Yuba River Development Project
FERC Project 2246 Relicensing

Water Temperature Modeling

Thursday, January 20, 2011

Meeting Agenda

- Introductions
- Review previous meetings
- Review previous modeling efforts
- Watershed review
- Platform review
- Period of simulation
- Next steps

Previous Meetings

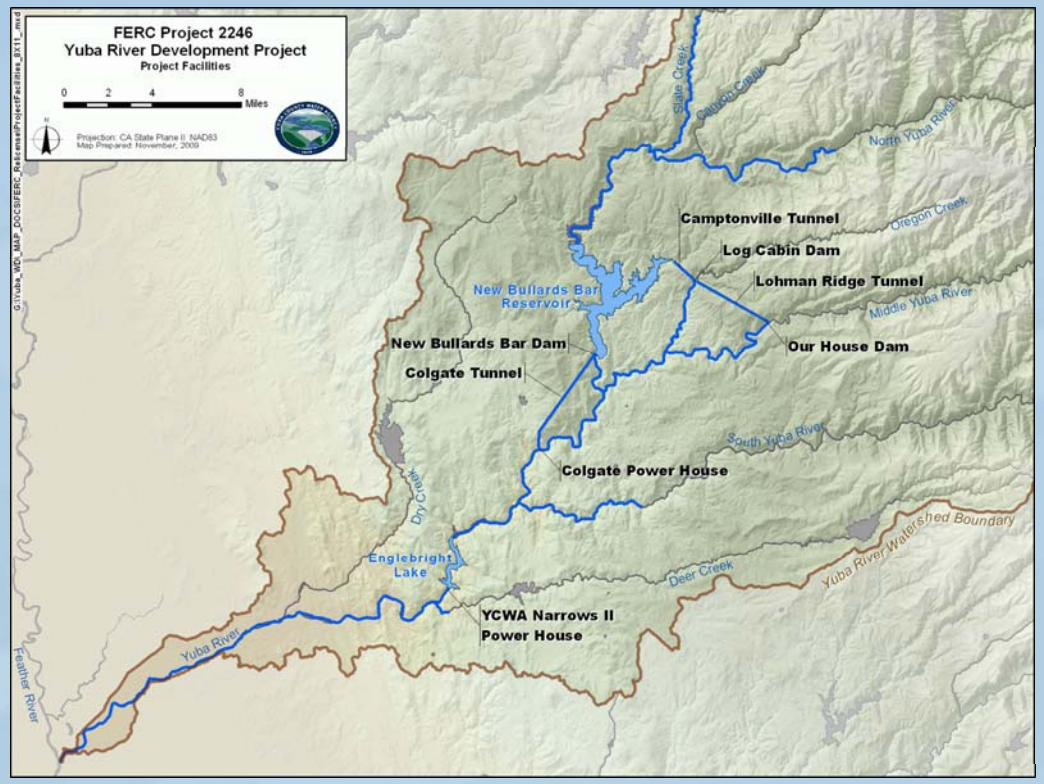
- November 12, 2009 – Operations Overview
- June 9, 2010 – Study Plan Discussion
- September 9, 2010 – Modeling Presentation

Previous Water Temperature Modeling Efforts

- 1991 SWRCB Hearings
  - CE-QUAL-R1 model of New Bullards Bar Reservoir
  - Regressions for temps from NBB to Englebright Reservoir release
  - HEC-5Q model of lower Yuba River
- 2001 SWRCB Hearings
  - Regressions for Englebright release, and lower Yuba River temperatures
- 2006 Lower Yuba River Accord
  - Regressions for NBB release, Eng release, lower Yuba River

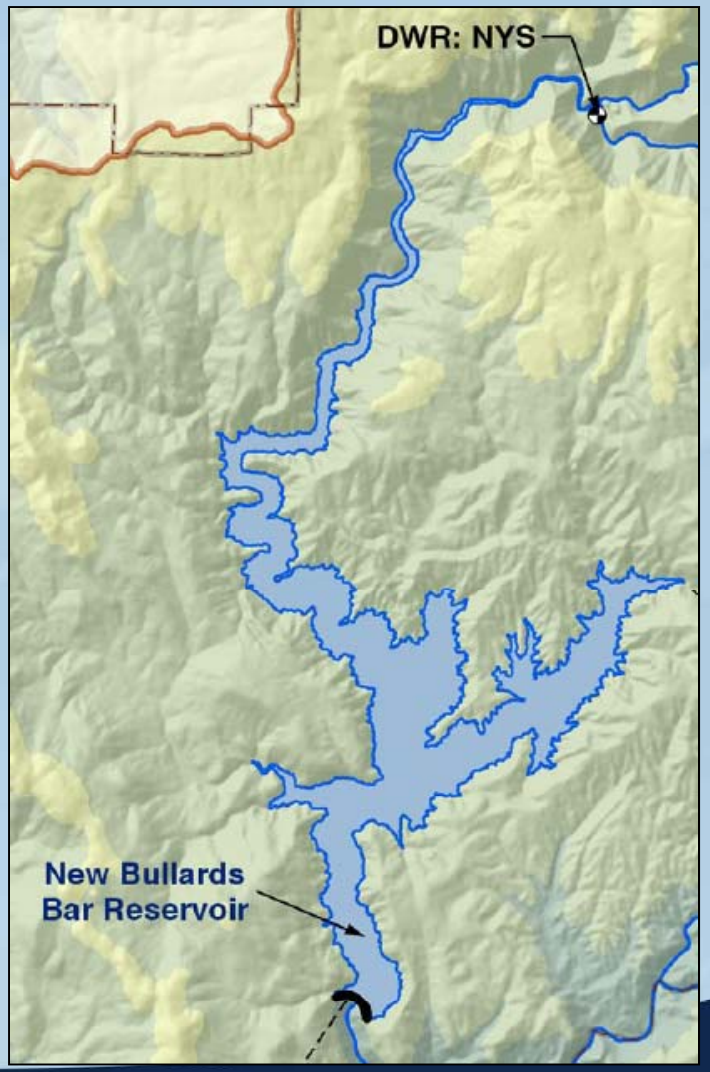
Watershed Review

- Key Modeling Elements
  - New Bullards Bar Reservoir
  - Middle Yuba River-Yuba River complex
  - Englebright Reservoir
  - Lower Yuba River
- Other potentially contributing factors
  - Dobbins Creek
  - Dry Creek
  - Deer Creek



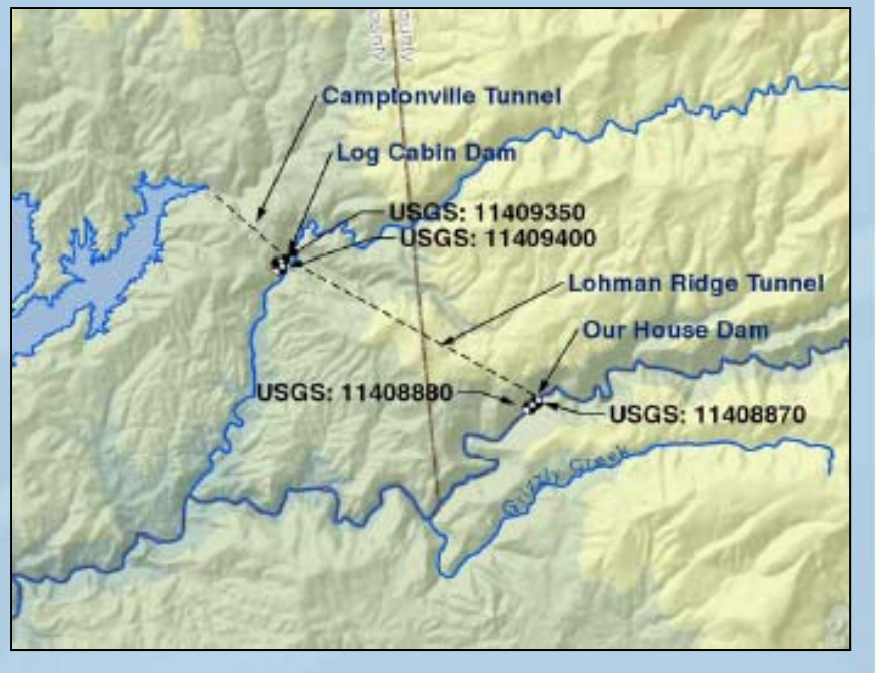
New Bullards Bar Reservoir

- Historical monthly profiles near Colgate Intake
  - 8/25/89-Present
  - Upper 300 feet of reservoir
- Historical Daily North Yuba River water temperatures
  - 8/5/05-Present
- Historical Daily Camptonville Tunnel water temperatures
  - 7/7/08-Present
- Historical Hourly Colgate Unit 1 and Unit 2 temperatures
  - 4/1/00-Present
- Historical Daily Fish Hydro release temperatures
  - 7/17/08-Present



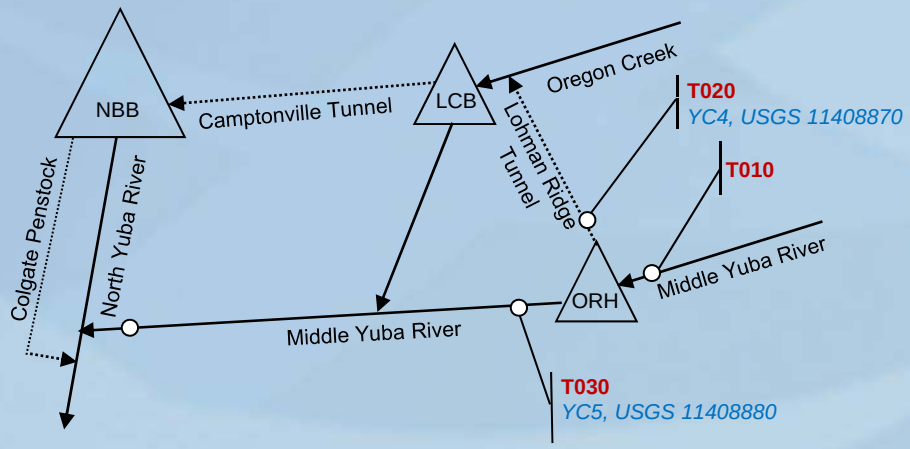
Middle Yuba River Complex

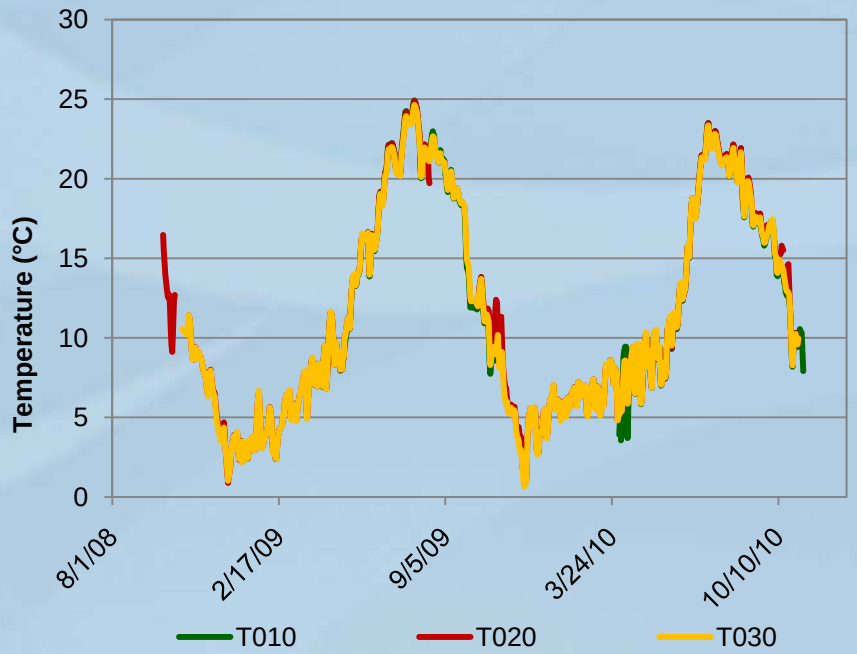
- Middle Yuba River above Our House Dam
  - Downstream point of YB-DS simulation
  - 3/27/09-Present
- Middle Yuba below Our House Dam
  - 10/23/08-Present
- Lohman Ridge Tunnel Intake
  - 12/18/03-Present
- Oregon Creek above Log Cabin Dam
  - 7/7/2008-Present
- Oregon Creek below Log Cabin Dam
  - 8/29/08-Present
- Camptonville Tunnel Intake
  - 7/7/2008-Present
- Middle Yuba River near confluence with North Yuba River
  - 8/18/08-Present



Our House Dam

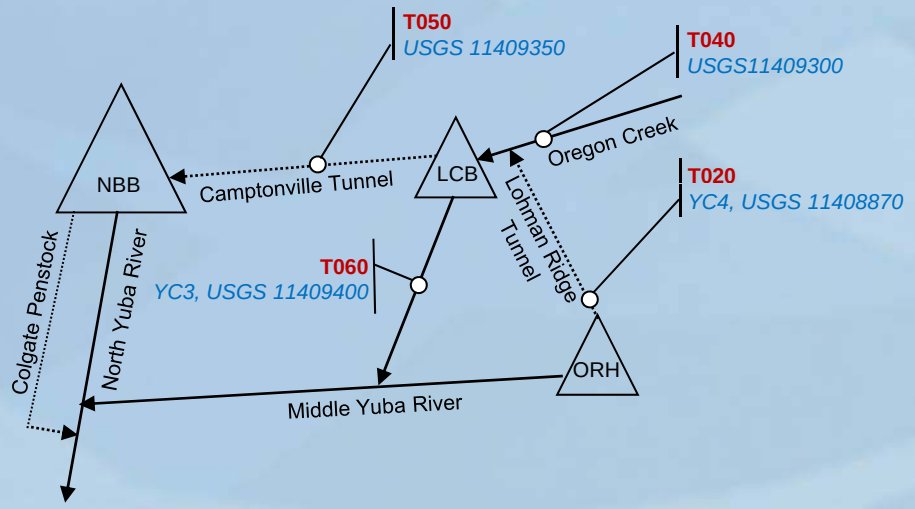
Analysis of Historical Water Temperatures

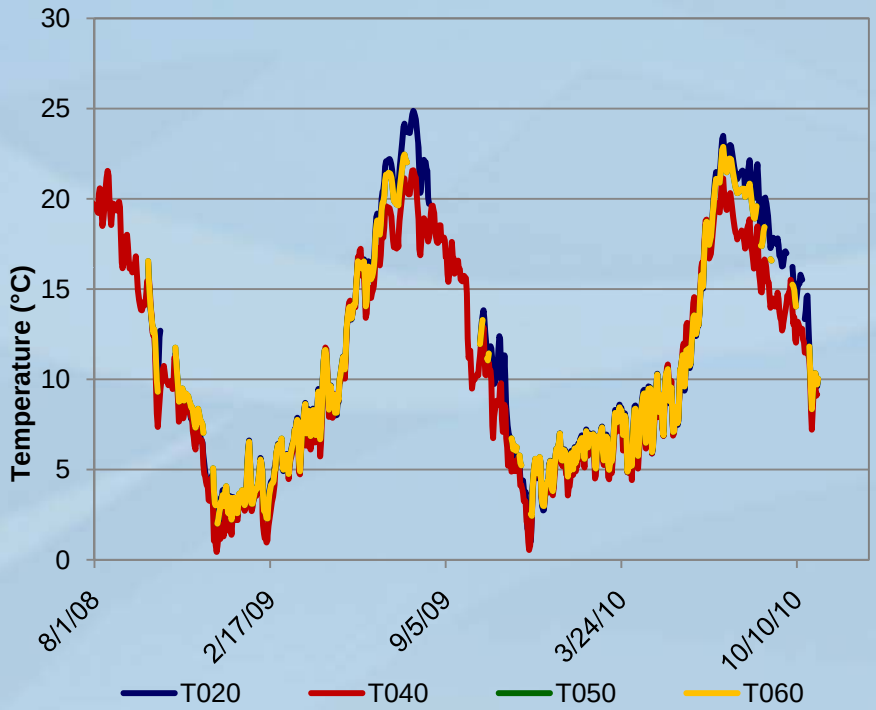




Log Cabin Dam

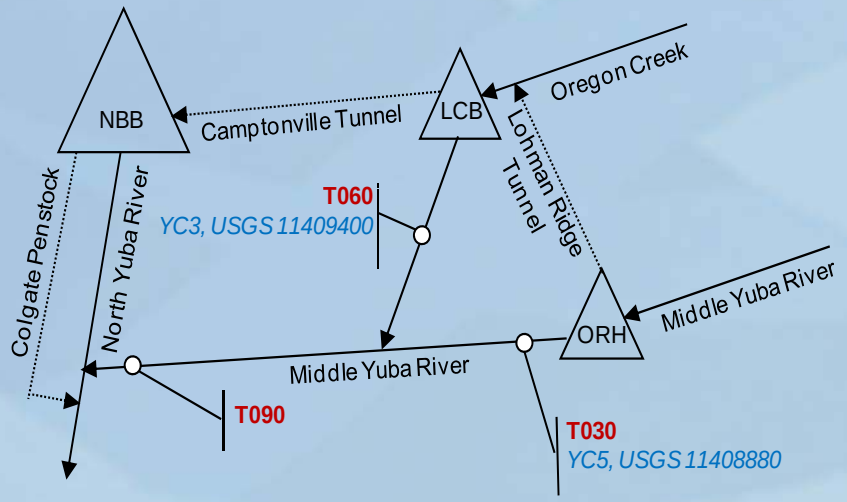
Analysis of Historical Water Temperatures

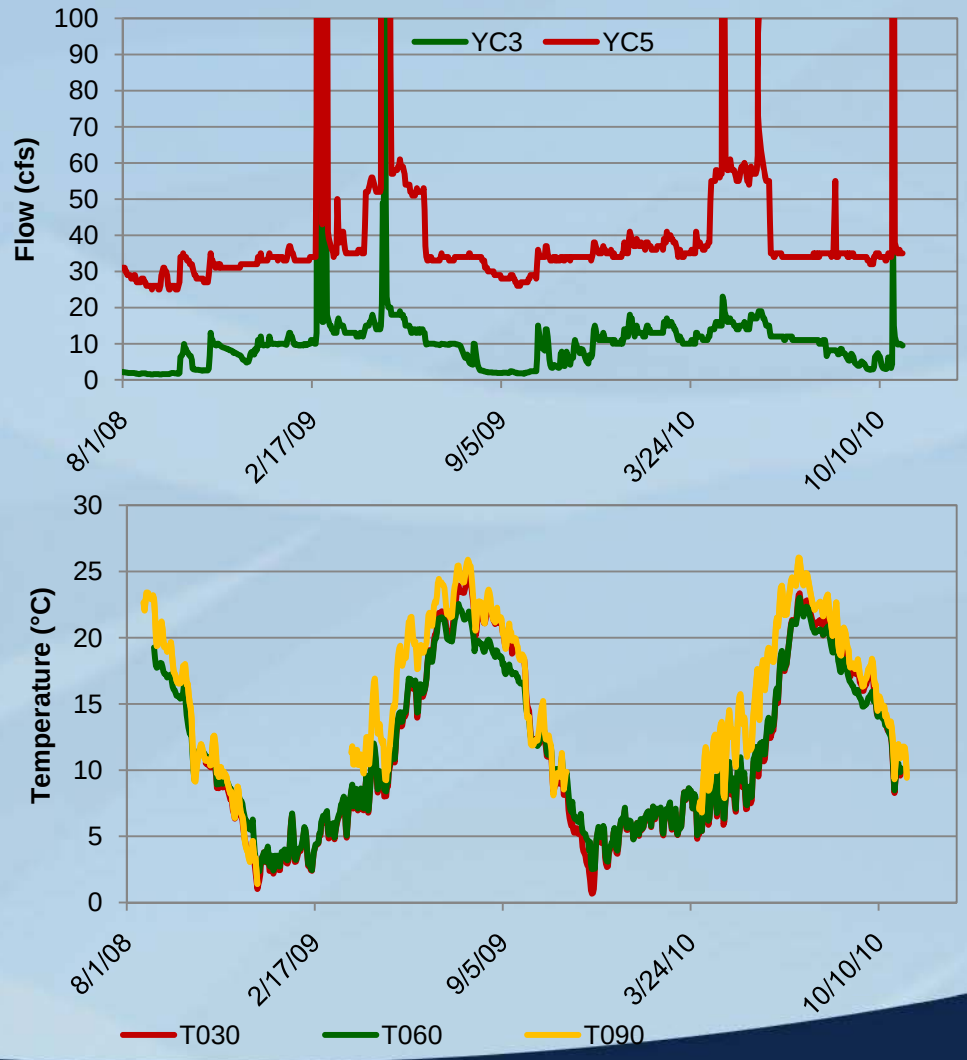




Middle Yuba River

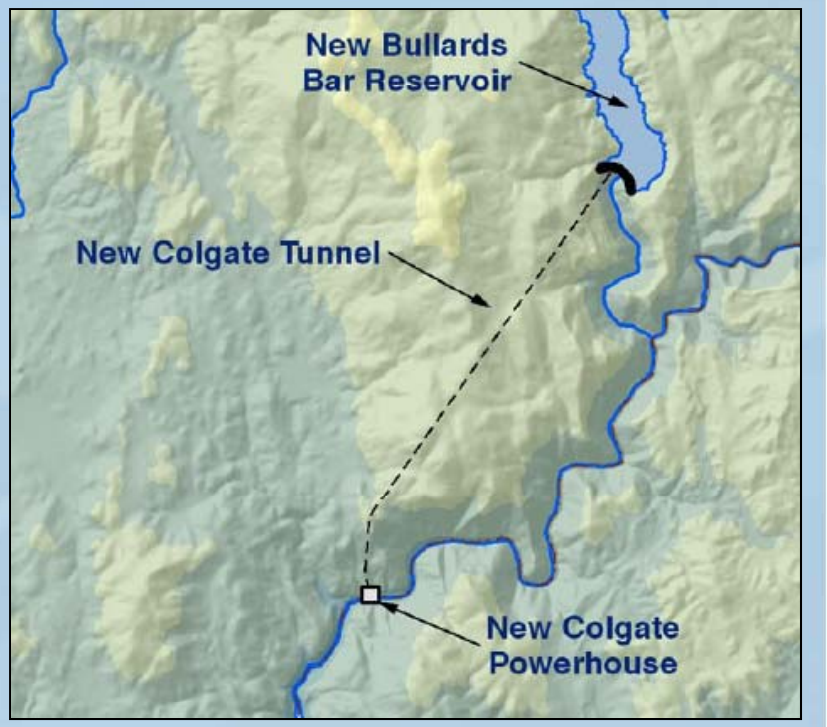
Analysis of Historical Water Temperatures





Middle Yuba-North Yuba River Confluence

- Historical Daily North Yuba River above Middle Yuba River
  - 8/18/08-Present
- Middle Yuba River upstream of confluence with North Yuba River
  - 8/18/08-Present
- Yuba River below confluence of North and Middle Yuba rivers
  - 8/18/08-Present



Middle Yuba-North Yuba River Confluence

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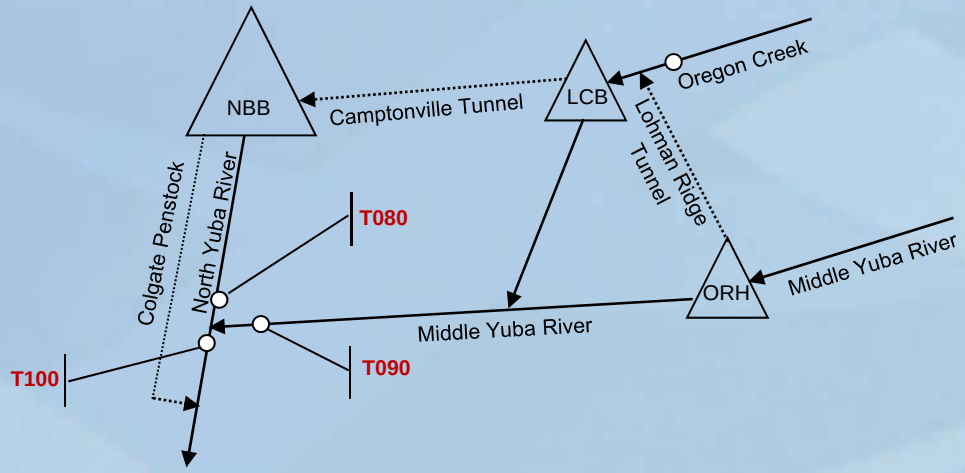
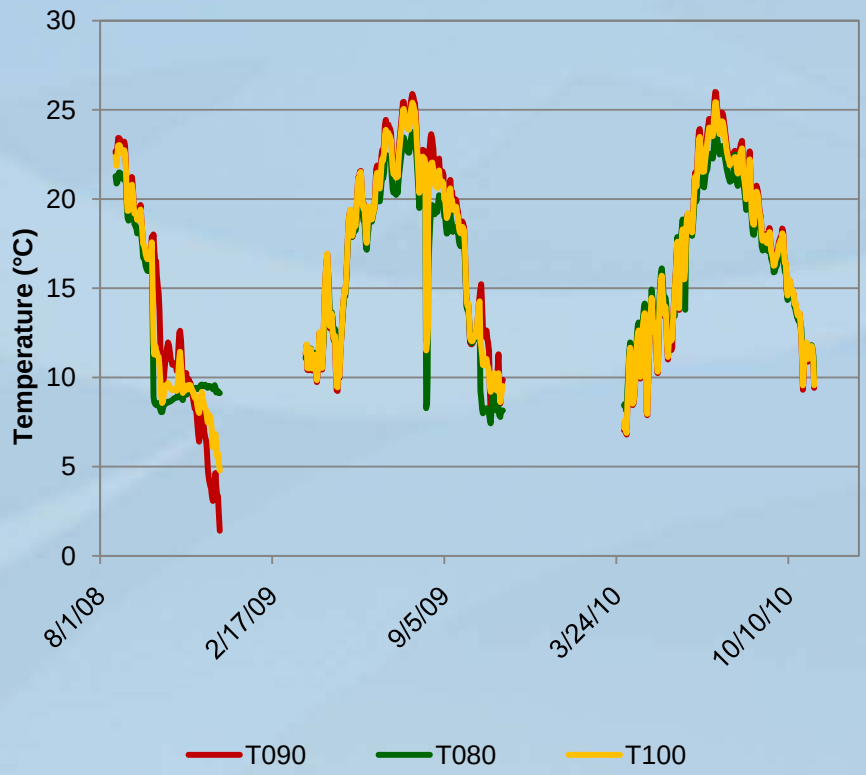
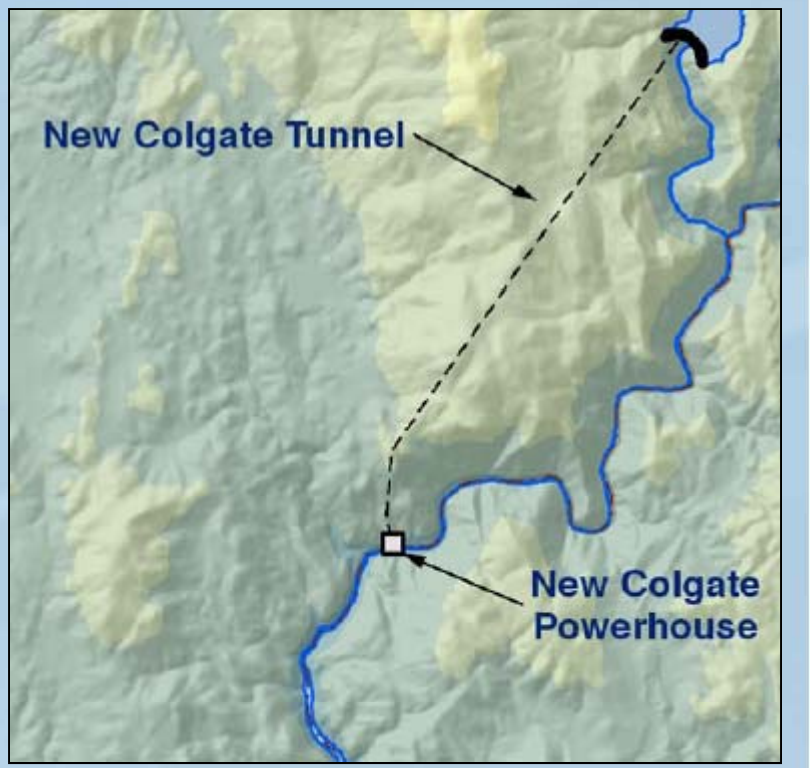




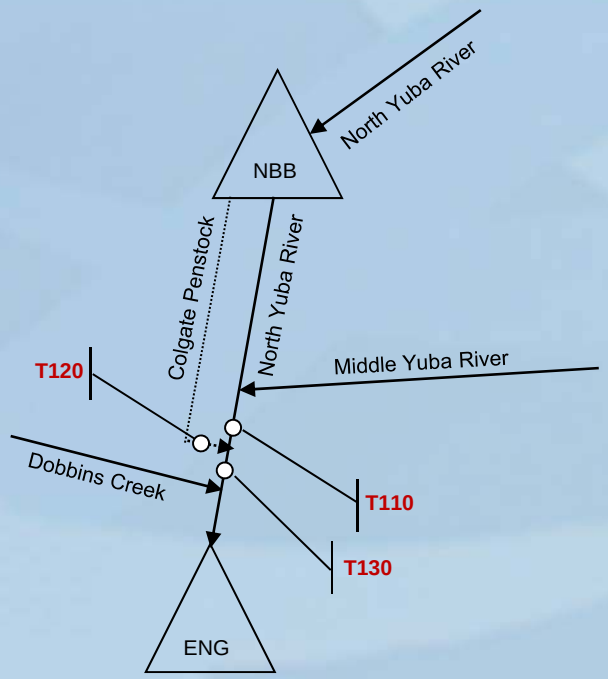
Yuba River near Colgate Powerhouse

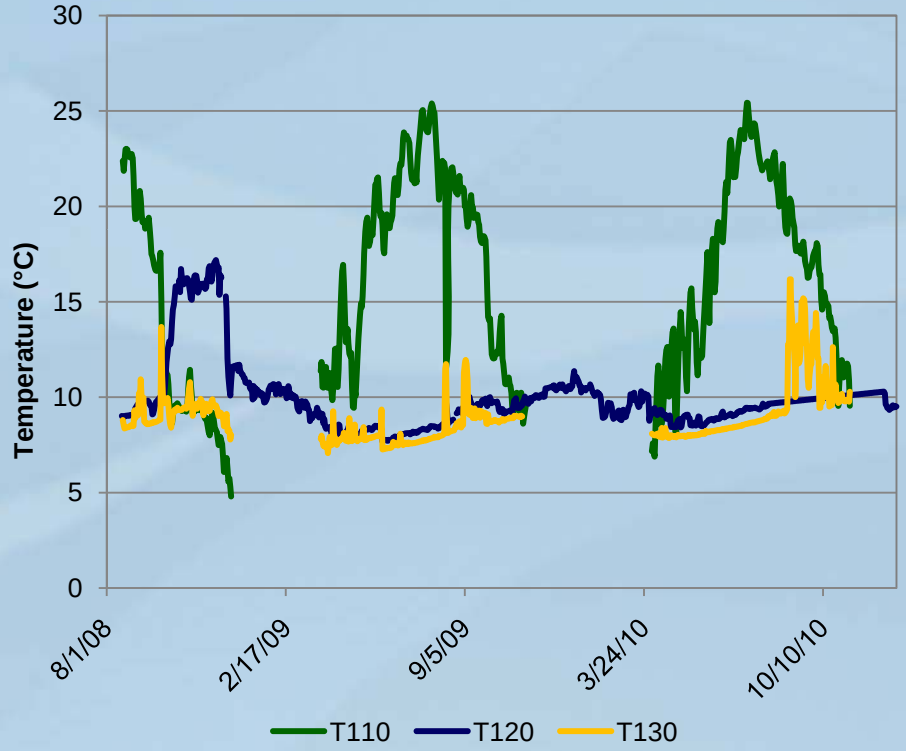
- Historical Daily Yuba River upstream of Colgate Powerhouse
  - 8/18/08-Present
- Historical Colgate Powerhouse Units 1 and 2
  - 4/1/00-Present (Hourly)
  - 9/21/95-Present (Daily)
- Historical Daily Yuba River downstream of Colgate Powerhouse
  - 8/18/08-Present



Yuba River near Colgate Powerhouse

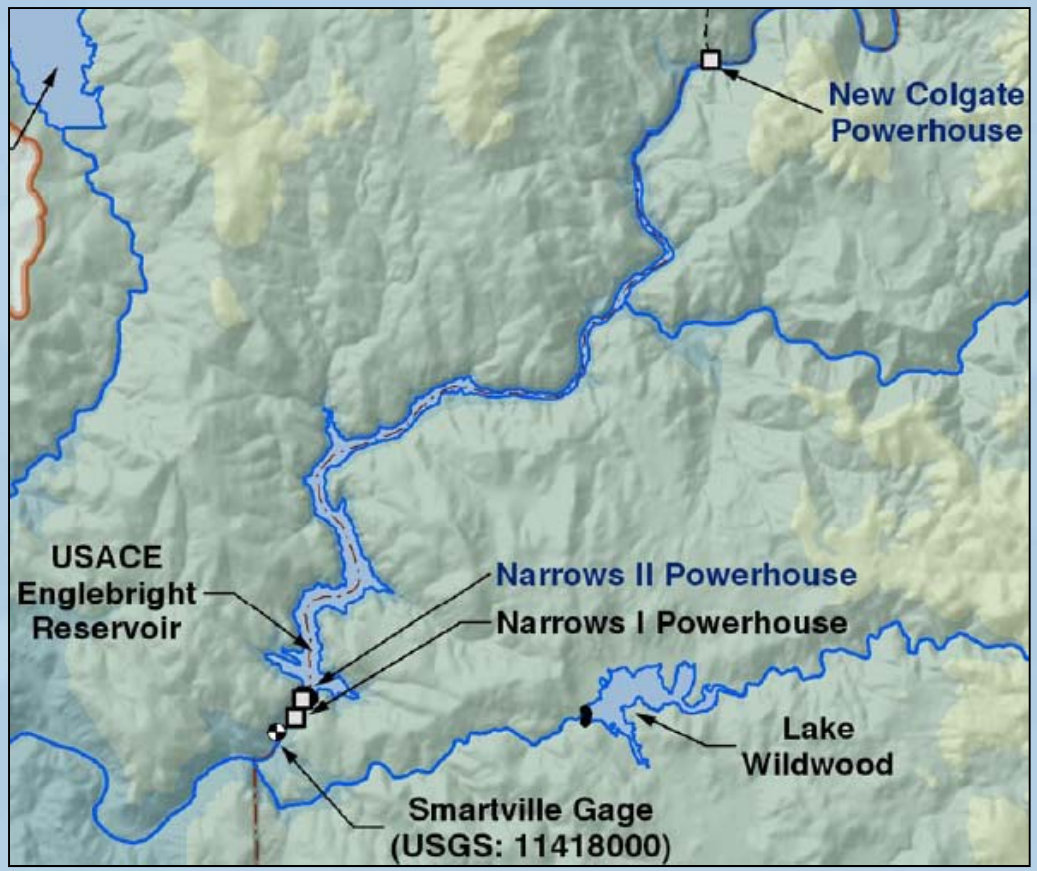
Analysis of Historical Water Temperatures





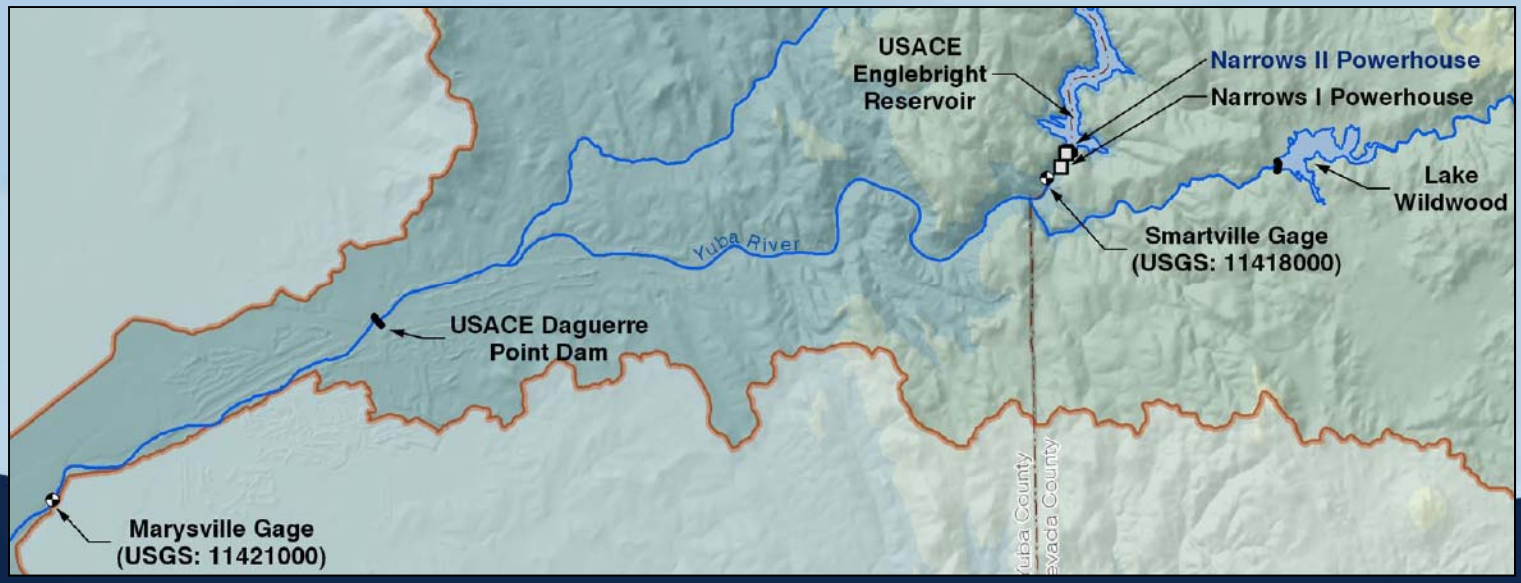
Englebright Reservoir

- Historical Monthly Reservoir Profiles
  - 1/24/90-Present
  - Upper 100 feet of reservoir
- Historical Hourly Narrows 2 Water Temperatures
  - 9/1/99-Present
- Historical Hourly Yuba River at Smartville Water Temperatures
  - 10/1/02-Present



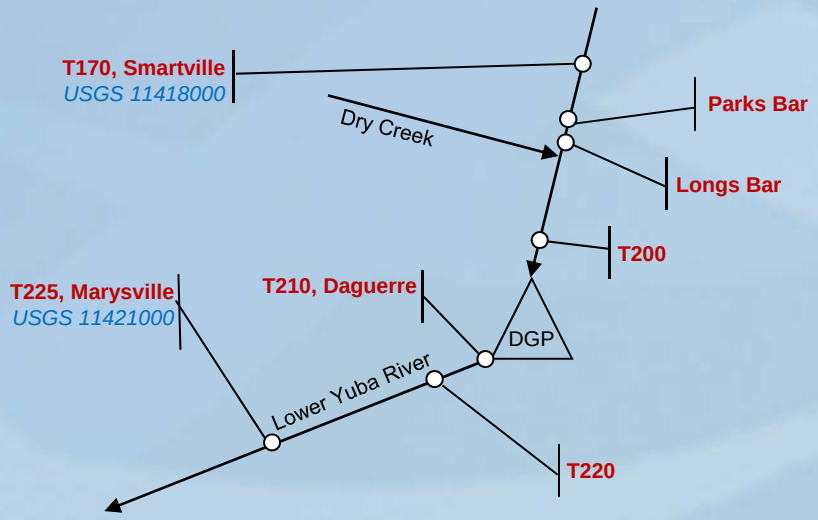
Daguerre Point Dam

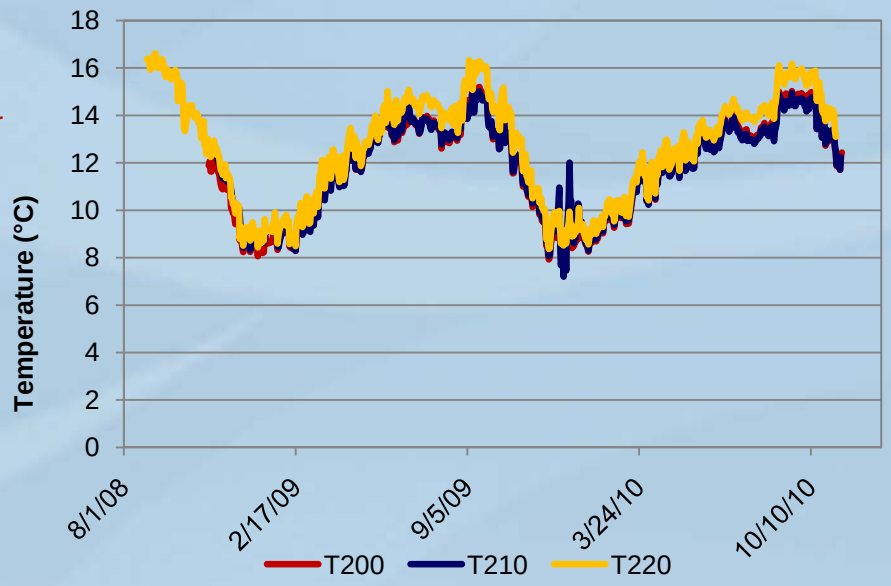
- Historical Hourly Yuba River at Smartville
  - 10/1/02-Present
- Historical Daily Yuba River above Daguerre Point Dam
  - 11/7/08-Present
- Historical Hourly Yuba River at Daguerre Point Dam
  - 10/1/2002-Present
- Historical Daily Yuba River below Daguerre Point Dam
  - 11/17/08-Present



Daguerre Point Dam

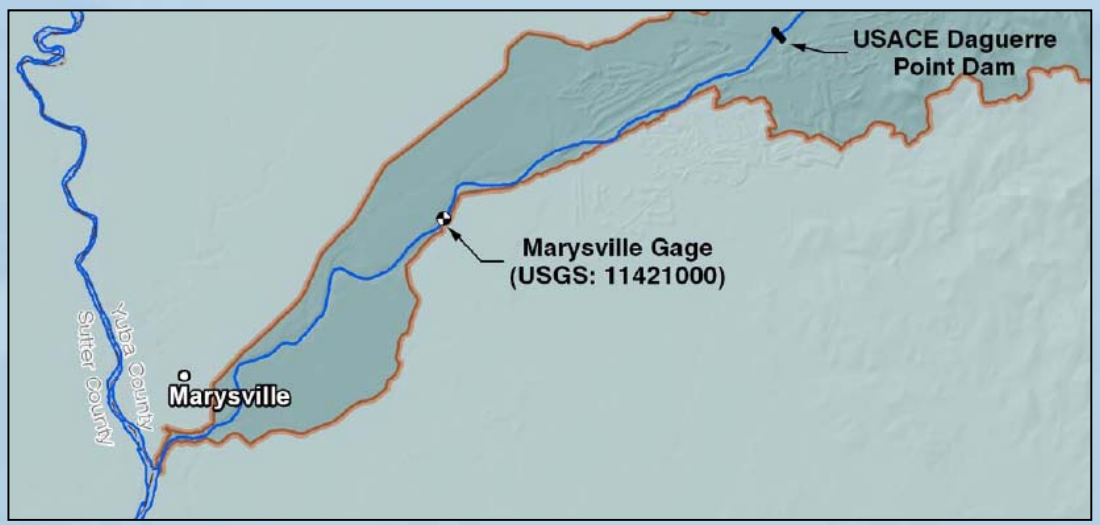
Analysis of Historical Water Temperatures





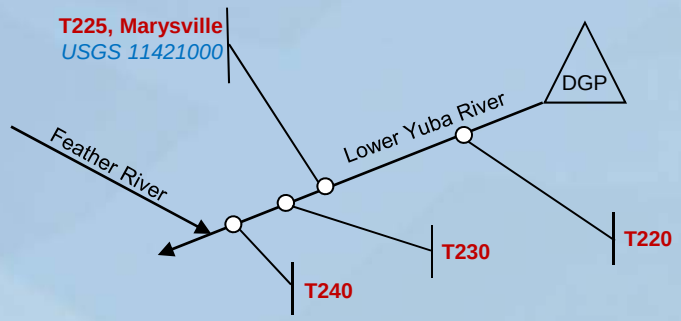
Yuba River below Daguerre Point Dam

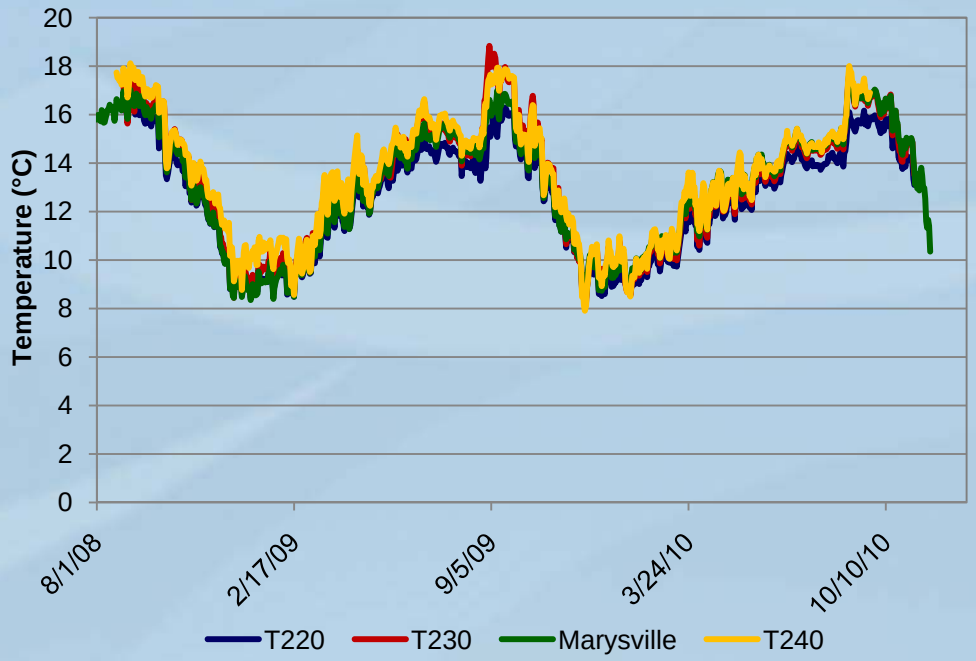
- Historical Hourly Yuba River at Daguerre Point Dam
  - 10/1/2002-Present
- Historical Daily Yuba River below Daguerre Point Dam
  - 11/17/08-Present
- Historical Yuba River at Marysville Gage
  - 10/1/89-5/11/99 (Daily)
  - 10/1/02-Present (Hourly)
- Historical Daily Yuba River near Simpson Lane Bridge
  - 8/27/08-Present
- Historical Daily Yuba River at Marysville
  - 8/18/08-Present



Yuba River below Daguerre Point Dam

Analysis of Historical Water Temperatures



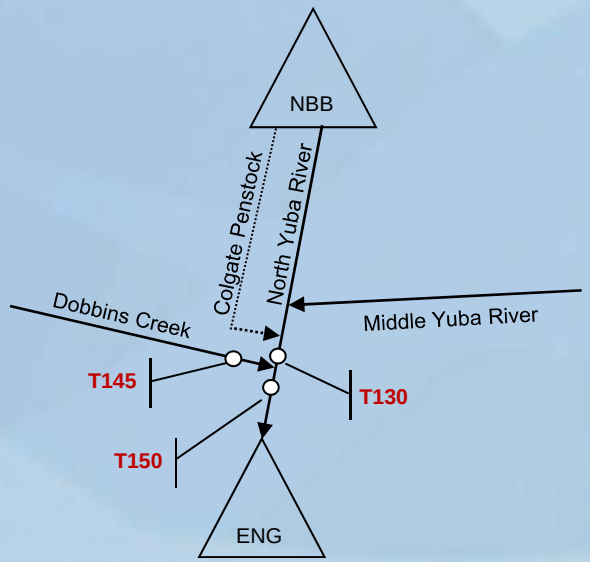


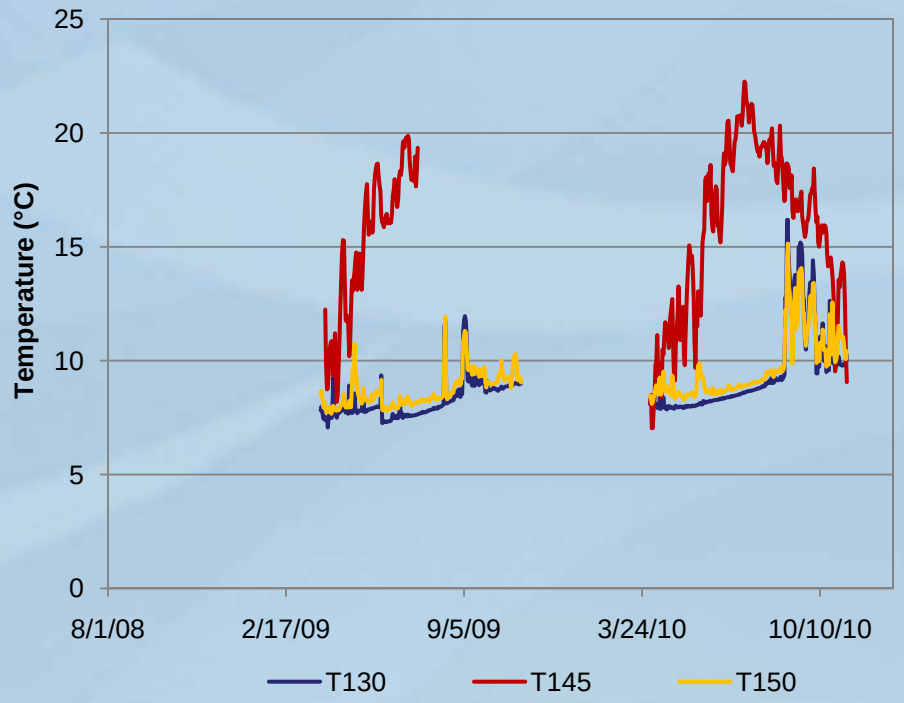
Other Locations

- These areas do not appear to have a notable effect on water temperatures
  - Dobbins Creek
  - Deer Creek
  - Dry Creek

Dobbins Creek

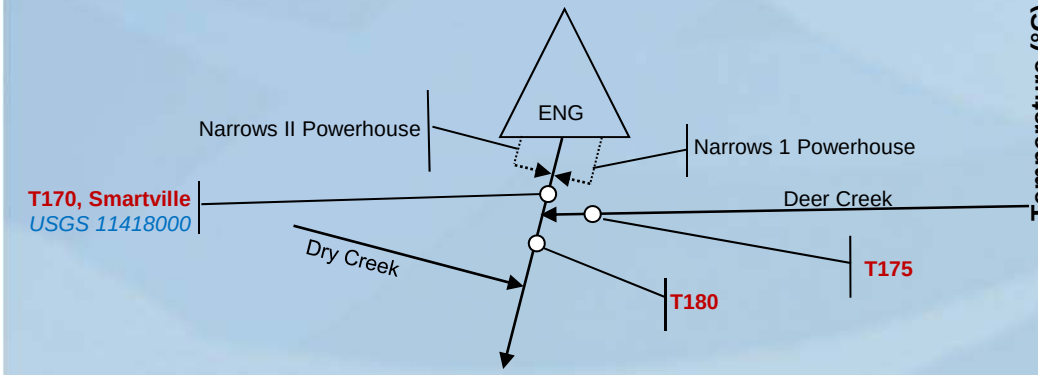
Analysis of Historical Water Temperatures

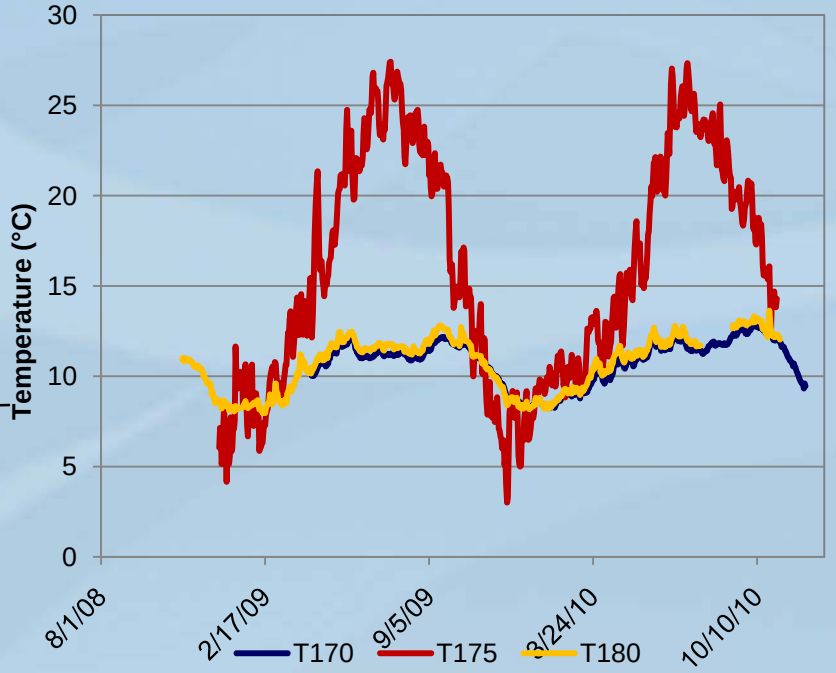




Deer Creek

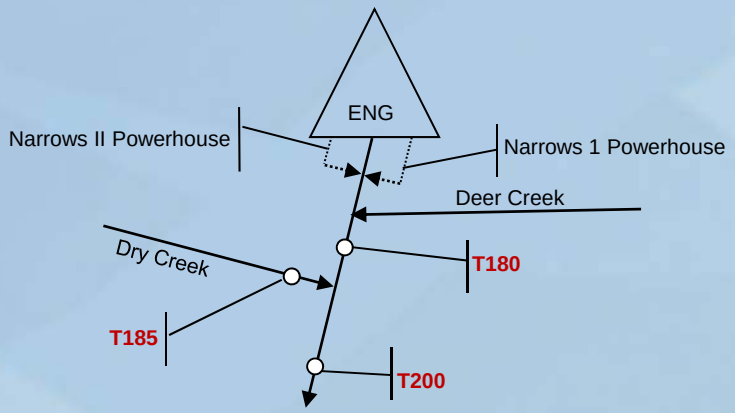
Analysis of Historical Water Temperatures

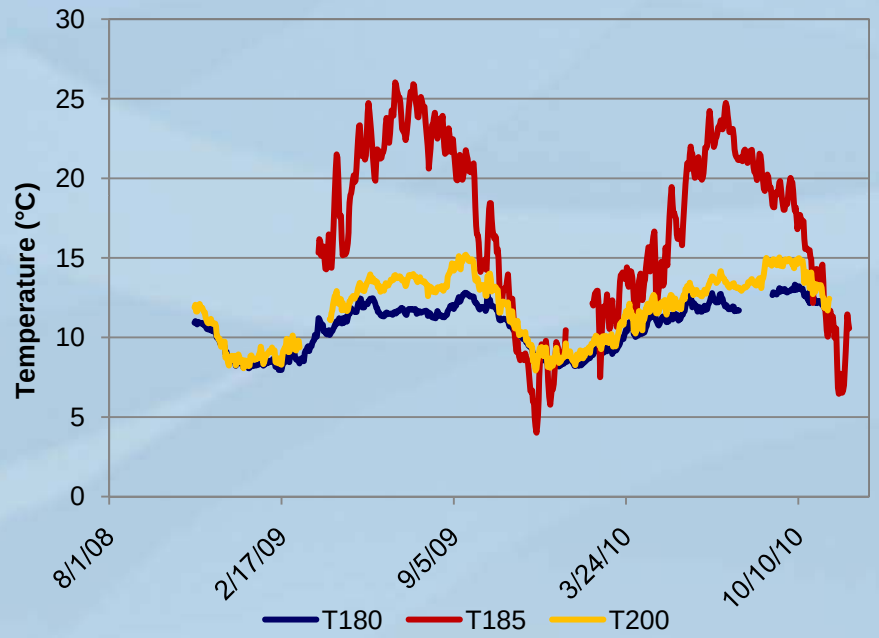




Dry Creek

Analysis of Historical Water Temperatures

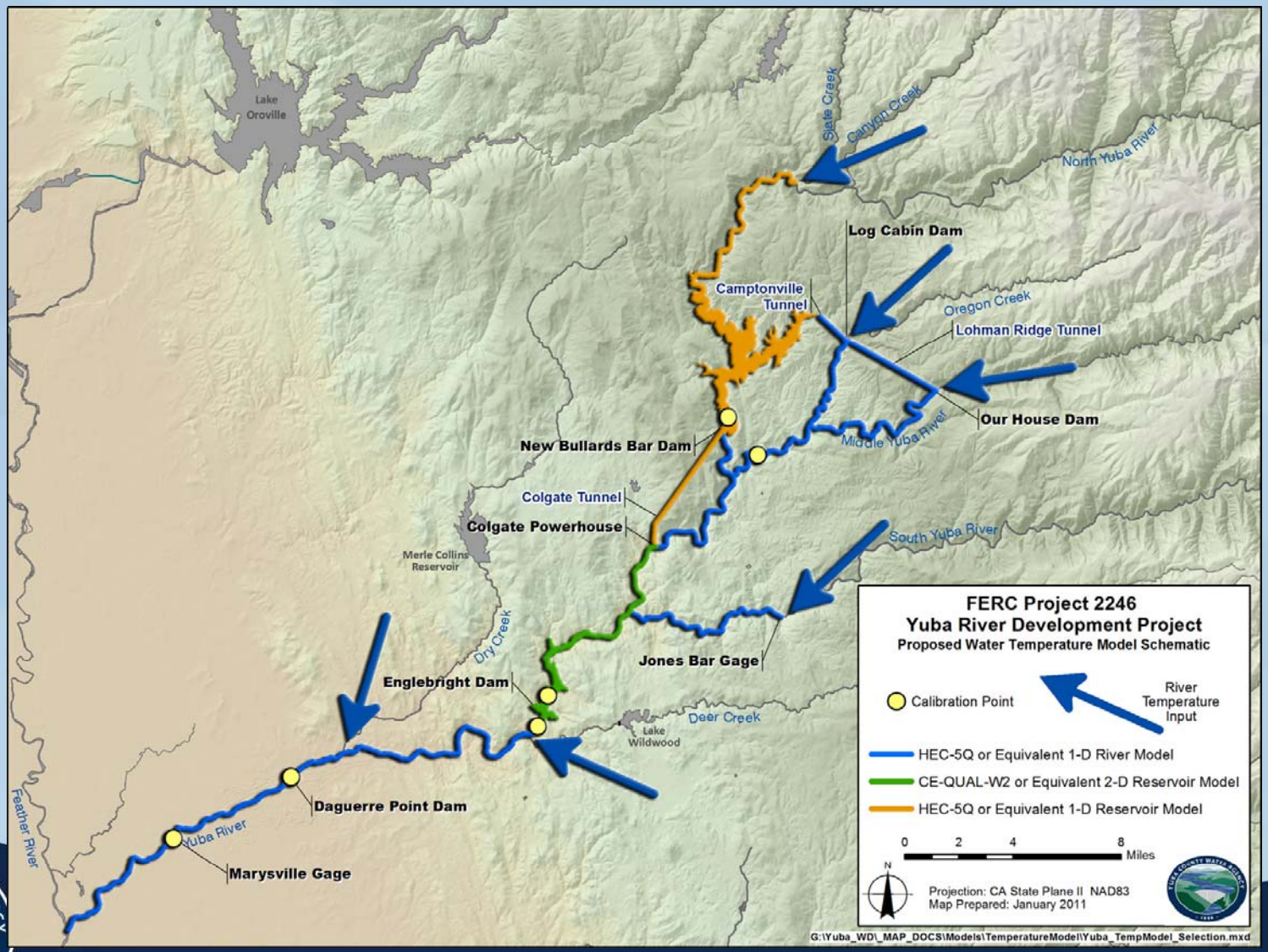




What effects are we trying to model?

- NBB release temperatures (through Colgate PH) on lower Yuba River temperatures due to:
  - Storage change
  - Flow change
  - Outlet used
- Effect of NBB change in flow through low level outlet on North Yuba and Yuba River temperatures above Englebright
- Effect of change in Our House and Log Cabin diversions on Middle Yuba River and Oregon Creek temperatures
- Effect of change in Englebright flow on lower Yuba temperatures
- Effect of Daguerre diversion on lower section of lower Yuba River temperatures
- Effect of upstream project changes on Middle Yuba and South Yuba temperatures

Modeling Platform Review



Potential River Models

SNTEMP

- Developed by USGS
- Widely used
- Mean Daily Temperatures & Diurnal temp (max & min)
- Lots of tools to work with data
- Regression module to fill in missing data
- Simple stream geometry
  - Average width and power function for change with flow ($w = a \times Q^b$)
  - Depth from Mannings equation
- Good translation of solar radiation with elevation
- Handles vegetation shading and topographic shading

Potential River Models

SNTEMP

- Weakness in Maximum temperature prediction
  - “backcasts” streamflow to get maximum temp.
  - Sensitive to width estimate (heat flux)
- Single Year simulation
  - 366 time periods
- Would require hydraulic modeling of all reaches
- Strong toolset
- Extensively used, well documented
- Maybe easier to implement than some other models

Potential River Models

HSPF

- Developed by USGS
- Focused on complete hydrologic cycle
- Capable of simulating wide range of water quality constituents
- Relies on volumetric calculation to determine surface area and depth of flow rather than hydraulic routing
- Requires many files

Potential River and Reservoir Models

HEC-5Q

- Developed by HEC
- Widely used for reservoir and river simulations
- Well documented
- 1-dimensional model
- Includes hydraulic and hydrologic routing
- Capable of simulating gate operations/multiple outlets
- Integrated River and Reservoir models into a single file
- Equilibrium temperature computed in external processor (HEATX)
- Capable of simulating multiple years

Potential Reservoir Models

CE-QUAL-W2

- Developed by Army Corps of Engineers Environmental and Water Quality Operational Studies Work Unit
- 2-Dimensional model
- Capable of simulating gate operations/multiple outlets
- Widely used for reservoir simulations
- Well documented
- Equilibrium temperatures computed internally
- Capable of simulating multiple years

Potential Reservoir Models

CE-QUAL-R1

- Developed by Army Corps of Engineers Environmental and Water Quality Operational Studies Work Unit
- 1-Dimensional model

Period of Simulation

Available Meteorological Input Data

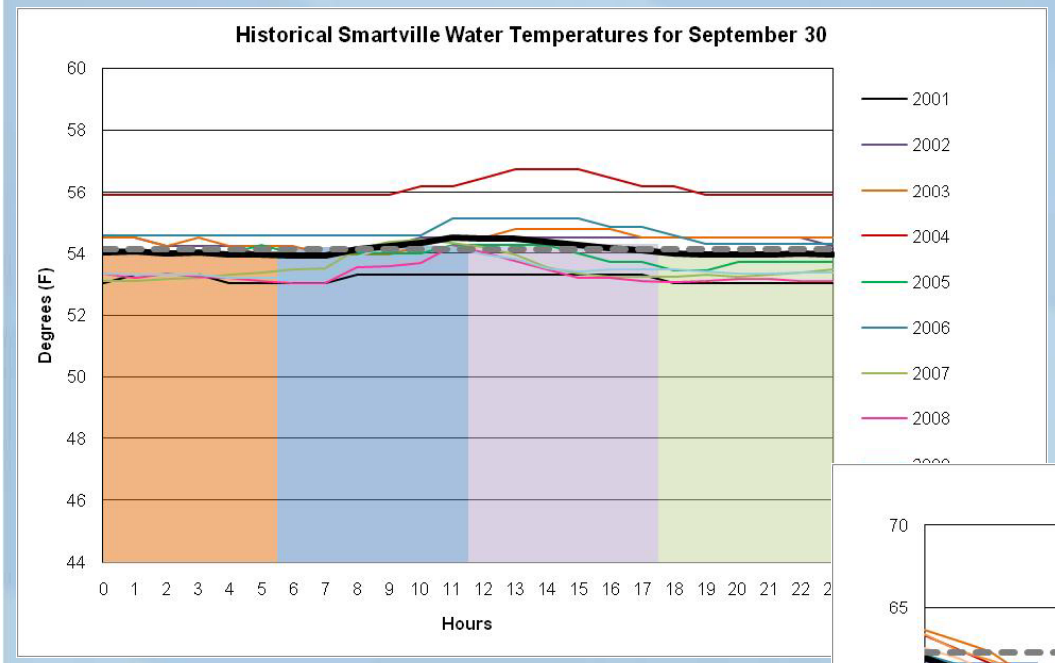
- Daily meteorological observations since 1951
  - Marysville
  - Downieville
- Daily CIMIS data since 1983
  - Nicolaus
  - Browns Valley
  - Durham
- Daily meteorological data since 1981
  - Oroville Dam
  - Yuba City
  - Chico

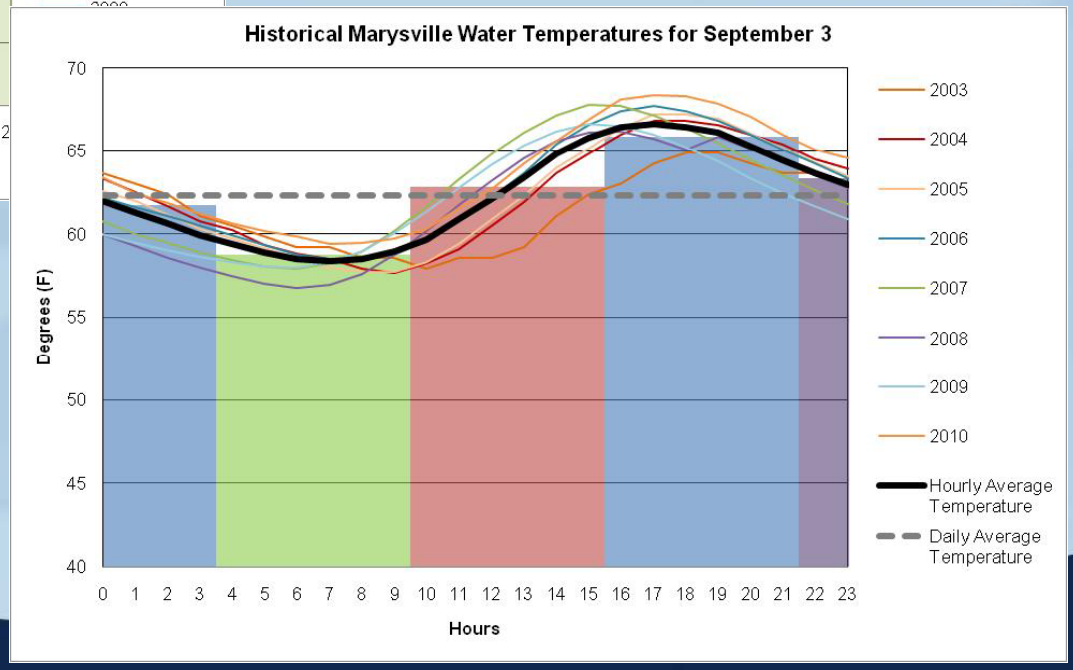
Period of Simulation

Potential Time Steps

- Daily Time Step
  - Advantages
    - Matches timestep with hydrologic model
    - Matches timestep with greatest range of available historical data
    - Relatively quick simulation time
  - Concerns
    - Doesn't capture diurnal variation in temperatures
- Hourly Time Step
  - Advantages
    - Captures full range of daily temperature variability
  - Concerns
    - May not be supported by available input data
    - May require excessive simulation time
- Sub-Daily Time Step (6 Hour?)
  - Advantages
    - Captures trends of daily max and min temps
    - Relatively quick simulation time
  - Concerns
    - Doesn't capture full range of daily variation in temperature
    - May not be supported by input data

Comparison of Potential Time Steps





Next Steps

- Get general consensus on modeling approach
- Get general consensus on platform selection
- Get general consensus on time step
- Start modeling

- Next meeting?