3.2.2 Water Resources

This section discusses water resources potentially affected by the Project. Section 3.2.2.1 discusses water quantity and uses, and Section 3.2.2.2 discusses water quality, including water temperature.

3.2.2.1 Affected Environment

3.2.2.1.1 Water Quantity and Uses

Section 3.1 of this PAD provides a description of the Yuba River basin including hydroelectric and water projects in the basin, existing dams in the basin, tributaries downstream of the Project, drainages areas at key locations, relevant river miles, a streambed gradient from the Project to the Yuba River's confluence with the Feather River, and a description of reaches potentially affected by the Project. Information regarding existing hydrology and water availability for use by the Project, as well as monthly flow duration curves and maximum and minimum flow releases from the Narrows 1 Powerhouse and in the Yuba River at Smartsville Gage is provided in Section 3.0 of the draft Exhibit B, which is included in Appendix C to this PAD. In addition, Section 5.3.8 in Appendix C describes the critical period used to calculate the Project's dependable capacity. Licensed Project facilities do not include a reservoir or dam, but, through an agreement with the U.S., the Project uses storage in Englebright Reservoir. Morphometric information regarding Englebright Reservoir is provided in Section 3.1.1.2.7.

Existing and potential designated Beneficial Uses of surface waters in and around the Project are established by the Central Valley Regional Water Quality Control Board (RWQCB), in its Water Quality Control Plan Report (Basin Plan) (Central Valley RWQCB 2018). The Basin Plan identifies streams and watersheds with unique Hydro Unit (HU) numbers. The Project and the watershed area downstream of the Project fall within a single Basin Plan unit, HU 515.3, which includes the Yuba River from the USACE's Englebright Dam to the Feather River. Designated beneficial uses of surface water in these units are shown by HU in Table 3.2.2-1.

Table 3.2.2-1. Beneficial Uses of surface water in and around the Project and the downstream of the Project as designated by Hydro Unit in the Basin Plan.

Designated Beneficial Use Description from Basin Plan, Section 2		Designated Beneficial Use by HU from Basin Plan, Table 2-1	
		Use	USACE's Englebright Dam to the Feather River
			HU 515.3
Agricultural Supply (AGR)	Farming, horticulture, or ranching, including, but not limited to, irrigation (including leaching of salts), stock watering, or support of vegetation for range grazing	IRRIGATION	Existing
		STOCK WATERING	Existing
Industry	Hydropower generation	POWER (POW)	Existing

Table 3.2.2-1. (continued)

Designated Beneficial Use Description from Basin Plan, Section 2		Designated Beneficial Use by HU from Basin Plan, Table 2-1	
		Use	USACE's Englebright Dam to the Feather River HU 515.3
Water Contact Recreation (REC-1)	Recreational activities involving body contact with water, where ingestion of water is reasonably possible; these uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs	CONTACT	Existing
		CANOEING AND RAFTING	Existing
Non-Contact Water Recreation (REC-2)	Recreational activities involving proximity to water, but where there is generally no body contact with water, nor any likelihood of ingestion of water; these uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tide-pool and marine life study, hunting, sightseeing or aesthetic enjoyment in conjunction with the above activities	OTHER NON-CONTACT	Existing
Freshwater Habitat[1]	Warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates	WARM[1]	Existing
	Cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates	COLD[1]	Existing
Migration of Aquatic Organisms (MGR)	Habitats necessary for migration or other temporary activities by aquatic organisms, such as anadromous fish[1]	WARM[2]	Existing
		COLD[3]	Existing
Spawning (SPWN)	High-quality aquatic habitats suitable for reproduction and early development of fish	WARM[2]	Existing
		COLD[3]	Existing
Wildlife Habitat (WILD)	Terrestrial or wetland ecosystems including, but not limited to, preservation or enhancement of terrestrial habitats or wetlands, vegetation, wildlife (*e.g.*, mammals, birds, reptiles, amphibians, invertebrates) or wildlife water and food sources	WILDLIFE HABITAT	Existing

Source: Central Valley RWQCB 2018
[1] Anadromous does not include resident. Any hydrologic unit with both WARM and COLD beneficial use designations is considered a COLD waterbody for the application of water quality objectives.
[2] Striped bass, sturgeon, and shad
[3] Salmon and steelhead

3.2.2.1.2 Water Quality

Basin Plan Designated Beneficial Use and Water Quality Objectives

As described in Section 1.3.9, the Basin Plan establishes water quality standards for the Yuba River Basin (Central Valley RWQCB 2018). The standards are composed of designated existing and potential Beneficial Uses, which are described in Table 3.1-2, and Water Quality Objectives, which are provided in Table 3.2.2-2. The objectives are primarily narrative, incorporating California's numeric Title 22 drinking water standards by reference.

Table 3.2.2-2. Water Quality Objectives to support designated Beneficial Uses in the vicinity of the Project as established by the CVRWQCB and listed in the Basin Plan.

Water Quality Objective	Description
Bacteria	In terms of fecal coliform. Less than a geometric average of 200/100 ml on five samples collected in any 30-day period and less than 400/100 ml on ten percent of all samples taken in a 30-day period.
Biostimulatory Substances	Water shall not contain biostimulatory substances that promote aquatic growth in concentrations that cause nuisance or adversely affect beneficial uses.

Table 3.2.2-2. (continued)

Water Quality Objective	Description
Chemical Constituents[1]	Waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses. Specific trace element levels are given for certain surface waters, none of which include the waters in the vicinity of the Project. Electrical conductivity (at 77 ºF) shall not exceed 150 micromhos (µmhos)/cm (90 percentile) in well-mixed waters of the Feather River from the Fish Barrier Dam at Oroville to Sacramento River. Other limits for organic, inorganic and trace metals are provided for surface waters that are designated for domestic or municipal water supply. In addition, waters designated for municipal or domestic use must comply with portions of Tit 22 of the Cal. Code Regs. For protection of aquatic life, surface water in California must also comply with the California Toxics Rule (40 C.F.R. Part 131).
Color	Water shall be free of discoloration that causes a nuisance or adversely affects beneficial uses.
Dissolved Oxygen (DO)	Monthly median of the average daily dissolved oxygen concentration shall not fall below 85 percent of saturation in the main water mass, and the 95 percent concentration shall not fall below 75 percent of saturation. Minimum level of 7 mg/L. Specific DO water quality objectives below Oroville dam are 8.0 mg/L from September 1 to May 31, for Feather River from Fish Barrier Dam at Oroville to Honcut Creek (surface water body #40). When natural conditions lower dissolved oxygen below this level, the concentrations shall be maintained at or above 95 percent of saturation.
Floating Material	Water shall not contain floating material in amounts that cause a nuisance or adversely affect beneficial uses.
Oil & Grease	Water shall not contain oils, greases, waxes, or other material in concentrations that cause a nuisance, result in visible film or coating on the surface of the water or on objects in the water, or otherwise adversely affect beneficial uses.
pH	The pH of surface waters will remain between 6.5 and 8.5, and cause changes of less than 0.5 in receiving water bodies.
Pesticides	Waters shall not contain pesticides or a combination of pesticides in concentrations that adversely affect beneficial uses. Other limits established as well.
Radioactivity[2]	Radionuclides shall not be present in concentrations that are harmful to human, plant, animal, or aquatic life nor that result in the accumulation of radionuclides in the food web to an extent that presents a hazard to human, plant, animal, or aquatic life.
Sediment	The suspended sediment load and suspended-sediment discharge rate of surface waters shall not be altered in such a manner as to cause a nuisance or adversely affect beneficial uses.
Settleable Material	Waters shall not contain substances in concentrations that result in the deposition of material that causes a nuisance or adversely affects beneficial uses.
Suspended Material[2]	Waters shall not contain suspended material in concentrations that cause a nuisance or adversely affect beneficial uses.
Tastes and Odor[3]	Water shall not contain taste- or odor-producing substances in concentrations that impart undesirable tastes and odors to domestic or municipal water supplies or to fish flesh or other edible products of aquatic origin, or that cause nuisance, or otherwise adversely affect beneficial uses.
Temperature	The natural receiving water temperature of interstate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Quality Control Board that such alteration in temperature does not adversely affect beneficial uses. Increases in water temperatures must be less than 5 ºF above natural receiving-water temperature.
Toxicity	All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life. Compliance with this objective will be determined by analyses of indicator organisms, species diversity, population density, growth anomalies, and biotoxicity tests as specified by the Regional Water Quality Control Board.
Turbidity	In terms of changes in turbidity (NTU) in the receiving water body: where natural turbidity is 0 to 5 NTUs, increases shall not exceed 1 NTU; where 5 to 50 NTUs, increases shall not exceed 20 percent; where 50 to 100 NTUs, increases shall not exceed 10 NTUs; and where natural turbidity is greater than 100 NTUs, increase shall not exceed 10 percent.

Source: Central Valley RWQCB 2018.

[1] There is no waterbody specific salinity objective that applies to the Project Vicinity. Salinity is therefore addressed through the chemical constituents objective.

[2] The radioactivity and suspended material objectives do not apply to the Project. Project Operations and Maintenance does not contribute radioactive or suspended material into the Yuba River.

[3] Tastes and Odors limits for drinking water are provided as secondary Maximum Containment Levels in Tit 22 of the Cal. Code Regs.

Two of the numerical Water Quality Objectives, Temperature and Turbidity, include, at least in part, a criterion limiting changes to receiving water. The Temperature objective states that “natural receiving waters” should not be warmed by more than 5 degrees Fahrenheit (°F), while the Turbidity objective provides restrictions for percentage increases in turbidity. These objectives are difficult to apply to a hydroelectric project because one cannot easily identify "natural receiving waters" or ambient conditions as one could with, for instance, a point-source discharge. The analysis in this section makes a good faith effort to apply the intent of the Basin Plan's Temperature and Turbidity objectives.

CWA 303(d)-listed Impaired Water Bodies and TMDL

Based on a review of the most current CWA Section 303(d) list and its associated TMDL Priority Schedule, the SWRCB lists the Yuba River from Englebright Dam to the Feather River confluence as impaired under CWA Section 303(d) for copper and mercury. Copper was first added to the 303(d) list in 2014 and has a target TMDL date of 2027. The lower Yuba River has been listed as impaired for mercury since 2010 with a target TMDL date of 2027 (SWRCB 2018).

General Water Quality

As part of YCWA's Yuba River Development Project relicensing, existing water quality data, including from the lower Yuba River, were reviewed and these data met numerical Water Quality Objectives established in the Basin Plan (YCWA 2010, YCWA 2017).

Further, YCWA conducted a water quality study in 2012 that included a sampling location in the Yuba River near the Smartsville gage (and in proximity to Narrows 1 Powerhouse) as well as four locations further downstream (Table 3.2.2-3). YCWA found that none of the samples taken in the lower Yuba River in either June or August 2012 was inconsistent with the Basin Plan Water Quality Objectives or other benchmarks identified by YCWA (YCWA 2013). In fact, many parameters tested for in the lower Yuba River by YCWA resulted in "non-detections" and "J" qualified data. A "non-detection" by the laboratory means the analyte was not detected above the method's reporting limit. A "J" qualified result by the laboratory means the analyte was detected above the laboratory's method detection limit, but in concentrations below the method's reporting limit. "J" qualified results are estimated values without the statistical certainty associated with concentrations above the method's reporting limit.

Table 3.2.2-3. Water quality sampling results in the Yuba River downstream of Englebright Dam from YCWA's Yuba River Development Project relicensing Water Quality Study in 2012.

Analyte	Sample Location	Smartsville Gage (RM 24.0)		Below Deer Creek (RM 23.4)		Daguerre Point Dam (RM 11.6)		Walnut Avenue (RM 8.3)		Marysville (RM 0.2)	
	Date	6/6/2012	8/29/2012	6/5/2012	8/27/2012	6/7/2012	8/27/2012	6/7/2012	8/27/2012	6/7/2012	8/27/2012
	Units	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result
***IN SITU* MEASUREMENTS**											
Temperature	°C	11.2	11.6	12	11.8	12.5	11.9	13.4	14.0	13.7	13.6
Specific Conductance	µSiemans/cm	64	74	64	74	66	75	68	78	73	87
pH	stnd units	8	7.6	7.9	7.7	7.5	7.36	7.9	7.6	7.9	7.7
Dissolved Oxygen	mg/L	13.1	10.1	11.3	12	11	10.9	10.7	11.4	9.9	10.4
Turbidity	NTU	11.9	5.5	0.0	0.6	2.6	0.4	0.0	6.1	0.0	20.1
BASIC WATER QUALITY											
Alkalinity, Total (as CaCO3)	mg/L	28	32	32	32	32	34	33	34	41	42
Ammonia (as N)	mg/L	ND[1]	ND	ND	ND	ND	--[2]	ND	ND	ND	ND
Calcium	mg/L	8.55	8.4	8.31	8.41	8.18	8.31	8.09	8.69	8.19	9.43
Carbon, Dissolved Organic	mg/L	5.2	4.8	5.2	5	5.2	5	5.2	5.2	5.4	5.5
Carbon, Total Organic	mg/L	4.7	4	4.4	4.3	4.8	3	5.4	4.4	4.7	5.5
Chloride	mg/L	0.78 (J[3])	0.66 (J)	0.81 (J)	0.73 (J)	0.9 (J)	0.74 (J)	0.9 (J)	0.76 (J)	0.98 (J)	2.5
Hardness, Total	mg/L	28	32	31	30	31	30	32	32	33	36
Magnesium	mg/L	2.61	2.63	2.67	2.57	2.77	2.61	2.77	2.77	3.05	3.38
Nitrate (as N)	mg/L	0.15	ND	ND	ND	0.041 (J)	ND	ND	ND	0.12	ND
Nitrite (as N)	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
o-Phosphate (as P)	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phosphorus, Total	mg/L	0.14	0.055 (J)	0.086 (J)	ND	0.16	0.027 (J)	0.14	ND	0.13	0.026 (J)
Potassium	mg/L	0.453 (J)	0.404 (J)	0.474 (J)	0.377 (J)	0.482 (J)	0.485 (J)	0.481 (J)	0.43 (J)	0.469 (J)	0.481 (J)
Sodium	mg/L	3.55	1.97	2.54	1.94	2.58	2.02	2.52	2.07	3.01	2.51
Solids, Total Dissolved	mg/L	43	30	40	53	53	57	57	57	63	67
Solids, Total Suspended	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	2.9	ND
Sulfate	mg/L	2.4	2.1	2.4	2.3	2.4	2.3	2.5	2.5	3.2	6.4
Sulfide, Total	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Kjeldahl Nitrogen	mg/L	ND	ND	ND	ND	ND	--[c]	ND	ND	ND	ND
TOTAL METALS CONCENTRATIONS											
Aluminum	µg/L	25.7	50.7	28.8	19.9	23.3	15.3	23.6	13	51.9	31.6
Arsenic	µg/L	0.56	0.58	0.53	0.60	0.42	0.57	0.41	0.58	0.46	0.56
Cadmium	µg/L	ND	ND	ND	0.007 (J)	0.004 (J)	0.004 (J)	0.003 (J)	0.008 (J)	0.005 (J)	0.009 (J)
Chromium	µg/L	0.21	0.24	0.21	0.21	0.21	0.21	0.4	0.20	0.27	0.25
Copper	µg/L	0.4	0.41	0.42	0.33	0.42	0.36	0.4	0.32	0.51	0.47
Iron	µg/L	40	34	43	24	26	19	30	22	71	74
Lead	µg/L	0.016 (J)	0.011 (J)	0.019 (J)	0.017 (J)	0.013 (J)	0.003 (J)	0.013 (J)	ND	0.038 (J)	0.048
Nickel	µg/L	0.81	0.57	0.74	0.71	0.56	0.79	0.58	0.74	0.71	1.88
Selenium	µg/L	ND	ND	ND	ND	ND	ND	ND	0.152	ND	0.079
Silver	µg/L	ND	0.69	ND	0.65	ND	0.54	ND	0.55	ND	0.69
Zinc	µg/L	0.1 (J)	0.39 (J)	0.18 (J)	ND	0.24	ND	0.19 (J)	ND	0.25	ND
Mercury	ng/L	0.87	ND	0.93	ND	0.92	ND	0.96	ND	1.75	0.002 (J)
Methyl Mercury	ng/L	0.038 (J)	0.24	0.035 (J)	0.11 (J)	0.039 (J)	0.14 (J)	0.045 (J)	0.06 (J)	0.06	0.18 (J)

Table 3.2.2-3 (continued)

Analyte	Sample Location	Smartsville Gage (RM 24.0)		Below Deer Creek (RM 23.4)		Daquerre Point Dam (RM 11.6)		Walnut Avenue (RM 8.3)		Marysville (RM 0.2)	
	Date	6/6/2012	8/29/2012	6/5/2012	8/27/2012	6/7/2012	8/27/2012	6/7/2012	8/27/2012	6/7/2012	8/27/2012
	Units	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result
DISSOLVED METALS CONCENTRATIONS											
Aluminum	µg/L	12.8	5.2	10.3	1.9 (J)	2.8 (J)	1.5 (J)	2.2 (J)	1.5 (J)	2.2 (J)	2 (J)
Arsenic	µg/L	0.55	0.55	0.53	0.60	0.43	0.49	0.41	0.54	0.44	0.60
Cadmium	µg/L	ND	0.003 (J)	ND	0.006 (J)	ND	ND	ND	0.003 (J)	0.005 (J)	0.003 (J)
Chromium	µg/L	0.19	0.23	0.19	0.19	0.18	0.20	0.17	0.19	0.18	0.18
Copper	µg/L	0.35	0.44	0.36	0.35	0.54	0.37	0.43	0.37	0.51	0.37
Iron	µg/L	17	6 (J)	17	6 (J)	9 (J)	5 (J)	10	9 (J)	13	28
Lead	µg/L	0.004 (J)	0.005 (J)	0.026 (J)	ND	0.01 (J)	ND	0.006 (J)	ND	0.011 (J)	ND
Nickel	µg/L	0.76	ND	0.66	ND	0.61	ND	0.55	ND	0.64	0.047 (J)
Silver	µg/L	ND	0.66	ND	0.61	ND	0.51	ND	0.57	ND	0.59
Zinc	µg/L	0.3	ND	0.35	ND	0.3	ND	0.09 (J)	ND	0.38	ND
Methyl Mercury	ng/L	ND	0.24	ND	ND	ND	0.08 (J)	ND	0.16 (J)	0.036 (J)	0.24

[1] "ND" means the analyte was not detected above the method's reporting limit or the laboratory's method detection limit.
[2] A double dash means the data were not collected.
[3] "J" means the analyte was detected below the method's reporting limit, but above the laboratory's method detection limit.

In addition, on September 24, 2020, YCWA collected water grab samples and in-situ measurements from the Narrows 1 Powerhouse discharge during operation. Samples were analyzed for the same parameters that were analyzed during YCWA's 2012 water quality study as part of the Yuba River Development Project relicensing. All applicable in-situ measurements met the Water Quality Objectives (WQO) outlined in the Basin Plan (Table 3.2.2-4). The WQO for dissolved oxygen (DO) is a minimum level of 7.0 mg/L, the DO collected during field sampling was 10.81 mg/L. The WQO for pH is between 6.5 and 8.5, the in-situ measurement of pH was 7.68, meeting the Basin Plan Objective. Turbidity and temperature WQOs outlined in the Basin Plan are determined from an assessed change to the water and are not applicable in this context. The Temperature objective states that "natural receiving waters" should not be warmed by more than 5 degrees Fahrenheit (°F), while the Turbidity objective provides restrictions for percentage increases in turbidity. In this context turbidity and temperature objectives are difficult to apply because of the difficulty identifying "natural receiving waters" or ambient conditions as one could with, for instance, a point-source discharge.

Table 3.2.2-4. In-Situ measurements collected from Narrows 1 discharge on September 24, 2020.

Measurement	Result	Unit	Water Quality Objective
Dissolved Oxygen	10.81	mg/L	< 7mg/L
Turbidity	0.0	NTU	-
pH	7.68	pH	Between 6.5-8.5
Temperature	12.91	°C	-
Specific Conductivity	0.088	ms/CM	-

During the September 2020 water quality sampling event 31 parameters resulted in "non-detections" and 2 were "J" qualified. "J" qualified results are provided in Table 3.2.2-5 and "non-detections" are listed in their respective parameter group. The conventional chemistry parameters that came out as non-detects include ammonia (as N), carbonate (as CaCO3), hydroxide (as CaCO3), nitrate\nitrite (as N), dissolved orthophosphate (as PO4), sulfide, total phosphorous (as P), and total suspended solids. Analyzed metals that resulted in non-detects include aluminum, arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, potassium, selenium, silver, and zinc. Every dissolved metal analyzed resulted in a non-detect (aluminum, arsenic, cadmium, chromium, copper, iron, lead, nickel, silver, zinc). YCWA is unaware of any indications that the Project is responsible for water quality that is inconsistent with qualitative Water Quality Objectives in the Basin Plan.

Table 3.2.2-5. Water Quality Sampling Results from Narrows 1 discharge on September 24, 2020

Analyte	Units	Result	Reporting Limit	Detection Limit
CONVENTIONAL CHEMISTRY PARAMETERS				
Bicarbonate (as CaCO3)	mg/L	38	5.0	0.50
Chloride	mg/L	0.83	0.50	0.026
Sulfate (as SO4)	mg/L	3.0	0.50	0.038
Total Alkalinity	mg/L	38	5.0	1.0
Total Dissolved Solids	mg/L	60	10	5.0
Total Hardness as CaCO3	mg/L	41	1.0	0.19
Total Kjeldahl Nitrogen	mg/L	0.22	0.20	0.040

Table 3.2.2-5. (continued)

Analyte	Units	Result	Reporting Limit	Detection Limit
CONVENTIONAL CHEMISTRY PARAMETERS				
Total Organic Carbon	mg/L	1.5	1.0	0.54
Total Organic Carbon (dissolved)	mg/L	1.3	1.0	0.54
METALS				
Calcium	mg/L	12	1.0	0.044
Magnesium	mg/L	2.9	1.0	0.043
Sodium	mg/L	2.3	1.0	0.029
MERCURY				
Total Methyl Mercury (as Mercury)	ng/L	0.025(J)	0.050	0.017
Dissolved Methyl Mercury (as Mercury)	ng/L	0.02 (J)	0.050	0.02

[1] "J" means the analyte was detected below the method's reporting limit, but above the laboratory's method detection limit.

Water Temperature

YCWA does not have historical water temperatures for the Narrows 1 Powerhouse. Yuba River water temperatures at Smartsville and in the Narrows 2 Powerhouse were studied extensively as part of the Yuba River Development Project relicensing, and a suite of water temperature models was developed with the capability of simulating water temperatures resulting from Yuba River Development Project operations for a period of record matching that of the Yuba River Development Project FERC Relicensing Operations Model, WYs 1970 through 2010. (YCWA 2013b.) The Yuba River Development Project Water Temperature Model consists of three separate models that are run in series to simulate water temperatures from upstream to downstream: 1) the Upper Temperature Model; 2) the Englebright Temperature Model; and 3) the Lower Temperature Model. These are collectively referred to as the YRDP Temp Models, and each is summarized below.

- Upper Temperature Model. This model uses the USACE's HEC model, HEC-5Q, to simulate water temperatures upstream of Englebright Reservoir. The model used hydrologic output from the YRDP Ops Model; a historically-based synthetic timeseries for water temperatures on the Middle Yuba River above Our House Diversion Dam, on Oregon Creek above Log Cabin Diversion Dam, and on the North Yuba River above New Bullards Bar Dam; accretions below each of the Yuba River Development Project's dams; and a historically-based synthetic timeseries of meteorological conditions to simulate Yuba River Development Project effects on water temperatures. The model extents include a vertically-segmented one-dimension representation of New Bullards Bar Reservoir, the Middle Yuba River from Our House Diversion Dam to its confluence with the North Yuba River, Oregon Creek from Log Cabin Diversion Dam to its confluence with the Middle Yuba River, the North Yuba River from New Bullards Bar Dam to its confluence with the Middle Yuba River, and the Yuba River from its headwaters at the confluence of the North Yuba and Middle Yuba rivers to where the Yuba River reaches the NMWSE of Englebright Reservoir.
- Englebright Temperature Model. This model uses the USACE's CE-QUAL-W2 model to simulate water temperatures in Englebright Reservoir. The models uses hydrologic

output from the YRDP Ops Model, simulated water temperatures on the Yuba River below the New Colgate Powerhouse from the Upper Temperature Model; a historically-based synthetic timeseries of water temperatures in the South Yuba River near Jones Bar; accretions to Englebright Reservoir; and historically-based synthetic meteorological conditions to simulate Yuba River Development Project effects on Englebright Reservoir water temperatures. The model provides a two-dimensional representation of Englebright Reservoir, including flows through both of the powerhouses at Englebright Dam.

- Lower Temperature Model. This model uses the USACE's HEC-5Q to simulate water temperatures in the Yuba River from Englebright Dam to the Yuba River's confluence with the Feather River. The model uses hydrologic output from the YRDP Ops Model; simulated Yuba River water temperatures below Englebright Dam from the Englebright Temperature Model; a historically-based timeseries of water temperatures in Deer Creek near its confluence with the Yuba River and Dry Creek near its confluence with the Yuba River; and historically-based meteorological conditions to simulate Project effects on the Yuba River below Englebright Dam.

The YRDP Temp Models were developed using available information about the physical reservoir and river channel geometry. The historically-measured data described above then were used to calibrate each water temperature model. Meteorological input data are described in YCWA 2013b.

The three above temperature models calibrated extremely well, and the YRDP Temp Models outputs are extremely reasonable and valid for use in comparing alternatives. After calibration, each temperature model was validated using a different period of hydrology than was used for the calibration. In each phase, the simulated output was compared against historical data to determine if refinement to the calibration was required. After the three temperature models were calibrated and validated, they were run to simulate Yuba River Development Project operations.

The YRDP Temp Models used as historical input water temperatures, as well as flow, assuming historical releases from upstream water projects. Since historical inflow water temperatures were not available for the full period of record, synthetic inflow water temperatures were needed to run the water temperature model. For the YRDP Temp Models, a binary set of water temperatures at each input location were based on historically wet or dry conditions; for a given date, there were only two potential inflow water temperatures, and the temperature used for that date was selected based on overall basin hydrology. With the extended period of record of available monitoring data for the Narrows Relicensing, the approach for developing water temperature inputs for the Narrows Water Temp Models was updated to use a regression for each location based on flow and meteorological conditions. This updated approach allows for more variation in inflow water temperatures and decouples each location's water temperatures from overall basin hydrology. The regression equation used to develop input water temperatures is of the form:

Water Temperature = A*EQTEMP^2 + B*EQTEMP + C*ln(Q)^2 + D*ln(Q) + E*EXRATE + F*SWRAD + G where:

- A, B, C, D, E, F, and G are regression coefficients;
- EQTEMP is the equilibrium temperature (F);
- Q is flow (cfs);
- EXRATE is the heat exchange coefficient (BTU/ft2/Day/F); and
- SWRATE is the short-wave solar radiation (BTU/ft2/Day).

The EQTEMP, EXRATE and SWRATE values are all computed as part of the meteorological input data for the water temperature model; the process for computing them is describe in YRDP Relicensing Study 2-6. Regression equation coefficients were calibrated for the North Yuba River upstream of New Bullards Bar Reservoir, the Middle Yuba River upstream of Our House Diversion Dam, Oregon Creek upstream of Log Cabin Diversion Dam, and the South Yuba River upstream of Jones Bar. Regression coefficients were developed for four periods of the year at each location to better capture seasonal trends in water temperatures for December through March, April through June, July through September, and October through November periods using the available period of record of observed water temperatures at each location. Seasonal regression coefficients were used to develop inflow water temperatures for Narrows Ops Model period of record. Results of regression-based water temperatures compared to observed temperatures for each of the four locations are shown in Figures 3.2.2-1 through 3.2.2-4.

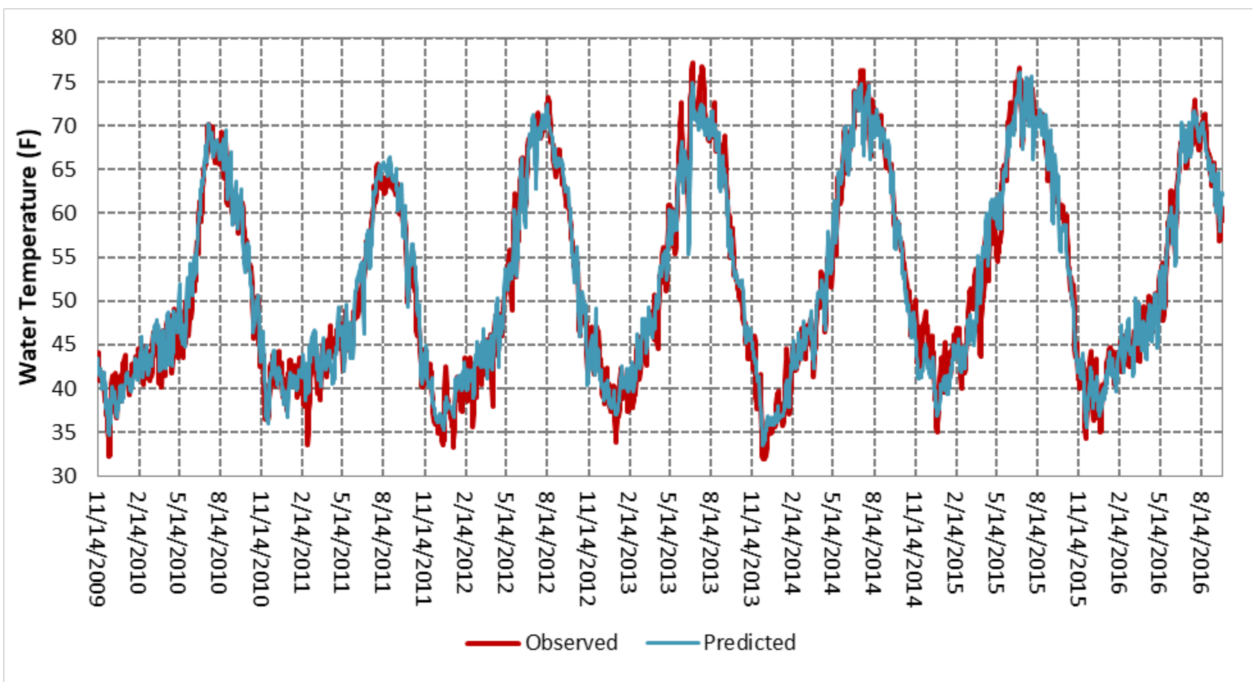

Figure 3.2.2-1. Comparison of regression-based water temperatures and observed water temperatures for the North Yuba River upstream of New Bullards Bar Reservoir.

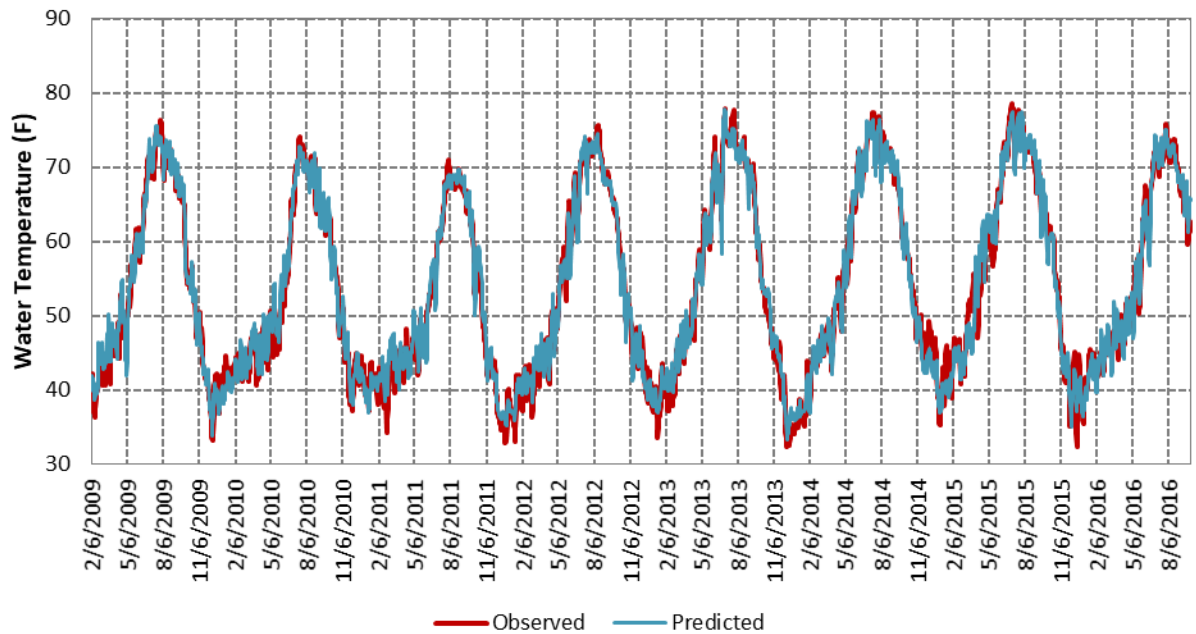

Figure 3.2.2-2. Comparison of regression-based water temperatures and observed water temperatures for the Middle Yuba River upstream of Our House Diversion Dam.

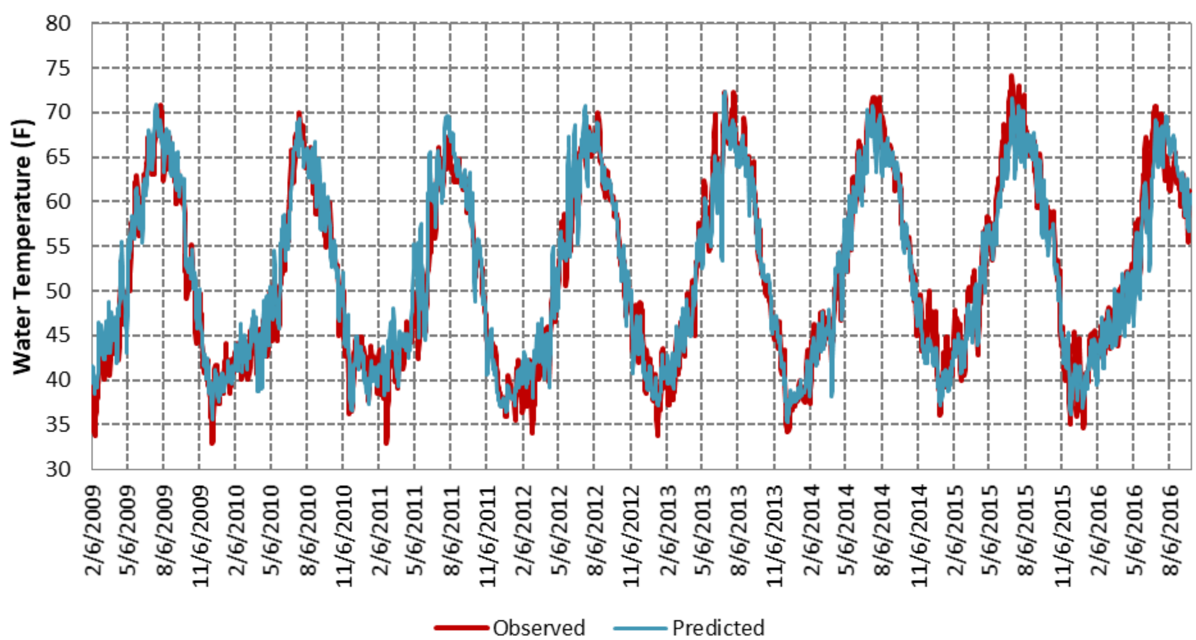

Figure 3.2.2-3. Comparison of regression-based water temperatures and observed water temperatures for Oregon Creek upstream of Log Cabin Diversion Dam.

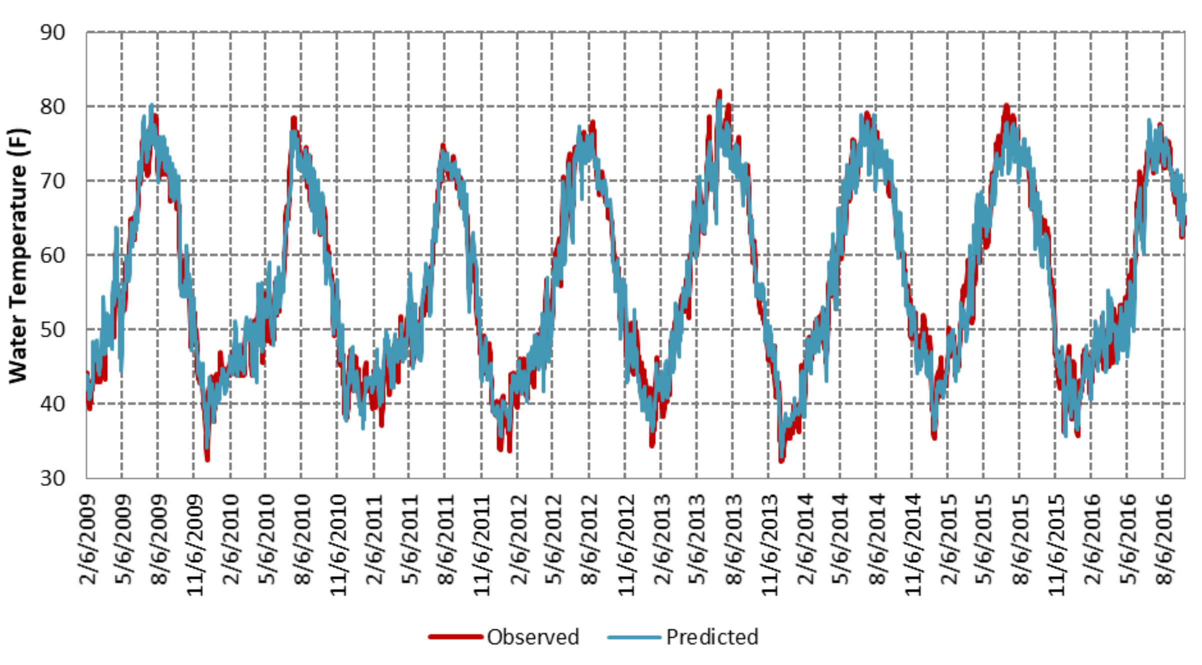

Figure 3.2.2-4. Comparison of regression-based water temperatures and observed water temperatures for the South Yuba River upstream of Jones Bar.

No changes were made to the YRDP Temp Models configuration for the Narrows Hydroelectric Project relicensing other than: 1) updating the YRDP Temp Model's period of record to coincide with the Narrows Ops Model period of record of WY 1976 through WY 2008): and 2) refining the inflow water temperature data as described above.

The water temperature models and model output are included as Attachment 3.2.2-1. Model output includes average daily water temperatures for WY 1976 through WY 2008 for Narrows 1 Powerhouse releases and at the Smartsville Gage, as well as other nodes in the lower Yuba River. Results of the water temperature models under Base Case operations are presented below for three representative WYs: 1) 1998, wet hydrology; 2) 2005, normal hydrology; and 3) 2001, dry hydrology. Figures 3.2.2-5, 3.2.2-6, and 3.2.2-7 show simulated average daily water temperatures for Narrows 1 Powerhouse releases and for the Yuba River at the Smartsville Gage. Discontinuities in Narrows 1 Powerhouse water temperatures shown on the figures are indicative of the Narrows 1 Powerhouse not running during those periods.

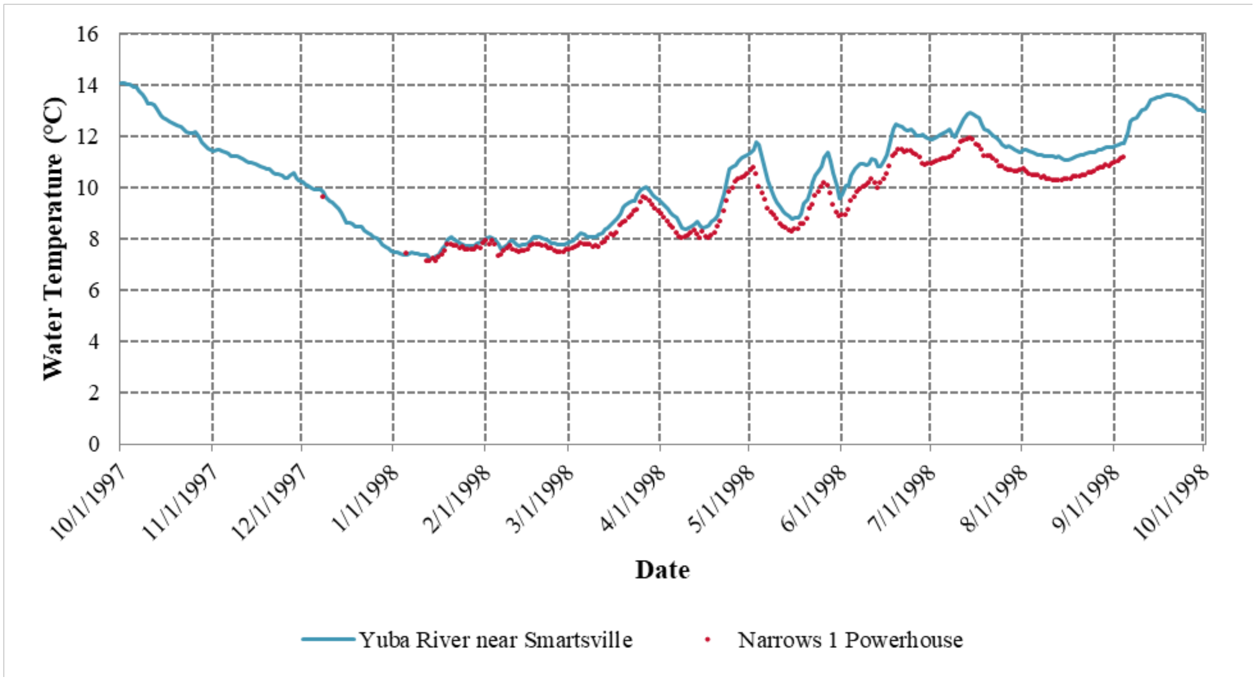

Figure 3.2.2-5. Simulated average daily water temperatures for a representative wet WY (1998) for Narrows 1 Powerhouse releases and the Yuba River at the Smartsville Gage.

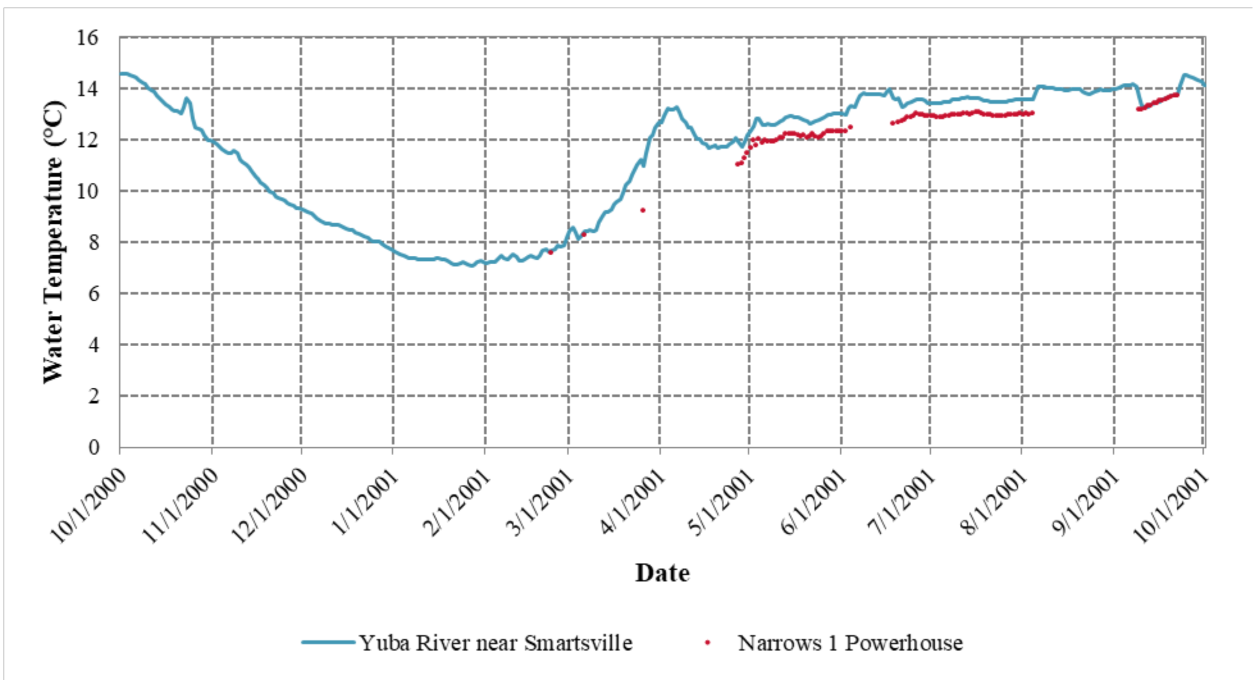

Figure 3.2.2-6. Simulated average daily water temperatures for a representative dry WY (2001) for Narrows 1 Powerhouse releases and for the Yuba River at the Smartsville Gage.

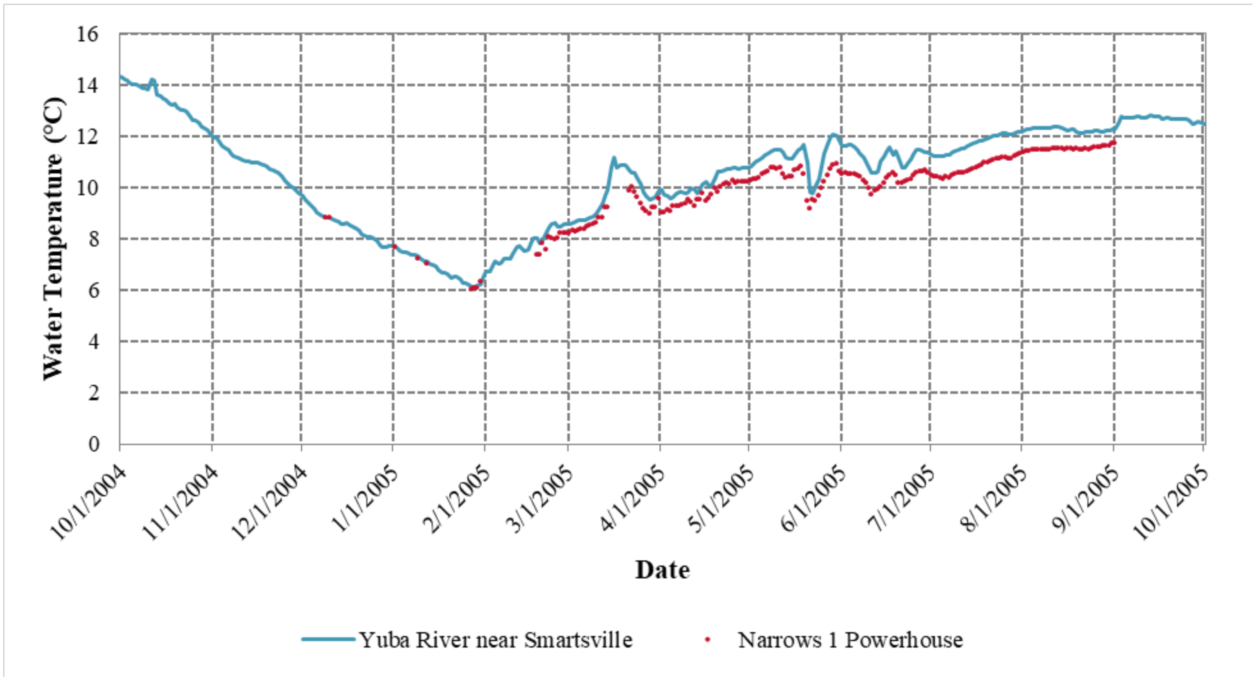

Figure 3.2.2-7. Simulated average daily water temperatures for a normal WY (2005) for Narrows 1 Powerhouse releases and for the Yuba River at the Smartsville Gage.

Figures 3.2.2-5, 3.2.2-6, and 3.2.2-7 show that in the representative wet, normal, and dry WYs, releases from the Narrows 1 Powerhouse are never warmer than, and are usually cooler than, water temperatures at the Smartsville Gage.

Water temperature and dissolved oxygen in Englebright Reservoir have been well studied by YCWA. YCWA has been collecting reservoir water temperature profiles at Englebright Reservoir at a target frequency of about once every 2 weeks year-round from August 1989 to the present, and dissolved oxygen profiles at the same frequency beginning in October 2010. Profiles are collected at one location near the dam, and beginning in April 2011, at an additional location approximately 3.3 miles upstream of the dam. Water temperature profiles in Englebright Reservoir show a consistent pattern from year to year, as illustrated in Figure 3.2.2-8. In general, there is no to weak stratification during the spring months and a thermocline develops in the summer. The strongest thermoclines usually exist from August through January; the reservoir turns over in winter, and then begins to weakly set up in the spring likely during the runoff period. During summer, the thermocline generally occurs from 10 to 30 ft deep. This pattern is consistent with warm monomictic lakes (Wetzel 1983) - temperatures do not drop below approximately 7ºC, the reservoir circulates freely in winter, and stratifies in summer. Water temperatures near the Narrows 1 intake range from approximately 8ºC to 12ºC.

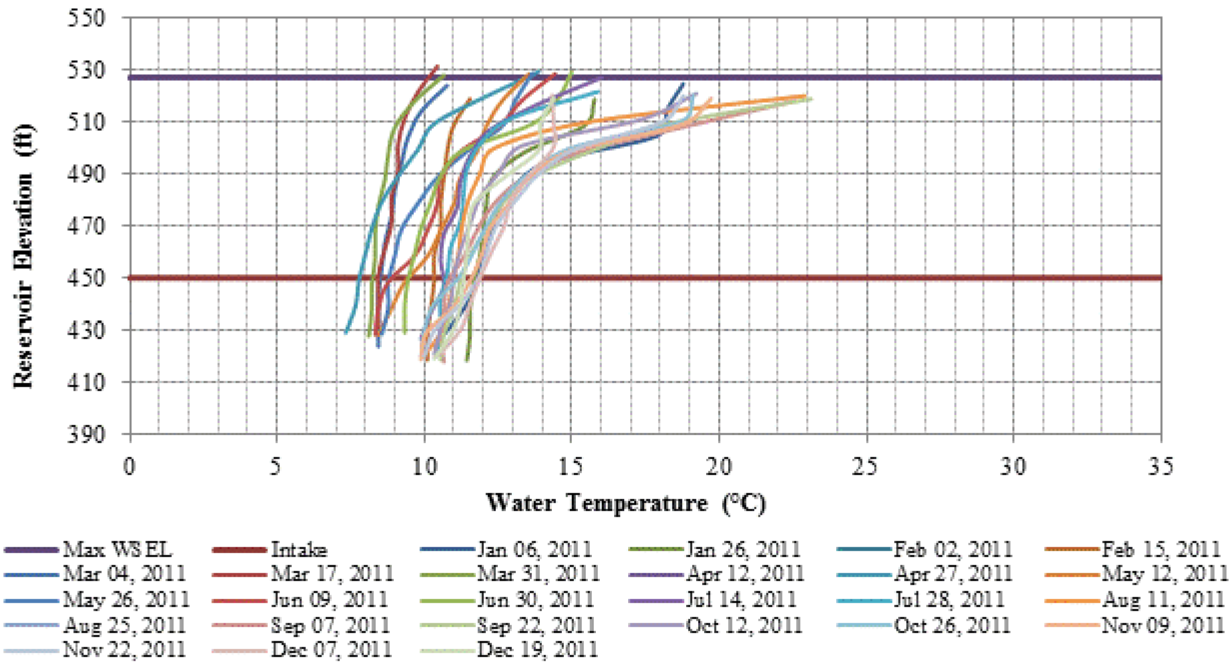

Figure 3.2.2-8. Water temperature profiles in Englebright Reservoir near the dam in 2011 (From YCWA 2017, Figure 3.3.2-3).

There were only a few cases where DO concentrations were inconsistent with the DO Water Quality Objective in the Basin Plan. In November 2010, DO was observed at concentrations less than the Basin Plan objective of 7.0 mg/L at a depth below the Narrows 1 intake. During this month, a strong thermocline was observed from 10 to 30 ft deep, and the lower DO concentrations were observed well into the hypolimnion from 40 to 100 ft deep (YCWA 2017, Table 3.2.2-6).

Table 3.2.2-6. Monthly minimum, average and maximum DO concentrations in Englebright Reservoir near the dam, at all depths, from November 2010 through August 2012 (From YCWA 2017, Table 3.3.2-11).

Month	Minimum DO (mg/L)	Average DO (mg/L)	Maximum DO (mg/L)
2010			
November	6.52	9.21	10.38
December	10.33	10.45	10.55
2011			
January	10.36	10.93	11.44
February	11.27	11.58	11.84
March	11.82	12.00	12.16
April	11.66	11.87	12.06
May	11.36	11.59	11.85
June	10.84	11.41	11.89
July	9.94	11.00	11.72
August	9.80	10.98	11.92
September	9.38	10.25	11.01
October	9.41	9.88	10.37
November	8.02	9.45	10.85
December	10.74	10.96	11.38
2012			
January	10.86	11.26	11.96

Table 3.2.2-6. (continued)

Month	Minimum DO (mg/L)	Average DO (mg/L)	Maximum DO (mg/L)
2012(cont'd)			
February	9.25	10.45	11.89
March	11.06	11.43	11.67
April	10.66	11.25	11.55
May	9.67	10.79	11.24
June	9.97	10.62	11.01
July	8.46	9.33	10.00
August	7.97	8.97	9.98
Average	**9.97**	**10.71**	**11.31**

Mercury

Mercury contamination is common in California aquatic food webs, affecting both the fishing and aquatic life beneficial uses in many areas of the state, with long-term trends indicating little change over the past few decades (Davis et al. 2007). In the Yuba watershed, local sources of mercury and, hence, methylmercury are a legacy of historic gold mining practices on the river, which used mercury amalgamation in the gold recovery process, much of which was lost to the environment (Alpers et al. 2005; Hunerlach et al. 1999; May et al. 2000). Regional and global atmospheric sources of mercury also substantially contribute to mercury impacts to the Sacramento–San Joaquin River system (Davis et al. 2009).

YCWA detected mercury at almost all surface water locations in spring and summer 2012 surface water sampling as part of the Yuba River Development Project relicensing (YCWA 2013). Mercury concentrations in the lower Yuba River ranged from non-detection to 1.75 ng/L across all samples and seasons (n=10, Table 3.2.2-3). These total mercury concentrations are far less than California Toxics Rule benchmark of 50 ng/L (EPA 2000). YCWA also sampled for mercury in 2020 immediately downstream of the Narrows 1 Powerhouse discharge during powerhouse operation and the concentration of both dissolved and total mercury was below the laboratory method detection limit.

In addition to the seasonal synoptic sampling, in 2012, samples were also collected downstream of the Narrows 2 Powerhouse at a time of higher turbidity (between 40 and 80 NTU) and spill over Englebright Reservoir as part of the Yuba River Development Project relicensing. Below Narrows 2 Powerhouse, mercury concentrations were 9.66 ng/L on March 16 and 19.4 ng/L on March 19, 2012 (YCWA 2013). When Englebright Reservoir was spilling during the sampling period, the tailrace water was observably mixed with surface runoff.

Mercury has been comprehensively studied in Englebright Reservoir by the USGS and other interested parties as it related to sediment, water quality, and fisheries. As part of the Yuba River Development Project relicensing, YCWA collected grab samples in the spring and summer of 2012 from six locations in Englebright Reservoir, three surface samples and three near the bottom. Total mercury concentrations ranged from 0.31 ("J" qualified) ng/L to 15.9 ng/L. These total mercury concentrations are far less than California Toxics Rule benchmark of 50 ng/L (EPA 2000). Total methylmercury ranges from less than 0.05 ng/L (non-detection) to 0.311 ng/L (YCWA 2013).

Bioaccumulation in fish has also been studied by multiple authors in Englebright Reservoir and the lower Yuba River (Table 3.2.2-7). Findings from these studies indicate that fish tissue concentrations of mercury are greater than human health-based criteria at some locations. Using available fish tissue data and risk-based methodologies, the California Office of Environmental Health Hazard Assessment (OEHHA) has issued species-specific fish ingestion advisories for trout, sunfish, and bass caught in Englebright Reservoir (OEHHA 2009). OEHHA has issued no advisories for the lower Yuba River.

Table 3.2.2-7. Mercury concentrations in fish from Englebright Reservoir and the Lower Yuba River by location and species (From YCWA 2017, Table 3.3.2-16).

Sample Location	Species	Number of Fish Sampled	Concentration (ppm wet-weight)[1]	Total Length (mm)[2]	Reference
Englebright Reservoir					
USACE's Englebright Reservoir—South Yuba Arm, Hogsback Ravine Arm, and mid-section.	largemouth smallmouth and spotted bass	56	0.45 (mean)	338 (mean)	May et al. 2000, OEHHA 2009
	Bluegill and green sunfish	31	0.30 (mean)	161 (mean)	
	Rainbow trout	49	0.08 (mean)	290 (mean)	
	Carp	1	0.88	440	Slotton et al. 1997
USACE's Englebright Reservoir—South Yuba Arm, Hogsback Ravine Arm, and mid-section. (cont.)	Hardhead	1	0.47	540	Slotton et al. 1997
	Sacramento sucker	5	0.41-0.89	410-523	
USACE's Englebright Reservoir	Largemouth Bass	Individual fish	0.2 - 1	--	Holmberg et al. 2011[3]
	Largemouth Bass	composite	0.82 (mean)	--	
	Redear Sunfish	composite	0.25 (mean)	--	
	Black Crappie	composite	0.25 (mean)	--	
Lower Yuba River					
Narrows 2 Powerhouse Reach, Lower Yuba River, approximately 2.2 miles downstream of Englebright Dam	Rainbow Trout	9	0.07 - 0.13 mean 0.10	≥ 150	Slotton et al. 1997
Daguerre Point Dam Reach, Lower Yuba River approximately 0.9 mile upstream of its confluence with the Feather River	Rainbow trout	1	0.02	≥150	SWRCB 2002 *IN* CVRWQCB 2009
		1	0.46		
	Sacramento sucker	2	0.22 and 0.38		
	Smallmouth bass	4	0.26-0.72 (avg. 0.43)		
Lower Yuba River, approximately 3.6 miles upstream of its confluence with the Feather River	Sacramento pikeminnow	2	0.31 and 1.43	≥150	Davis et al. 2002 *IN* CVRWQCB 2009
	Sacramento sucker	5 (composite)	0.39		

Table 3.2.2-7. (continued)

Sample Location	Species	Number of Fish Sampled	Concentration (ppm wet-weight)[1]	Total Length (mm)[2]	Reference
Lower Yuba River					
Lower Yuba River, approximately 3.6 miles upstream of its confluence with the Feather River	Rainbow trout	3	0.08-0.10 (mean 0.09)	310 (avg.)	Grenier at al. 2007 *IN* CVRWQCB 2009
Lower Yuba River, approximately 3.6 miles upstream of its confluence with the Feather River (cont.)	Sacramento pikeminnow	5	0.19-1.58 (mean 0.84)	≥ 150	
	Sacramento sucker	3	0.11-0.73 (mean 0.26)	420 (mean)	

1 All results are in parts per million (ppm) wet-weight or were assumed to be in wet-weight.
2 mm indicates millimeters
3 USACE has been collecting fish tissue composite samples and analyzing them for mercury since 2003. When composite sample results exceed
USEPA guidelines, individual fish are analyzed. Individual fish concentrations are available for largemouth bass. See Figure 5 of Holmberg et al. 2011.

Attachment 3.2.2-1

Water Temperature Model and Model Output
On DVD

Due to the file type of the Water Temperature and Output Model, a copy of the Attachment is not included in YCWA's electronic filing of the PAD, but a DVD of the Water Temperature and Output Model was provided to FERC. A copy of Attachment 3.2.2-1 will be made available by YCWA upon request.