



Photo credit: John Hannon, Reclamation

Data Development

Mechele Pacheco, Hydrologic Engineer
Reclamation, Bay Delta Office



Data Development Documentation

- Document Link:
 - [Data Development](#)
- Technical Memorandum Status:
 - Final Draft
 - Enhancements since Mid-Term Peer Review:
 - Minor modifications based on MTC feedback
 - Minor modifications based on Panel Comments



Data Development Philosophy

- Collaborative data gathering process
- Model application needs
 - Data Frequency: Capture project operations and maximum water temperatures
 - Data Precision: Operate a facility to downstream water temperature targets within tenths of a degree Fahrenheit on a daily average
- Quality data
 - Methods for data QA/QC, gap filling, meta data, and data integrity
 - Improve calibration and model performance
 - Identifies opportunities to enhance future monitoring



WTMP Model Data Requirements

- Geometry
- Hydrology
 - Inflow (hourly, daily)
 - Outflow/operations (hourly)
 - Storage (hourly, daily)
 - Selective withdrawal operations (daily, weekly)
- Temperature
 - Inflow (hourly, daily)
 - Outflow (hourly, daily)
 - Temperature profiles (weekly, monthly)
- Meteorology
 - Solar Radiation (hourly)
 - Cloud Cover (hourly)
 - Air Temperature (hourly)
 - Dew Point and Wet Bulb Air Temperatures (hourly)
 - Wind Speed and Direction (hourly)
 - Atmospheric Pressure (hourly)



Geometry: Sacramento/Trinity System

- Trinity Lake
 - Bathymetry/S-A-V
 - Dam infrastructure (outlets, spillway)
- Lewiston Lake
 - Bathymetry/S-A-V
 - Temperature Control Curtain
 - Dam infrastructure (outlets, spillway)
- Trinity River from Lewiston Dam to North Fork Trinity River
 - USGS hydrography data and known locations of hydrologically significant confluences
 - Tributary confluences



Geometry: Sacramento/Trinity System continued

- Clear Creek Tunnel
 - Heating estimated based on measured flow and water temperature data
- Whiskeytown Lake
 - Temperature Control Curtain
 - Judge Francis Carr Powerplant
 - Dam infrastructure (outlets, spillway)
- Spring Creek Tunnel
 - Heating estimated based on Clear Creek Tunnel annual average heating
- Clear Creek from Whiskeytown Dam to Sacramento River
 - USFWS habitat survey data



Geometry: American River System

- Folsom Lake
 - Bathymetry/S-A-V
 - Temperature Shutters
 - Dam infrastructure (outlets, spillway)
- Lake Natoma
 - Topographic transect data
 - Diversion
 - Dam infrastructure (outlets, spillway)
- American River
 - Digital terrain model



Geometry: Stanislaus River System

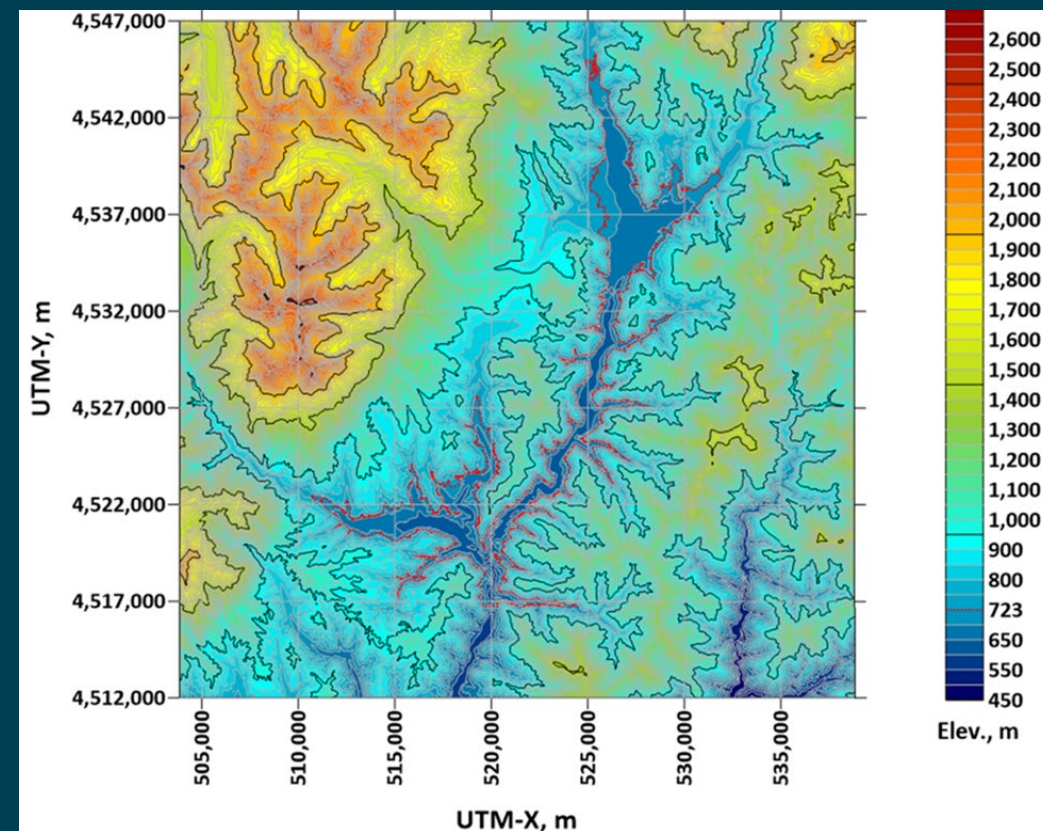
- New Melones Lake
 - Bathymetry
 - Submerged Dam (Segment 88, 211 ft)
 - Dam infrastructure (outlets, spillway)
- Tulloch Lake
 - Bathymetry
 - Dam infrastructure (outlets, spillway)
- Stanislaus River (including Goodwin Dam)
 - HEC-5Q model structure
 - Between New Melones Dam and Tulloch Lake, reach representing Goodwin Lake
 - EFDC-1D model structure (TetraTech)
 - Goodwin Dam to the confluence with the San Joaquin River
 - Tributary confluences



Bathymetry: Trinity Lake

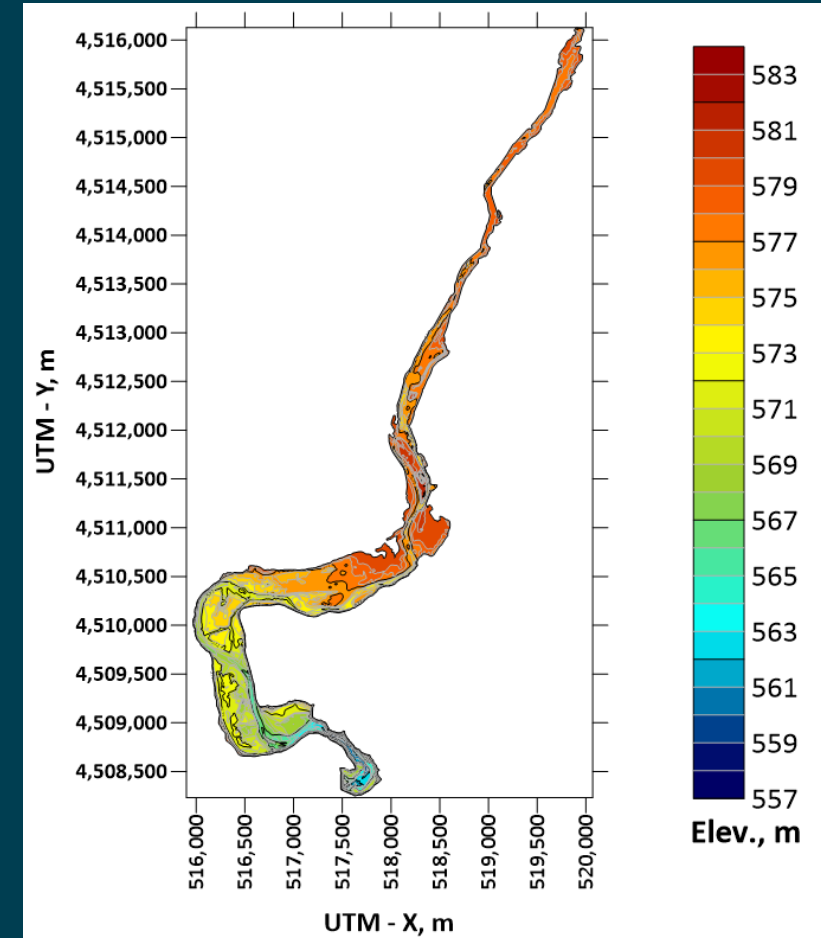
- Data Sources

| Title | Source | Datum | Units |
|--|-----------|------------------|--|
| USGS 1 arc second n41w123 20210624 (data set/map) | USGS 2021 | NAD83; NAVD88 | Geographic coordinates; decimal degrees |
| USGS Topographic Quadrangle Map: Trinity Dam, California | USGS 1982 | NAD27; NGVD29 | UTM Coordinate (Zone 19): Meters |
| Esri World Imagery (satellite imagery) | Esri 2022 | WGS84 | Meters |



Bathymetry: Lewiston Lake

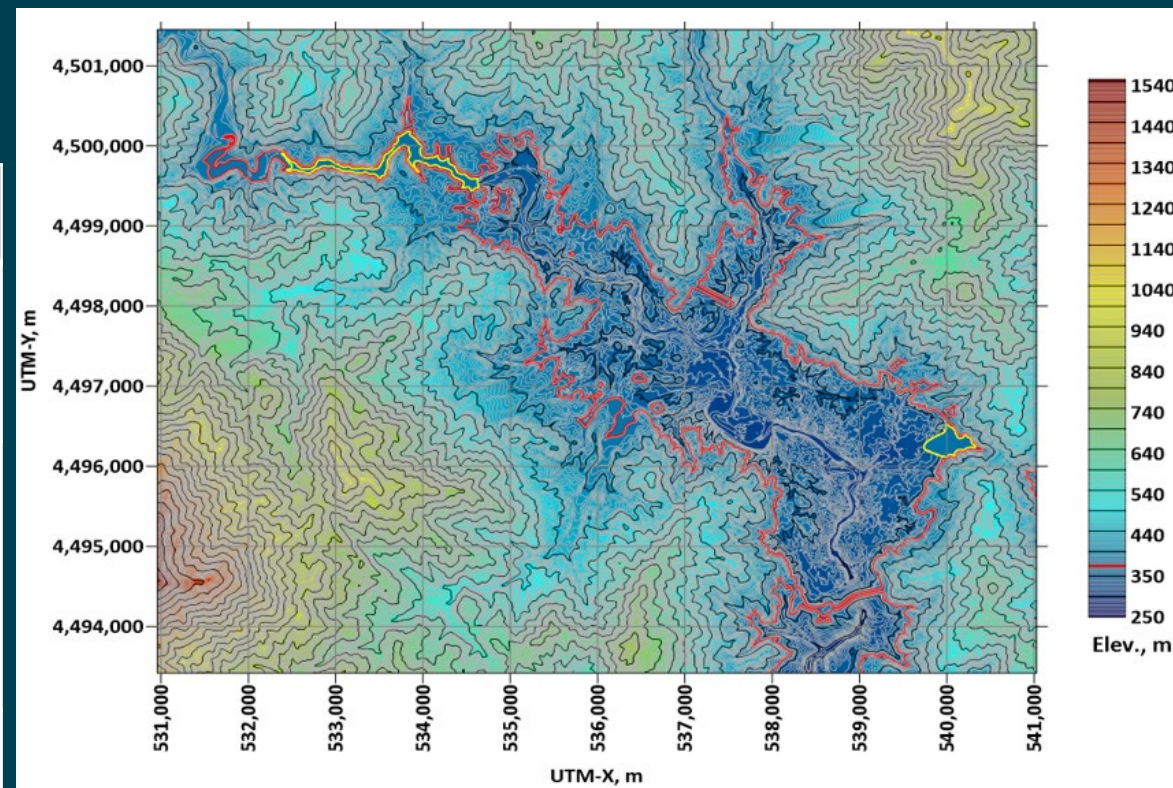
- Data Sources
 - Reclamation provided detailed bathymetry data, in 50 m intervals
 - Developed 100 m interval cross sections (Jayasundara and Deas, 2013)



Bathymetry: Whiskeytown Lake

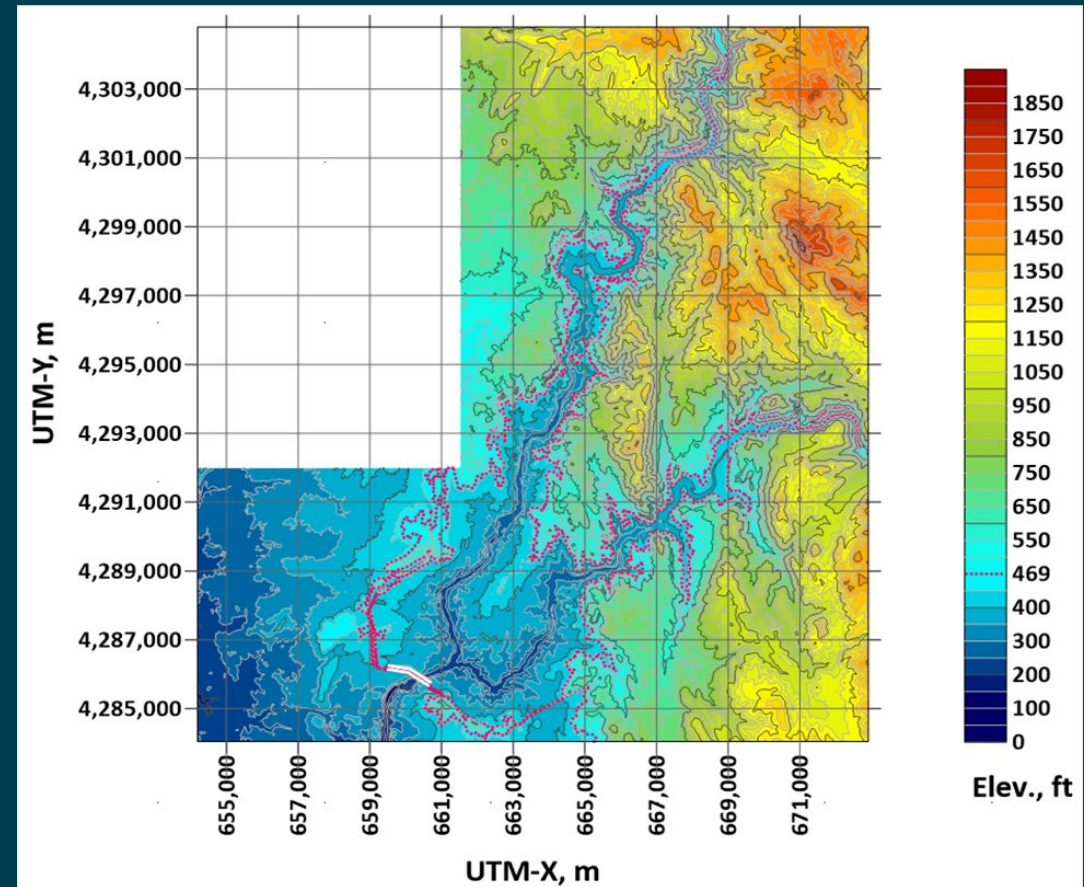
• Data Sources

| Title | Source | Datum | Units |
|--|-------------------|--|--|
| USGS 1 arc second n41w123 20210624 (data set/map) | USGS 2021 | NAD83 NAVD88 | Geographic Coordinates: decimal degrees |
| The U.S. Geological Survey (USGS) Bathymetry, Topography and Orthomosaic imagery for Whiskeytown Lake, northern California | Logan et al. 2020 | NAD83 NAVD88 | UTM Coordinate (Zone 10): Meter |
| Historic 1956 US Department of Interior topographic maps of the Whiskeytown Reservoir Area | Alster 1956 | NAD27 (Calif. State Plan, zone 0401) NGVD29 | UTM Coordinate (Zone 10): Feet |



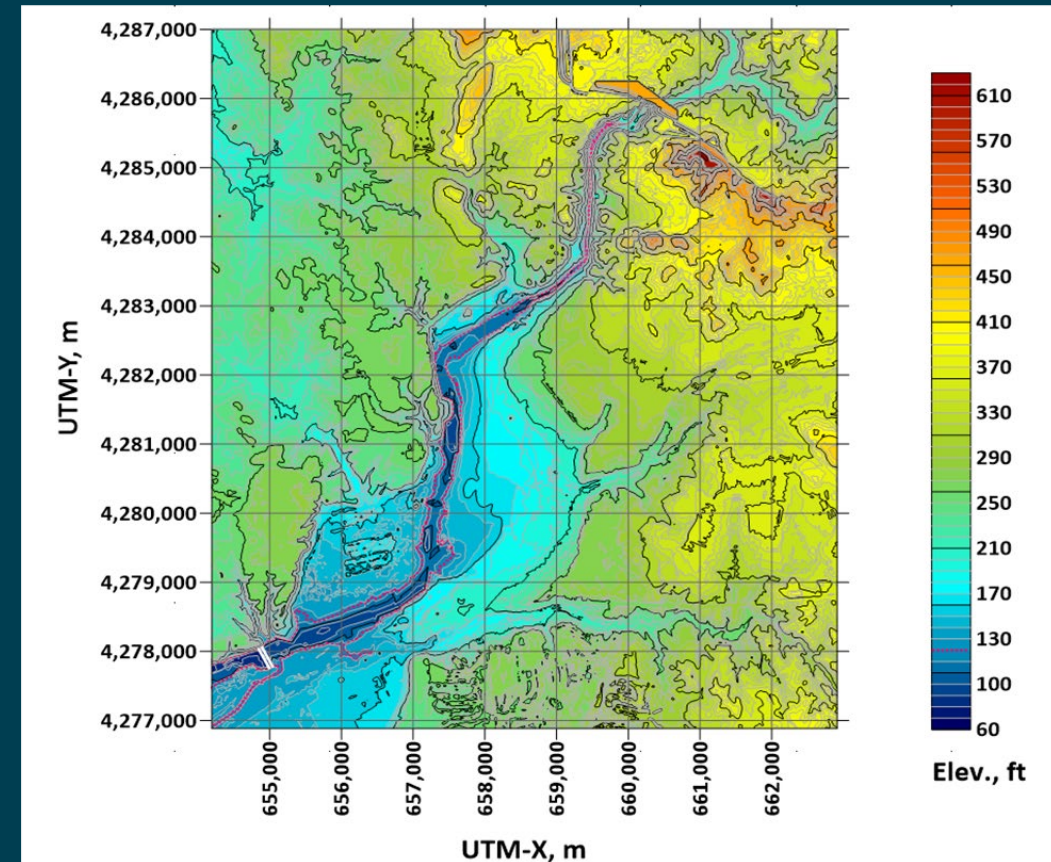
Bathymetry: Folsom Lake

- Data Sources
 - Folsom Reservoir bathymetry (2005 USBR Sedimentation Survey)



Bathymetry: Lake Natoma

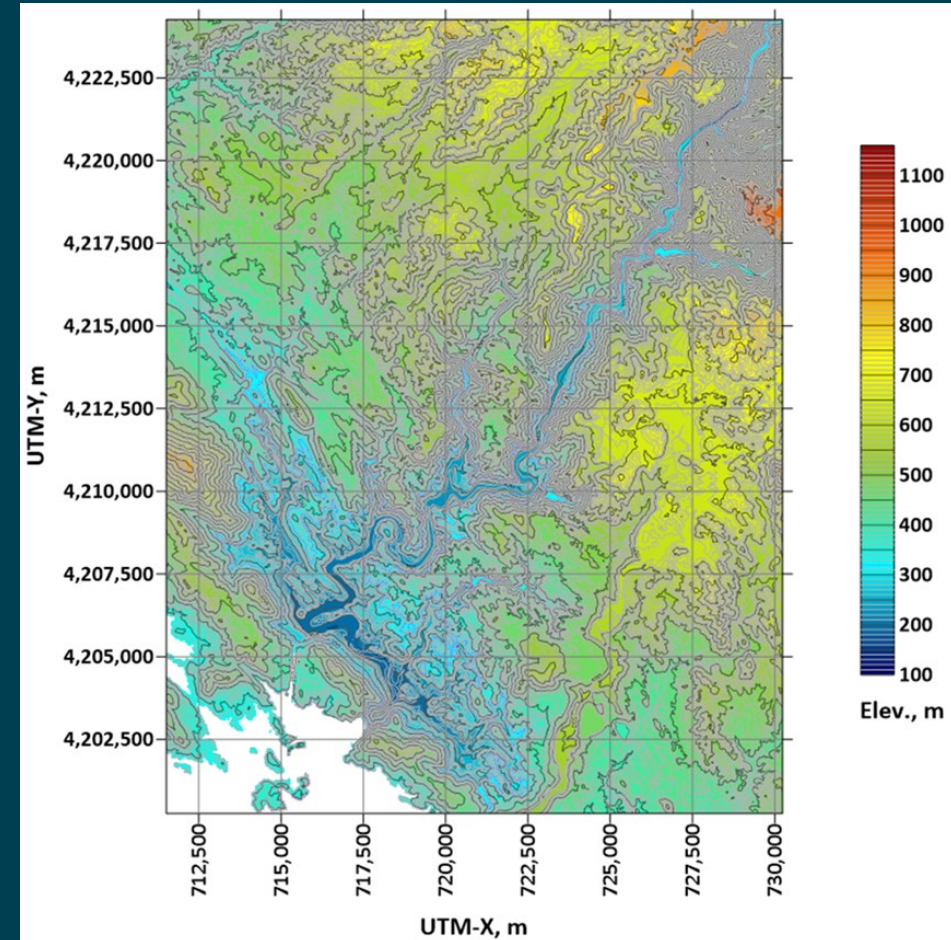
- Data Sources
 - Created from Topographic transect data collected by cbec, Inc.
 - 34 transects collected



Bathymetry: New Melones Lake

- Data Source
 - high-resolution multibeam bathymetric survey conducted by Tetra Tech in April 2012 (Tetra Tech 2012)

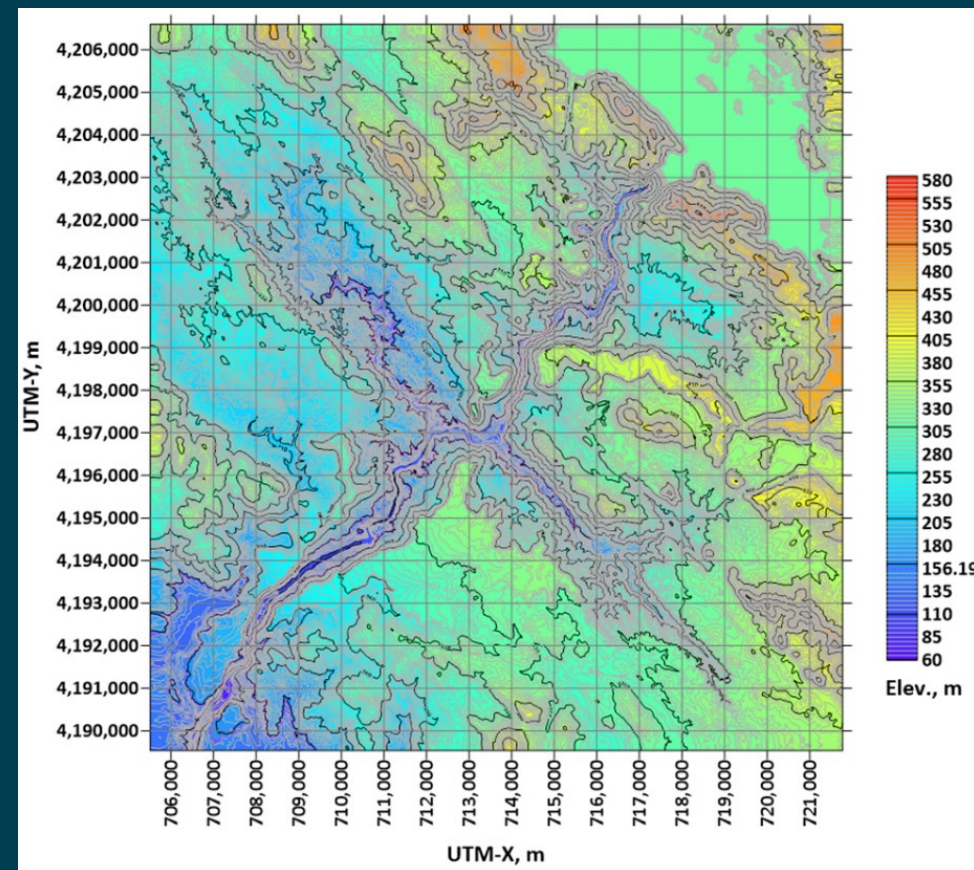
| Title | Source |
|--------------------------|------------|
| Principal bathymetry | Tetra Tech |
| USGS_13_n38w121_20220103 | USGS 2022a |
| USGS_13_n39w121_20220206 | USGS 2022b |



Bathymetry: Tulloch Lake

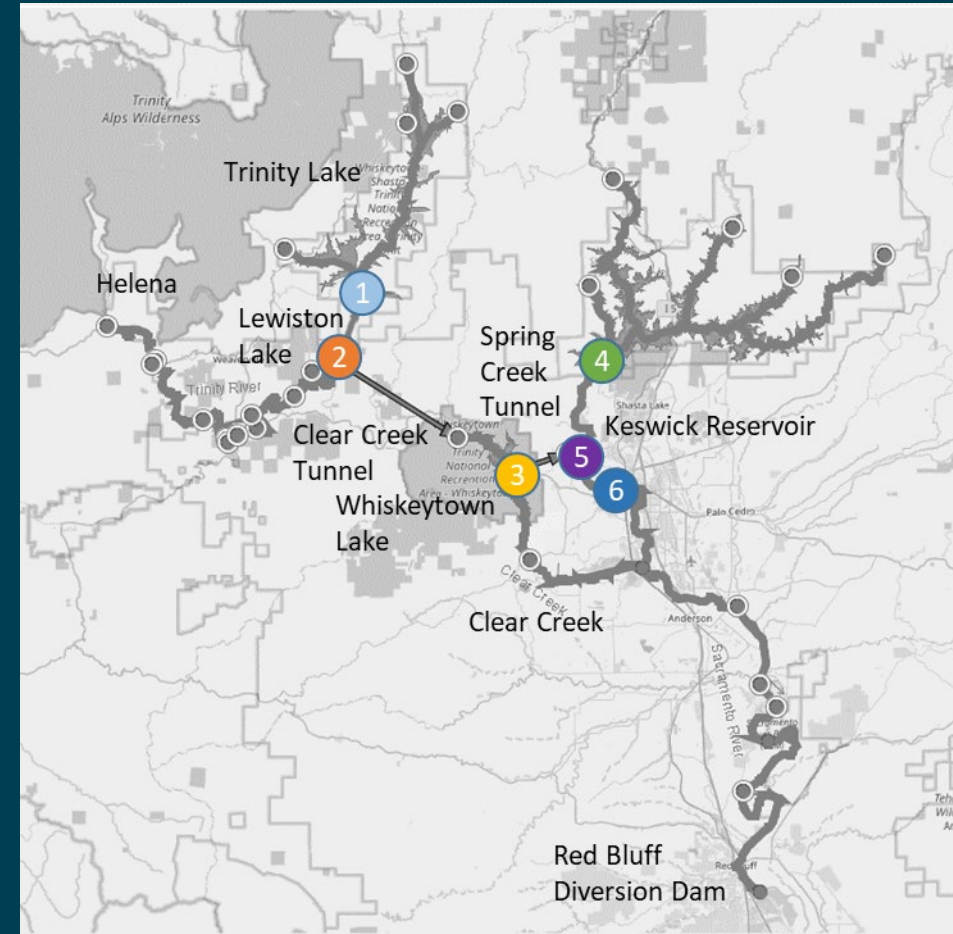
- Data Source
 - high-resolution multibeam bathymetric survey conducted by Tetra Tech in April 2012 (Tetra Tech 2012)

| Title | Source |
|--------------------------|------------|
| Principal bathymetry | Tetra Tech |
| USGS_13_n38w121_20220103 | USGS 2022a |
| USGS_13_n39w121_20220206 | USGS 2022b |



Hydrology Example: Sacramento/Trinity System Controlled Flows

- 1. Trinity Lake
 - Powerhouse, bypass, spillway
- 2. Lewiston Lake
 - Clear Creek Diversion, powerhouse, hatchery, spillway
- 3. Whiskeytown Lake
 - Spring Creek Diversion, low level outlet, spillway



Trinity Lake Sources of Flow Data

| Site Number/ Abbreviation | SHEF Code | Agency | Site Active? | Site Name | Data Types | Data Frequency | Application of Data |
|------------------------------|-------------------------|--------|-----------------|--|---------------|-------------------|------------------------|
| TRN | QG1, QG2, QG | USBR | YES | Generation Release from Trinity Dam Powerhouse Units 1 and 2, and total release (QG=QG1+QG2) | Q | Hourly | Boundary Condition |
| TRN | QS | USBR | YES | Trinity Dam spill release | Q | Hourly | Boundary Condition |
| TRN | QU1, QU2, QU3, QU | USBR | YES | Outlet release from gates 1, 2, and 3, and total outlet release (QU=QU1+QU2+QU3) | Q | Hourly | Boundary Condition |
| TRN | QT | USBR | YES | Total Dam Release (QT=QG+QS+QU) | Q | Hourly | Boundary Condition |
| TRN | HL | USBR | YES | RESERVOIR ELEVATION | Stage | Hourly | Boundary Condition |
| TRN | LS | USBR | YES | RESERVOIR STORAGE | Storage | Hourly | Boundary Condition |
| TRN | QI | USBR | YES | COMPUTED INFLOW | Flow | Daily | Boundary Condition |



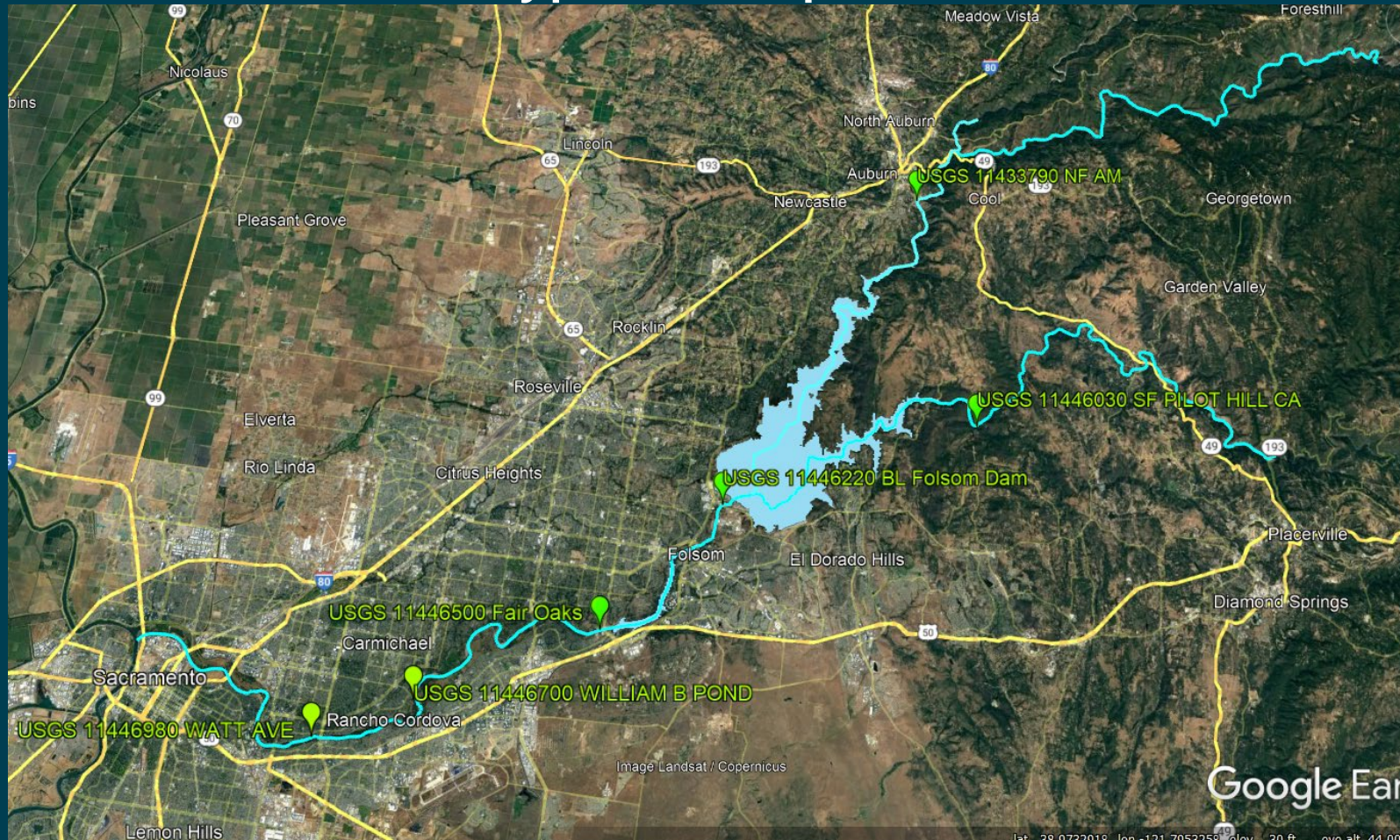
Trinity Lake Flow Data Quality

- Data quality assessment
 - Identify gaps
 - Identify invalid zeros
 - Check that data were consistent
- Invalid zeros were removed and became gaps in the data
- Gaps were filled by balancing reported values where appropriate
- Other gaps were filled using standard gap-filling protocols
 - e.g. linear interpolation or last best value for small gaps



Water Temperature Example: American River System Water Temperature Gages

- Water temperature gages
 - Watt Avenue: Typical Compliance Location



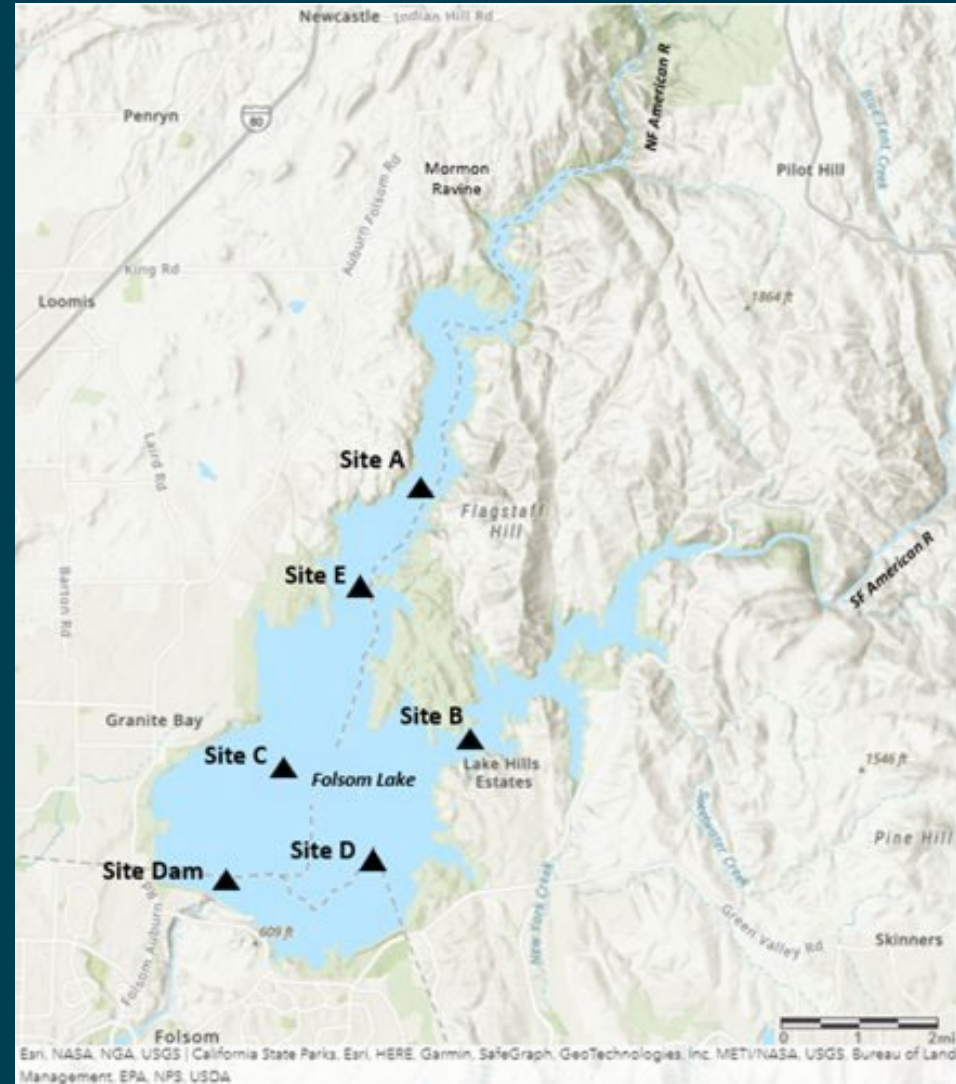
Folsom Lake Inflows

- North Fork American River Inflows
 - USGS gaging station on the North Fork American River at Auburn Dam Site near Auburn, CA (USGS 11433790/ CDEC NFA)
- South Fork American River Inflows
 - USGS gaging station on the South Fork American River near Pilot Hill, CA (USGS 11446030)
- Newcastle Powerhouse/Mormon Ravine Inflows
 - Estimated based on the 2006-2012 monthly averaged water temperatures measured at two PCWA water temperature stations (14-A and 3-A).



Folsom Lake In-Lake Temperature Profiles

- Folsom Lake In-Lake Vertical Temperature Profiles
 - 185 in-reservoir temperature profiles were collected between January 1st, 2001, and December 31st, 2021, in roughly two- to four-week intervals



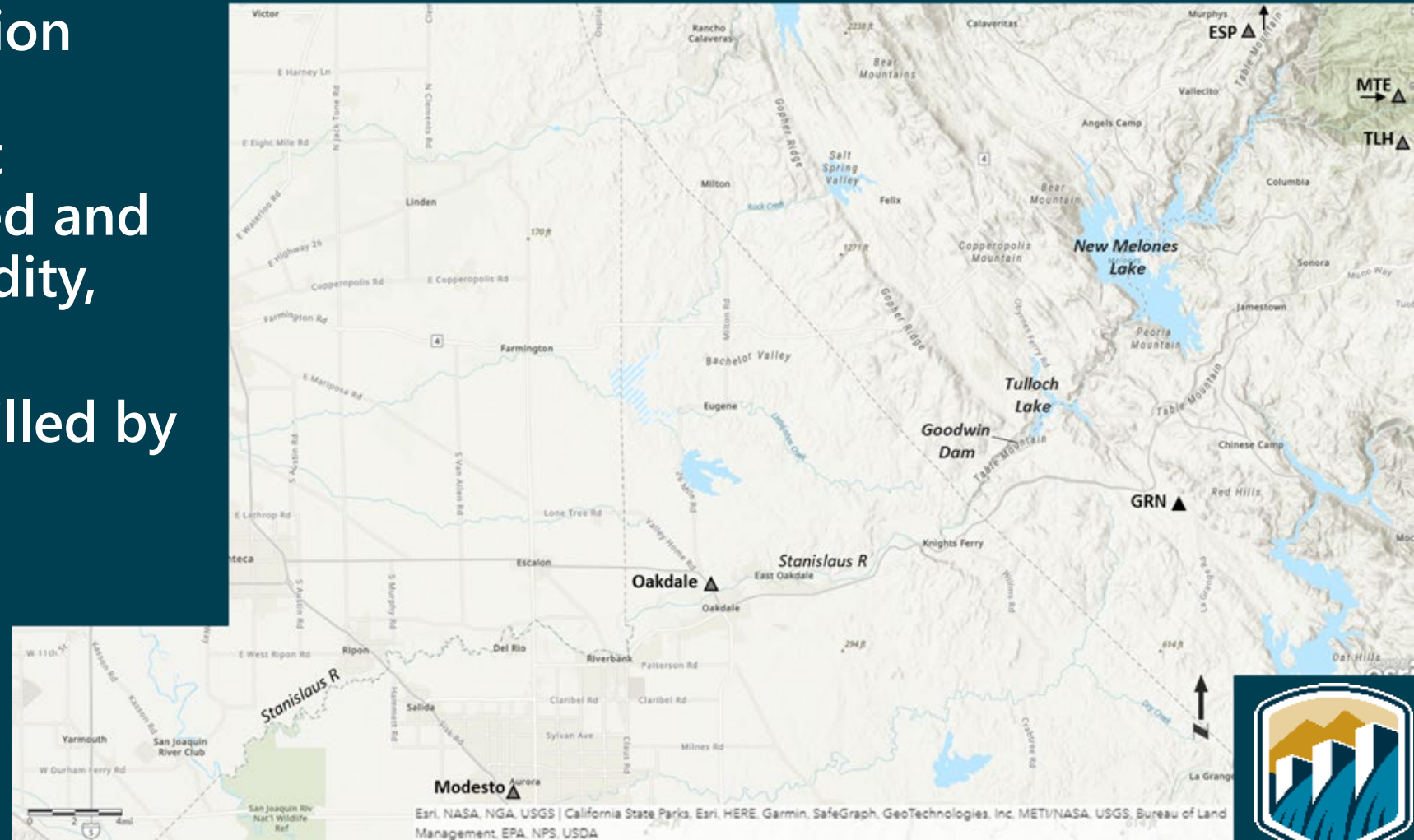
Lower American River Water Temperature Data Sources

| Site Number/ Abbreviation | SHEF Code | Agency | Site Active? | Site Name | Data Types | Data Frequency | Application of Data |
|------------------------------|--------------|--------|-----------------|---|---------------|-------------------|------------------------|
| 11446220 | n/a | USGS | YES | American River below Folsom Dam near Folsom CA | Tw | Hourly | Boundary Condition |
| 11446700 | n/a | USGS | YES | American River at William B Pond Park at Carmichael, CA | Tw | Hourly | Calibration |
| 11446980 | n/a | USGS | YES | American River below Watt Avenue Bridge near Carmichael, CA | Tw | Hourly | Calibration |



Meteorology Example: Stanislaus River System Meteorologic Stations

- Green Springs Met Station data was used for air temperature, dew point temperature, wind speed and direction, relative humidity, and solar radiation.
- Gaps in the data were filled by nearby stations
 - Oakdale
 - Telegraph Hill (TLH)
 - Esperanza (ESP)
 - Mount Elizabeth (MTE)
 - Modesto



Data Development Summary

- **Accomplishment:**

- Developing and applying the models for the WTMP requires acquiring and organizing a considerable amount of information and data to support modeling goals.
- Flexible structure: As improved data becomes available (e.g., river bathymetry, improved boundary conditions flows and temperatures) models can be updated.

- **Assessment:**

- **Geometric Data:**

- Well defined for reservoirs
- Largely sufficient for stream reaches

- **Hydrology, Water Temperature, and Meteorology Data:**

- 331 data sets are used for the Sacramento, Trinity, American, and Stanislaus River basin models. Of those data sets, 29 have gaps of sufficient duration that required additional efforts to fill.

