

Study 2.1
HYDROLOGIC ALTERATION
November 2010

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 stream flow.

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

[Relicensing Participants - This section is a placeholder in the Pre-Application Document (PAD). Section 5.11(d)(2) of 18 CFR states that an applicant for a new license must in its proposed study "*Address any known resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.*" During 2010 study proposal development meetings, agencies advised Licensee that they would provide a brief written description of their jurisdiction over the resource to be addressed in this study. If provided before Licensee files its Proposed Study Plan and Licensee agrees with the description, Licensee will insert the brief description here stating the description was provided by that agency. If not, prior to issuing the Proposed Study Plan, Licensee will describe to the best of its knowledge and understanding the management goals of agencies that have jurisdiction over the resource addressed in this study. Licensee]

3.0 Study Goals and Objectives

The goal of this study is to characterize various metrics of hydrologic alteration due to Project O&M.

4.0 Existing Information and Need for Additional Information

Section 6.0, and in particular Sections 6.3 (Project Operations) and 6.4.1 (Current FERC Project License), of YCWA's Preliminary Information Package (YCWA) describes current Project operations, including flow and ramping rate requirements. Appendix F in the Preliminary Information Package includes extensive stream and reservoir hydrology data.

4.1 Existing Information Available for Indicators of Hydrologic Alteration Analysis

Provided below is a summary of existing "full range" regulated streamflow gage data on Project-affected streams with a record of at least 20 years, and the period of available data. A 20-year

minimum for continuous regulated streamflow data was selected per the recommendations of The Nature Conservancy (TNC) in their Indicators of Hydrologic Alteration (IHA) Version 7 Users Manual (TNC 2007). A detailed description of IHA and its proposed use as part of this study is provided in Section 5.

- Middle Yuba River below Our House Diversion Dam (USGS Gage 11408880 available from October 1, 1968 through October 1, 2008)
- Oregon Creek Below Log Cabin Diversion Dam (USGS Gage 11409400 available from September 1, 1968 through September 1, 2008)
- Middle Yuba River near North San Juan (USGS Gage 11410000 available from July 1, 1900 through March 17, 2005)
- North Yuba River below New Bullards Bar Dam (USGS Gage 11413520 available from August 13, 1966 through September 30, 2004)
- Yuba River at Smartville (USGS Gage 11418000 available from October 1, 1941 through September 30, 2008)
- Yuba River near Smartville (USGS Gage 11419600 available from October 3, 1960 through December 11, 2002)
- Yuba River near Marysville (USGS Gage 11421000 available from October 1, 1943 through September 30, 2008)

In addition, synthesized regulated streamflow data have been developed by YCWA at several other locations. YCWA anticipates using synthesized streamflow data for analysis under this study proposal at the following locations:

- Yuba River below confluence with Middle Yuba River (from October 1, 1969 through September 30, 2008)
- Yuba River below New Colgate Powerhouse (from October 1, 1969 through September 30, 2008)
- Yuba River below confluence with Deer Creek (from October 1, 1969 through September 30, 2008)

4.2 Existing Information Available for Flood Frequency Analysis

Annual peak instantaneous flow rates are available at the stream gage locations listed below. These data can be used to generate flood recurrence intervals using statistical methods.

- Middle Yuba River below Our House Diversion Dam (USGS Gage 11408880 from water years (WY) 1969 through 2008)
- Oregon Creek Below Log Cabin Diversion Dam (USGS Gage 11409400 from WY 1969 through 2008)
- North Yuba River below Goodyears Bar (USGS Gage 11413000 from WY 1931 through 2008)

- North Yuba River below New Bullards Bar Dam (USGS Gage 11413520 from WY 1967 through 2004)
- Yuba River at Smartville (USGS Gage 11418000 from WY 1942 through 2008)
- Yuba River at Marysville (USGS Gage 11421000 from WY 1944 through 2008)

5.0 Study Methods and Analysis

5.1 Study Area

For the purpose of this study, the study area includes 1) the Middle Yuba River from and including Our House Diversion Dam Impoundment to the confluence with the North Yuba River, 2) Oregon Creek from and including the Log Cabin Diversion Dam Impoundment to the confluence with the Middle Yuba River, 3) the North Yuba River from and including New Bullards Bar Dam Reservoir to the confluence with the Middle Yuba River, and 4) and the portion of the Yuba River from the confluence of the North and Middle Yuba rivers to the Feather River, including USACE's Englebright Reservoir.

If YCWA proposes an addition to the Project, the study area will be expanded if necessary to include areas potentially affected by the addition.

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, 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.

- 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 in Licensee's Stream Fish Populations Study report). The purpose of this effort is not to conduct a focus study (i.e., no effort in addition 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, 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

The study will be completed in six steps, each of which is described below.

5.3.1 Step 1 – Ramping Rate Analysis

YCWA will analyze 15 minute data from WYs 1970 through 2008 below the New Colgate and Narrows 2 powerhouses and 1-hour data from WYs 1970 through 2008 below the Log Cabin and Our House diversion dams. Licensees existing FERC license includes ramping rate limitations at one location - below Narrows 2 Powerhouse.

An exceedance probability of change in flow and stage in 15 minute and 1hour intervals for the New Colgate and Narrows 2 powerhouses and 1 hour interval for the Log Cabin and Our House diversion dams as measured at the nearest stream gage below the facility will be calculated for up-ramps and down-ramps as observed during the period of record. The greatest hourly rate of change in flow for the largest 10 rate-of-change events will also be provided to illustrate change events. For the 10 largest events, 24-hour hydrographs with descriptions of event conditions will be provided.

Flow change events will be separated into controlled and uncontrolled conditions for comparison, where controlled conditions are defined as time periods when Licensee has full control of downstream flow and ramping.

5.3.2 Step 2 - Spill Analysis

YCWA will compute the magnitude, duration, and volume of historical spill events below the following dams:

- North Yuba River – New Bullards Bar Dam
- Middle Yuba River – Our House Diversion Dam
- Oregon Creek – Log Cabin Diversion Dam
- Yuba River – Englebright Dam

In addition to this cataloging, YCWA will calculate the starting storage condition that would have been necessary to prevent these spill events, based on the total volume of spilled water. This hypothetical storage condition will be compared to typical storage targets for the time period spills occurred. Since neither USACE's Englebright Reservoir nor the Our House Diversion Dam impoundment have flood management responsibilities, only New Bullards Bar Reservoir will be evaluated.

5.3.3 Step 3 - Indicators of Hydrologic Alteration (IHA) Analysis

In order to assess the impacts of flow regulation on Project-affected streams, flow characteristics will be computed and comparison tables prepared for the regulated and unimpaired flow condition on the stream locations listed in Section 4.1. The IHA methodology will be applied (Richter *et al.* 1996). Richter suggests that the hydrologic attributes of a stream can be described by five fundamental groups of statistics.¹

- Group #1: Magnitude of monthly water conditions
- Group #2: Magnitude and duration of annual extreme water conditions
- Group #3: Timing of annual extreme water conditions
- Group #4: Frequency and duration of high and low pulses
- Group #5: Rate and frequency of change in water conditions

Statistics will be computed for the five IHA Groups using IHA Version 7, a software package developed by Totten Software Design and Smythe Scientific Software. Statistics will be further aggregated into five water year type categories (critical, dry, below normal, above normal and wet; Yuba River Index year-types per SWRCB RD-1644). IHA is generally used to calculate statistics for pre-project and post-project conditions using a continuous gage record. If adequate pre-project data are not available for analysis, developed unimpaired hydrology can be joined with existing regulated-condition data to create a record long enough for IHA analysis. When this is done, the first half of the record used for IHA analysis contains simulated without-project flows, and the second half includes historical gaged flows under regulated conditions. Because the reaches to be analyzed have experienced flow regulation well before the Relicensing

¹ IHA Version 7 includes additional parameters called Environmental Flow Components (EFC.) Licensee will use the five groups of statistics listed above to analyze hydrologic variability, but do not propose to utilize or provide the output from the newer EFC module of IHA. .

Hydrology Period of Record, in most cases extending to the term of the gaging records, the inflow hydrology data (developed for Water Years 1970-2008) will be used to analyze without-Project conditions.²

5.3.4 Step 4 - Flood Frequency Analysis

YCWA will develop flood frequency curves utilizing annual peak flow data at the locations listed in Section 4.2. These curves will be generated using PeakFQ, a software package developed by the United States Geological Survey which provides estimates of instantaneous annual-maximum peak flows for a range of recurrence intervals using a Pearson Type III (logarithmic) frequency distribution (Flynn et al. 2006). The parameters of the Pearson Type III frequency curve are estimated by the logarithmic sample moments (i.e., mean, standard deviation, and coefficient of skewness) with adjustments for low outliers, high outliers, historic peaks, and generalized skew. Data for this analysis will be the series of annual instantaneous peak flows for the period of record of each gage listed in Section 4.2. As sample size warrants at each streamflow gage, standard recurrence interval flows will be reported including 1.5, 2, 2.33, 5, 10, 25, 50, 100, 200, and 500 years.

5.3.5 Step 5 - 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. IHA data will be presented in their standard output format.

5.3.6 Step 6 – 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

This study proposal does not include any study-specific consultation requirements.

7.0 Schedule

Licensee anticipates the schedule to complete the study as follows assuming the PAD is filed on November 1, 2010, and FERC issues its Study Determination by October 4, 2011:

² To create the record for IHA analysis, the simulated inflow record for the 1970-2008 WY period will be falsely dated for the WY 1931-1969 pre-project period, and IHA will be run to analyze a flow record from 1931 through 1969, providing 39 years of data representing both with- and without-project conditions. Although the historical WY 1931-1969 period did not experience the same frequency and distribution of water years as the WY 1970-2008 period, this approach provides a reasonable comparison of hydrologic attributes for with- and without-regulation conditions.

Ramping Rates at Select Conveyance Reaches (Step 1) October-November 2011
Spill Cataloging (Step 2)..... October-November 2011
Indicators of Hydrologic Alteration (Step 3) August 2012
Indicators of Flood Frequency Analysis (Step 4) January 2012
Data Quality Assurance/Quality Control (Step 5)October 2011 - August 2012
Prepare Report (Step 6).....October 2011 – October 2012

8.0 Consistency of Methodology with Generally Accepted Scientific Practices

IHA and PeakFQ are widely used hydrologic assessment tools and are endorsed by several state and federal agencies. All other analyses will be conducted using best available scientific practices

9.0 Level of Effort and Cost

[Relicensing Participants – Licensee will include a cost range estimate for this study in its Proposed Study Plan. Licensee]

10.0 References Cited

Flynn, Kathleen M., Kirby, William H. and Hummel, Paul R. 2006. User’s Manual for Program PeakFQ, Annual Flood-Frequency Analysis Using Bulletin 17B Guidelines. Online document: <http://pubs.usgs.gov/tm/2006/tm4b4/tm4b4.pdf>

Hersh, Eric S. and Maidment, David R. October 2006. Assessment of Hydrologic Alteration Software: Final Report. Center For Research in Water Resources. The University of Texas at Austin. Austin, TX. Online document: http://www.twdb.state.tx.us/RWPG/rpgm_rpts/2005483029_HydrologicSoftware.pdf

Richter, B.D., J.V. Baumgartner, J. Powell, and D.P. Braun. 1996. A method for assessing hydrologic alteration within ecosystems. Conservation Biology 10:1163-1174.

State Water Resources Control Board (SWRCB). 2003. Revised Water Right Decision 1644 in the Matter of Fishery Resources and Water Right Issues of the Lower Yuba River.

The Nature Conservancy (in collaboration with Totten Software Design and Smythe Scientific Software). 2007. Indicators of Hydrologic Alteration – Version 7 User’s Manual. Online document

Yuba County Water Agency (YCWA). 2009. Yuba River Development Project relicensing Preliminary Information Package. <http://www.ycwa-relicensing.com/default.aspx>

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