Study 3.12

NEW COLGATE POWERHOUSE RAMPING[1]

March 2012

1.0 Project Nexus

Yuba County Water Agency's (Licensee or YCWA) continued operation and maintenance (O&M) of the Yuba River Development Project (Project) affects flows, which could affect resident fish populations, in the Yuba River downstream of the Project's New Colgate Powerhouse.

2.0 Resource Management Goals of Agencies with Jurisdiction Over the Resource to be Studied

YCWA believes that four agencies have jurisdiction related to the effects of New Colgate powerhouse ramping on resident fish populations: 1) United States Department of Interior, Fish and Wildlife Service (USFWS); 2) United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS); 3) California Department of Fish and Game (CDFG); and 4) State Water Resources Control Board, Division of Water Rights (SWRCB). Each of these agencies and their jurisdiction and management direction, as understood by YCWA at this time, is discussed below.

USFWS

USFWS's jurisdiction and goals and objectives are described by USFWS on pages 1 through 3 of USFWS's March 7, 2011 letter to FERC that provided USFWS's comments on YCWA's PAD. USFWS's jurisdiction, goals and objectives are not repeated here.

NMFS

NMFS's statutory authorities and responsibilities are described by NMFS in Section 2.0 of Enclosure A in NMFS's March 7, 2011 letter to FERC providing NMFS's comments on YCWA's PAD. NMFS's jurisdiction and responsibilities are not repeated here.

CDFG

CDFG's jurisdiction is described by CDFG on page 1 of CDFG's March 2, 2011 letter to FERC providing CDFG's comments on YCWA's PAD. CDFG's goal, as described on page 2 of

[1] Yuba County Water Agency's (Licensee or YCWA) YCWA's August 2011 Revised Study Plan did not include a study regarding New Colgate Powerhouse ramping. In its September 30, 2011 Study Determination, FERC stated: "*...given the peaking operation of the New Colgate powerhouse and the effect peaking operations may have on resident fish populations (study criteria 5), we are recommending that YCWA develop a ramping study for the reach between New Colgate powerhouse and the normal elevation of Englebright reservoir (study FERC-1). The study should analyze the impacts of peaking operations on changes in flow, depth, velocity, wetted perimeter, and areas of inundation using time steps typical of peaking operations. The study should be developed after consultation with, NMFS, Cal Fish and Game, the Water Board, and FWS and filed for Commission approval.*" (Appendix A, p 48.) YCWA filed this new Study with FERC on March 8, 2012, and the Study was approved by FERC on May 14, 2012 without modification.

CDFG's letter is to preserve, protect, and as needed, to restore habitat necessary to support native fish, wildlife and plant species.

SWRCB
SWRCB has authority under the federal Clean Water Act (33 U.S.C. §11251-1357) to restore and maintain the chemical, physical and biological integrity of the Nation's waters. Throughout the relicensing process the SWRCB maintains independent regulatory authority to condition the operation of the Project to protect water quality and the beneficial uses of stream reaches consistent with Section 401 of the federal Clean Water Act, the Regional Water Quality Control Board Basin Plans, State Water Board regulations, CEQA, and any other applicable state law.

3.0 Study Goals and Objectives

The goal of this study is to determine the impact of New Colgate Powerhouse ramping may have on resident fish populations between New Colgate Powerhouse and the normal elevation of Englebright reservoir. This goal will be accomplished by analyzing the effects of New Colgate Powerhouse peaking operations on changes in flow, depth, velocity, wetted perimeter, and areas of inundation using time steps typical of New Colgate Powerhouse peaking operations

4.0 Existing Information and Need for Additional Information

4.1 Operation of New Colgate Powerhouse

New Colgate Powerhouse is located on the north side if the Yuba River at River Mile 33.9[2] approximately 1.7 miles upstream of the normal maximum water surface elevation (NMWSE) of Englebright Reservoir.[3] The 340 megawatt (MW) aboveground powerhouse contains two Pelton type turbines, and under a design head of 1,306 ft has a measured maximum flow of 3,430 cubic feet per second (cfs).[4] The powerhouse receives water from New Bullards Bar Reservoir via the 5.2-mile-long New Colgate Power Tunnel and Penstock, which have a maximum flow capacity of 3,500 cfs.

USGS Gage 11413510, New Colgate Powerplant near French Corral, has measured flow releases from New Colgate Powerhouse since October 1, 1966. The gage measurement device is a penstock flow meter. Mean daily flow data from the gage is available for the entire period of

[2] River miles (RM) were calculated using the National Hydrography Dataset (NHD) GIS data. River miles start at the confluence of a stream or river into another stream or river (river mile 0) and increase upstream to the terminus of the stream. River miles denoted here indicate the location as measured from the confluence of the Yuba River with the Feather River.

[3] Englebright Dam was constructed by the California Debris Commission in 1941; is owned, operated and maintained by the United States Army Corps of Engineers; and is not included as a Project facility in FERC licenses for the Yuba River Development Project.

[4] Note that based on a June 10, 1992, FERC order, the FERC-authorized installed capacity in kilowatts (kW) for each of the two units in New Colgate Powerhouse is 157,500 kW, for a total powerhouse capacity of 315,000 kW.

record; 15-minute flow data from the flow gage is also available. There are no flow or stage gages in the Yuba River between the powerhouse and Englebright Reservoir.

Overall Project operation changed significantly beginning in 2006 and 2007 when a pilot project of the Lower Yuba River Accord flow schedules were implemented. In 2008, the Lower Yuba Accord flow schedules were permanently adopted by the SWRCB through Water Right Order 2008-0014.

New Colgate Powerhouse is a highly versatile facility, and is used for a combination of peaking and base generation. Depending upon energy demand, powerhouse generation can be fluctuated in about 10 minutes from a minimum of 1 MW with only one unit operating to maximum load of 340 MW with both units operating, if both units are ramped up at the same time. This ability to rapidly fluctuate generation, together with substantial storage available in New Bullards Bar Reservoir, makes the New Colgate Powerhouse important and unique to the Northern California power grid.

For most of the year, New Colgate Powerhouse is operated as a peaking facility, or to provide ancillary services such as spinning reserves or regulation. Under peaking operations, releases through the powerhouse are concentrated to hours of the day when power is most valuable or when power is needed most (such as weekdays from mid-morning through early evening, largely corresponding to warmer times of the day and/or peak workday and early evening hours). Under ancillary services operations, the generating station may be ramped upwards or downwards quickly, to respond to power system load changes on a near-real-time basis, and generating station output and flows may vary substantially minute-to-minute.

The powerhouse also often operates under a combined peaking/ancillary service protocol, with one unit operating in peaking mode and the other unit responding to ancillary service requirements. During some of the late 1990s and early 2000s, New Colgate Powerhouse operations were focused on weekday peak generation. More recently, power generation has shifted to a schedule driven by a balance of peak period generation and providing ancillary services to the region.

At many times, New Colgate Powerhouse provides a significant percentage of the required ancillary service for grid regulation of the region, as dispatched by the California Independent System Operator (ISO), the entity responsible for maintaining grid reliability in California. Peaking operations dominate power generation operations at New Colgate Powerhouse. However, under high flow conditions some or all of the available capacity is used for base load generation, generating continuously 24 hours a day, while high inflow to the reservoir must be moved through the system.

In general, New Colgate Powerhouse ramps up and down typically at least once a day from a few cfs to close to full flow for peaking operations, and can ramp up and down as much as 1,000 cfs or more several times each day for ancillary services. Figure 4.1-1 shows a typical peaking operation for a 10 day period from September 21, 2010 through September 30, 2010 using 15-minute flow readings. Figure 4.1.2 shows a typical ancillary services operation for a 10 day period from January 19, 2010 through January 28, 2010, also using 15-minute flow readings.

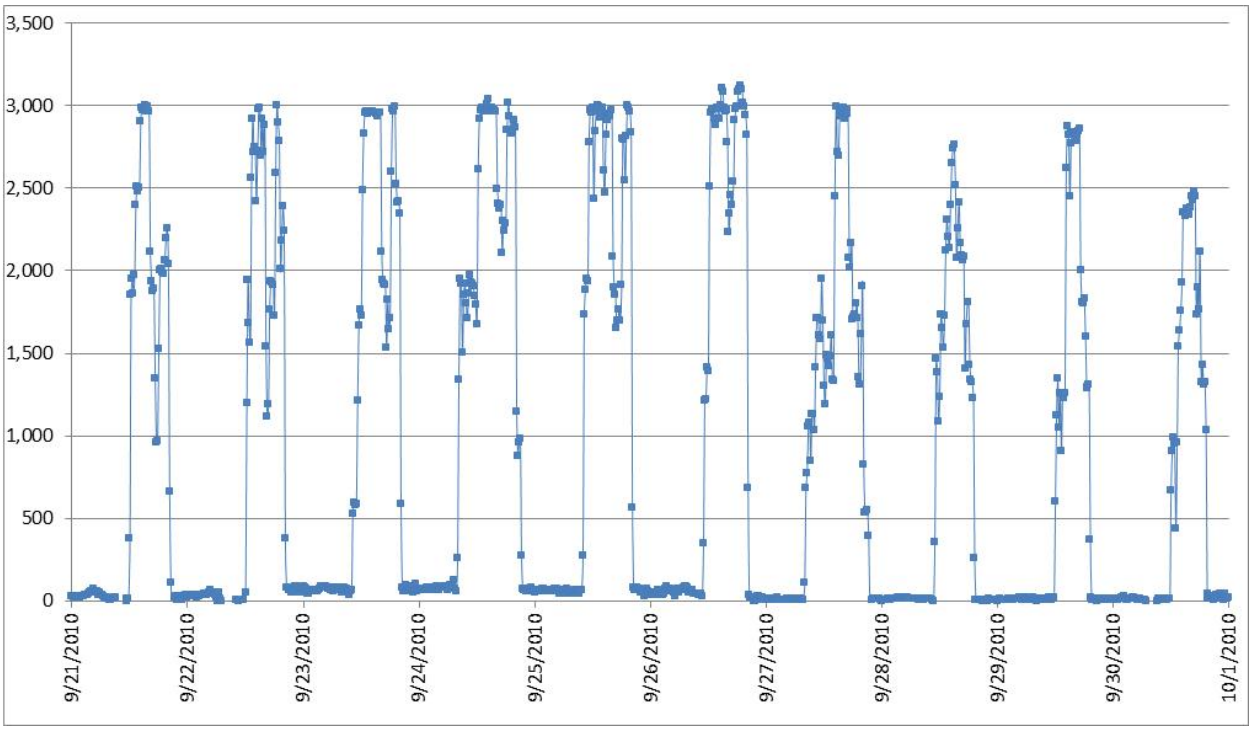

Figure 4.1-1. Typical peaking operation of New Colgate Powerhouse. Flows shown are 15 minute flow readings from September 21, 2010 through September 30, 2010.

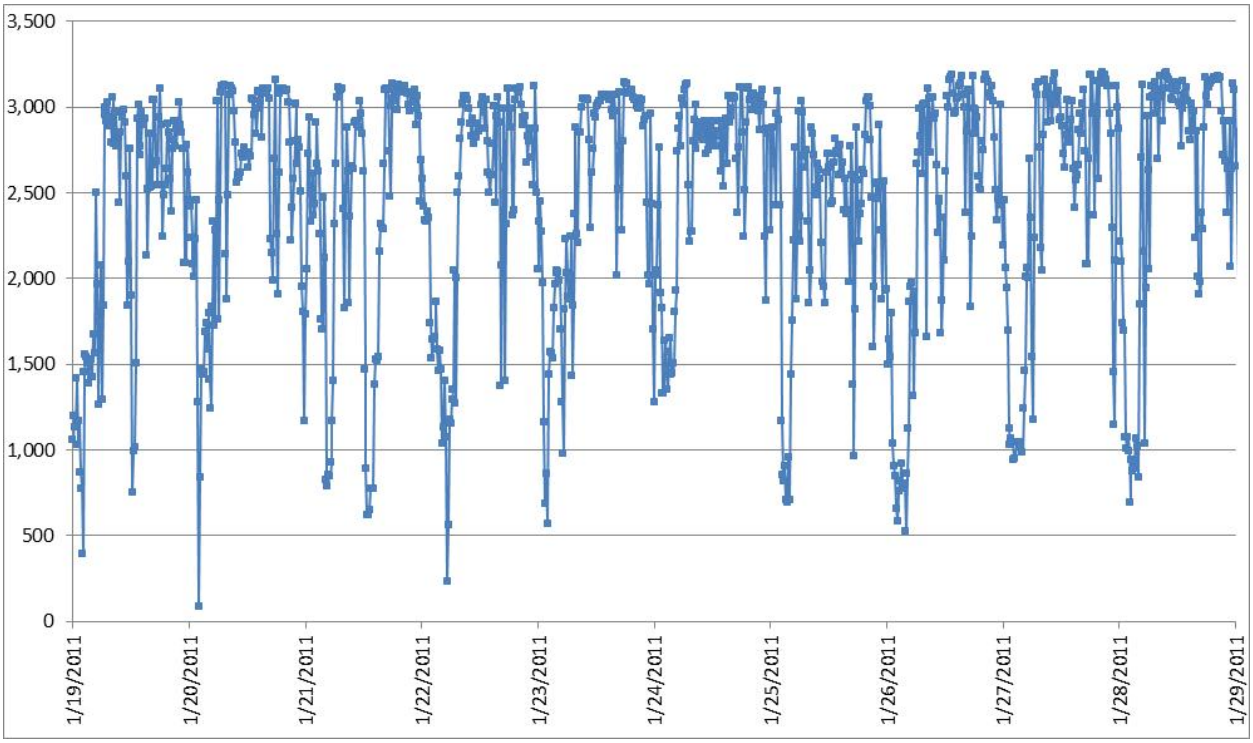

Figure 4.1-2. Typical ancillary services (regulation) operation of New Colgate Powerhouse. Flows shown are 15 minute readings from January 19, 2011 through January 28, 2010.

Additional information regarding flow and stage in the New Colgate Powerhouse Reach will be forthcoming from YCWA's Instream Flow Upstream of Engelebright Reservoir Study (Study 3.10), in which YCWA will collect channel and hydraulic measurements for input and analysis in the PHABSIM hydraulic/habitat model. Approximately 17 transects will be selected in the reach to represent the range of habitat types in the reach. YCWA proposes to co-locate approximately four to six ramping rate transects with the 17 PHABSIM habitat transects.

4.2 Habitat and Resident Fish Populations

The 1.7 mile New Colgate Powerhouse Reach is a relatively straight, narrow, and low gradient (i.e., < 1%) section of river. Bed and bank are strongly controlled by bedrock. Valley walls are steep and rugged, providing very limited access. Mesohabitats are mainly pools (i.e., 33%), rapids (24%), runs (18%), low gradient riffles (12%), and glides (12%). Relatively large point bars are located at the two large bends in the river. Valley slopes are heavily timbered. Two small named tributaries, French Ravine Creek and Branch Creek, and two small unnamed creeks enter the reach.

YCWA was unable to find any historic surveys of the resident fish population in the Yuba River between New Colgate Powerhouse and Englebright Reservoir. However, it is likely that a transition fishery[5] occurs in this area. The nearest known fish surveys were conducted by Gast et al. (2005), who in 2004 snorkeled in the Middle Yuba River about 0.5 mile downstream of Our House Dam – about 20 mile upstream of New Colgate Powerhouse. The snorkelers found rainbow trout (*Oncorhynchus mykiss*), Sacramento pikeminnow (*Ptychocheilus grandis*), hardhead (*Mylopharodon conocephalus*), smallmouth bass (*Micropterus dolomieui*), and various sucker species (Family Catastomidae) (Gast et al. 2005). Hardhead is a CDFG Species of Special Concern and Forest Service Sensitive Species. CDFG does not stock fish in this area.

It is also possible that fish in Englebright Reservoir could move upstream into the Yuba River. YCWA was unable to find any recent fish population studies in Englebright Reservoir, but CDFG fish stocking records are informative. Englebright Reservoir has a long history of annual fish stocking activities dating back to 1959 (Central Valley Fish Hatchery 1959; CDFG 1974). CDFG stocking records indicate that fish plantings in Englebright Reservoir have taken place from 1965 through 2007. During this period, just over 756,000 rainbow trout, 228,320 Kokanee (*O. nerka*), 6,973 lake trout, nearly 28,000 brown trout (*Salmo trutta*), 4,000 Eagle Lake rainbow trout, 2,640 brook trout (*Salvelinus fontinalis*), 45 white crappie (*Pomoxis annularis*), and 80 black crappie (*P. nigromaculatus*) were planted (CDFG 2007). Stocked species were primarily from the Shasta and San Joaquin hatcheries. Creel surveys conducted from July 2003 through May 2004 documented 12 sport fish species in Englebright Reservoir, including spotted bass (*Micropterus punctulatus*), smallmouth bass (*M. dolomieu*), largemouth bass (*M. salmoides*), bluegill (*Lepomis macrochirus*), brown trout (*Salmo trutta*), rainbow trout, common carp (*Cyprinus carpio*), channel catfish (*Ictalurus punctatus*), crappie (*Pomoxis* spp.), Kokanee,

[5] A transition fishery is one that includes both coldwater and warmwater fishes and is typically found in the Sierra in lower elevations where the fish community transitions from a coldwater fishery dominated by trout in the higher elevations to a warm water fishery in the lower elevations.

sucker (*Catastomus* spp.), yellow perch (*Perca flavescens*), and Sacramento pikeminnow (CDWR 2006). Additionally, Englebright Reservoir has a known self-sustaining population of hardhead (J. Rowan, pers. comm., 2011).

Additional information regarding the resident fish populations in the New Colgate Powerhouse Reach will be forthcoming from YCWA's Stream Fish Populations Upstream of Engelebright Reservoir Study (Study 3.8), in which YCWA will perform quantitative electro fishing surveys at one site in the reach in 2012 and 2013.

5.0 Study Methods and Analysis

Stranding rate has been found to be sensitive to rate of stage change (Beck 1989, Olson 1990, and Hunter 1992). Such studies identify that rate of change of operations, coupled with interactions of channel flow and channel morphology, can affect stranding rate.

To understand the relationship between flow fluctuations induced by New Colgate Powerhouse and the potential for stranding in New Colgate Powerhouse Reach, the study will include hydraulic/channel morphology studies and visual observation at locations in the reach that are most prone to stranding of fish. Hydraulic/channel morphology study methods and analysis will include field measurement and modeling of flow, depth, velocity, wetted perimeter, and inundation. Visual observation for stranding of fish will be conducted during scheduled ramping events at the sites selected for hydraulic study. While all fish present, or suspected to be present, will be included in the study, the target species for analysis and observation is rainbow trout.

The hydraulic parameters of flow, depth, velocity, wetted perimeter and areas of inundation will be modeled using the transect based one-dimensional HYDSIM hydraulic model of the River Habitat Simulation (RHABSIM) model. A primary component of the HYDSIM model is the development of stage versus discharge relationships at cross sections. The one-dimensional transect based model is well suited to provide the hydraulic information needed to evaluate the potential for stranding in this reach of the Yuba River. The river channel to be studied is a simple trapezoidal stream highly confined with little to no floodplain, therefore the hydraulic programs in RHABSIM, together with proper selection and distribution of field measured transects should provide accurate results of the depth/velocity vs. flow relationships for this reach. Transverse, or shallow floodplain flow conditions that would warrant two dimensional modeling of the river have not been observed for this reach of the river.

Ramping rate assessments by Hunter (1992) on rivers in Washington State, PacifiCorp (1994) on the Klamath River in Oregon, the Water Forum on the Lower American River (2004), the USACE on the Russian River (2000), and others all relied on stage versus discharge and hydraulic/channel information obtained or obtainable from the one-dimensional hydraulic model HYDSIM.

5.1 Study Area

For the purpose of this study, the study area includes approximately 1.7 miles of the Yuba River from New Colgate Powerhouse at RM 33.9 to the normal water surface elevation (NMWSE) of Englebright Reservoir at approximately RM 32.2 (New Colgate Powerhouse Reach).

5.2 General Concepts and Procedures

The following general concepts and practices apply to the study:

- Personal safety is the most important consideration of each fieldwork team.
- Licensee will make a good faith effort to obtain permission to access private property where needed well in advance of entering the property.
- Field crews may make minor variances to the FERC-approved study in the field to accommodate actual field conditions and unforeseen problems. When minor variances are made, Licensee's field crew will follow the protocols in the FERC-approved study.
- When Licensee becomes aware of major variances to the FERC-approved study, Licensee will issue an e-mail to the Relicensing Contact List describing the variance and reason for the variance. Licensee will contact by phone the Forest Service (if the variance is on National Forest System land), USFWS, NMFS, SWRCB and CDFG to provide an opportunity for input regarding how to address the variance. Licensee will issue an e-mail to the Relicensing Contact List advising them of the resolution of the variance. Licensee will summarize in the final study report all variances and resolutions.
- Licensee's performance of the study does not presume that Licensee is responsible in whole or in part for measures that may arise from the study.
- Global Positioning System (GPS) data will be collected using either a Map Grade Trimble GPS (sub-meter data collection accuracy under ideal conditions), a Recreation Grade Garmin GPS unit (3 meter data collection accuracy under ideal conditions), or similar units. GPS data will be post-processed and exported from the GPS unit into Geographic Information System (GIS) compatible file format in an appropriate coordinate system using desktop software. The resulting GIS file will then be reviewed by both field staff and Licensee's relicensing GIS analyst. Metadata will be developed for deliverable GIS data sets. GIS maps will be provided to agencies in a form, such as ESRI Shapefiles, GeoDatabases, or Coverage with appropriate metadata, that is useful for interactive data analysis and interpretation. Metadata will be Federal Geographic Data Committee (FGDC) compliant.[6]
- Licensee's field crews will record incidental observations of aquatic and wildlife species observed during the performance of this study. All incidental observations will be reported in the appropriate Licensee report (e.g., incidental observations of special-status fish recorded during fieldwork for the Special-Status Turtles – Western Pond Turtle Study will be reported

[6] The Forest Service and CDFG each requested that a copy of the GIS maps be provided to them when the maps are available.

in Licensee's Stream Fish Populations Study report). The purpose of this effort is not to conduct a focused study (i.e., no effort in addition to the specific field tasks identified for the specific study) or to make all field crews experts in identifying all species, but only to opportunistically gather data during the performance of the study.

- Field crews will be trained on and provided with materials (e.g., Quat) for decontaminating their boots, waders, and other equipment between study sites. Major concerns are amphibian chytrid fungus, Didymosphenia geminate algae, and invasive invertebrates (e.g., zebra mussel, *Dreissena polymorpha*). This is of primary importance when moving: 1) between tributaries and mainstem reaches; 2) between basins (e.g., Middle Yuba River, Yuba River, and North Yuba River); and 3) between isolated wetlands or ponds and river or stream environments.

5.3 Methods[7]

The study includes seven steps, each of which is described below. The study requires three primary sources of data: 1) existing operations and hydrologic information; 2) hydraulic and topographic measurements; and 3) visual observation for stranding. All hydraulic and topographic measurements needed for this study will be developed by YCWA's Instream Flow Upstream of Englebright Reservoir Study (Study 3.10), which uses the RHABSIM/HYDSIM model for modeling river hydraulics. YCWA does not propose to use the habitat index Weighted Useable Area, developed in the Study 3.10, as part of the ramping study. Only the hydraulic output at select study locations will be used.

5.3.1 Step 1 – Visual Observation for Stranding

Much of the following description of visual observation methods is derived from stranding studies conducted in the lower Yuba River by the Lower Yuba River Accord River Management Team (RMT 2003).

Because hydraulic variables only indicate the potential for stranding, ramping studies often include visual empirical observation surveys in addition to hydraulic modeling (YCWA 2003, PacifiCorp 2004, Hunter 1992). Visual observation also allows investigators to focus in on specific areas where, by professional judgment and empirical indicators, stranding would be most likely to occur.

5.3.1.1 Number of Observations and Seasonal and Daily Timing

Each site will be surveyed on three different dates. Each survey will begin approximately 1-2 hours before a hydro-peaking event is scheduled to end, will continue throughout the down ramping, and will terminate no less than 1 hour after down-ramping has ended.

[7] FERC's September 30, 2011 Study Determination, directed that this study should "*…analyze the impacts of peaking operations on changes in flow, depth, velocity, wetted perimeter, and areas of inundation using time steps typical of peaking operations.*" (Appendix A, p. 48). This study complies with FERC's direction.

The first survey will be scheduled to occur within one month after anticipated emergence of rainbow trout fry, which is expected to be in April and May (Lower Yuba River Accord 2010) with the first survey likely between mid-May and mid-June. General timing of rainbow trout emergence in the Yuba River will be monitored via Study 3.8 Stream Fish Populations Upstream of Englebright Reservoir. YCWA will also conduct one or two visual reconnaissance foot surveys for evidence of presence of trout fry prior to the first stranding observation survey. The second and third surveys will occur between 3 and 5 weeks after the previous survey. Although ramping under normal operations may occur during hours of darkness, observations for stranding will only be scheduled during daylight hours.

5.3.1.2 Flow Range

Observation for stranding will coincide with the normal range of representative flow fluctuations associated with hydro-peaking at New Colgate Powerhouse. This range is typically 60 cfs to 3,200 cfs, depending on the flow in the river.

5.3.1.3 Study Site Identification

The study area is mostly trapezoidal channel with abrupt banks. There are only two locations in the study area where point bars have formed that may be prone to stranding and are not affected by water levels in Englebright reservoir. These are Condemned Bar approximately 0.3 mile below the powerhouse and French Bar approximately 1.2 miles downstream of the powerhouse. The hydraulic and topographic complexity of these bars appears to be relatively low; Condemned Bar appears to have an isolated perched pool and French Bar has a side channel.

Stranding observation sites will be located at these bars, as determined during site selection with Relicensing Participants as part of Study 3.10. It's important that hydraulic modeling transects also be located at the bars selected for observation. The locations of observation study sites will be identified in the field in consultation with Relicensing Participants as part of transect selection process described in Step 3. Preferred sites for observation will be low-gradient bars with bar slopes ranging from 0–5 percent and/or with topographic lows where fish could be stranded (Hunter 1992).

5.3.1.4 Study Site Mapping

The selected bars will be mapped. Bar slope will be surveyed along one or more transects perpendicular to the river course using the differential leveling method.

Sites characteristics will be classified according to the following definitions:

- Side channel - Secondary channels formed along the lateral margins of bars that are typically separated from the main channel at low flow.

- Backwater - Relatively large pools formed along the lateral margins of bars by sediment deposition, beaver dams, and other obstructions.

- Pothole - Small, isolated depressions typically caused by local scouring around obstructions (e.g., woody vegetation) on bar surfaces.

- Low-gradient bar - Bars with <5% slopes (to be determined from field survey).

5.3.1.5 Stranding Survey

The primary objective of this task will be to visually determine the presence or absence of stranded fish in edgewater, backwater, perched habitats, and on exposed bars at the observation study sites. The survey method will be from both above and below the water (snorkeling). Only deeper (i.e., >1-2 feet) perched and backwater habitats will be snorkeled. Because of the high flows to be studied, main channel habitats will not be snorkeled.

Potential stranding areas less than 1 – 2 feet deep will be surveyed by wading facing or at an oblique angle to the sun to avoid shadows and observers will wear polarized sun glasses.

Immediately before and after each studied ramping event, the occurrence and relative abundance of fish in edgewater, backwater, perched habitats will be determined by surveying the observation sites. Field crews will consist of two persons experienced in snorkeling and fish identification. One or both persons depending on site width will start at the downstream end of each site and work slowly upstream, searching the entire site for fish. In large side channels or backwaters, counts will be made along 3 or 4 band transects spaced at equal intervals across the width of the site. The width of each transect will depend on visibility, which will be determined by measuring the distance from a person's position to the farthest point at which he or she can clearly distinguish an object similar in shape and size to a resident trout fry or juvenile. The species, number, and size class of fish will be recorded on plastic slates.

During the down ramping event, exposed shorelines will be surveyed as flows recede. For large bar areas that cannot be completely searched, band transects measuring 5 to 10 feet in width will be established perpendicular to the shoreline (e.g., extending from the existing shoreline to the predicted shoreline location after the flow reduction) two to three locations representing the range of bar slopes. Each field crew member will be positioned at one of the selected courses at the beginning of the ramping event. As flows recede and the bar is exposed, the crew will search the exposed portion of the transect and record the number, size, and species of stranded fish. Searching will include turning over gravel and cobble to determine the presence of fish below the surface. Following a period of 20 to 30 minutes of searching at one site, the crews will travel by boat to the next nearest site and begin searching the transects there for another 20 to 30 minutes before moving on to another site or back to the original site, depending on the total number of sites. This will continue until the ramping event has ended and all sites have been searched.

Physical habitat conditions will be documented at potential stranding areas before, during, and after the ramping event. Temporary staff gages will be placed in all off-channel and bar stranding sites where stranding is being monitored. Pressure transducers will be placed in the main channel and in any side channel at each study site. The pressure transducers will be

programmed to record water level (referenced to the site temporary benchmark) every 15 minutes for a period of time before, during, and after the flow change. Sketches will be drawn and photographs taken to document the dimensions, general habitat features, and degree of isolation of each site. The degree of isolation and ability of fry or juveniles to return to the main river will be visually assessed based on fish size (i.e., body depth) and the depth, continuity, and direction of flow between each site and the main channel.

5.3.1.6 Results of Stranding Observation Survey

Several tables, plots, and maps will be derived from the survey data. These will include but not be limited to:

- Potential stranding zones and features mapped on a scale map or GIS satellite image, if available at a suitable resolution
- Transect survey data
- The number, size, species, and mapped location of observed non-stranded and stranded fish
- The date, time, river stage and discharge at the time of observed stranding
- Photographs of stranding sites and stranding features

5.3.2 Step 2 – Compile Operations and Hydrologic Information

YCWA will compile relevant operations and hydrology data to describe New Colgate Powerhouse peaking operations. For the New Colgate Powerhouse, release rates and ramping 15-minute flow data for a representative time period will be obtained to characterize historical flows and changes in flow rates for the powerhouse. Hourly data for the period of record will also be reviewed. In addition to New Colgate Powerhouse releases, New Colgate Powerhouse Reach flows are affected by releases from new Bullards Bar Dam, flows from Oregon Creek, flows from the Middle Yuba River and runoff from the watershed area that contributes below the gage locations for each of these flows. Flows into the New Colgate Powerhouse Reach will be determined by summation of the following data: 1) New Colgate Powerhouse releases; 2) flow below New Bullards Bar Reservoir (USGS Gage 11413520); 3) flows on Oregon Creek below Log Cabin Diversion Dam (USGS Gage 11409400); 4) flows on the Middle Yuba River below Our House Diversion Dam (USGS Gage 11408880); and 5) synthesized accretions for the watershed below these gages derived from synthesized accretions for Englebright Reservoir used in the Water Balance/Operations Model Study (Study 2.2).

5.3.3 Step 3 – Select Transects to Measure and Model

Ramping rate transects will be co-located with transects to be selected in the field for Study 3.10. Approximately four to six transects will be placed. Ramping rate transects will be selected in the field simultaneously with the Study 3.10 transects. Particular attention will be paid to selecting transects used for the ramping rate study at river cross-sections that are more problematic for fish stranding (e.g., low sloping cobble bars or perched pools). The two primary cobble bars that will likely be studied for ramping make up approximately 20 percent of the New Colgate Powerhouse

Reach. Therefore, transects selected for ramping studies will also be used for Study 3.10. While YCWA expects that only the transects specifically selected for ramping will be needed, more of the Study 3.10 transects can be used for ramping analysis if needed and appropriate.

YCWA will make a good faith effort to schedule the transect selection field visit on a day convenient to YCWA and interested Relicensing Participants (ideally, scheduling meetings at least 30 days in advance of the meeting or site visit to allow all Relicensing Participants to participate), and will provide an e-mail notice confirming the meeting at least 10 days in advance of the site visit. If agreement regarding transects is not reached, YCWA will note the disagreements in its final report, including why YCWA did not adopt the recommendation. YCWA will offer a pre-field presentation and orientation meeting ahead of the field visit. The pre-field meeting will include a description of the study site, mesohabitat units, and possibly preliminarily selected transects. The basis for selection, still photos, aerial video (if available), and maps of these features will also be provided.

5.3.4 Step 4 – Collect Hydraulic and Topographic Measurements at Transects

Hydraulic parameters will be measured using a combination of standard techniques of the USFWS methodology (Trihey and Wegner 1981; Bovee 1982) and the United States Geological Survey (USGS) (Bovee 1997, Bovee *et al.* 1998, and Rantz 1982). Hydraulic modeling will utilize the HYDSIM hydraulic model.

5.3.4.1 Target Calibration Flows

Target calibration flows for the ramping rate study will be the same as those for Study 3.10. For the Study 3.10 hydraulic modeling, three calibration flows (i.e., low, middle and high) are normally selected with the goal of achieving an even, logarithmic spacing of flows that allows for development of an adequate stage/discharge relationship in the HYDSIM model.[8] In other words, the stage change between calibration flows should be sufficient to test for a linear relationship between the log of discharge and log of stage minus stage of zero flow (IFG-4), or through the use of hydraulic conveyance modeling (MANSQ). Other general guidelines for selecting calibration flows include:

- The low, middle, high, and high-high calibration flows should all be within the range of Project flow control.
- Incremental differences between the calibration flows should be within the control capabilities of the flow control mechanism.
- The low calibration flow should be low enough to model down to the current instream flow requirement and adequately capture low flows that are currently released or expected to be released by the Project.

[8] An additional (fourth) stage/discharge "peaking" measurement will be taken in the New Colgate Powerhouse Reach.

- The middle calibration flow should be the approximate logarithmic midpoint between the high and low calibration flow targets, thus providing the necessary spread to assess the relationship between stage and discharge.

Where possible, considering safety and physical limitations, the high calibration flow should be high enough to model up to the entire range of flows within the unimpaired flow exceedance curve or the highest flow anticipated in the reach during the new license, whichever is less.

- A fourth stage-discharge point (high-high) and margin velocities will be collected to improve the high range of extrapolation.
- The high calibration flow should be within the physical limits of field measurement options using manual meters or an acoustic Doppler current profiler (ADCP).

Table 5.3.4-1 shows YCWA's preliminary target calibration flows based on the above guidelines and the current operations of the Project. YCWA will confirm target calibration flows in consultation with the Relicensing Participants.

Table 5.3.4-1. Target calibration flows.

Reach	Existing Lowest Minimum Flow Requirement	Target % Exceedance [Unregulated (u) or Regulated (r)]	Target Calibration Flow[1]			
			Low	Mid	High	High-High
	cfs	%	cfs	cfs	cfs	cfs
New Colgate Powerhouse Reach	43[2]	10 (r)	100	600	1,570	3,260

[1] Values are target flows. Measured flows may vary by +/- 10%. Team safety will be evaluated at each flow. Relicensing participants will be notified of any significant changes in target flows.

[2] Result of the combined minimum flows for New Bullards Bar Dam, Log Cabin Dam and Our House Dam.

5.3.4.2 Surveying and Controls

All elevations will be surveyed by standard differential survey techniques using an auto-level or total station instrument. Headpin and tailpin elevations, water surface elevations (WSE), hydraulic controls, and above-water bed and bank elevations will be referenced to a temporary benchmark serving a single transect or transect cluster. The surveyed portion of the streambed will extend up to the flood-prone elevation of both banks on all riffles and on other cross sections as stipulated in the Study 1-1, Channel Morphology Above Englebright Reservoir study plan. Where reasonable (line of sight or one turning point), benchmarks will be tied together. At a minimum, all transects surveyed in a single mesohabitat unit will have a common datum. Transect locations will be fixed, to the accuracy level possible, using a handheld GPS instrument.

5.3.4.3 Water Surface Elevation-Discharge

Stage versus discharge measurements will be obtained at four discharges. Water surface elevations will be measured at multiple points across the channel except when conditions are unsafe at high flow. In these circumstances measurements will only be taken as far out from the accessible shoreline as is safe and physically possible. When only a stage/discharge

measurement is taken, discharge through the study site will be measured using manual velocity meters or a combination of an ADCP (described below) and manual velocity meters at an appropriate cross section(s).

5.3.4.4 Velocity Calibration

One velocity calibration set will be collected at the high flow at each transect; or at middle flow if safety or physical conditions are limiting at the high flow. Additional velocity data will be collected on the stream margins (when accessible) at the fourth stage-discharge measurement (high-high). If personnel safety is a concern at high flow, all or a portion of the velocity calibration will be measured at middle flow with WSE/discharge collected at high and low flows. This determination will be made in the field by Licensee.

Velocities will be measured using hand-held current meters and/or ADCP, depending on the depth and width of the stream. Hand-held velocity measurements will use calibrated digital Swoffer® brand, Price AA, or pygmy velocity meters mounted on standard USGS top-set wading rods in depths less than approximately 3.0 ft or where use of the ADCP is not practical. At cross-sections and flows where predominant depths are greater than 3.0 ft, velocity distributions will be measured using an ADCP mounted on a small inflatable cataraft or a rigid trimaran.

Both the Swoffer and Price AA meters are accurate in velocities ranging from 0.1 to 25.0 ft per second, while Pygmy meters are accurate from 0.1 to 4.9 ft per second. Published technical specifications for the Teledyne RDI Rio Grand ADCP are: velocity accuracy: ±0.25% of the (water + boat) velocity ±0.25cm/s at a minimum] velocity resolution of 0.1cm/s and up to a maximum water velocity of ±20m/s.

ADCP data collection will follow USGS standards for measuring discharge (Mueller et al. 2009). Exceptions may be made as certain guidelines are not necessarily applicable in all data collection situations. In addition to these guidelines, simultaneous readings from a nearby upstream or downstream active stream gage (if it exists) will be recorded and included along with the stream gage number in the instream flow report(s).

Post processing of ADCP data for purposes of hydraulic modeling requires that: 1) velocities in each ADCP ensemble (vertical) be reported as a mean column value in the horizontal plane (magnitude and direction); 2) mean column velocities be interpolated or averaged to user defined stations across the transect; 3) mean column velocities at each station from ‘good’ passes will be averaged together, and; 4) discharge will be calculated using averaged data.

Temporary staff gages will be installed and the stage and time of day will be recorded at the beginning and end of each transect measurement to note potential changes in stage during the survey of each transect.

5.3.4.5 Substrate

Substrate size on the transect will be collected because substrate size is a factor in determining the potential of a site to cause stranding. Cobble size substrate is more likely and sand size

substrate is less likely to cause stranding (Hunter 1992). Substrate will be classified according to a standard procedure, and will be evaluated visually during low flow conditions. Percent occurrence of all substrate sizes within the immediate vicinity of each vertical (1-2 feet radius from vertical) will be recorded. Particle size classification and coding are shown in Table 5.3.2-2.

Table 5.3.4-2. Substrate particle size classification and coding.

Substrate Type	Size (inches)	Code
Organics, vegetation	--	0
Clay, silt (fines)	<0.1	1
Sand (coarse)	0.1-0.2	2
Small gravel	0.2-1.0	3
Medium gravel	1-2	4
Large gravel	2-3	5
Small cobble	3-6	6
Medium cobble	6-9	7
Large cobble	9-12	8
Boulder	>12.0	9
Bedrock	--	10

5.3.4.6 Miscellaneous Field Data Collection Methods

Photographs will be taken of all transects from downstream and other points as necessary at each measured flow. To the extent possible, each photograph will be taken from the same location at each of the three levels of flow.

Data sheets for each study site will be completed as follows:

- Photo Log – for each flow/visit
- Site Documentation – sketch or aerial video capture showing location, type, and numbering of transects – completed once
- GPS UTM Coordinates for each headpin (or mid-channel if headpin reading could not be obtained) and benchmark – completed once
- Water Surface Elevation and Level Loop – WSE completed at each calibration flow, level loop completed once, pin heights validated at each visit
- Cover Description – completed once
- Discharge – for each flow, at one two or more transects
- Depth and Velocity – at each transect for one calibration flow (middle or high)
- Stage of Zero Flow – collected once for each transect
- Cross Section Profile and Substrate – completed once for each transect
- Task Completion Checklist – in field for every visit

5.3.5 Step 5 – Hydraulic Modeling of Transects

Because the hydraulic model for both the ramping rate study and Study 3.10 are one in the same, modeling and consultation with Relicensing Participants will occur simultaneously. YCWA will consult with interested and available Relicensing Participants regarding hydraulic calibration. YCWA will make a good faith effort to schedule the consultation on a day or days convenient to Licensee and interested Relicensing Participants (ideally, scheduling meetings at least 30 days in advance of the meeting to allow all Relicensing Participants to participate), and will provide an email notice confirming the meeting at least 10 days in advance of the meeting. If agreement regarding the hydraulic calibration is not reached, Licensee will note the disagreements in its final report, including why Licensee did not adopt the recommendation. Calibration reports will be provided to the Relicensing Participants at least 30 days prior to the meeting.

The purpose calibration is to accurately simulate the measured velocities and water surface elevations at the observed flows while at the same time providing reasonable velocities and water surface elevations at the range of simulated flows. Changes to velocities will be kept to a minimum and the decks revised only when specific changes improve model performance.

5.3.5.1 Water Surface Elevations

The hydraulic model will be calibrated in the HYDSIM routine of RHABSIM 3.0. Hydraulic modeling procedures appropriate to the study site and level of data collection will be used for modeling water surface elevations and velocities across each transect. For water surface elevations, these procedures will include: the development of stage/discharge rating curves using log-log regression (IFG4); Manning's formula (MANSQ); and/or step backwater models (WSP, HecRas); direct comparison of results; and selection of the most appropriate and accurate method. Log-log and MANSQ will be run for each transect, with MANSQ set as the default modeling method. If individual transects do not calibrate sufficiently well using MANSQ, based on general guidelines of maximum Beta (0.5), and/or professional judgment, then log/log will be chosen. Data file construction, calibration, and simulation will follow standard procedures and guidelines outlined in the PHABSIM Reference Manual Version II, Instream Flow Information Paper No.26 (Milhous, R.T., M.A. Updike, and D.M. Schneider 1989).

5.3.5.2 Velocities

The hydraulic model utilizes two basic methods for predicting velocities over a range of flow simulations. The primary approach, termed the "one-velocity set" method, uses measured velocities across a given transect and estimates a Manning's N value for each cell. Calibration techniques include adjustments to the Manning's N to obtain accurate predictions of measured velocities, as well as reasonable predictions of velocities at simulated flows. An alternative approach to modeling velocities, termed the "depth-calibration" method, can be used in the absence of measured velocities. In general, depth calibration procedures will be used to model large sections of a transect if very high velocities and/or entrained air preclude data measurement.

If scour or flushing analyses require near bottom velocities, they will be estimated from the mean column value using the appropriate hydraulic equation.

5.3.5.3 Model Extrapolation

Model extrapolation beyond the maximum Project release flow of 3,260 is necessary because a ramping event can occur when there is substantial flow in the river channel. Extrapolation of flows beyond the highest calibration measurement is often necessary to achieve as much of the range of the hydrograph as possible. Extrapolation beyond the measured calibration stage/discharge pairs collected in the field will typically be 0.4 times (or 40% of the lowest stage/discharge pairs) and 2.5 times (or 250% of the highest stage/discharge pairs). The limits of extrapolation beyond these factors will depend on model performance, channel shape, and modeling methods; all of which contribute to establishing reasonable extrapolation limits within the hydraulic model. During model calibration, the available Relicensing Participants will agree to the limit of model extrapolation during calibration consultation.

5.3.5.4 Produce Tables and Plots of Flow Versus Hydraulic and Topographic Variables

Several different tables and plots of key variables will be derived from the hydraulic model output. Licensee will consult with Relicensing Participants regarding the output tables and graphics to be included in the draft and final report. These will include but not be limited to:

- Plots and tables of wetted perimeter versus discharge for each transect and cumulative for specified transects. Magnitude change and the percent change in wetted perimeter between any combination of two flows will be presented;
- Plots and tables of stage versus discharge for each transect and cumulative for specified transects. Magnitude change and the percent change in stage between any combination of two flows will be presented;
- Dynamic view of cross sectional profiles showing the difference in stage and wetted perimeter between any combinations of two user defined flows. The cross sectional profile will also depict the substrate along the transect;
- Plots and tables of the magnitude change and the percent change in velocity. As needed, changes in velocity can be shown as average channel velocity or the velocity profile can be partitioned out to a certain location along a certain transect.

The above plots and tables will identify:

- The discharge below which potential for stranding is greatest
- The potential for stranding under different Project ramping scenarios relative to the rate of change in flow, stage, depth, wetted perimeter, and velocities under different ramping rate alternatives.
- Evaluate potential stranding in inundation areas.

- Evaluate the potential for bed scour or flushing of fry or juveniles during rapid flow increases.

5.3.7 Step 6 - Data Quality Assurance/Quality Control

All data, including both input data and output data, will undergo a quality assurance/quality control (QA/QC) procedure, and then will be entered into and organized in both Excel and HEC-DSS formats, where applicable, and will be made available to the Relicensing Participants.

5.3.8 Step 7 – Prepare Report

YCWA will prepare a report that includes the following sections: 1) Study Goals and Objectives; 2) Methods and Analysis; 3) Results; 4) Discussion; and 5) Description of Variances from the FERC-approved study proposal, if any.

6.0 Study-Specific Consultation

The following are specific areas for which the YCWA will consult with the Relicensing Participants:

- YCWA will consult with interested and available Relicensing Participants regarding specific study sites and transects. YCWA will make a good faith effort to schedule the consultation on a day convenient to YCWA and interested Relicensing Participants (ideally, scheduling meetings at least 30 days in advance of the meeting or site visit to allow all Relicensing Participants to participate), and will provide an email notice confirming the meeting at least 10 days in advance of the meeting or site visit. If agreement regarding study sites and transects is not reached, YCWA will note the disagreements in its final report, including why YCWA did not adopt the recommendation. YCWA will offer a pre-field presentation and orientation meeting ahead of each field visit. The pre-field meeting will include a description of the study site, mesohabitat units, and possibly preliminarily selected transects. The basis for selection, still photos, aerial video (if available), and maps of these features will also be provided. (Steps 1 and 3.)
- Simultaneously with Study 3.10, YCWA will consult with interested and available Relicensing Participants regarding hydraulic calibration of the hydraulic model. YCWA will make a good faith effort to schedule the consultation on a day or days convenient to YCWA and interested Relicensing Participants (ideally, scheduling meetings at least 30 days in advance of the meeting to allow all Relicensing Participants to participate), and will provide an email notice confirming the meeting at least 10 days in advance of the meeting. If agreement regarding the hydraulic calibration is not reached, YCWA will note the disagreements in its final report, including why YCWA did not adopt the recommendation. Calibration reports will be provided to the Relicensing Participants at least 30 days prior to the meeting. (Step 4.)
- YCWA will consult with Relicensing Participants regarding the output tables and graphics to be included in the final report (Step 4 and Step 5).

7.0 Schedule

FERC's December 8, 2011 letter required that YCWA provide a modified study to FERC for approval no later than March 8, 2012. YCWA may, at its own risk, and assuming Relicensing Participants cooperation, will begin steps 1 and 2 in early 2012. The schedule provided below assumes FERC will approve the modified study no later than mid March 2012.

Step 1 - Compile Operations and Hydrologic Information..... February 2012
Step 2 - Select Study Sites and Transects to Measure and Model.. ..... January - March 2012
Step 3 - Collect Hydraulic and Topographic Measurements..... April - August 2012
Step 4 - Hydraulic Modeling of Transects..... August 2012
Step 5 - Visual Observation for Stranding..... May through August 2012
Step 6 - Data Quality Assurance/Quality Control..... August 2012
Step 7 - Prepare Report .....August - September 2012

8.0 Consistency of Methodology with Generally Accepted Scientific Practices

The study of rate of stage change and rate of bar exposure or the systematic visual observation of fish stranding are standard methods for evaluating the effects of hydro-ramping on downstream fish populations (Hunter 1992, Beck 1989, Olson 1990, and Lower Yuba River Accord 2010).

9.0 Level of Effort and Cost

YCWA estimates the cost to complete this study in 2012 dollars is between $50,000 and $100,000.

10.0 Attachments

This study plan includes one attachment:

- Attachment 3-12A Documentation of Transmittal of Draft Study Plan to NMFS, USFWS, SWRCB and CDFG for 30-Day Review and Comment

YCWA did not receive comments by the February 24, 2012 due date from NMFS, USFWS, SWRCB, nor CDFG. Therefore, comments and replies to this Study are not included with this study.

11.0 References Cited

Beck, R. W., 1989. Skagit River salmon and steelhead fry stranding studies. Prepared for Seattle City Light Environmental Affairs Division, Seattle, WA.

Bovee, K. 1982. A guide to stream habitat analysis using the instream flow incremental methodology. Instream Flow Information Paper No. 12. FWS/OBS-82/26. U.S. Fish and Wildlife Service, Office of Biological Services, Fort Collins, Colorado.

_____. 1997. Data collection procedures for the Physical Habitat Simulation System. U.S. Geological Survey, Biological Resources Division, Fort Collins, Colorado.

_____, B.L. Lamb, J.M. Bartholow, C.B. Stalnaker, J. Taylor and J. Henriksen. 1998. Stream habitat analysis using the instream flow incremental methodology. U.S. Geological Survey, Biological Resources Division Information and Technology Report USGS/BRD-1998-0004.

Hunter, M.A., 1992. Hydropower Flow Fluctuations and Salmonids" A Review of the Biological Effects, Mechanical Causes, and Options for Mitigation. Habitat Management Division, Washington State Department of Fisheries. Technical Report Number: 119.

Lower Yuba Accord River Management Planning Group. 2010. Lower Yuba River Water Temperature Objectives – Technical Memorandum. November 2010.

Milhous, R.T., D.L. Wegner, and T. Waddle. 1984. User's Guide to the Physical Habitat Simulation System (PHABSIM). Instream Flow Information Paper No. 11. U.S. Fish and Wildlife Service. FWS/OBS-81/43 Revised.

_____, M.A. Updike, and D.M. Schneider. 1989. Physical Habitat Simulation System Reference Manual-Version II. Instream Flow Information Paper No. 26. U.S. Fish and Wildlife Service. Biological Report. 89(16).

Olson, F.W. 1990. Down ramping Regime for Power Operations to Minimize Stranding of Salmonid Fry in the Sultan River. Report prepared for Snohomish County Public Utility District No. 1, Everett, WA.

PacifiCorp, 2004. Klamath River Hydroelectric Project - Ramping and Flow Fluctuation Evaluation Study Plan – Section 6. Pacific Corp, Klamath River Hydroelectric Project FERC No. 2082.

Rantz, S.E. 1982. Measurement and computation of stream flow: Volume 1. Measurements of stage and discharge. USGS Water Supply Paper 2175.

Trihey, E.W., and D. Wegner. 1981. Field data collection procedures for use with the Habitat Simulation System of the Instream Flow Group, USFWS, Fort Collins, Colorado.

Waddle, T.J., ed. 2001. PHABSIM for Windows: User's Manual and Exercises: Fort Collins, CO, USGS.

Yuba County Water Agency (YCWA). 2003. Lower Yuba River Redd Dewatering and Fry Stranding Monitoring and Evaluation Plan. Prepared by Jones and Stokes, Sacramento, CA.

Yuba County Water Agency (YCWA). 2010. Yuba County Water Agency, Pre-Application Document.

ATTACHMENT 3-12A

Transmittal of Draft Study Plan to USFWS, NMFS, SWRCB and CDFG

Page Left Blank

Lynch, Jim

From:	Lynch, Jim
Sent:	Wednesday, January 25, 2012 10:25 AM
To:	'Daniel_Welsh@fws.gov'; 'ksmith@dfg.ca.gov'; 'alison_willy@fws.gov (Alison_Willy@fws.gov)'; 'Rick Wantuck'; 'Larry Thompson'; 'John Wooster'; 'JParks@waterboards.ca.gov'; 'MaryLisa Lynch'; 'Sharon Stohrer (SSTOHRER@dfg.ca.gov)'
Cc:	'caikens@ycwa.com'; 'Geoff Rabone'; 'Alan Mitchnick'; 'Kenneth Hogan'
Subject:	Yuba Relicensing: Transmittal of Draft Study 3.12, New Colgate Powerhouse Ramping, for 30-Day Review Period
Attachments:	Study 03-12 - New Colgate Powerhouse Ramping - DRAFT - New Study per FERC 093011 Determination.doc

- YUBA RIVER DEVELOPMENT PROJECT RELICENSING -

Transmittal of New Colgate Powerhouse Ramping Study (Study 3.12) Plan for 30-Day Review Period
- Written Comments due to YCWA by Close of Business on February 24, 2012 -

On September 30, 2011, FERC's Director of Energy Projects issued a Study Determination related to Yuba County Water Agency's (YCWA) relicensing of its Yuba River Development Project, FERC Project 2246. The Determination required, among other things, that YCWA develop and file with FERC by December 29, 2011 (90 days from the date of the Determination) a new study to assess the effects of ramping at the Project's New Colgate Powerhouse on resident fish populations. The Determination also required YCWA to consult with the USFWS, NMFS, CDFG and SWRCB regarding the study, providing them 30 days to review the draft study plan, and include evidence of consultation in YCWA's final plan filed with FERC.

On December 8, 2011, FERC issued a letter that revised the schedule for filing of the final study with FERC from December 29, 2011 to March 8, 2012 (70 days from the date of the December 8 letter).

Attached to this e-mail for your review is a draft Study 3.12, New Colgate Powerhouse Ramping, in Microsoft Word™ format. We would appreciate your written comments on the draft Study plan no later than close of business on February 24, 2012, 30 days from the date of this e-mail.

We will address your written comments in the Study plan that we file with FERC, and attach your written comments to the Study plan we file. We may call you if we have any questions regarding your comments to be sure we understand them or to reconcile differences.

Let us know if there is anything we can do to facilitate your review.

If you have any questions about this e-mail, please contact Jim Lynch.

Curt Aikens
General Manager
Yuba County Water Agency
530-741-6278 x115

This e-mail sent on behalf of the above party by:

1

Senior Vice President, Hydropower Services

2379 Gateway Oaks, Suite 200 | Sacramento, CA 95833
916.564.4214 | d: 916.679.8740 |c: 916.802.6247
james.lynch@hdrinc.com | hdrinc.com

2