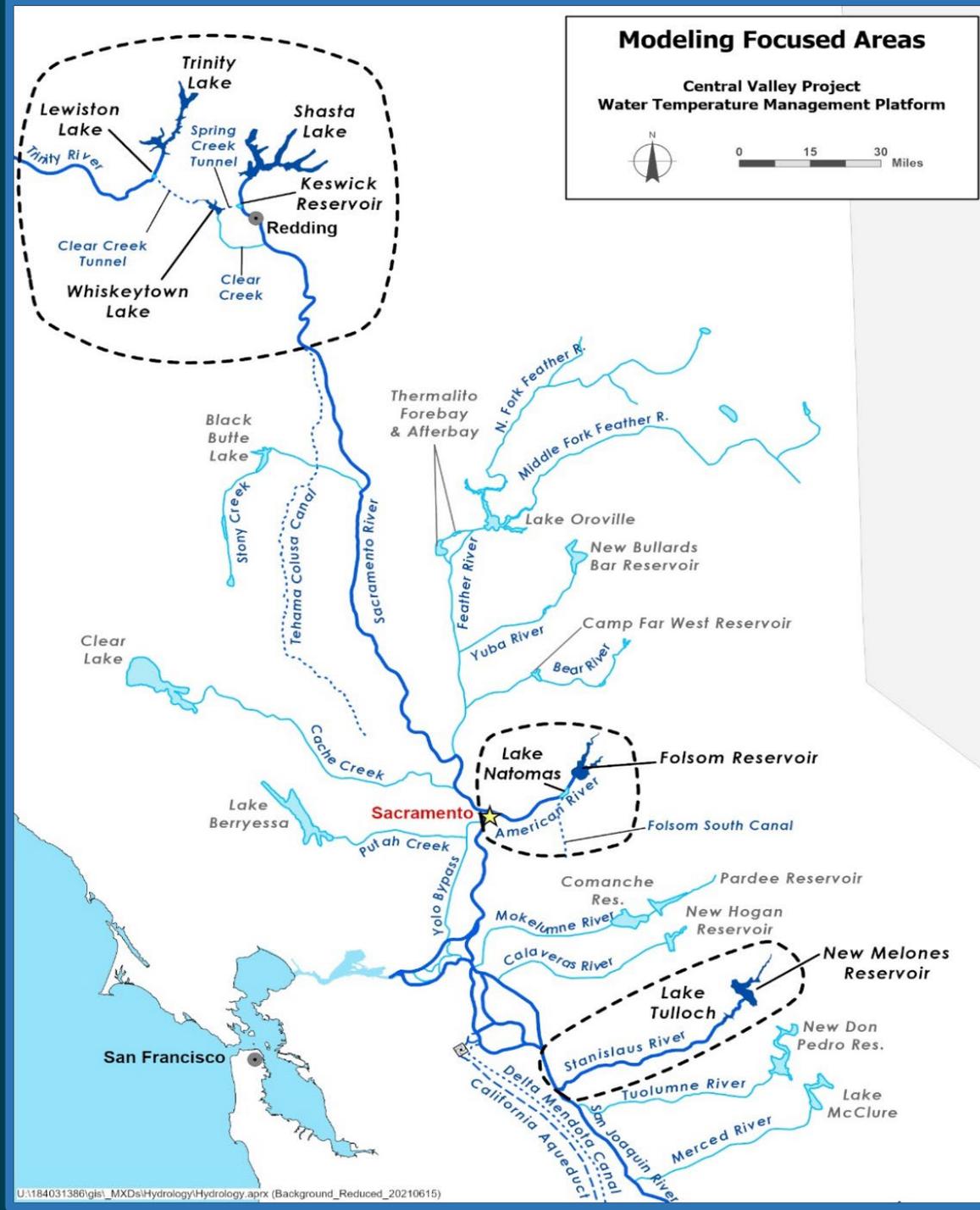


Overall Documentation Philosophy

- Target replication of methods and model results:
 - Robust
 - Transparent assumptions
 - Detailed
- Guidance:
 - EPA https://www.epa.gov/sites/default/files/2015-04/documents/cred_guidance_0309.pdf
 - CWEMF <https://cwemf.org/wp/wp-content/uploads/2021/11/Modeling-Protocols-Report-Final-11-19-2021.pdf>



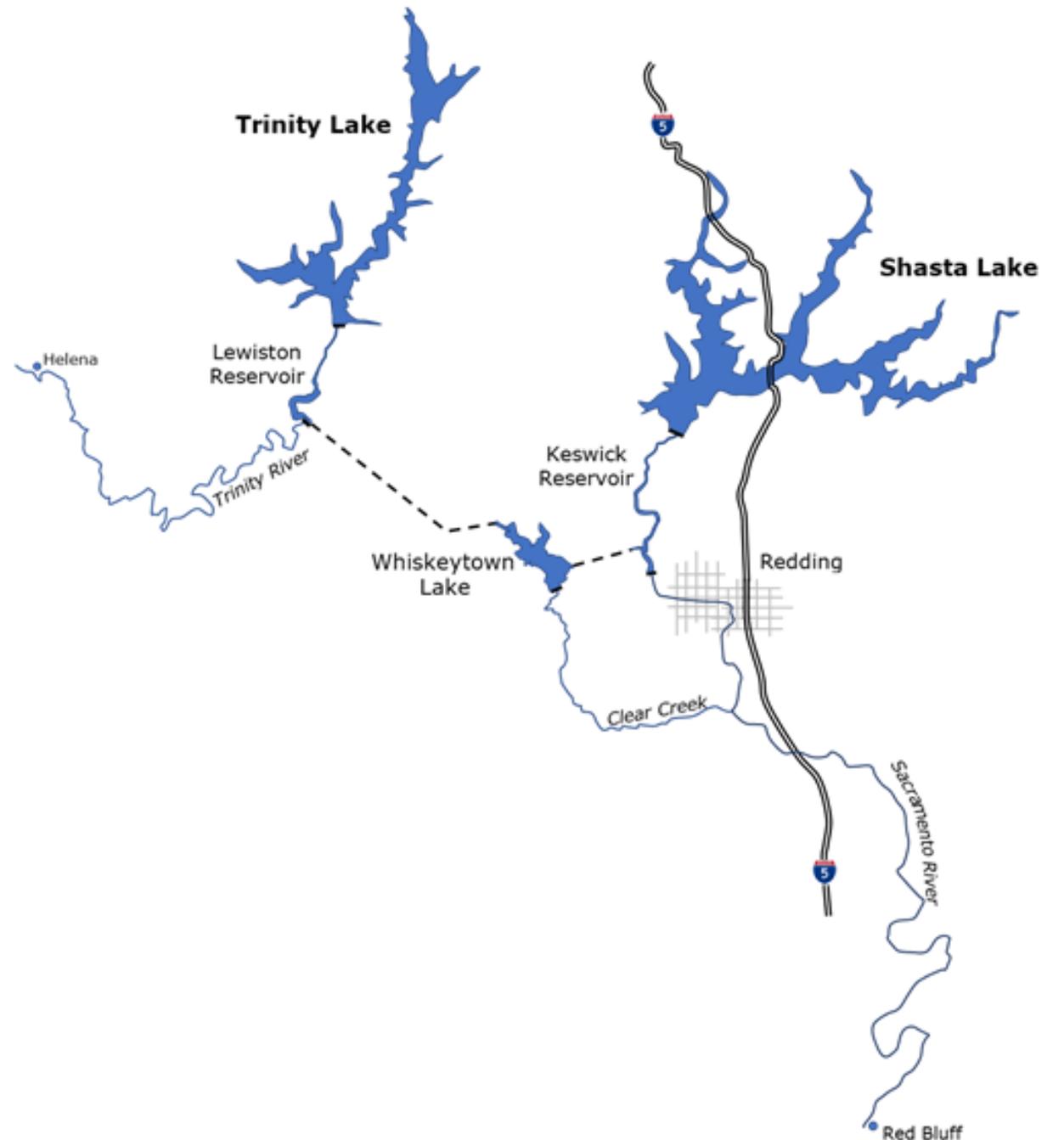
WTMP Model Domain



WTMP Model Domain

Sacramento/Trinity River System

- Trinity Lake to Helena
- Whiskeytown to Clear Creek confluence
- Lake Shasta to Red Bluff



WTMP Model Domain

American River System

- Folsom Reservoir to American River confluence



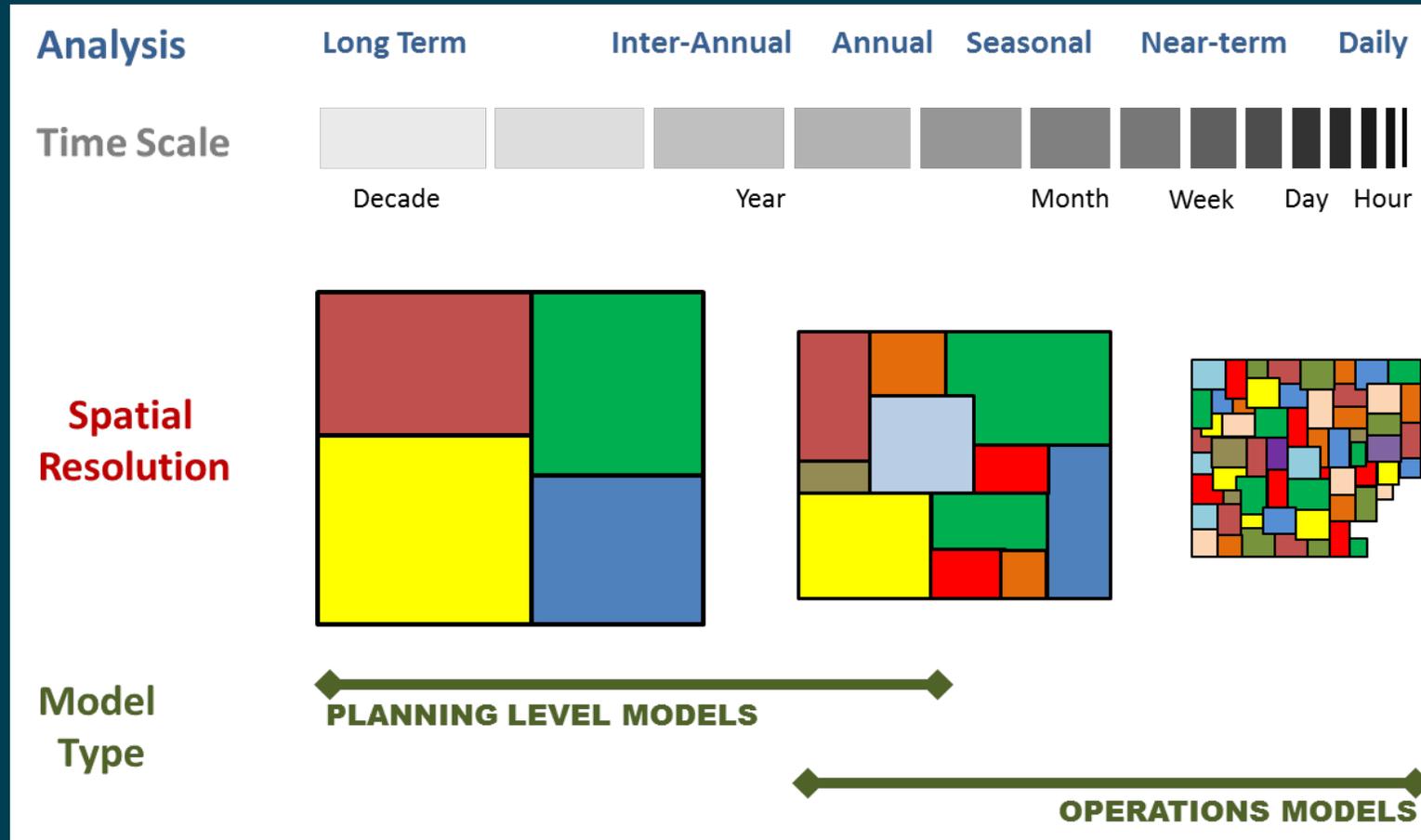
WTMP Model Domain

Stanislaus River System

- New Melones Reservoir to San Joaquin River confluence

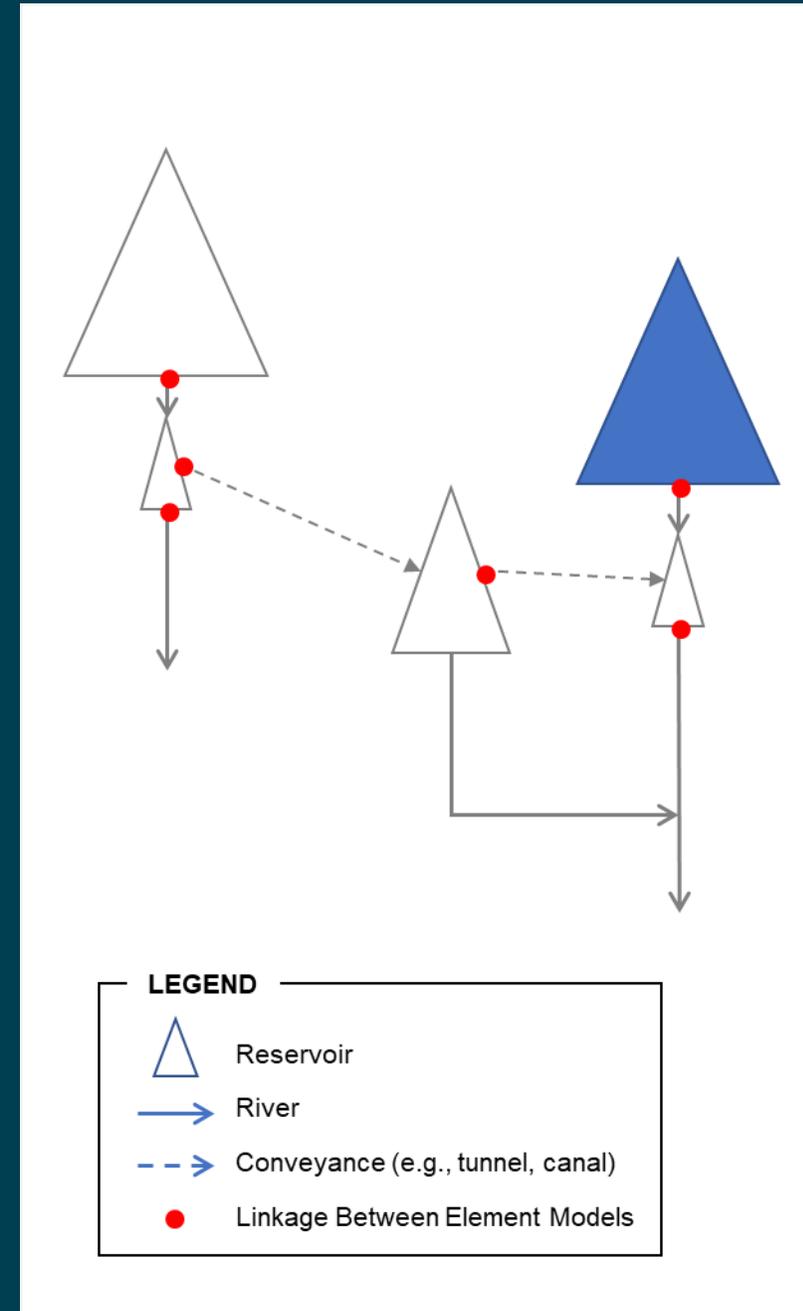


Model Spatial and Temporal Considerations



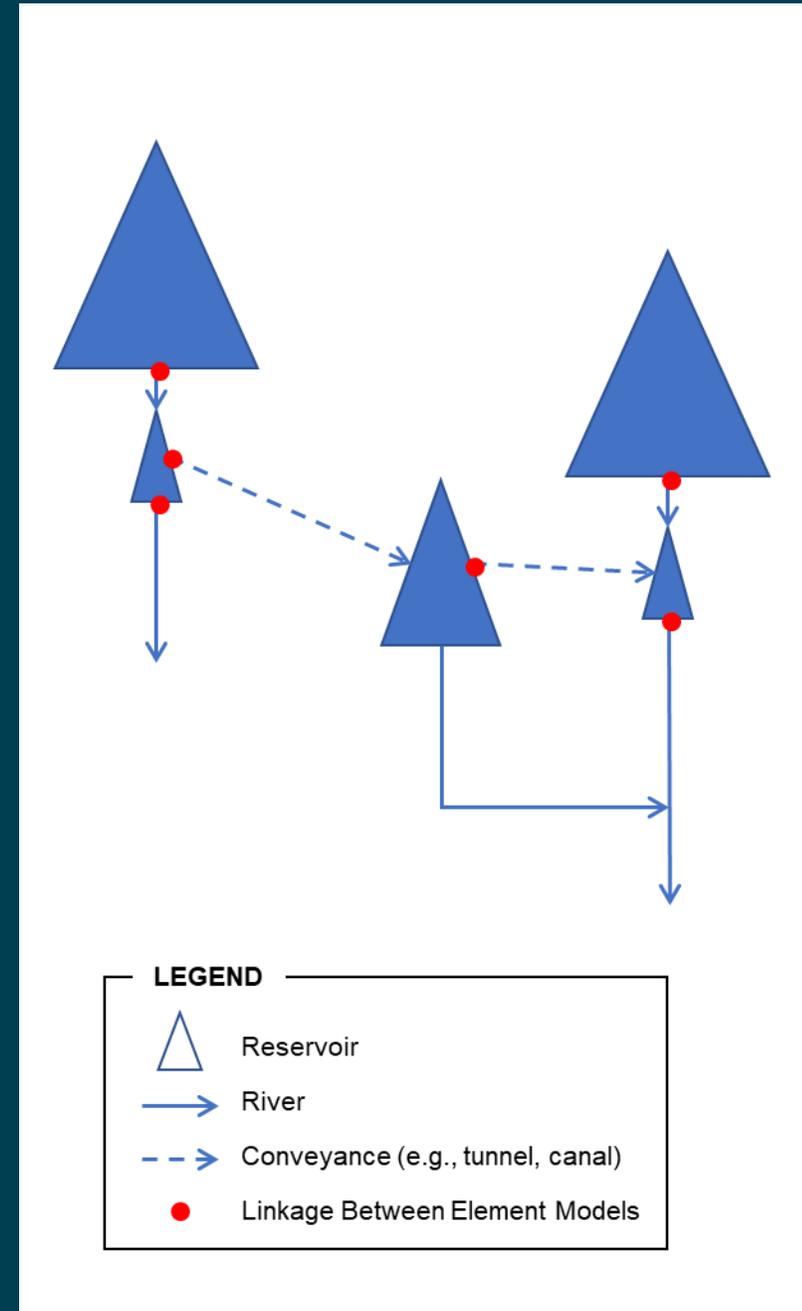
Model Type – Element Model

- Represents one element of a multi-component system.
 - Statistical Model
 - Physically Based Model



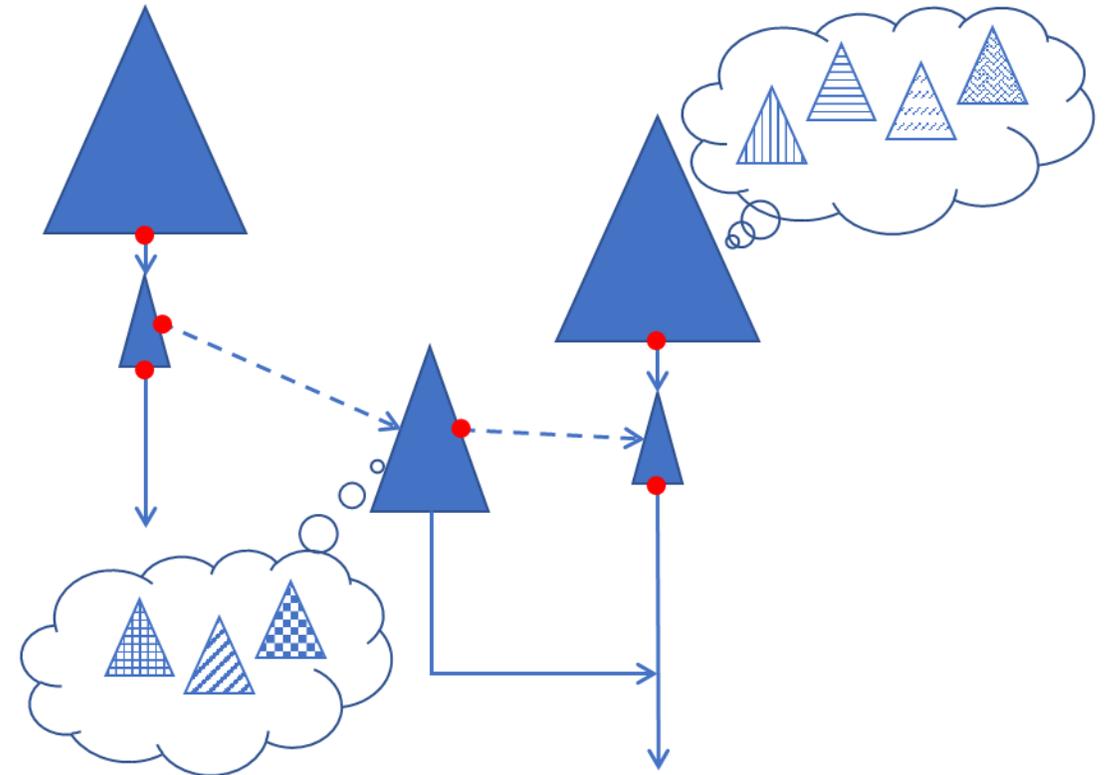
Model Type – Modeling System

- Composed of individual element models
 - Same time-step
 - Solved simultaneously
 - Fixed solution scheme



Model Type – Modeling Framework

- Integrated use of individual or multiple element models
 - Ability to “turn on or off” models
 - Customizable
 - Information sharing links
 - Model integrity and consistency



LEGEND

-  Reservoir
-  River
-  Conveyance (e.g., tunnel, canal)
-  Linkage Between Element Models

WTMP Development is On-Going

- Work products are preliminary and will be finalized at the end of the project
- **Mid-Term Peer Review Summer 2022**
 - Phase I – Shasta/Keswick
 - Request to Panel: Identify improvements to data development, calibration/validation process, and representation of the system
 - WTMP action: Address suggestions within scope of project and identify opportunities for future efforts
- **Final Peer Review Summer 2023**
 - Phase I – Trinity, Whiskeytown, American, and Stanislaus
 - Phase II – Model Application



On-Going Research

- Reclamation's Science and Technology Grant Program:
 - Evaluating Water Temperature Modeling and Prediction in the Sacramento River Basin
 - Evaluate existing meteorological forecasting methods and skill
 - Test new methods to improve meteorological inputs and inflow temperature
- Delta Stewardship Council: Pending
 - Shasta TCD local flow patterns
 - ADCP and ADVP testing



Temperature Models and Climate Variability

- **How is the WTMP addressing this?**
 - Model Selection: Numerical Model Criteria
 - Physically based models
 - Sensitivity testing
 - Model Development: Planning Level Model
 - Climate variability and sea level rise assumptions
 - Routine model performance assessment
 - Phase II
 - Re-calibration of models



Presentation Layout

- Morning discussion covers the fundamentals of the model development effort:
 - **Phase I**
 - Model Framework Selection
 - Model Selection
 - Data Management
- Afternoon discussion highlights Shasta/Keswick implementation:
 - **Phase I**
 - Data Development
 - Model Development, Calibration and Validation

