Photo credit: John Hannon, Reclamation

Model Development: Geometric Representation, Boundary, and Initial Conditions

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Reclamation, Bay Delta Office

Model Development Outline

- Sacramento/Trinity River System
    - Geometric Representation
    - Boundary Conditions
    - Initial Conditions

- American River System
    - Geometric Representation
    - Boundary Conditions
    - Initial Conditions

- Stanislaus River System
    - Geometric Representation
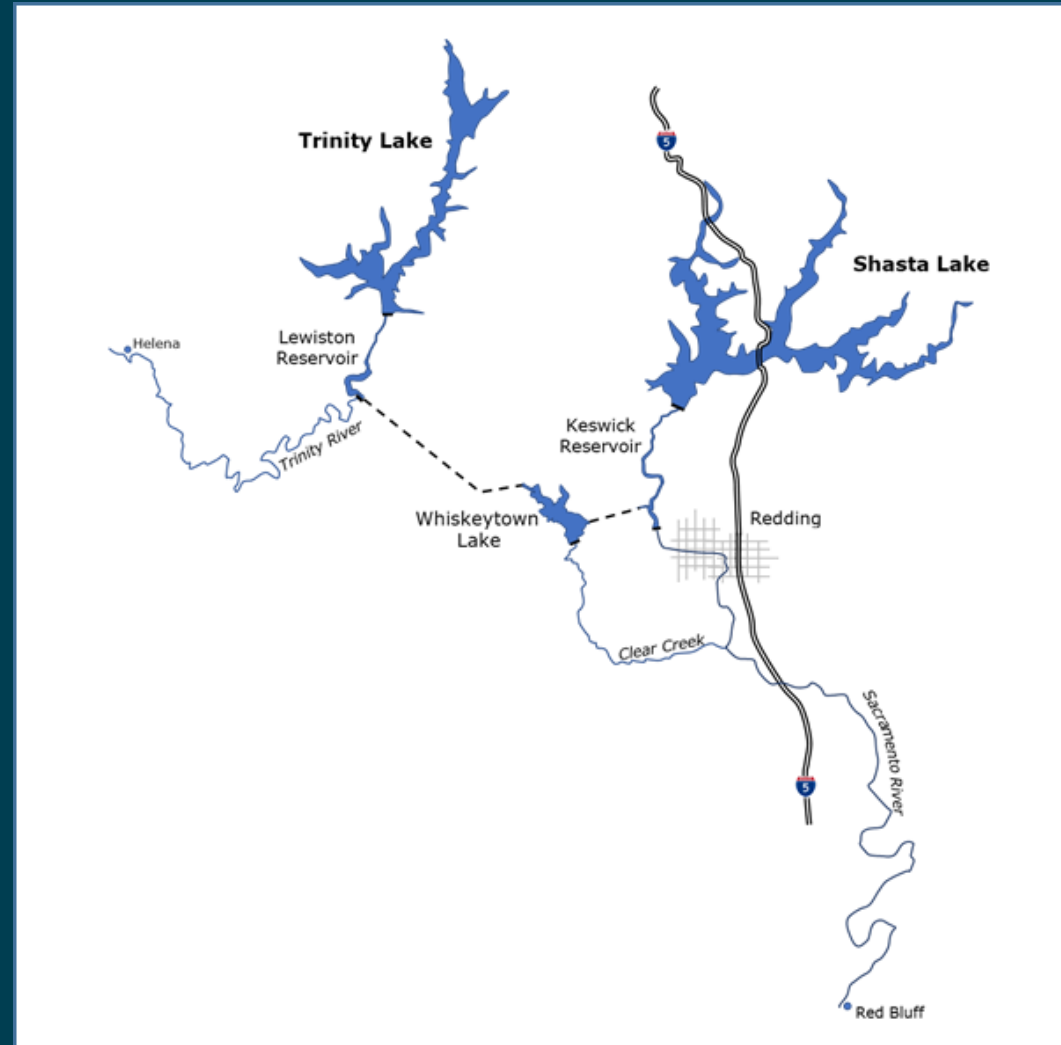   - Boundary Conditions
    - Initial Conditions

Sacramento/Trinity River System

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

Trinity Lake Geometric Representation

- **Crest of dam elevation**
  - 2,395 feet (730.0 meters)
- **Full pool elevation**
  - 2,387 feet (727.6 meters)
- **Total storage**
  - 2,448,000 acre-feet
    (about 3.02x109 m^3)
- **Surface area**
  - 17,690 acres (7,159 hectares)
- **Top of conservation pool**
  - 2,370 feet (722.4 meters)

Source: Reclamation

Trinity Lake CE-QUAL-W2 Geometry
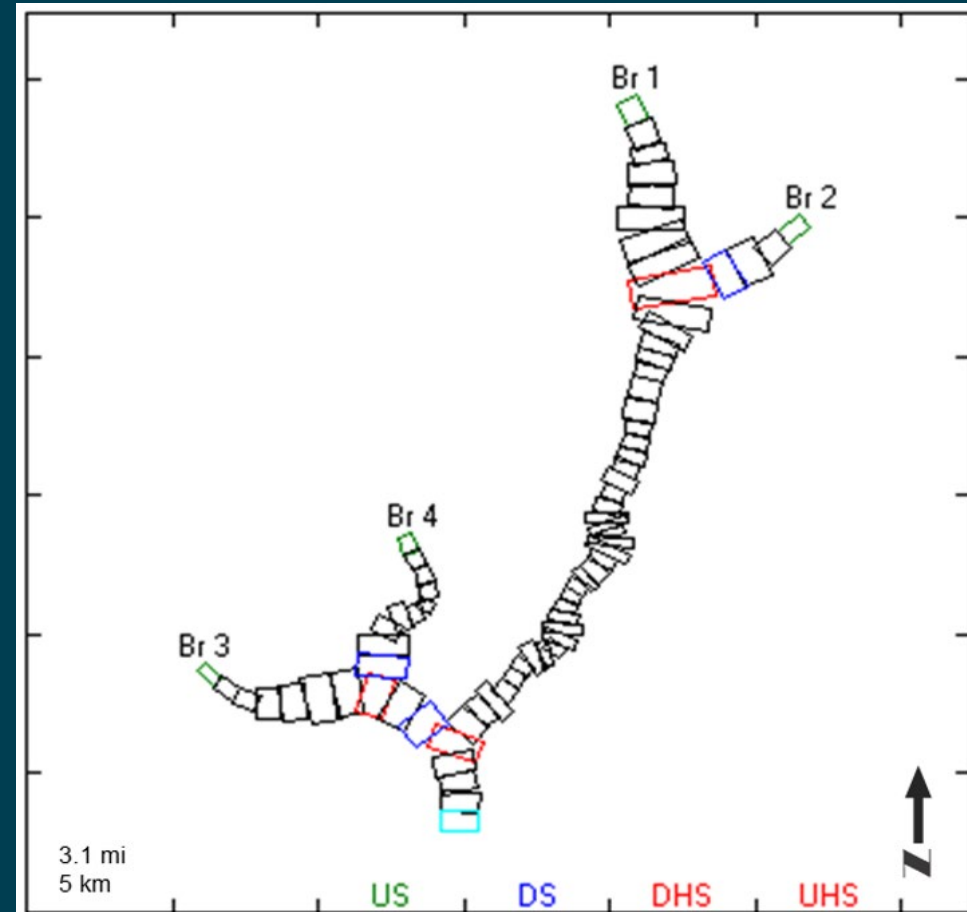
- **Trinity Lake Model**
  - **Four branches**
    - Branch 1: Trinity River
    - Branch 2: East Fork Trinity River
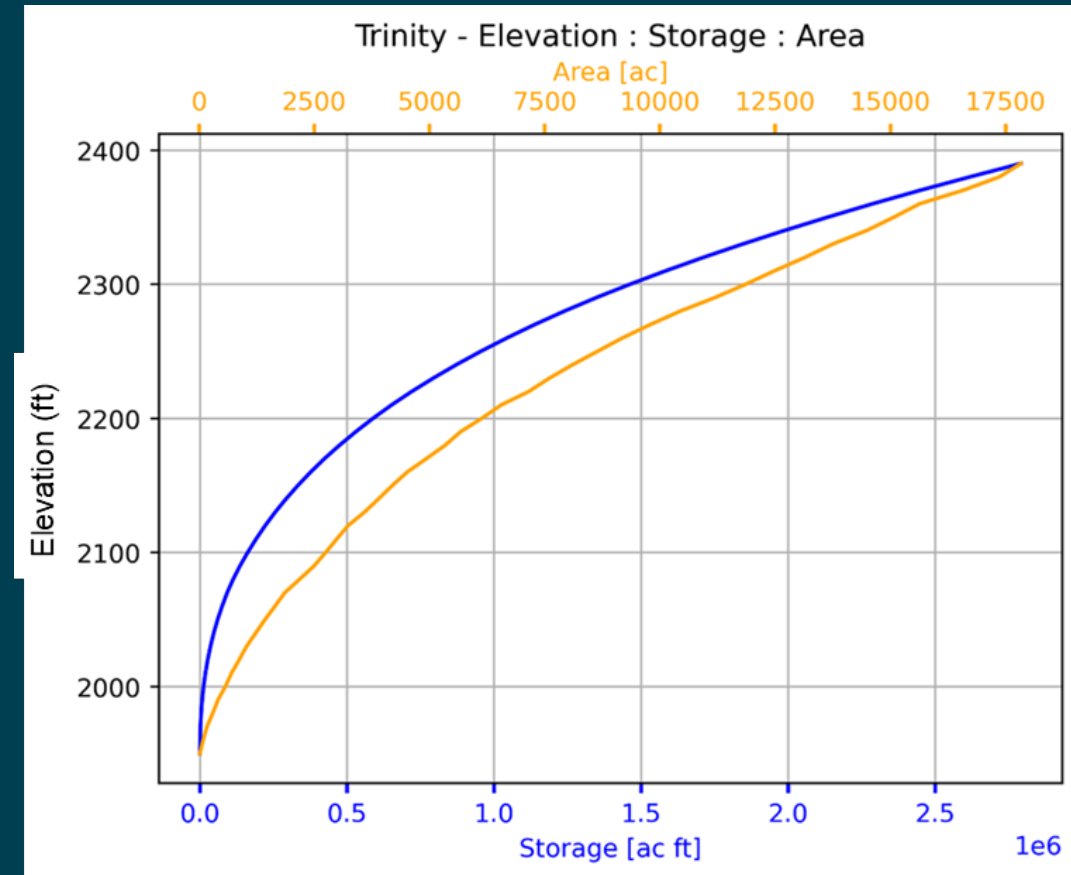   - Branch 3: Stuart Fork
    - Branch 4: East Fork Stuart Fork
  - **Layer thickness: 1 meter**
  - **Maximum number of layers: 135**

Trinity Lake ResSim Geometry

- 147 horizontal layers

- Uniform 3.0 feet (0.91 meter) thickness

- Infrastructure
  - Spillway: 2,370 feet (722.4 meters)
  - Powerhouse intake: 2,100 feet (640.1 meters)
  - Powerhouse bypass: 1995.5 feet (608.2 meters)

Lewiston Lake Geometric Representation

- **Crest of dam elevation**
  - 1,910 feet (582.2 meters)
- **Full pool elevation**
  - 1,902 feet (579.7 meters)
- **Total storage**
  - 14,660 acre-feet (about 3.02×10^9 m^3)
- **Surface area**
  - 750 acres (303.5 hectares)
- **Temperature Control Curtain**
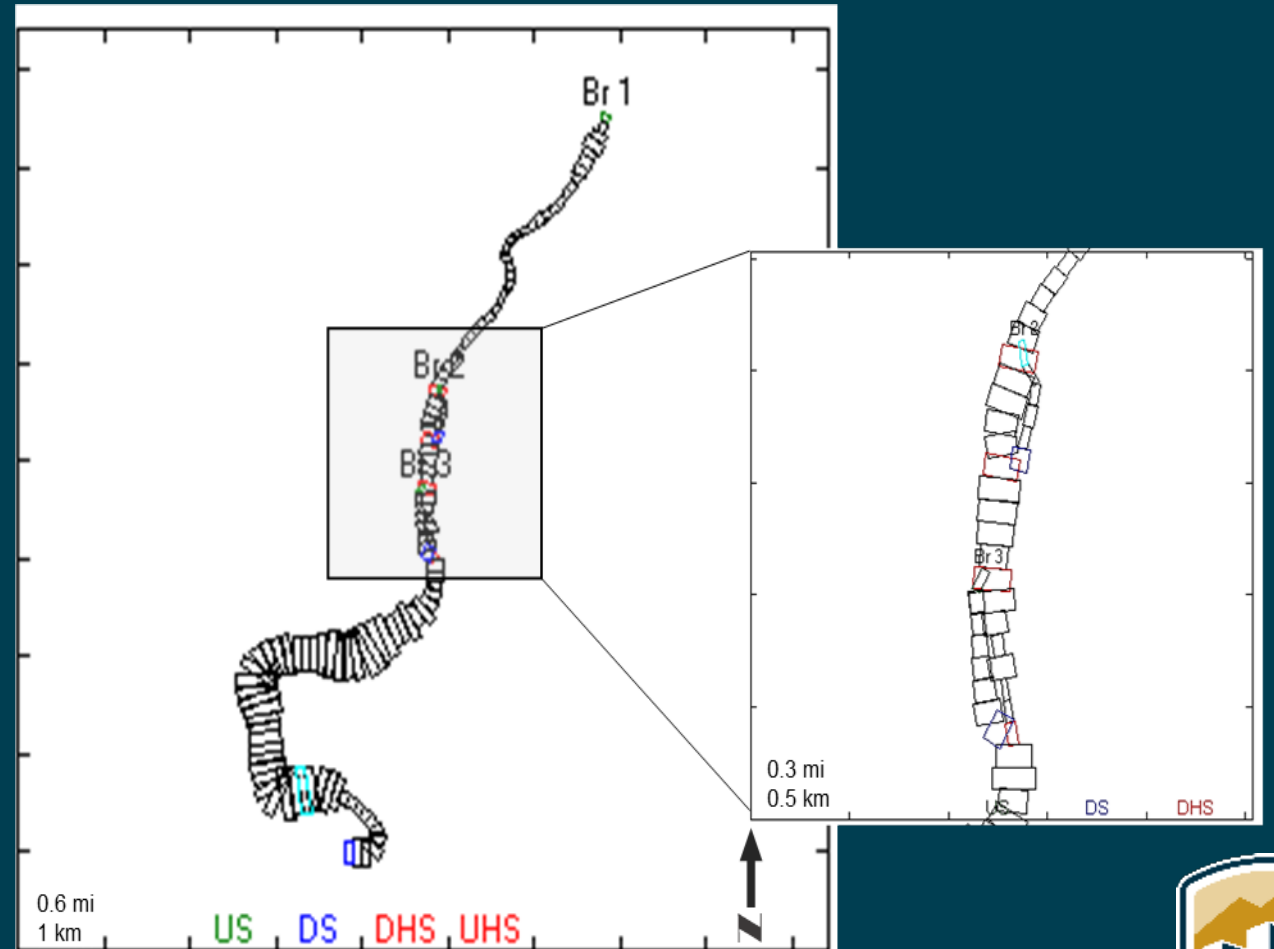

Source: Reclamation

Lewiston Lake CE-QUAL-W2 Geometry

- **Lewiston Lake Model**
  - **Three branches**
    - Branch 1: Lewiston Lake
    - Branch 2: Side Channel 1
    - Branch 3: Side Channel 2
  - **Layer thickness: 0.5 meters**
 - **Maximum number of layers: 50**

Lewiston Lake ResSim Geometry

- **24 horizontal layer**
- **Uniform 3.0 feet (0.91 meters) thickness**
- **Infrastructure**
  - Spillway: 1,874.5 feet (571.4 meters)
  - Clear Creek Tunnel: 1,898 feet (578.5 meters)
  - Powerhouse intake: 1,874.5 feet (571.4 meters)
  - Fish hatchery intake: 1,840 feet (560.8 meters)

Lewiston - Elevation : Storage : Area
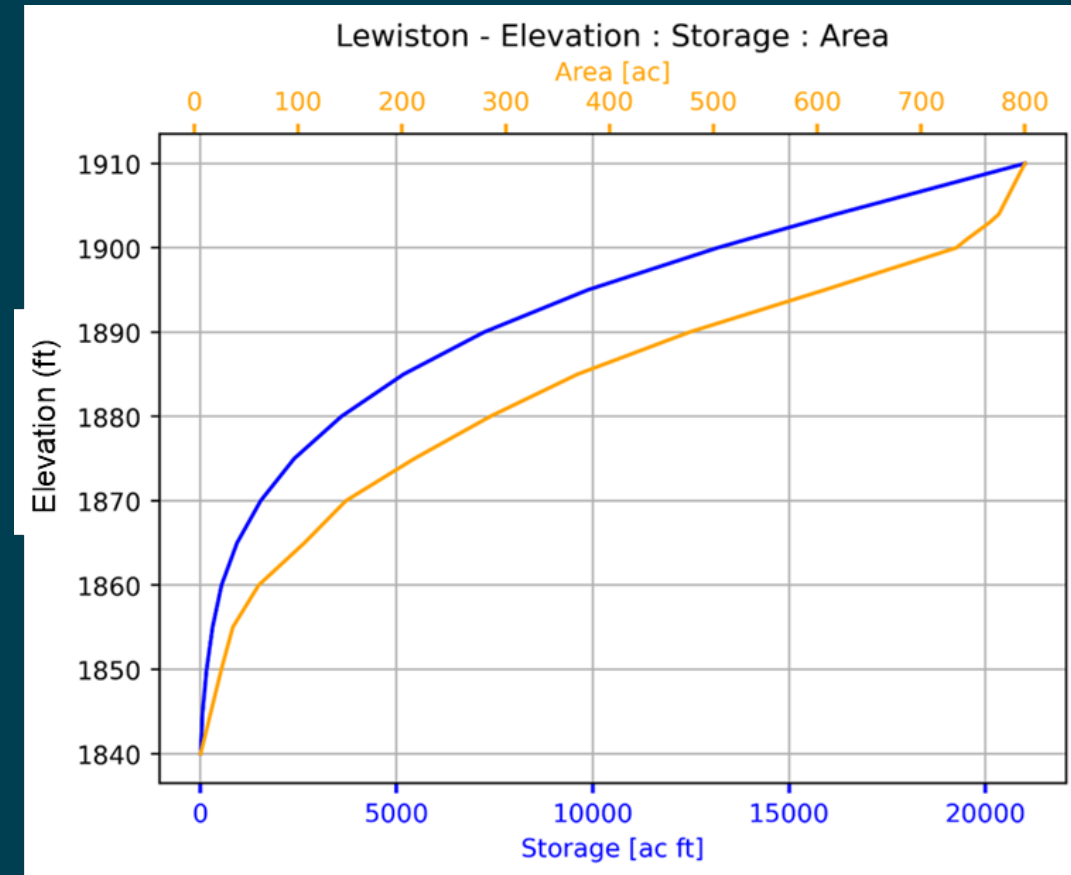
Trinity River ResSim Representation

- Lewiston Dam to the confluence with the North Fork Trinity River at Helena
- 14 junctions
- 13 reaches
- Reach lengths: 2,500 to 3,500 feet (792 to 1,067 meters)
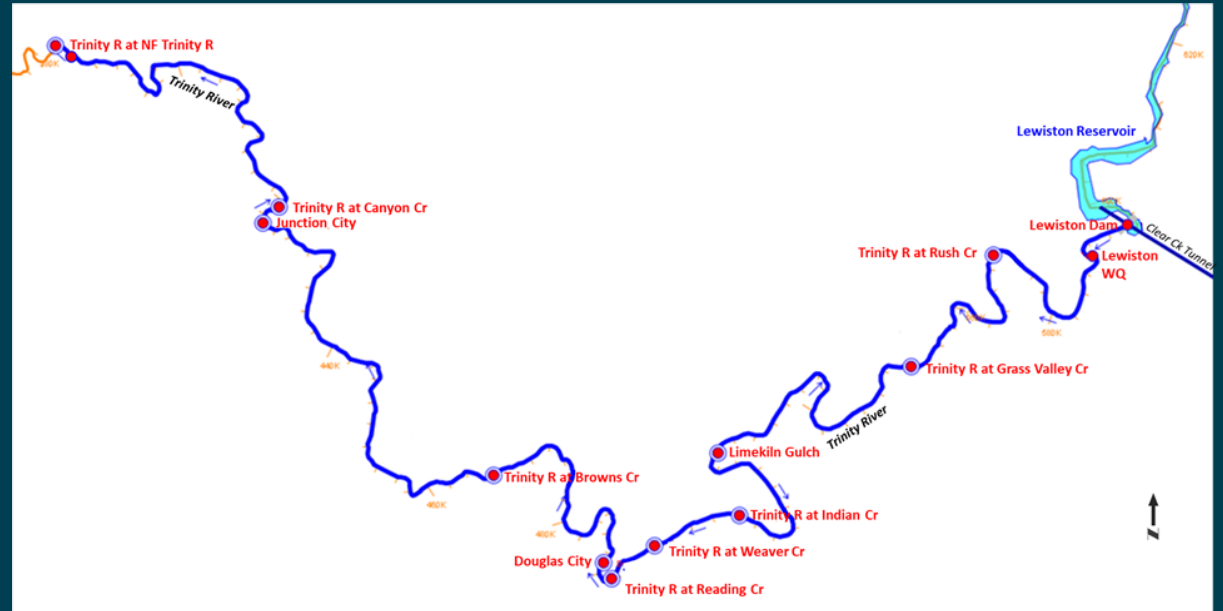
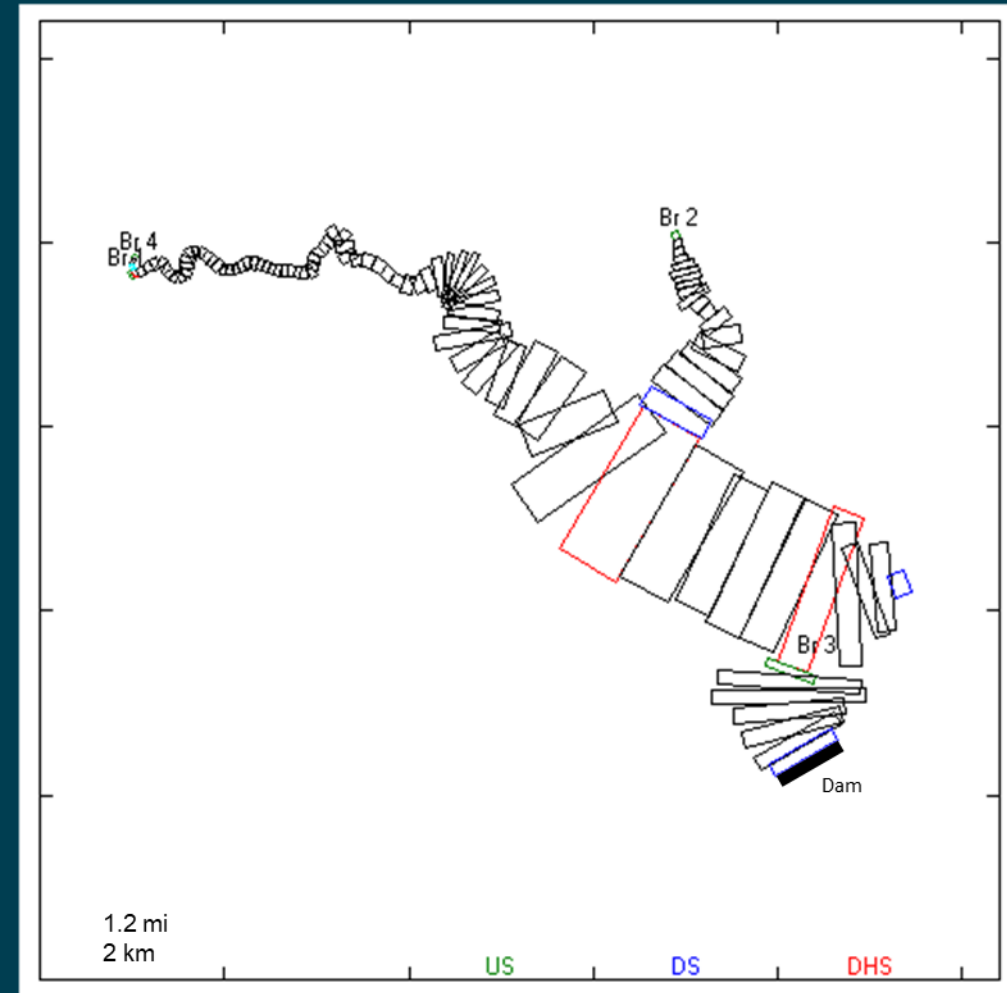# Whiskeytown Lake Geometric Representation

- Crest of dam elevation
  - 1,228 feet (374.3 meters)
- Full pool elevation
  - 1,210 feet (368.8 meters)
- Total storage
  - 274,389 acre-feet (about 338.5×10^6 m^3)
- Surface area
  - 3,459 acres (1,400 hectares)
- Temperature Control Curtains

Source: Reclamation

Whiskeytown Lake CE-QUAL-W2 Geometry

- **Whiskeytown Lake Model**
  - **Four branches**
    - Branch 1: Whiskeytown Lake
    - Branch 2: Whiskey Creek arm
    - Branch 3: Whiskeytown Dam arm
    - Branch 4: Clear Creek arm
  - **Layer thickness: 1 meter**
  - **Maximum number of layers: 73**

Whiskeytown Lake ResSim Geometry

- 82 horizontal layers

- Uniform 3.0 feet (0.91 meters) thickness

- Infrastructure
  - Spillway: 1,211 feet (369.1 meters)
  - Spring Creek Tunnel: 1,905 feet (333.8 meters)
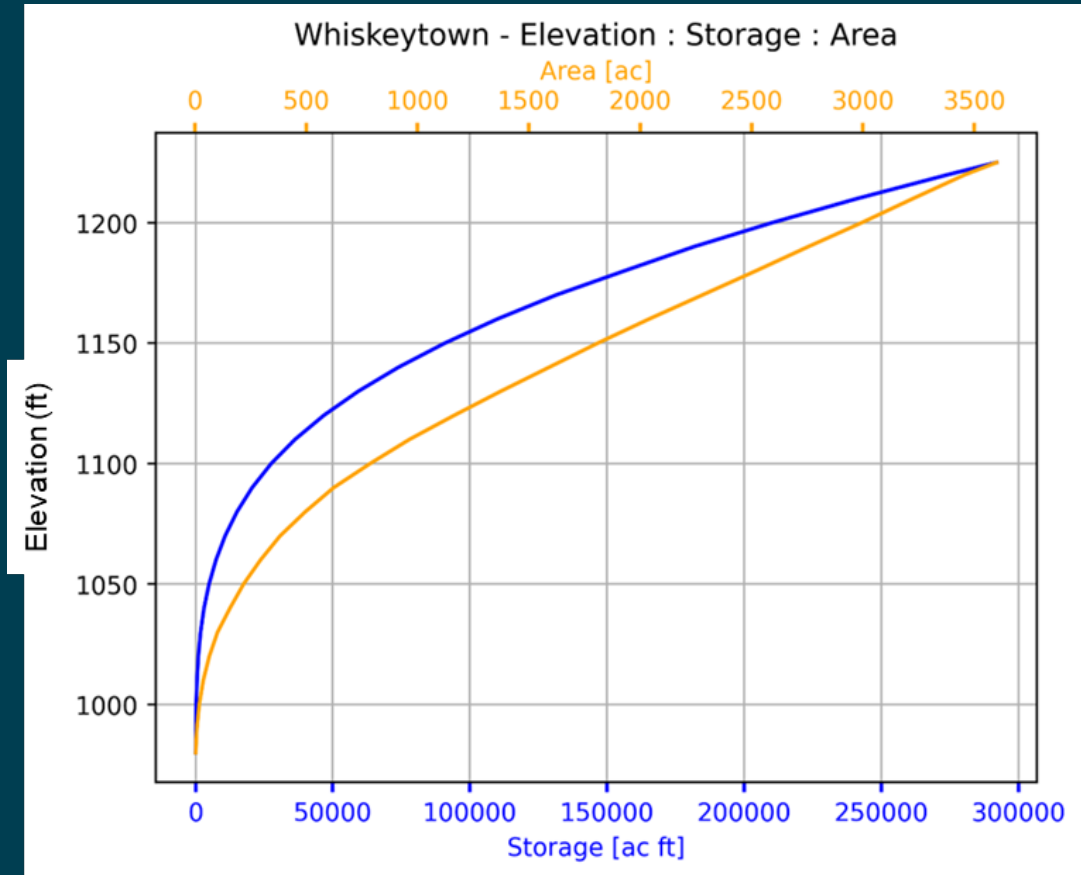
Clear Creek ResSim Representation

- **Whiskeytown Dam to the confluence with the Sacramento River**

- **3 junctions**

- **2 reaches**

- **Reach length: 3,500 feet (1,067 meters)**

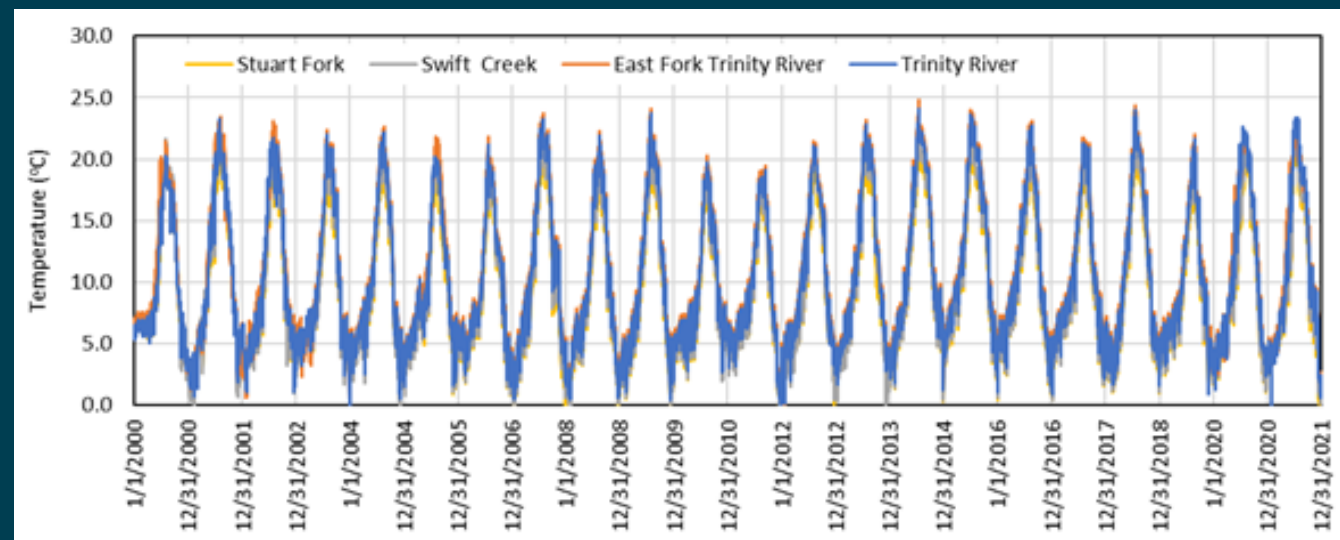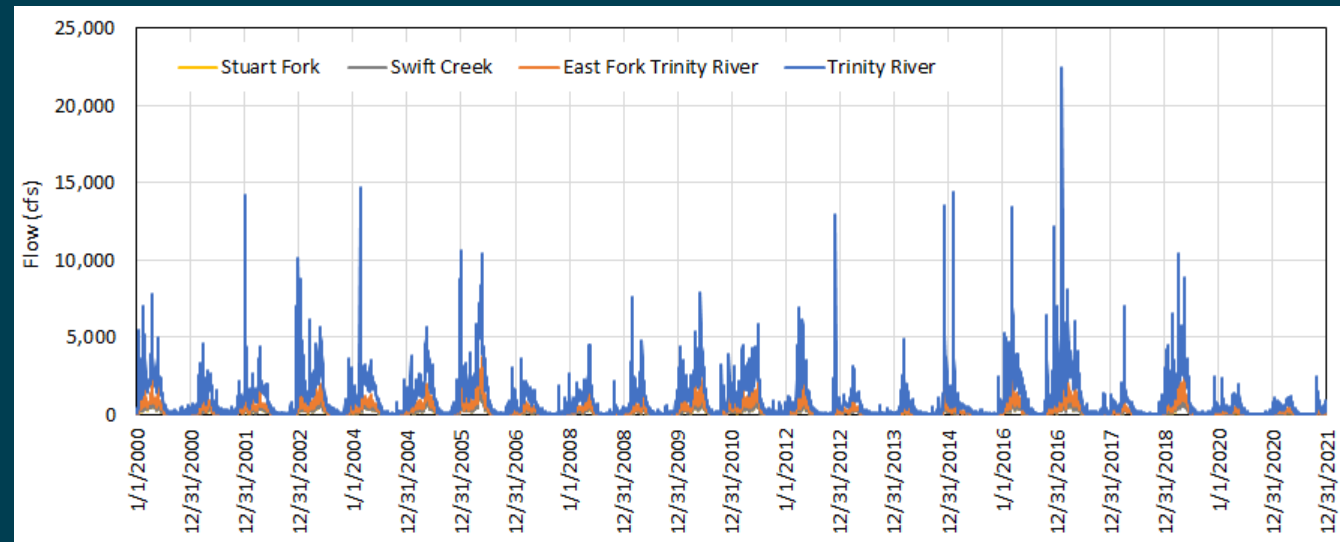# Boundary Conditions: Trinity Lake

Boundary Condition	Type	Flow	Temperature	Note/Source
Trinity River	Inflow	Measured (d)	Estimated (d)	Reclamation (2022b)
East Fork Trinity River	Inflow	Estimated (d)	Estimated (d)	Reclamation (2022b)
Swift Creek	Inflow	Estimated (d)	Estimated (d)	Reclamation (2022b)
Stuart Fork	Inflow	Estimated (d)	Estimated (d)	Reclamation (2022b)
East Fork Stuart Fork	Inflow	Estimated (c)	Estimated (c)	See text
Trinity Dam PH	Outflow	Measured (h)	n/a	Reclamation (2022b)
Trinity Dam Auxiliary	Outflow	Measured (h)	n/a	Reclamation (2022b)
Trinity Dam Spill	Outflow	Measured (h)	n/a	Reclamation (2022b)
Accretion/Depletion	Inflow	Calculated (d)	Estimated (d)	See text

Stream	Trinity River	East Fork Trinity R.	Swift Creek	Stuart Fork
Proportion of Inflow	56.5%	20.1%	11.4%	12.0%

Boundary Conditions: Lewiston Lake

Boundary Condition	Type	Flow	Temperature	Note/Source
Trinity Dam total release	Inflow	Measured (h) Modeled (h)	Measured (h) Modeled (h)	Reclamation (2022b)
Below Trinity Dam	Inflow	n/a	Measured (h) Modeled (h)	Reclamation (2022b)
Clear Creek Tunnel Diver.	Outflow	Measured (h)	n/a	Reclamation (2022b)
Lewiston Dam Spill	Outflow	Measured (h)	n/a	Reclamation (2022b)
Lewiston Dam PH	Outflow	Measured (h)	n/a	Reclamation (2022b)
Lewiston Dam Fish Hatch.	Outflow	Measured (h)	n/a	Reclamation (2022b)
Accretion/Depletion	Inflow	Calculated (d)	Estimated (d)	See text

Boundary Conditions: Trinity River

Boundary Condition	Type	Flow	Temperature	Note/Source
Lewiston Dam total release	Inflow	Measured (h) Modeled (h)	Measured (h) Modeled (h)	Reclamation (2022b)
Rush Creek	Inflow	Measured (d)	Measured/ Estimated (d)	Reclamation (2022b)
Grass Valley Creek	Inflow	Measured (d)	Measured/ Estimated (d)	Reclamation (2022b)
Indian Creek	Inflow	Measured (d)	Measured/ Estimated (d)	Reclamation (2022b)
Weaver Creek	Inflow	Measured (d)	Measured/ Estimated (d)	Reclamation (2022b)
Reading	Inflow	Estimated (d)	Measured/ Estimated (d)	Reclamation (2022b)
Browns Creek	Inflow	Estimated (d)	Measured/ Estimated (d)	Reclamation (2022b)
Canyon Creek	Inflow	Estimated (d)	Estimated (d)	Reclamation (2022b)
Accretion/Depletion	Inflow	Calculated (d)	Estimated (d)	See text

Boundary Conditions: Whiskeytown Lake

Boundary Condition	Type	Flow	Temperature	Note/Source
Clear Creek	Inflow	Estimated (d)	Estimated (d)	Reclamation (2022b)
Judge Francis Carr PH	Inflow	Measured (h) Modeled (h)	Measured (h) Estimated (h) Modeled (h)	Reclamation (2022b)
Whiskey Creek	Inflow	Estimated (c)	Estimated (c)	See text
Whiskeytown Dam Outlets	Outflow	Measured (h) Estimated (h)	n/a	Reclamation (2022b) See text
Whiskeytown Spill	Outflow	Measured (h)	n/a	Reclamation (2022b)
Spring Creek Tunnel Diver.	Outflow	Measured (h)	n/a	Reclamation (2022b)
Accretion/Depletion	Inflow	Calculated (d)	Estimated (d)	See text

Boundary Conditions: Clear Creek

Boundary Condition	Type	Flow	Temperature	Note/Source
Whiskeytown Dam total release	Inflow	Measured (h) Modeled (h)	Measured (h) Modeled (h)	Reclamation (2022b)
Accretion/Depletion	Inflow	Calculated (d)	Estimated (d)	See text

Initial Conditions: Sacramento/Trinity River System

- **Trinity**
  - Initial reservoir stages: Jan 1st, 00:00 measured values
  - Water Temperature Profile: vertical temperature profile measured closest to January 1st*

    * when absent, the vertical temperature profile measured closest to January 1 was used as a first estimate in an iterative process

- **Lewiston**
  - Initial reservoir stages: Jan 1st, 00:00 measured values
  - Water Temperature Profile: isothermal profile at 43.5°F (6.4°C)

- **Trinity River from Lewiston Dam to North Fork Trinity River**
  - Initial water temperature: 48.2°F (9°C) on January 1st at 00:00 at all junctions.

Initial Conditions: Sacramento/Trinity River System Continued

- **Whiskeytown**
  - Initial reservoir stages: Jan 1st, 00:00 measured values
  - Water Temperature Profile: isothermal profile at 48.2°F (9.0°C)

- **Clear Creek from Whiskeytown Dam to Sacramento River**
  - Initial water temperature: 48.2°F (9°C) on January 1st at 00:00 at all junctions.

American River System

Folsom Reservoir to American River confluence

Folsom Lake Geometric Representation

- **Crest of dam elevation**
  - 480.5 feet (146.5 meters)
- **Top of conservation**
  - 473 feet (144.2 meters)
- **Total storage**
  - 1,050,000 acre-feet   (about 1.3×10^9 m³)
- **Surface area**
  - 11,630 acres (4,705 hectares)
- **Temperature Control Shutters**
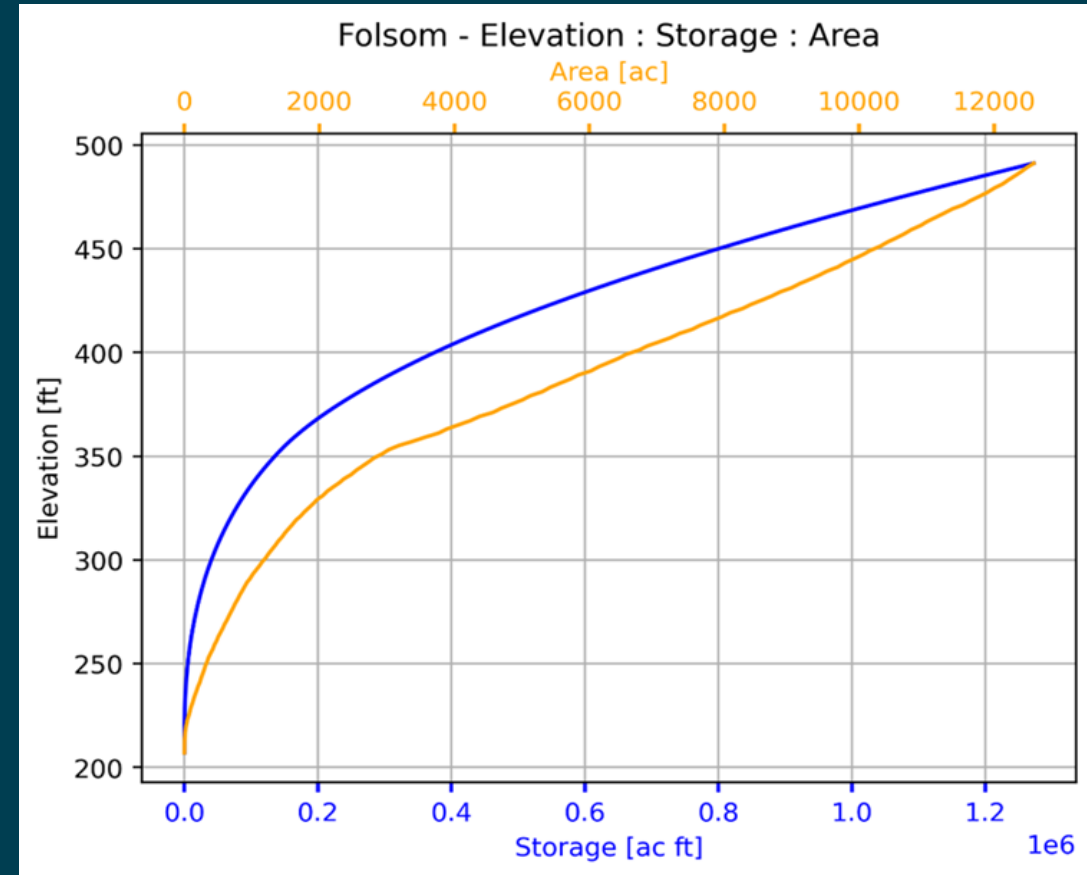

Source: Reclamation

Folsom Lake: CE-QUAL-W2 Geometry

- **Folsom Lake Model**
  - **Three branches**
    - Branch 1: North Fork American River arm
    - Branch 2: South Fork American River arm
    - Branch 3: Offshoot of branch 2
  - **Layer thickness: 2 feet**
  - **Maximum number of layers: 142**
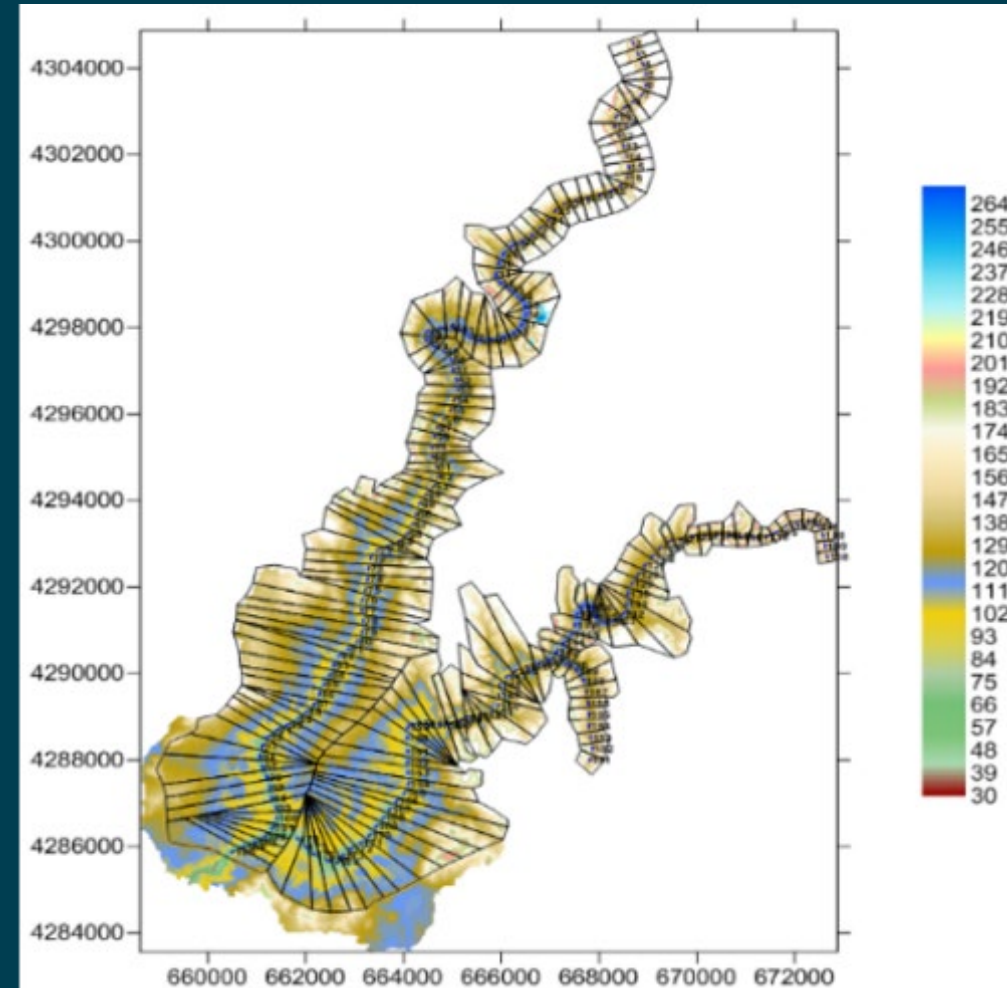
Folsom Lake ResSim Geometry

- **95 horizontal layers**

- **Uniform 3.0 feet (0.91 meters) thickness**

- Infrastructure
  - Power Penstocks: 299.3 feet
  - Service Spillway: 418 feet
  - Emergency Spillway: 418 feet
  - Auxiliary Spillway: 367.02 feet
  - Upper river outlets: 275.5 feet
  - Lower river outlets: 205.5 feet
  - Municipal Diversion: Variable
  - El Dorado Diversion: Variable

Folsom - Elevation : Storage : Area

Lake Natoma Geometric Representation

- Full pool elevation
  - 125 feet (41.7 meters)

- Total storage
  - 8,800 acre-feet
    (about 1.08×10^7 m³)
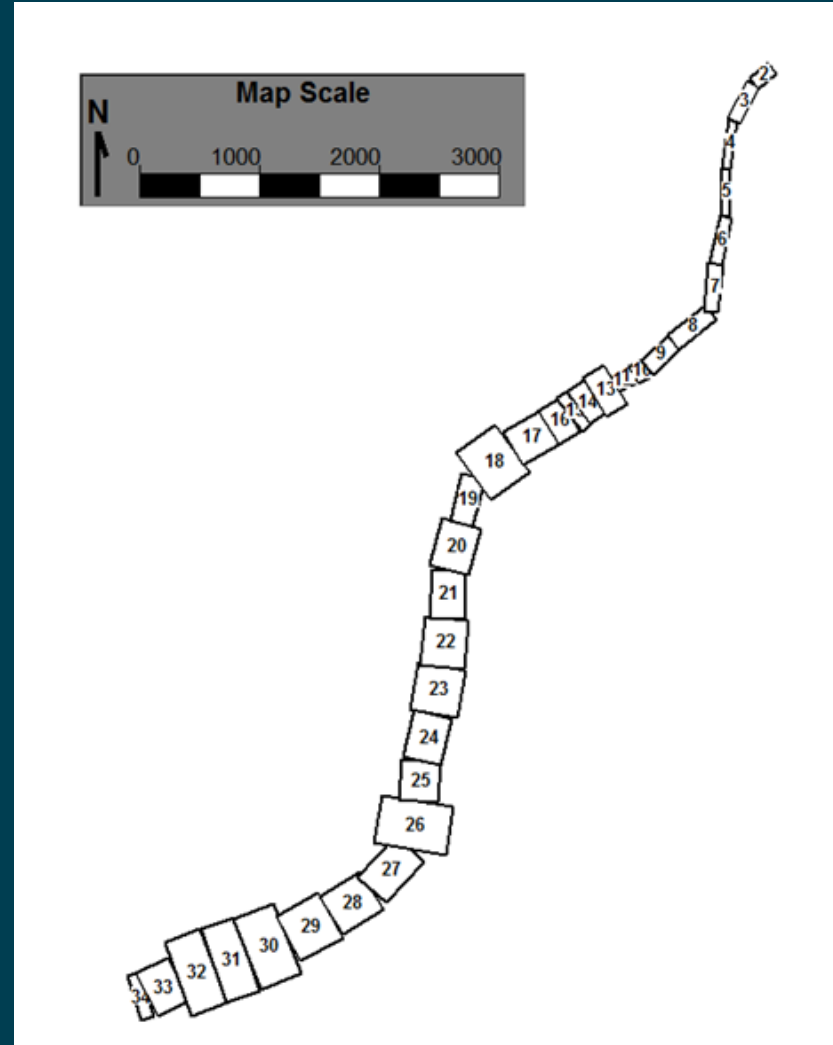
- Surface area
  - 550 acres (233 hectares)

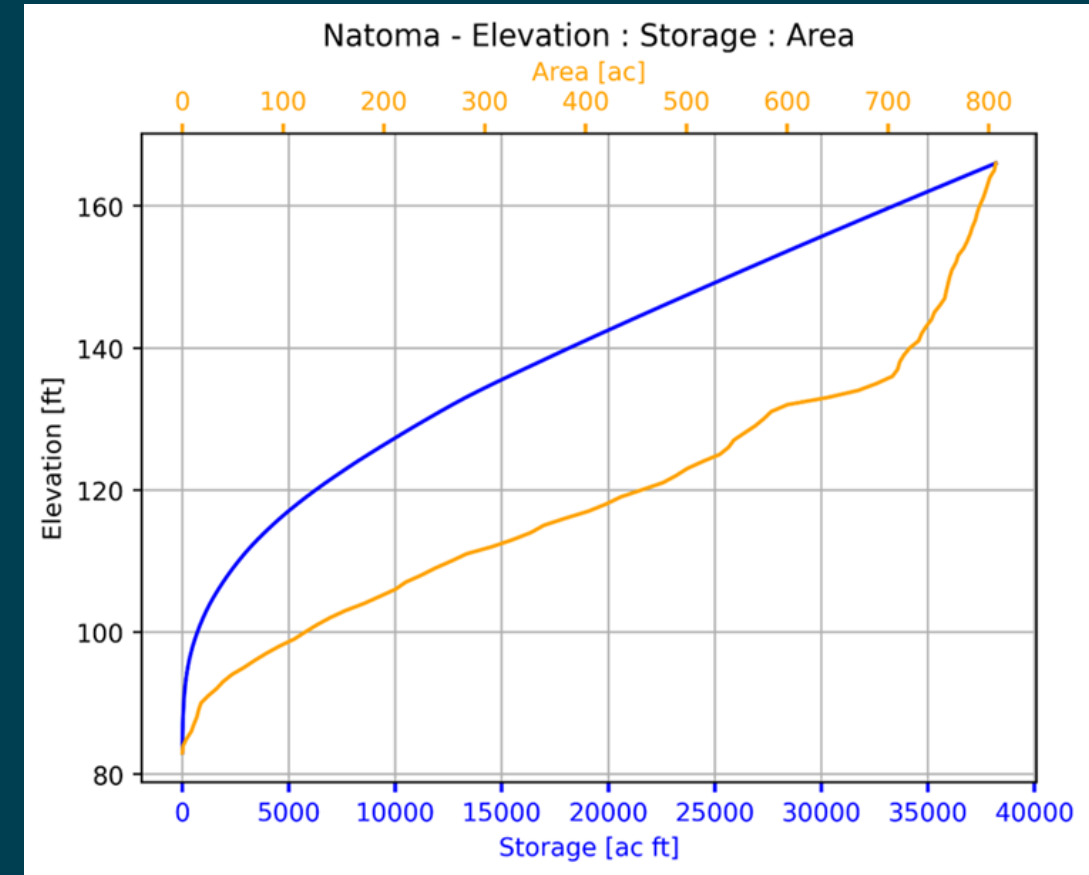Source: Reclamation

Lake Natoma : CE-QUAL-W2 Geometry

- **Lake Natoma Model**
  - One branch
  - Layer thickness: 1 foot
 - Maximum number of layers: 85

Lake Natoma ResSim Geometry

- **28 horizontal layers**

- **Uniform 3.0 feet (0.91 meters) thickness**

- **Infrastructure**
  - Spillway: 102.4 feet
  - Powerhouse: 105 feet
  - Fish Hatchery: 118.5 feet
  - Folsom South Canal: 120 feet

Natoma - Elevation : Storage : Area

American River ResSim Representation

- Nimbus Dam to the confluence with the Sacramento River

- 7 junctions

- 6 reaches

- Reach lengths: 2,500 to 3,500 feet (792 to 1,067 meters)
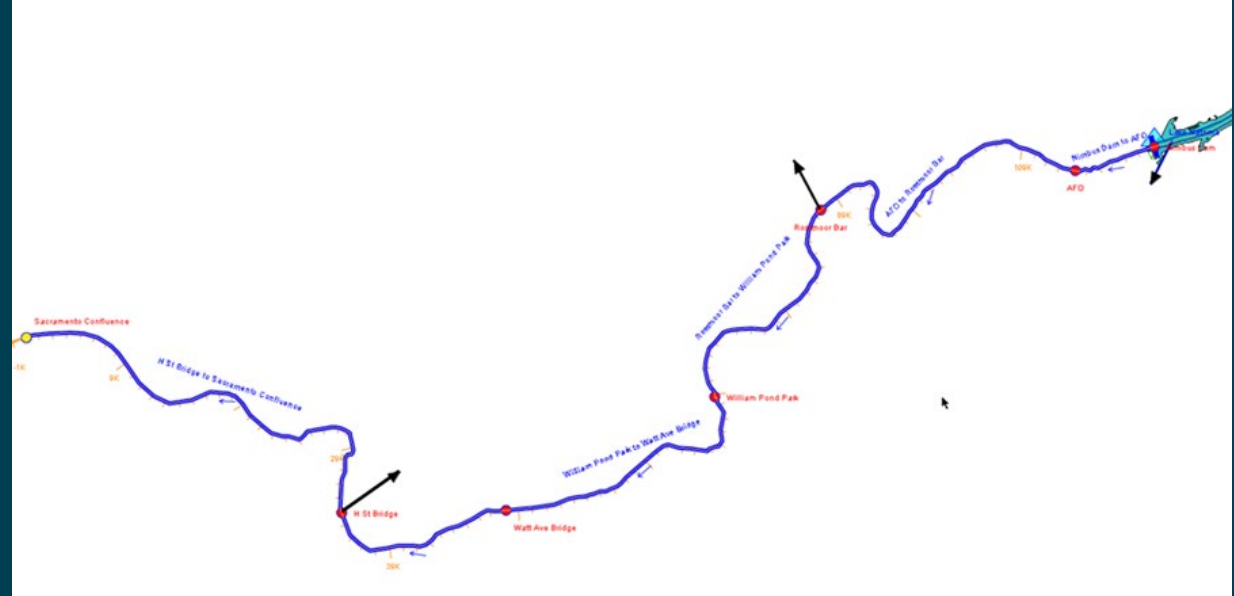
Boundary Conditions: Folsom Lake

Boundary Condition	Type	Flow	Temperature	Note/Source
North Fork American River	Inflow	Measured (d)	Measured (h)	Reclamation (2022b)
South Fork American River	Inflow	Measured (d)	Measured (h)	Reclamation (2022b)
Newcastle Powerplant/ Mormon Ravine	Inflow	Measured (d)	Estimated (d)	Reclamation (2018) See text
American R. Pump Station	Outflow	Measured (d)	n/a	Reclamation (2022b)
El Dorado ID	Outflow	Measured (d)	n/a	Reclamation (2022b)
Folsom Dam Municipal Intake (and operations)	Outflow	Measured (h)	n/a	Reclamation (2022b)
Folsom Dam Outlets	Outflow	Measured (h)	n/a	Reclamation (2022b)
Folsom Dam Powerhouse	Outflow	Measured (h)	n/a	Reclamation (2022b)
Folsom Dam Spill	Outflow	Measured (h)	n/a	Reclamation (2022b)
Folsom TCD	Outflow	Measured (h)	n/a	Reclamation (2022b)
Accretion/Depletion	Inflow	Calculated (d)	Estimated (d)	See text

Boundary Conditions: Lake Natoma

Boundary Condition	Type	Flow	Temperature	Note/Source
Folsom Dam total release	Inflow	Measured (h) Modeled (h)	Measured (h) Modeled (h)	Reclamation (2022b)
Below Folsom Dam	Inflow	n/a	Measured (h) Modeled (h)	Reclamation (2022b)
Nimbus Dam PH	Outflow	Measured (h)	n/a	Reclamation (2022b)
Nimbus Dam Spill	Outflow	Measured (h)	n/a	Reclamation (2022b)
Nimbus Dam Fish Hatchery	Outflow	Measured (h)	n/a	Reclamation (2022b)
Folsom South Canal	Outflow	Measured (d)	n/a	Reclamation (2022b)
Accretion/Depletion	Inflow	Calculated (d)	Estimated (d)	See text

Boundary Conditions: American River

| Boundary Condition	Type	Flow	Temperature	Note/Source
Nimbus Dam total release	Inflow	Measured (h) Modeled (h)	Measured (h) Modeled (h)	Reclamation (2022b)
Carmichael Water Dist.	Outflow	See text	n/a	See text
City of Sacramento	Outflow	See text	n/a	See text
Accretion/Depletion	Inflow	Calculated (d)	Estimated (d)	See text

Initial Conditions: American River System

- Folsom Lake
  - Initial reservoir stages: Jan 1st measured values
  - Water Temperature Profile: measured vertical temperature profile*
    * not available for 2000, Jan 2nd 2020 used

- Lake Natoma
  - Initial reservoir stages: Jan 1st measured values
  - Water Temperature Profile: isothermal profile at 50.0°F (10.0°C)

- American River
  - Initial water temperature: 48.2°F (9°C) on January 1st at 00:00
    at all junctions.

Stanislaus River System

New Melones Reservoir to San Joaquin
River confluence
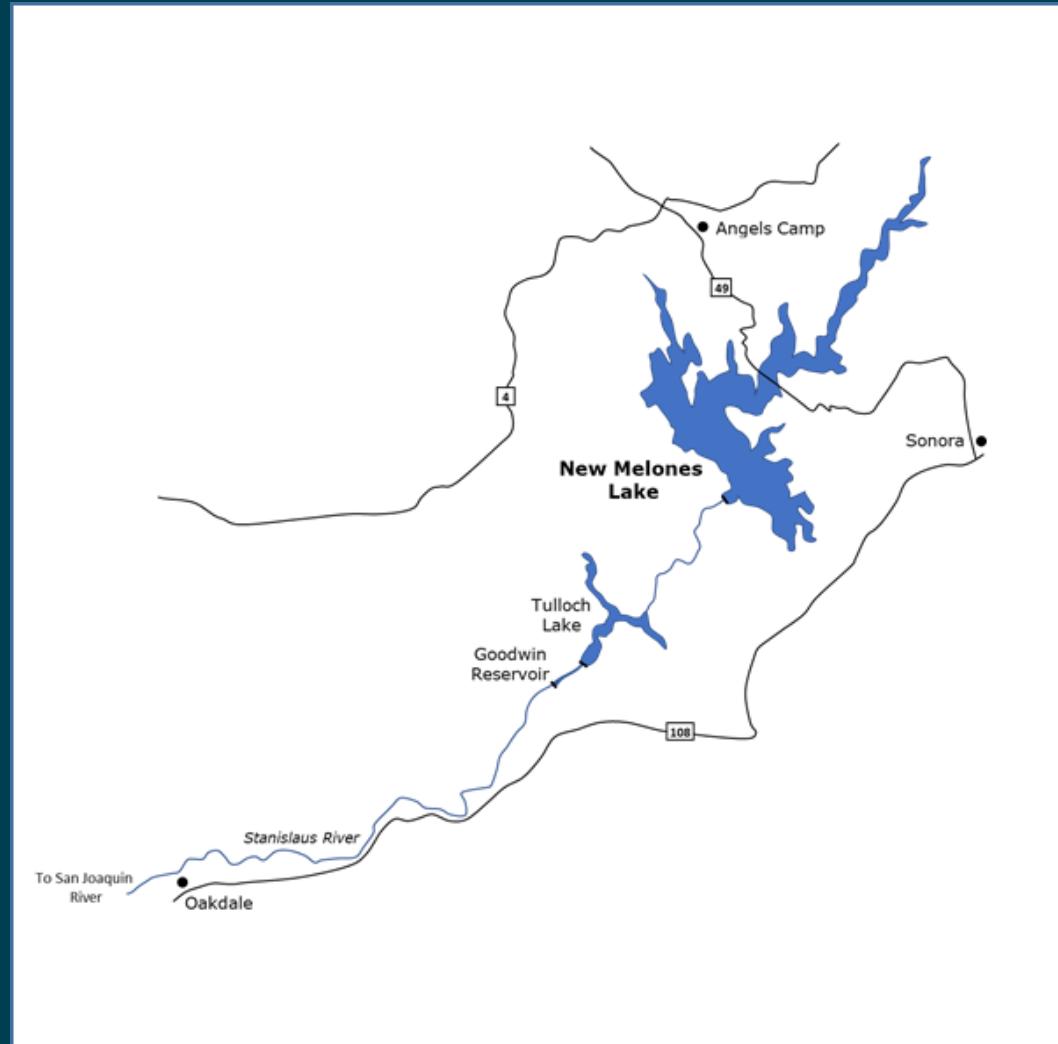
New Melones Lake Geometric Representation

- **Crest of dam elevation**
  - 1,135 feet (345.95 meters)

- **Full pool elevation**
  - 1,088 feet (332 meters)

- **Total storage**
  - 2,400 acre-feet (about 3.0×10^9 m^3)

- **Surface area**
  - 12,500 acres (5,100 hectares)

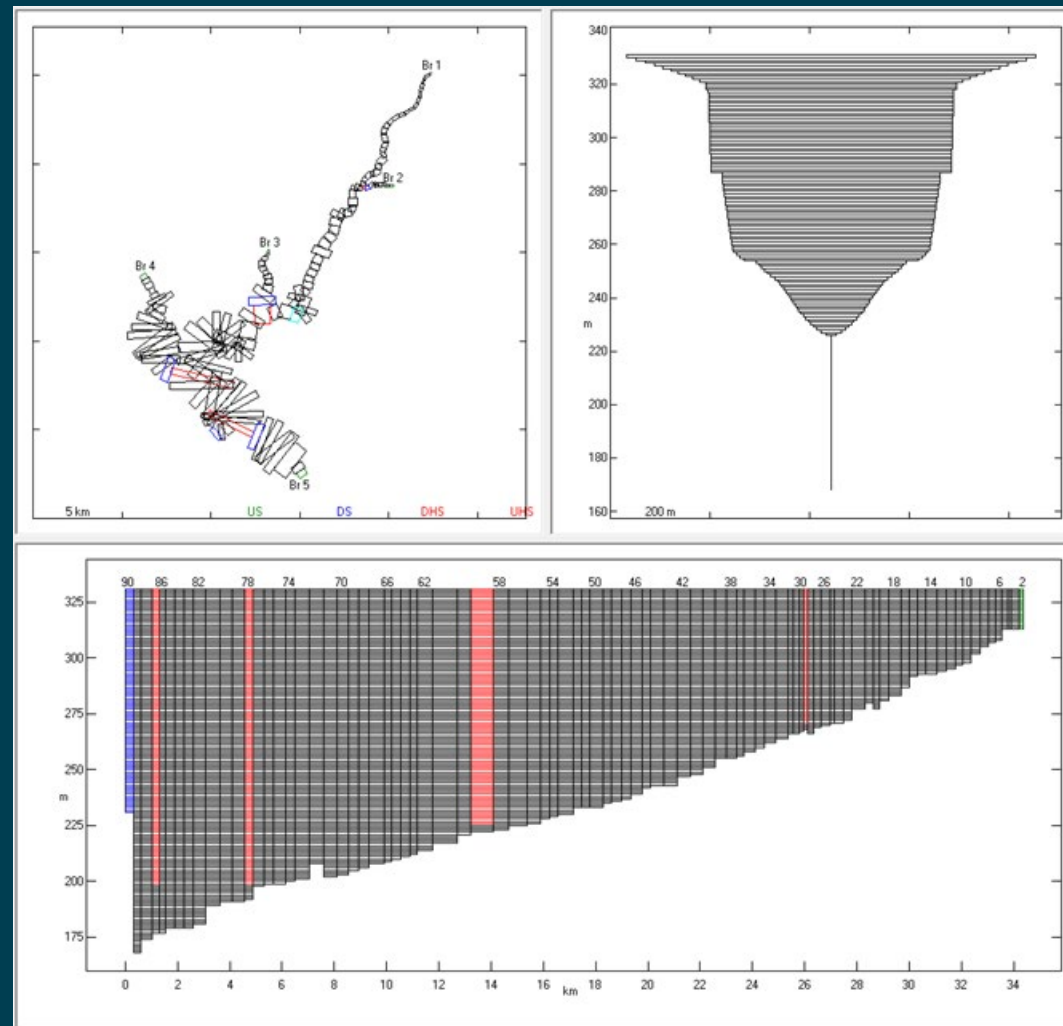- **Old Melones Dam**

Source: Reclamation

New Melones Lake: CE-QUAL-W2 Geometry

- **New Melones Lake Model**
  - **Five branches**
    - Branch 1: New Melones Lake
    - Branch 2: South Fork Stanislaus River
    - Branch 3: Coyote Creek
    - Branch 4: Angels Creek
    - Branch 5: Bear Creek
  - **Layer thickness: 1 meter**
  - **Maximum number of layers: 170**

New Melones ResSim Geometry

- **Uniform 3.0 feet (0.91 meters) thickness**

- **Infrastructure**
  - Spillway: 1088 feet (331.6 meters)
  - Upper outlet: 760 ft (231.6 meters)
  - Lower outlet: 543 feet (165.5 meters)
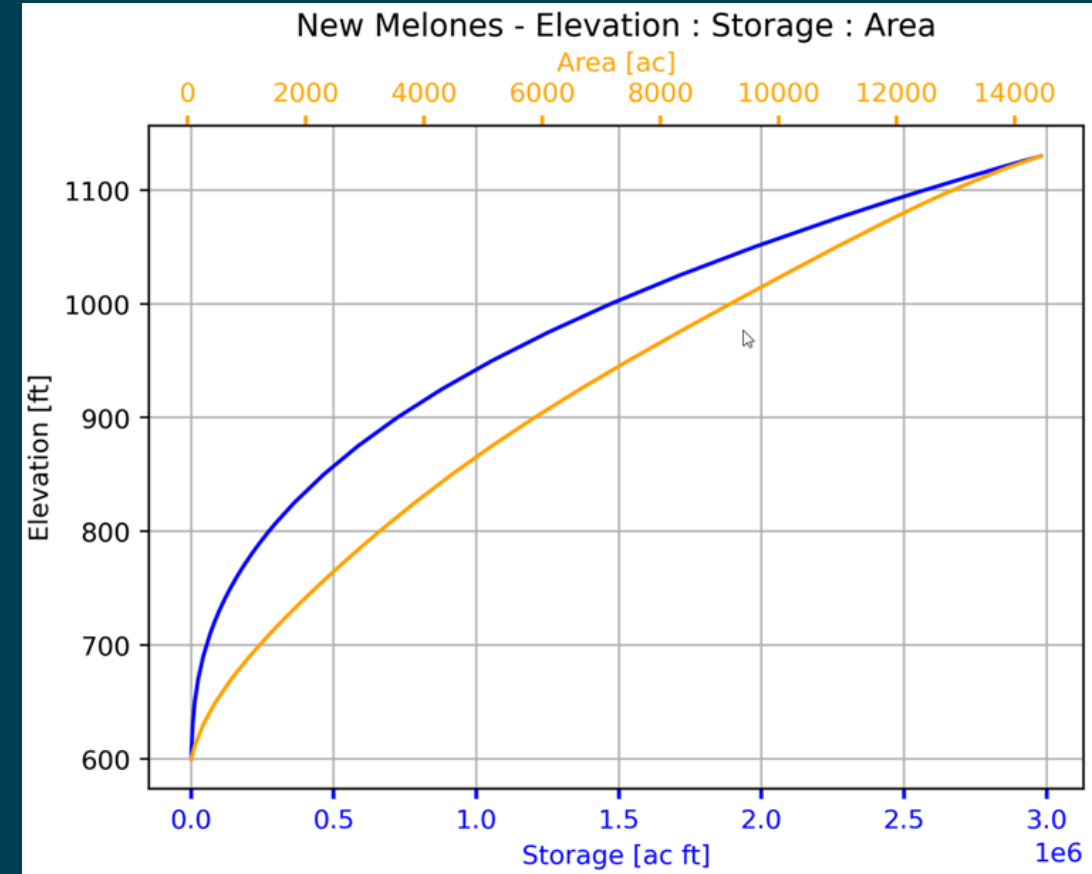
Tulloch Lake Geometric Representation

- **Crest of dam elevation**
  - 510 feet (160.0 meters)
- **Full pool elevation**
  - 504 feet (154 meters)
- **Total storage**
  - 67,000 acre-feet (about 9.3×10^7 m^3)
- **Surface area**
  - 1,280 acres (hectares)
- **Top of conservation pool**
  - 510 feet (160 meters)

Source: Reclamation

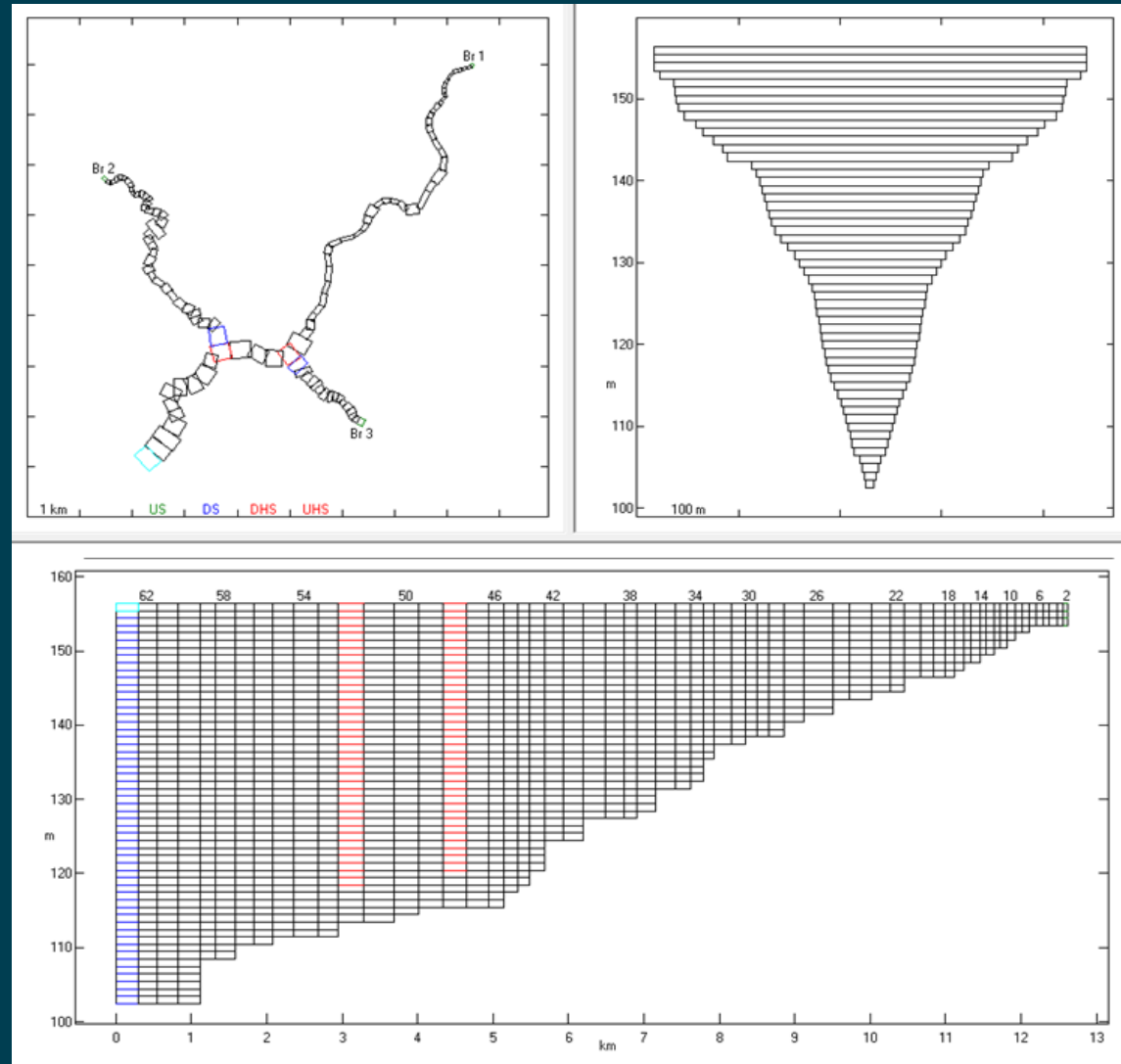# Tulloch Lake: CE-QUAL-W2 Geometry

- **Tulloch Lake Model**
  - **Three branches**
    - Branch 1: Stanislaus River
    - Branch 2: Black Creek
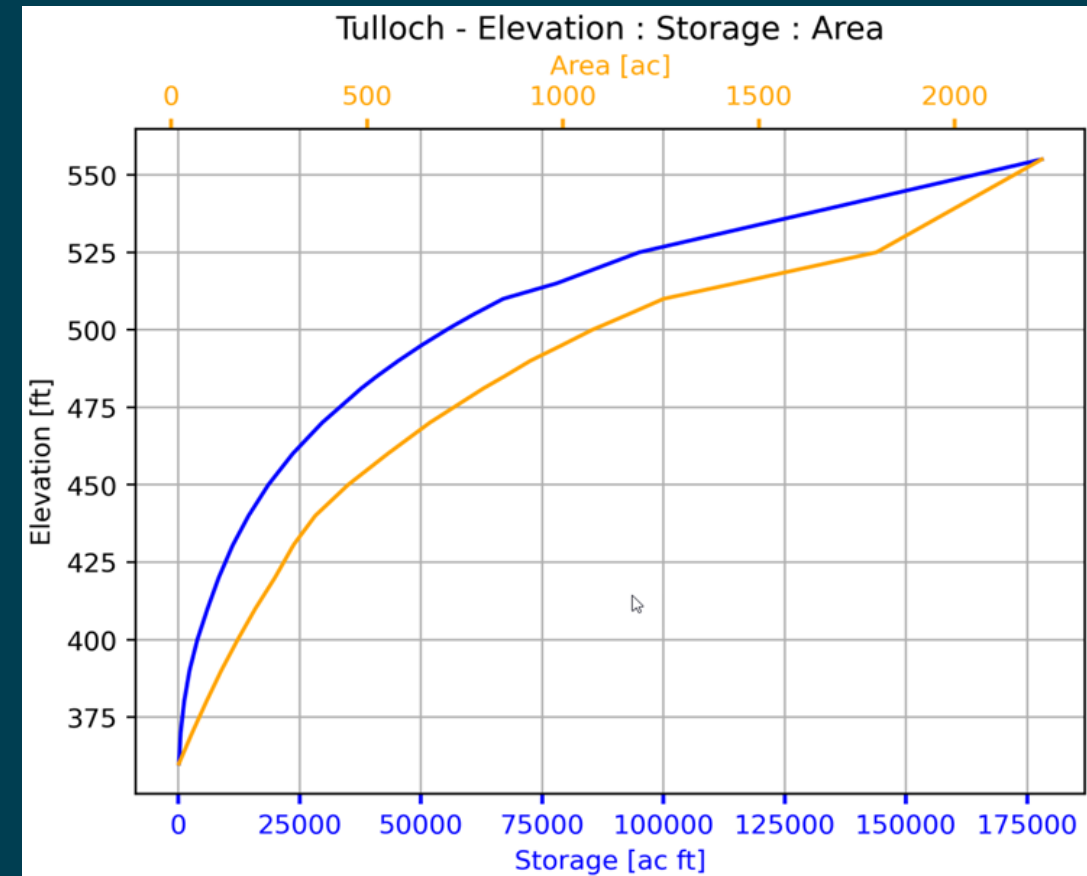   - Branch 3: Green Spring Run
  - **Layer thickness: 1 meter**
 - **Maximum number of layers: 54**

Tulloch Lake ResSim Geometry

- **Uniform**
  3.0 feet (0.91 meters) thickness

- **Infrastructure**
  - Spillway: 481 feet (146.6 meters)
  - Powerhouse: 381 feet (116.1 meters)
  - Low outlets: 381 feet (116.1 meters)

Tulloch - Elevation : Storage : Area

Riverine Segments of the Stanislaus River ResSim Representation

- New Melones Dam and the upper limit of Tulloch Lake,

- Impounded reach between Tulloch Dam and Goodwin Dam

- Goodwin Dam to the San Joaquin River

- 9 junctions

- 7 reaches

- Reach lengths: 2,000 to 2,500 feet (609.6 m to 762.0 m)
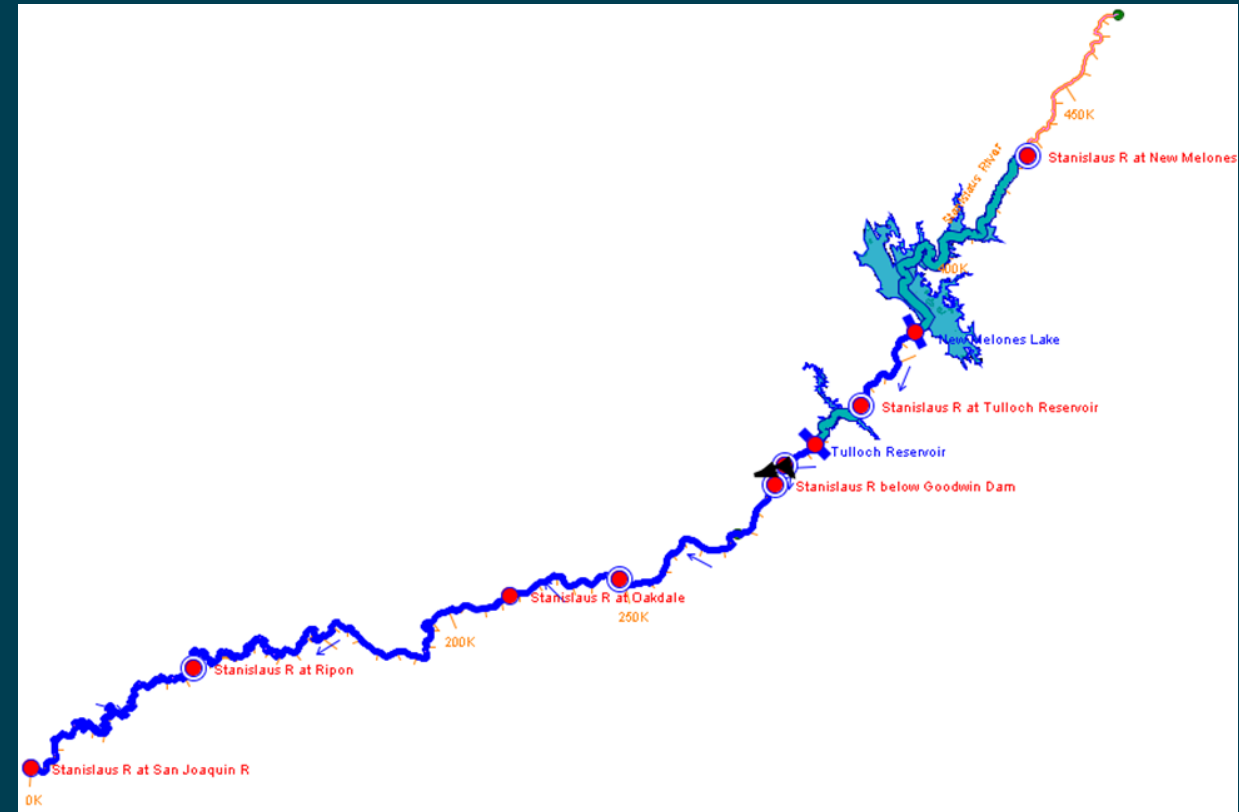
Boundary Conditions: New Melones Lake

Boundary Condition	Type	Flow	Temperature	Note/Source
Stanislaus River Mainstem	Inflow	Estimated (h)	Estimated (h)	See text
South Fork Stanislaus River	Inflow	Estimated (c)	Estimated (c)	See text
Coyote Creek	Inflow	Estimated (c)	Estimated (c)	See text
Angels Creek	Inflow	Estimated (c)	Estimated (c)	See text
Bear Creek	Inflow	Estimated (c)	Estimated (c)	See text
New Melones Dam PH	Outflow	Measured (h)	n/a	Reclamation (2022b)
New Melones Dam Spill	Outflow	Measured (h)	n/a	Reclamation (2022b)
New Melones Outlet	Outflow	Measured (h)	n/a	Reclamation (2022b)
Accretion/Depletion	Inflow	Calculated (d)	Estimated (d)	See text

Boundary Conditions: Tulloch Lake

Boundary Condition	Type	Flow	Temperature	Note/Source
Stanislaus River	Inflow	Measured (h)	Measured (h)	Reclamation (2022b)
Black Creek	Inflow	Estimated (c)	Estimated (c)	See text
Green Spring Run	Inflow	Estimated (c)	Estimated (c)	See text
Tulloch Dam PH	Outflow	Measured (d)	Measured (d)*	Reclamation (2022b)
Tulloch Dam Regulating Flow	Outflow	Measured (d)	n/a	Reclamation (2022b)
Tulloch Dam Spill	Outflow	Measured (d)	n/a	Reclamation (2022b)
Accretion/Depletion	Inflow	Calculated (d)	Estimated (h)	See text

Boundary Conditions: Stanislaus River

Boundary Condition	Type	Flow	Temperature	Note/Source
Oakdale Canal	Outflow	Measured (d)	n.a.	Reclamation (2022b)
South San Joaquin Canal	Outflow	Measured (d)	n.a.	Reclamation (2022b)

Initial Conditions: Stanislaus River System

- **New Melones Lake**
  - Initial reservoir stages: Jan 1st, 00:00 measured values
  - Water Temperature Profile: based on days in close proximity to January 1*
    - * when absent, the vertical temperature profile measured closest to January 1 was used as a first estimate in an iterative process

- **Tulloch Lake**
  - Initial reservoir stages: start date measured values
  - Water Temperature Profile: closest measured profile to Feb 5 of the start year

- **Stanislaus River**
  - Initial water temperature: 50ºF (10℃) at all junctions.

Model Geometry, Boundary, and Initial Conditions Summary

- Specification of flow, temperature, and meteorologic boundary conditions is a critical element in modeling the Sacramento River/ Trinity River system, the American River system, and the Stanislaus River system

- Detailed physical data has been assembled for all of the reservoirs and river reaches in the study domain. This data has been used to prepare both system level models and high-resolution models. As improved data becomes available (e.g., river bathymetry, improved boundary condition flows and temperatures) models can be updated.

- System level and high-resolution models can be run from consistent boundary conditions to facilitate application of the models and, as necessary, provide comparison of model results.