August 1, 2012 Don Pedro Project, FERC No. 2299-075

Honorable Kimberly D Bose
Secretary
Federal Energy Regulatory Commission
Mail Code DHAC PJ-12.3
888 First Street NE
Washington DC 20426

RE: Don Pedro Project, FERC No. 2299-075
Final Meeting Notes and Response to Relicensing Participant Comments on the April 9, 2012 Hydrology Workshop (W&AR-2)

As part of the ongoing ILP relicensing studies for the Don Pedro Project (FERC Project No. 2299-075), the Turlock Irrigation District and Modesto Irrigation District (collectively, the "Districts") held a relicensing participants meeting on April 9, 2012 as proposed in the Project Operations/Water Balance Model Study Plan ("W&AR-2") and approved by FERC in its December 22, 2011 Study Plan Determination. The Workshop was held to present, discuss and review the hydrologic data set being used by the Districts in the Operations Model. Materials for the meeting were distributed one week prior to the meeting for Relicensing Participants' review and working excel spreadsheets containing the hydrologic data set were presented and made available to participants during the April 9 workshop. Meeting materials were subsequently posted on the Don Pedro Relicensing website (www.donpedro-relicensing.com). Draft meeting notes were provided on April 17, 2012 for 30-day review and comment by participants, consistent with the Workshop Consultation Protocols filed by the Districts with FERC on May 18, 2012 following review by the Relicensing Participants.

Following the 30-day review period, comments were received from the California Department of Fish and Game ("CDFG"), the State Water Resources Control Board ("SWRCB"), Conservation Groups[1], and Mr. Bob Hackamack.

On June 6, 2012, as an action item from the April 9 workshop, the Districts issued for review a plan and a map describing the proposed methods and locations for accretion flow measurements on the Lower Tuolumne River. The Districts requested comments by June 20,

[1] American Rivers, American Whitewater, California Sportfishing Protection Alliance, California Trout, Inc., Central Sierra Environmental Resource Center, Environmental Defense Fund, Friends of the River, Golden West Women Flyfishers, Northern California Council Federation of Fly Fishers, Merced Fly Fishing Club, Pacific Coast Federation of Fishermen's Associations, Trout Unlimited, Tuolumne River Trust, and Water 4 Fish

HDR Engineering, Inc.
970 Baxter Boulevard
Suite 301
Portland, ME 04103-5346
Phone: (207) 775-4495
Fax: (207) 775-1742
www.hdrinc.com

2012. No comments were received. The Districts completed measurements the week of June 25, 2012 and distributed results for Relicensing Participants' review and comment on July 26, 2012. These results were also posted on the Don Pedro relicensing website.

In accordance with Appendix B of FERC's December 22, 2011 Study Plan Determination, this letter contains draft and final meeting notes, as well as Relicensing Participants' comments and the Districts' responses to those comments. Attachments A through H are provided as the meeting record:

Attachment A:	Turlock Irrigation District & Modesto Irrigation District's Reply to Relicensing Participants' Written Comments to the April 9, 2012 Hydrology Workshop for the Don Pedro Project (FERC Project No. 2299-075)
Attachment B:	Final Meeting Notes – W&AR-2 Hydrology Workshop and Workshop Materials
Attachment C:	Proposed and final accretion measurement methods and locations, as distributed to Relicensing Participants on June 6, 2012. (No comments received.)
Attachment D:	Draft Meeting Notes – W&AR-2 Hydrology Workshop, as distributed to Relicensing Participants on April 17, 2012
Attachment E:	California Department of Fish and Game comments regarding the April 9, 2012 Hydrology Workshop
Attachment F:	State Water Resources Control Board comments regarding the April 9, 2012 Hydrology Workshop
Attachment G:	Conservation Groups Comments regarding the regarding the April 9, 2012 Hydrology Workshop
Attachment H:	Mr. Bob Hackamack's Comments regarding the regarding the April 9, 2012 Hydrology Workshop

For the reasons provided in the Districts' responses to comments, the Districts are proceeding with development of the Project Operations Model consistent with the approach described in the study plan for WAR-2 and further detailed herein. The next Workshop Consultation Meeting for Study Plan W&AR-2 is scheduled for October 23, 2012 at which time the Project Operations Model logic, operating rules, underlying data, and base case will be presented, and relicensing participants interested in using the model will be trained in its use.

Sincerely,

HDR Engineering, Inc.

John Devine

John Devine, P.E.
Project Manager

ATTACHMENT A

Turlock Irrigation District & Modesto Irrigation District's Reply to Relicensing Participants' Written Comments to the April 9, 2012 Hydrology Workshop for the Don Pedro Project (FERC Project No. 2299-075)

Turlock Irrigation District & Modesto Irrigation District's Reply to Relicensing Participants' Written Comments to the April 9, 2012 Hydrology Workshop for the Don Pedro Project (FERC Project No. 2299-075, Tuolumne River, California)

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California Department of Fish and Game (CDFG)			
CDFG-01	**General**	The absence of FERC and National Marine Fisheries Service (NMFS) representatives at the *{April 9, 2012}* Hydrology Workshop (as well as at the subsequent Salmonid Population Information Integration and Synthesis Study Plan [W&AR-5] Workshop on April 10, 2012) concerns the Department. When scheduling future workshops, we recommend the Districts consult with key agency personnel and other relicensing participants prior to selecting dates, times, and locations to ensure the workshop audience is composed of representatives of the parties that requested (or in the case of FERC, required) the studies to be discussed at the respective workshops.	The Districts have made extensive efforts to set schedule dates well in advance of meetings. Attempts to find dates where all relicensing participants are available always results in some conflict. Schedule dates for 2012 were made for the entire year in early January 2012 with notice provided to all relicensing participants. The Districts are not in a position to require attendance. NMFS has indicated in prior correspondence that it intends to participate in the Don Pedro ILP in accordance with the requirements of the formal ILP process and not the "Applicants' process." NMFS re-iterated this approach in the Technical Panel dispute meeting as well (Transcript page 115, line 11/24). The Districts have taken all reasonable steps to provide and encourage participation in the relicensing process well over and above the requirements of the ILP, and will continue to do so, consistent with meeting their obligations as applicants for a new license.
CDFG-02	**General**	The Department recommends the Districts not proceed with implementing studies involving a prerequisite consultation step, until such consultation is explicitly approved by FERC staff.	The Districts appreciate the feedback and hope that the Workshop Consultation Process issued on March 5, 2012 and discussed at the Relicensing Participants meeting of March 20, 2012 addresses CDFG's concerns. Waiting for FERC's response would place an unnecessary burden on maintaining the study schedules. If FERC, after reviewing filings made as part of the process, requires the Districts to take additional steps, these steps may be able to be accomplished as part of Year 2 (2013) studies.
CDFG-03	**General**	The Department also recommends future workshops be facilitated by a neutral party with real time documentation of major action items and decision points. Issues involving water use and aquatic resources in the Tuolumne watershed have a long and sometimes contentious history. A professional facilitator would encourage full and effective participation, while minimizing unproductive rhetoric. Recording action items and substantive decisions while all parties are assembled would assist in the compilation of meeting notes and, ideally, reduce the number of note edits.	The Districts do not believe it necessary to engage the services of a facilitator. They look forward to continuing to work closely with all relicensing participants. The approach has been, and will continue to be, to record Action Items during the meetings, review them at the end of each meeting, post them to the website; and for those studies that involve the formal Workshop Consultation Process, include the Action Items in the meeting notes.
CDFG-04	**Specific**	The data sources rely on a combination of United States Geological Service (USGS) gages and stations maintained and monitored by the City and County of San Francisco (CCSF) and the Districts. The spreadsheet augments measured values with estimates utilizing historically derived factors affecting reservoir storage and flows, such as precipitation, evaporation, and seepage. As an example, the daily evaporation factors for the CCSF reservoirs were derived in the 1930s from measurements taken at Lake Eleanor. The date of the historical experience for developing the Don Pedro Reservoir evaporation factor is not specified, though it is assumed it is after the New Don Pedro Reservoir was constructed. Given the age of some of these relationships and intervening changes in climate and technology, the Department recommends a recalibration of key factors.	The factors used to estimate the net effect of precipitation and evaporation at CCSF reservoirs and Don Pedro reservoir have been in effect for decades, and described and implemented as presented in the Water Bank Accounting Procedures between CCSF and the Districts (http://www.donpedro-relicensing.com/Lists/Announcements/Attachments/32/Response%2021_Water%20Bank%20Accounting.pdf). The factors currently used to estimate reservoir storage and change in storage at CCSF reservoirs due to the net effect of precipitation and evaporation were established from recorded data from a floating evaporation pan at Lake Eleanor during 1910-1923 and recorded precipitation at Lake Eleanor during 1909-1933. Engineering judgment used at the time assumed that if no reservoir existed, one half of the precipitation over the surface of the lake would appear as runoff with the remaining half lost to seepage and evaporation from the soil. With the creation of a reservoir, all precipitation over the surface of the reservoir would appear as runoff. This relationship was incorporated into the factors still used today. Records of evaporation do not exist for Hetch Hetchy or Cherry Reservoirs; therefore, due to the proximity of these features to Lake Eleanor, their net evaporation-precipitation factors are assumed to be the same. The factors were established as monthly values, divided equally over the number of days within a month. No site-specific pan evaporation data exist that would improve the estimates. The average estimated net evaporation-precipitation from CCSF reservoirs is less than 9,500 acre-feet per year and is incorporated into the estimation of the average annual estimated unimpaired flow in the basin (1,900,000 acre-feet). Even if the estimated net evaporation-precipitation were to be low (or high) by 50%, it would represent a change of 0.25% of unimpaired flow. When compared to the errors involved in estimating surface flows by standard USGS gaging stations, any difference in net evaporation-precipitation is

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			insignificant. The Don Pedro factors for net evaporation-precipitation were derived from monthly averages actually experienced for a twenty-year period (circa 1970). The factors were established as monthly values, divided equally over the number of days within a month. The adopted factors equate to an average annual net 50 inches of evaporation-precipitation at Don Pedro Reservoir each year. When applied to an annually varying reservoir, net evaporation-precipitation amounts to approximately 45,000 acre-feet per year, or 2.4% of the average annual runoff. Similar to the comparison provided for CCSF reservoirs, even if the estimated net evaporation-precipitation were to be different by 50%, it would represent a change of only 1.2% of unimpaired flow in a year, which is insignificant in comparison to standard gaging errors. For reference purposes, we checked the evaporation rates recorded at New Melones Reservoir located north of the Tuolumne River Basin (http://www.usbr.gov/mp/cvo/vungvari/nmldop.pdf). That reservoir, which is similar in geographical characteristics, has an average effective evaporation of approximately 60 inches per year, confirming the reasonableness of the estimate used for Don Pedro Reservoir. If the New Melones value is applied to Don Pedro, the average computed evaporation would increase from 33,500 AF to 40,200 AF, an increase of 6,700 AF, or 0.3% of the average unimpaired flow of 1,934,000 AF. Revisiting the computation of net evaporation-precipitation may minimally change the distribution of the evaporation-precipitation component from month to month and year to year, but would result in the same long-term average effect on total unimpaired hydrology. Any refinement to its estimation would be small and is unwarranted because it would not improve the modeling of project operations or effects. The current procedures and assumptions have been used for decades leading to the establishment of a hydrologic record that has been accepted and used by TID/MID/CCSF and the State of California in water supply planning efforts. The Districts' procedures for estimating reservoir evaporation-precipitation in the computation of unimpaired flow or for modeling project operations adequately estimates the relatively small portion of water lost to evaporation. Adopting a different approach, or updating the values, would result in a minor adjustment at most, would be time-consuming and costly, and would not inform the development of license conditions.
CDFG-05	**Specific**	It is our understanding the Districts applied a gage summation (a.k.a. mass balance) approach to estimating the daily unimpaired hydrology for the Hetch Hetchy and Cherry-Eleanor watersheds, the Tuolumne River at La Grange, and the unregulated inflow to Don Pedro Reservoir. Due to a number of factors, which likely include the challenges associated with measuring storage changes on a daily basis, the daily unimpaired flow estimates calculated by the Districts fluctuate wildly and often include negative flow estimates. The following charts highlight these issues for the Tuolumne River at La Grange and for the unregulated inflow to Don Pedro Reservoir for water year 2010. The importance of developing a credible unimpaired hydrology within hydropower relicensings cannot be overstated, with participants relying on it throughout the process. In this instance, that includes applying the unimpaired hydrology to the daily time-step operations model being developed pursuant to Study Plan W&AR-2. Given this pivotal role, the Department recommends applying a more sophisticated approach to developing unimpaired hydrology for the Project. Specifically, the Department recommends that the Districts apply a gage proration methodology similar to that used by Margaret	The Districts have developed an estimate of unimpaired hydrology for the basin for the purpose of modeling Project operations and effects. The level of detail and accuracy of the estimate is consistent with acceptable engineering practices and has been accepted for decades by the State of California. The explicitly used elements of this hydrology that are necessary to model Project and river system operations will be unimpaired inflow to the Hetch Hetchy system reservoirs and the unregulated inflow to Don Pedro Reservoir that is not affected by CCSF facilities. The remainder of the unimpaired hydrology serves only as a backdrop to the development of the regulated flows in the basin. Modeling of Project operations will not be concerned with or affected by mean daily computed "negative flows" that sometimes occur at CCSF facilities or Don Pedro. These computed negative flows are typically the result of applying a computational mass balancing of several flows and changes in storage components, which may result in an occasional computed negative value for flow. These occurrences are considered anomalies in the day to day record, which tend to occur during low flow periods when a small misinterpretation of reservoir stage can overwhelm the determination of a small flow value. These anomalies in daily values will self-correct over several days of record. Within the modeling of CCSF facilities, the unimpaired flow data that will be used consists solely of the inflows to Hetch Hetchy Reservoir and Cherry/Eleanor Reservoirs. This daily record, potentially inclusive of intermittent negative daily flows, will be absorbed by reservoir operations (storage in Hetch Hetchy Reservoir up to 360,000 acre-feet and storage in Cherry/Eleanor Reservoirs up to 295,000 acre-feet). Within the model, an anomaly in inflows such as a negative flow one day and a compensating overestimation of inflow the next will be correctly accounted for, but the precise day-to-day fluctuation will be "lost" within the operation of the reservoir. Day-to-day operational decisions of CCSF reservoirs within the model will not show reaction to such anomalies. Once absorbed into reservoir storage, the model will depict a daily management of inflow and storage with an operation of releases and diversions based on daily, monthly, seasonal, and year-to-year decisions. The releases from CCSF facilities, one component from Hetch Hetchy Reservoir and a second component from the Cherry/Eleanor Reservoir, will be combined to be added to the total unregulated element of inflow to Don Pedro Reservoir. The unregulated element of inflow to Don Pedro Reservoir is the other component of unimpaired flow that is derived from the unimpaired hydrology which has been

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		Hannaford, P.E. in the Upper American River Project (FERC Project No. 2101). In general, this methodology involves adjusting the daily empirical data of one or more "nearby" USGS unimpaired streamflow gages based on differences in watershed area and precipitation to generate a new synthesized unimpaired data set. This synthesized unimpaired data set is further adjusted based on a monthly gage summation (rather than a daily gage summation) as necessary to preserve the mass balance within each sub-basin. [See document.]	developed by the Districts. This flow represents all runoff within the basin that occurs downstream of the three major CCSF storage facilities. These intervening flows are essentially unaffected by any development within the basin. Mathematically, the value is computed as the difference between the inflows to Hetch Hetchy and Cherry/Eleanor Reservoirs and the total unimpaired flow computed at La Grange. Within modeling, this daily fluctuating time series of values will be the same among alternative operation studies since it is unaffected by District or CCSF operations. CDFG is correct that, due to the same data challenges as described above for the computation of inflow to CCSF reservoirs, there are occurrences of "negative flows" within the record of unregulated inflow to Don Pedro Reservoir. From a perspective of **modeling the operations** of Don Pedro Reservoir, the intermittent occurrence of negative flows for the unregulated component of total Don Pedro Reservoir inflow will not be problematic. As described for the CCSF operation, Don Pedro Reservoir storage will absorb negative inflows as an adjustment to reservoir storage and be lost within the operation decisions which are more focused on greater-than-daily hydrology. The Districts are familiar with the methods applied in the UARP relicensing and do not believe they are needed at, preferred for, or applicable to Don Pedro. An excellent, long-term record of outflows already exists at the site under relicensing--the Don Pedro Project. There is no need to introduce the compounding errors of multiple flow prorations over the geographically diverse Tuolumne River watershed. A need to refine (adjust) the negative flow values for unregulated inflow to Don Pedro Reservoir may arise in the development of the Don Pedro Reservoir temperature model. It is anticipated that inflow will be modeled as two distinct components as described above, with separate temperature "tags" associated with each component. With this approach, negative inflow values associated with a component of inflow may not be acceptable for reservoir temperature modeling. If so, the daily unregulated inflow component will be adjusted through data smoothing techniques to remove the occurrence of negative values while preserving volume balances. To smooth the inflows into Don Pedro, the Districts may apply the Gaussian Kernel method (ksmooth) available within Math CAD (Version 14.0.2.5) if smoothing becomes necessary.
CDFG-06	**Specific**	In order to assist the Districts in the application of the gage proration methodology, the Department has identified the following USGS and California Data Exchange Center (CDEC) unimpaired flow records in the Tuolumne River Basin. These records are expected to be important in the application of the recommended methodology.	The Districts acknowledge the availability of these records of stream flows within the basin. If necessary, these data could assist in developing and applying a data smoothing protocol.
CDFG-07	**Specific**	In addition to facilitating development of an Operations/Water Balance Model, the Department considers reasonable and fairly accurate inflows, along with inflow temperatures, to be necessary to produce meaningful scenario results with the MIKE Three Dimensional Flexible Mesh (MIKE3-FM) reservoir temperature model proposed by the Districts.	The Districts agree. To support development of the temperature model, the Districts have compiled all available temperature data, including inflow temperatures. The Districts will be providing RPs with a summary of all temperature data gathered for the MIKE3-FM model during consultation regarding this model.
CDFG-08	**Specific**	The Department recommends the Districts further disaggregate the unregulated inflow into Don Pedro and determine the unimpaired flow in the North Fork Tuolumne upstream from the main-stem Tuolumne River, the South Fork Tuolumne River upstream from the main-stem Tuolumne River, and the Clavey River upstream from the main-stem Tuolumne River. The Department believes this additional unimpaired flow information will be needed to help address various interests of the relicensing participants, including the recreational boating interests. The gage proration methodology recommended by the Department in the preceding section should accommodate this enhancement. The Department also recommends the	The Districts do not agree with the need to disaggregate the sources of inflows into Don Pedro Reservoir into upper Tuolumne River tributaries. The two components of inflow being used (as described in response to CDFG-04) are adequate to model Project hydropower facilities and facilities that affect river operations downstream of Don Pedro Reservoir. The approach of two components of inflow is also properly defining the limit of available data representing inflow temperature data for Don Pedro Reservoir. Reservoir temperature model calibration is currently utilizing data available from measurement points below CCSF facilities and assumptions for stream temperatures associated with unregulated runoff. Development of unimpaired flow in tributaries upstream of Don Pedro, while potentially useful for other purposes, is unnecessary for Project operations modeling, would be costly, and does not have a nexus to the Project. Concerning configuration of the model and acquisition of data on accretion flows downstream of La Grange Dam, please refer to the memo distributed to the Relicensing Participants on June 6, 2012, which describes the planned initial set of accretion measurements for the Tuolumne River below La Grange Dam. The Districts are acquiring actual field data to supplement existing information concerning the hydrologic characteristics of the river. The Districts will use this field data to inform the configuration of the Water Operations Model and the River Temperature Model to estimate flow and temperature at various locations below La Grange Dam. These locations will be

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		Districts estimate the accretions and depletions in the reach between La Grange Dam and the confluence with the San Joaquin River. The accretion estimates should be calculated for each major inflow location, including Dry Creek and each agricultural return (i.e. Hickman spill, Faith Home spill, Rairden Gulch, etc.). The depletion estimates should include groundwater losses in Modesto Reservoir, Turlock Reservoir, Dawson Lake, and the entire Turlock Irrigation District and Modesto Irrigation District canal systems. The Department recommendation to expand the model node network downstream of La Grange Dam is consistent with the NMFS filing with FERC on April 16, 2012. In that filing, the NMFS noted model nodes are necessary in the lower Tuolumne River reaches heavily used for anadromous fish holding and spawning. The Department concurs with this reasoning and recommends that the presence of substantive agricultural diversions/returns in such reaches should also guide node location.	established in the models based on technical appropriateness and scientific need. In summary, the upstream river segments are not the subject of FERC jurisdiction or within the control of the Project. Further disaggregation of upstream river segments is not needed for modeling Project operations. Further disaggregation would not inform the development of license conditions nor enhance the understanding of the effects of the Don Pedro Project or resources in the lower Tuolumne River. Related to accretion flows, the Districts are undertaking an initial set of flow measurements at various locations downstream of La Grange Dam. These initial measurements will help inform the need for any further measurements. The Districts are also compiling the available data of operational outflows from the irrigation system to determine if they can serve as a systematic input to accretion flows. Related to the establishment of nodes, in hydrologic modeling nodes are located where there are predictable, systematic changes in flow. There is no reason to establish one node downstream of another unless flows have changed in some measurable and meaningful degree.
CDFG-09	**Specific**	It is our understanding based on an April 11, 2012 letter from FERC's Office of Energy Projects that once accretion and depletion measurements are taken by the Districts in the lower Tuolumne River, additional model nodes may be required by FERC. In response, the Department agrees with the NMFS recommendation "... several time periods of sampling are necessary to characterize accretion and depletion during the varying seasonal, climatic and diversion conditions that occur on an annual basis in the lower Tuolumne River."	The upcoming accretion data acquisition effort will provide insight to accretion flows to be incorporated into the models. The Districts recognize that a single year of data may not fully describe the variability of accretions in the river. In fact, multiple years of seasonal accretion data may not be adequate to describe the variability of accretions. To bring accretion data to the same degree of reliability as the current stream flow records at La Grange could take a decade or more of measurements. This is not practical. At most, within the time frames allotted in relicensing, what can be achieved is to develop a sense of whether the magnitude of accretion flows is only within the accuracy of recorded streamflows or significant enough to be recognized and accounted for as discrete inflows at certain locations along the lower Tuolumne River.
CDFG-10	**Specific**	Dale Stanton's last name is misspelled in the Attendee list.	The text will be corrected.
CDFG-11	**Specific**	The Districts note there was a March 20, 2012 meeting to discuss the Consultation Workshop Procedures and Protocols and that "no comments were provided by RPs on the procedures." To clarify, the Department did provide verbal comments at the March 20, 2012 meeting but did not file formal written comments. Two such verbal comments reiterated here are: 1) it would be helpful to have real time notes of action items/next steps; and 2) the filing of the final meeting summary should include a specific request for comment by FERC staff, not just assume approval if no response is provided.	CDFG's comments are noted. The Districts included item (1) in the Workshops to date and will continue to do so. Item (2) is left in the hands of FERC staff to decide if action is needed on a particular issue identified and discussed within the Workshop.
State Water Resources Control Board			
SWRCB-01	**Specific**	Many of the RPs inquired as to whether or not energy generation records or in-pipe acoustic velocity meter (AVM) measurements could be used to cross-check flows derived by other methods. The consultant for the Districts, Dan Steiner, responded that the derived flows have gone through a thorough analysis by CCSF and the Districts and that both have a great deal of confidence in the flows	The Districts disagree with the idea that "little additional work" would be required to provide additional information that will improve upon the data set already provided. Let's first comprehend which records could be alternatively derived. When estimating the total unimpaired runoff at La Grange the following data components are already used: (1) USGS measured flow at La Grange, (2) USGS measured flow at Modesto Irrigation District Main Canal, (3) USGS measured flow at Turlock Irrigation Canal, change in reservoir contents as determined from (4) USGS reported storage at (a) Hetch Hetchy Reservoir, (b) Cherry Reservoir, (c) Eleanor Reservoir, San Joaquin Pipeline Diversion as measured by CCSF, and (d) Don Pedro Reservoir, and (5) computed reservoir storage adjustment due to evaporation-precipitation. For the components derived from USGS records, there are no alternative means/parameters to establish the flow or reported value, nor is there

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		derived. Although CCSF and the Districts are confident in the current methods, many of the RPs would prefer extra assurance. Therefore, staff asks that CCSF and the Districts provide the RPs with any available energy generation records and AVM measurements and allow them to cross-check the derived flows. This would require very little additional work for the Districts.	an alternative to deriving the metered flow of the San Joaquin Pipeline at the Oakdale Meter House. An alternative estimation of reservoir evaporation-precipitation has been discussed in our response to CDFG-03. The Districts are willing to provide records of generation at the Don Pedro Project (and reservoir elevation data) on a daily basis to enable SWRCB to backcheck flows. Please let us know what period of record to provide. There are no AVM's at Don Pedro powerhouse. Within the unimpaired flow computations used by the Districts for modeling, the components of flow that could lend themselves to alternative estimation or validation concern only the disaggregation of the total unimpaired flow (described above) between flow into CCSF reservoirs and the unregulated flow into Don Pedro Reservoir. The unregulated inflow into Don Pedro Reservoir is the mathematical difference between total unimpaired flow at La Grange and the calculated unimpaired runoff (inflow) into the three major CCSF reservoirs. There is no alternative method to compute the unregulated inflow to Don Pedro Reservoir; therefore, the validity of the value is dependent upon the computation of the (1) total unimpaired flow at La Grange (previously discussed) and (2) calculated unimpaired runoff into CCSF reservoirs. The two components of CCSF unimpaired flow represent inflow into Hetchy Hetchy Reservoir and inflow into Cherry/Eleanor Reservoirs. For the computation of unimpaired flow into Hetch Hetchy Reservoir the following hydrologic elements are used: (1) USGS measured flow below Hetch Hetchy Reservoir, (2) change in reservoir contents as determined from USGS reported storage at Hetch Hetchy Reservoir, (3) computed reservoir storage adjustment due to evaporation-precipitation, and (4) computed flow through Canyon Tunnel. The USGS measurements and reported storage represent the best available data for these components, and the adjustment for reservoir evaporation-precipitation has been discussed in CDFG-03. The remaining parameter is flow through Canyon Tunnel (released from Hetch Hetchy Reservoir) which is computed as the sum of flow through Canyon Tunnel and the amount of flow released back to the Tuolumne River from Kirkwood Powerhouse above Early Intake. The flow through Canyon Tunnel is computed from the change in storage at Priest Reservoir and the metered flow through Moccasin Powerhouse, both parameters representing best available data. The river release from Kirkwood Powerhouse is estimated from USGS measured flow above and below the release point, which assumes that any change in flow between these points is due to the release from Kirkwood Powerhouse. Use of power generation records from Kirkwood Powerhouse would not be sufficient to determine total flow through Canyon Tunnel, as some flow may bypass the power units. Alternatively, there is an AVM in line with the flow to the units. It is estimated that the device was installed circa 2004 and would not provide complete coverage for the entire period of record to be modeled. Also, the limited record of the AVM has been noted with issues. Therefore, the Districts accept the current procedures as utilizing the best complete and consistent data to compute inflow to Hetch Hetchy Reservoir. Unimpaired inflow into Cherry/Eleanor Reservoirs is separately computed using the following hydrologic elements: (1) USGS measured flow below Cherry and Eleanor Reservoirs, (2) change in reservoir contents as determined from USGS reported storage at Cherry and Eleanor Reservoirs, (3) computed reservoir storage adjustment due to evaporation-precipitation, and (4) estimated flow through Holm Powerhouse. The flow through Holm Powerhouse is computed as the difference between flows measured in Cherry Creek by USGS above and below Holm Powerhouse. The USGS flow measurements below Cherry and Eleanor Reservoirs and reported storage represent the best available data for these components, and the adjustment for reservoir evaporation-precipitation has been discussed in CDFG-03. An alternative record of flow through Holm Powerhouse is included in the worksheet provided by the Districts and is titled "CCSF Holm Powerhouse" (identified as column 25). These data represent a combined source of record that includes AVM data for recent years (beginning circa 2004) and flow computations based on generation records prior to that time. Differences between the results of the currently employed above-below gage measured flow protocol and the alternative record exist. The Districts will continue to the use the current USGS measured flow protocol for its modeling to maintain a consistency of methodology for the entire period of record. It is important to keep in mind that the Project hydrology is already very well defined by three USGS gage records for flows at La Grange which is, when combined, the actual flow from Don Pedro. This is a very good record captured right at the outlet of the Project under review. To substitute a series of prorations from upstream gages of mismatched time periods over a highly geophysically diverse watershed would only result in a significantly less representative flow record. Validation of the developed data set for Hetch Hetchy and Don Pedro has occurred over many years. The existing data set is based on a consistent, accepted methodology for the period of record. Any alternative methodology would be based on mixed source and method

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			records that do not span the entire period of record, and these alternative records and methods themselves are subject to flaws and limitations. In the end, the result would be a slightly different record of data, not better or worse, with no practicable effect to modeling. Revisiting or re-computing this data set by other means would be very time consuming and would not inform the development of license conditions at Don Pedro Project.
SWRCB-02	**Specific**	It was requested that CCSF and the Districts provide the RPs with a description as to how the CCSF Hetch Hetchy system was operated. There was a request for a description of how the CCSF system is operated. CCSF and the Districts responded that a PowerPoint presentation regarding the operations of the Hetch Hetchy system was presented at an RP meeting in April, 2011. Over a year has passed since that meeting and many of the agencies and NGOs involved in the relicensing process are represented by different people. Staff asks that the Districts post this presentation to the Don Pedro Relicensing Website.	This PowerPoint presentation on the Hetch Hetchy Water & Power system was originally posted to the April 1, 2011 Relicensing Participants' Meeting Date (under the MEETINGS/CALENDAR tab) on the www.donpedro-relicensing.com website. It has now been re-posted to the website, under the INTRODUCTION/Announcement tab, as of June 14, 2012.
SWRCB-03	**Specific**	The Districts have agreed to prepare a map showing the proposed accretion flow measurement locations for RP review. In addition to the map, the Districts should also provide a write up describing the methods they propose to use in measuring accretion flows. The RPs should be given adequate time to review the methods and submit comments for the Districts' consideration.	A memo communicating the planned accretion measurement locations and methods was distributed to the Relicensing Participants on June 6, 2012, and posted on the relicensing website www.donpedro-relicensing.com under INTRODUCTION/Announcements. Relicensing Participants were given until June 20, 2012 to comment. No comments were received on the accretion measurement location or methods. The Districts collected the accretion measurements according to the proposed methods the week of June 25, 2012.
Conservation Groups			
CG-01	**Specific**	During the workshop there was a discussion about the reservoir evaporation component of the mass balance equations. It is not clear if the evaporation component implicitly includes a groundwater depletion component or not. Conservation Groups urge the districts to include a separate component within the mass balance equations that will define groundwater losses at the reservoirs, including Don Pedro Reservoir, La Grange Reservoir, Modesto Reservoir, Turlock Reservoir, and Dawson Lake. Further, groundwater losses and leaks should be defined for the entire canal system.	The reservoir evaporation-precipitation factors are described in the response to CDFG-04. Concerning a groundwater component of depletion from Don Pedro, La Grange, or CCSF Reservoirs, it is not conventional to include such a factor. At most, precipitation and evaporation is considered and incorporated as these factors will play out differently in reservoir losses/gains between alternative operation scenarios. For the computation of unimpaired flow, groundwater interaction with major reservoirs or the streams themselves is part of the overall occurrence of flow into or out of a stream between two points of measurement or computation, given no call-out distinction. For seepage from facilities such as canals and regulating reservoirs within the Districts' delivery systems, distinct assumptions and values are incorporated in the water operations model, and will be provided in the Operations Model Technical Memorandum, scheduled to be published in January 2013. These are provided for general information only. As FERC has indicated in its Scoping Document 2, considering alternatives which alter or modify irrigation or Municipal and Industrial diversions is not a reasonable NEPA alternative and will not be evaluated.
CG-02	**Specific**	For many years the Turlock Irrigation District (TID) has been working with the Cities of Ceres, Hughson, Modesto, and Turlock to develop a Regional Surface Water Supply Project (RSWSP) that would pump water from the Tuolumne River at Geer Road, located at approximately River Mile 26, treat it to drinking water standards, and then distribute the treated water to the four cities. As part of the SRP-9 Project, TID installed an "Infiltration Gallery" at this location that could later be connected to a pump and water treatment facility and then distributed to customers. As part of this work, TID has also completed an Environmental	The establishment of "nodes" in the Operations Model below La Grange Dam will occur as needed based on information gained from the field measurements of accretion, review of historical flow data, and practicable needs of the fishery/temperature assessments and investigations. The Operations Model is easily adapted to accommodate additional nodes should required studies define such a need. Alternate node locations can readily be established where significant accretion and/or depletions occur in the lower Tuolumne River.

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		Impact Report. Presently, the Cities of Ceres, Modesto, and Turlock are actively pursuing this project to provide treated surface water for their customers south of the Tuolumne River. Conservation Groups believe that a node or nodes should be added to the Operations Model that will help us understand the impacts of withdrawing water at the Geer Rd facility, should that project ever come on line. Presumably, that project could potentially add up to 100 cfs of additional flow from La Grange to Geer Rd, at which point the water would be withdrawn from the river for drinking water and other uses.	
CG-03	**Specific**	The Modesto Irrigation District has a number of "spills" from its canal system that either return to the Tuolumne, the Stanislaus, or the San Joaquin River, or simply collect at terminal locations and wetlands, such as the San Joaquin River National Wildlife Refuge. The Turlock Irrigation District has the Hickman and Faith Home spills, along with a number of terminal canal spills into the San Joaquin and Merced Rivers. Conservation Groups believe that nodes should be added to better define the water that is spilled through each of these locations.	The accretion study recognizes the occurrence of controlled and uncontrolled inflows and outflows to the river system. Based on the results of the study and other practicable needs of the fishery/temperature assessments and investigations, an appropriate number of nodes will be established in the Operations Model.
CG-04	**Specific**	The Oakdale Irrigation District spills tailwater into the MID canal system. A spill should be added that captures this water in the model.	For factors affecting the Districts' diversion needs, distinct assumptions and values are incorporated in the water operations model, and will be described in the Operations Model Technical Memorandum (January 2013).
CG-05	**Specific**	Currently, the Districts are required to release a minimum flow to the lower Tuolumne River for the benefit of the environment, per the 1995 Settlement Agreement and 1996 FERC ORER amending Article 37 of the Don Pedro Project License. In many years, the Districts release additional water, particularly in winter and spring, above the minimum flow releases for flood management and other purposes. Conservation Groups request that these two different releases (Article 37 minimum flows and flood release flows) be defined within the hydrology dataset with two separate nodes. This will enable relicensing participants to manipulate flood flow releases separately from minimum flow releases to better understand the role of flood management within Project Operations.	As part of their obligations as licensees for the Don Pedro Project, the Districts have agreed by settlement agreement to maintain certain minimum flows in the Tuolumne River at the La Grange gage. Releases for flood control purposes are incidentally dynamic within a study and are dependent upon flood control parameters, the underlying hydrology of the study, and the numerous water demands that are assumed in the study. Flood control releases are not manipulated, but are the result of distinct operations required when not occurring due to other Project operations. Explicit flood control releases are not conventionally established with model or user "control" at a node. Rather, a flood control release is the result of model logic that uses information concerning reservoir storage, flood control objectives, and current and projected inflows and water release demands. This systematic logic will estimate a required release that is compared to required minimum releases such as the 1995 Settlement Agreement. If the release is greater than minimally required, the larger release will be made. Model accounting for this circumstance will show flows made for the minimum requirement (e.g., the 1995 Settlement Agreement) and releases in excess of the minimum requirement, in this case for flood control needs. Modeling does not establish an explicit "node" for this release, but rather, the releases at the node are accounted between purposes. Data, in the form of results, will be available from the Operations Model to describe the amount of operations/releases due to flood control operations.
CG-06	**Specific**	Similarly, for the Don Pedro Reservoir storage node, the flood storage pool within the reservoir and the City and County of San Francisco water bank should each be represented as a separate node distinct from other water stored in the reservoir.	"Node" may not be the correct term used for the accounting of the CCSF Water Bank. The Water Bank Balance is an accounting mechanism used to define the amount of Don Pedro inflow that may be withheld by CCSF as otherwise required by the Fourth Agreement. The Water Bank Balance will be computed and shown in the results of the Operations Model based on current accounting procedures and will be dynamic to the operations of CCSF and Districts' operations. Flood control storage in Don Pedro Reservoir is not always explicitly defined; however, results from the Operations Model can be interpreted or will show periods of flood control and the parameters that controlled such operations.
CG-07	**Specific**	Within the watershed above the Don Pedro Reservoir, Conservation Groups request that the Districts develop and	The disaggregation of upstream streams (Clavey River, North and South Fork Tuolumne River) is not necessary for modeling inflows to the Don Pedro Project. See response to CDFG-08.

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		include for the Groveland Community Services District water withdrawals from the Mountain Tunnel. We also request the Districts develop and include nodes for the Clavey River, the North Fork of the Tuolumne River, and the South Fork of the Tuolumne River (including Middle Fork), separate from the other smaller tributaries.	Groveland Community Services District water withdrawals from the Mountain Tunnel will not be separately accounted or modeled in the Operations Model beyond what is already included in the underlying hydrology of the basin. This small withdrawal, recently amounting to approximately 0.5 mgd (500 acre-feet per year), is less than 1 cfs year round. Conventional modeling of the basin and facilities does not explicitly call out this withdrawal, and its effect if discernible will be inherently consistent between operation scenarios.
CG-08	**General**	Conservation Groups were concerned at the workshop by the appearance of negative daily values for inflow to reservoirs.	The occurrence of "negative flows" in the unimpaired data set for the Operations Model is not a concern for "flow modeling." See response to CDFG-05. If necessary for temperature modeling, such occurrences will be modified through accepted data smoothing techniques.
CG-09	**General**	The Study Dispute Panel's report (eLibrary 20120504-5163, pp. 13-15) recommends that the Districts use the workshop approach to sort out issues relating to accretions and depletions in the hydrology dataset. Conservation Groups recommend that it would be efficient and productive to schedule an additional hydrology workshop before the end of June (which could be held as a Webex conference call) to discuss the need for more than one measurement of accretions and depletions. An additional workshop held before summer would avoid potential delays that could arise if, when the Water Balance Model is presented as planned at a workshop in October, relicensing participants were not comfortable with the accretion and depletion calculations as presented. The Districts suggested during the Study Dispute technical meeting that measurements were best taken during the summer period.	The lack of initial or confirmation data for river accretions will not delay the development of the Operations Model. The model is proceeding in development with placeholders for accretions. Initial model development includes a Base Case, which has an operation representative of existing conditions of operations. The existing conditions of operations are almost void of consideration of downstream accretions as releases are established below La Grange Dam based on specified flow schedules. Accretions only affect the incidental flows that occur at locations below this control point. The exception to this circumstance is during flood control operations when releases from the Project may be constrained by the occurrence of flows above the Modesto gaging site. Again, a placeholder time series of accretion flow at the Modesto site is being used for model development purposes. As refinements may occur to this times series, input data for the Operations Model will be adjusted. The logic of the Operations Model is not anticipated to require modification due to refinement of accretion data. The first set of accretion flow measurements will occur in late June with results being shared with Relicensing Participants. The Districts agree with the Conservation Groups that an additional Hydrology Workshop to discuss, among other items, the findings of the first set of accretion measurements and the need for additional accretion measurements. The Districts are targeting early to mid-August at this time.
Bob Hackamack			
BH-01	**Specific**	Concerning the negative results for calculated inflow to HH Res and other reservoirs, I suggest one additional explanation that has not been discussed. One reason for some of the negative daily results may come from the use of the monthly evaporation/precipitation factors which were derived from monthly tests, whereas inflow calculations are made on every individual day. I'm sure some days are sunny, above average temperature for that subject month, windy and have no precipitation that leads to higher evaporation than is calculated using the average historical monthly factor, possibly leading to the calculated inflow higher than actual flow was. The warm and windy day case showing higher calculated inflow would go unnoticed by relicensing participants (RPs). Conversely, other days are cloudy, below that month's average temperature, calm and may have precipitation leading to lower evaporation than calculated using the monthly factor, leading to a calculated inflow lower than actual. That cool, calm case with lower calculated inflow than actual could show negative inflow on low inflow days. RPs would notice only the negative anomaly. The monthly total calculated inflow would come out fine by smoothing out the above and below extreme	The occurrence of "negative flows" in the unimpaired data set for the Operations Model is not a concern for "flow modeling." See response to CDFG-05. If necessary for temperature modeling, such occurrences will be modified through data smoothing techniques.

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		weather days embodied in the monthly factor because monthly factors presume every month has the same average daily weather as the month(s) when pan tests were made. As a way of reducing worry about the negative inflow days, it would be interesting to see if negative inflow days correlate among the three upper reservoirs. A more ambitious job would be to correlate negative days with weather data, say average daily temp, wind velocity, daily precipitation, and isolation. Another interesting correlation in low inflow months would be the relation of calculated inflow at Hetch Hetchy Reservoir with the recently installed real-time inflow gauge there, in use about four years, USGS 11274790, "TUOLUMNE R A GRAND CANYON AB HETCH HETCHY", remembering that this main stem gauge will show the largest amount, but not the total inflow.	
BH-02	**Specific**	You say in your Estimation of Tuolumne River Unimpaired Flow… paper on p.6, "the Operations Model will likely consider two components of inflow to Don Pedro Reservoir…" Explain why unimpaired flow at La Grange doesn't include calculated inflows shown in the three Columns AE, HH calculated inflow; and AF, Cherry & Eleanor calculated inflow? Perhaps AH, calculated DP "local" inflow should not be included since DP outflow and CCSF diversion are already counted. I've come to this conclusion after careful study of your equation for Column AG. Also, tell us whether the Districts and SFPUC count AE, AF and/or AH in their unimpaired flow at La Grange.	Two components of inflow to Don Pedro Reservoir will be incorporated into the Operations Model: (1) a component of inflow controlled by CCSF facilities, originating from CCSF reservoirs, and (2) a component of unregulated runoff from watershed areas below CCSF reservoirs. The inflow to Don Pedro Reservoir from CCSF facilities will be a controllable item in the Operations Model. The unregulated component of inflow to Don Pedro Reservoir is not modifiable by the model user as that component of flow in uncontrolled by facilities upstream of Don Pedro Reservoir, and will consistent/the same among study scenarios as a fixed times series of flow values. The unregulated inflow to Don Pedro Reservoir (Column AH) is one component of the three components of unimpaired runoff calculated in the worksheet. There are four basic, separate calculations for the unimpaired flow components shown in the worksheet. The overarching calculation is Column AH for the total unimpaired flow at La Grange. This computation simply develops a mass balance of releases from Don Pedro Reservoir and accounts for the change in reservoir storage in Don Pedro Reservoir and upstream reservoirs adjusted for precipitation and evaporation, and accounts for diversions from the basin through the San Joaquin Pipeline. The result is the computed flow at La Grange had no impairments occurred. The other three components of unimpaired flow is the geographical disaggregation of the total unimpaired flow. The disaggregation occurs by separately estimating unimpaired runoff (inflow) to the two CCSF reservoir complexes through their own sub-mass balance procedures. After estimating the two sub-area inflows for the CCSF reservoirs, the portion of runoff associated with the unregulated area of the watershed is merely the subtraction of the two reservoir-controlled inflows from the total unimpaired runoff that occurs into Don Pedro Reservoir. The three sub-components of unimpaired runoff shown in the worksheet (Column AE, AF and AH) must sum to be the total unimpaired runoff computed at La Grange (Column AG).
BH-03	**Specific**	You said at the 2011 W&AR-2 meeting that you would show a test of the accuracy of your water balance, but this April you seemed cool to including any test. One way you could test the accuracy and completeness of your model is to list your unimpaired flow at La Grange beside the same result reached by the Districts and SFPUC and show the long term difference and average difference and/or percent difference. You and all RP users would know that you are in agreement with the methods the District's and SFPUC are using, or why your model is more complete.	Mr. Steiner has stated that the computation of unimpaired flow as described during the Workshop is consistent with the procedures used by CCSF and the Districts for decades, uses available data, and is consistent with the methods used for other watersheds in California. There currently is no other method of computing unimpaired flow for the basin, nor is there one needed. The data developed is being used for the Operations Model. The gage data at La Grange of the three measured components of flow from Don Pedro are being used to establish Don Pedro inflows; therefore, using the method proposed by Bob would be comparing the data to itself.
BH-04	**Specific**	While you are figuring out the accretions from Turlock Lake Reservoir and Modesto Reservoir, also look into the riparian users along the river. In about 1970 the state listed	Accretions and depletions for the Districts' regulating reservoirs have been estimated and are included in the development of the Districts' simulated diversions, and will be described in the Operations Model Technical Memorandum (January 2013). Accretions and flows for the river are being measured in late June, with the work supplemented by information gained from the accretion monitoring effort (see accretion

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		summer riparian users in the reach not far downstream from La Grange as withdrawing 6 cfs directly from the river while the release (leakage) at LaGrange Dam was listed as 3 cfs. There could be other riparian pumpers farther downstream as well. I have been told that some of the Dry Creek flow comes from pirating from Modesto Reservoir as well as I have seen unintended release flow from MID flood irrigators along Dry Creek (where I lived for 35 years) and from intentional spill from the MID main canal aqueduct at its crossing of Dry Creek.	measurement memorandum). A simulation of Dry Creek flows for the period of record will be estimated for the Operations Model. Information such as provided by commenter will be considered for the simulation.
BH-05	**Specific**	W&AR-2 Project Operations/Water Balance Model in the 2011 Revised Study Plan beginning at electronic page 245 states in § 5.2 page 5 (electronic 246) ¶ 2 "There are no tributaries to the Tuolumne River downstream of [Modesto Gauge]." This is true, but nowhere is there provision for tail water entering the Tuolumne, Stanislaus, and possibly San Joaquin and Merced rivers from TID and MID canals. A few do enter upstream of the Modesto Gauge, but most do not. In October 2011, Allen Short, MID General Manager, said at a public meeting about selling MID water to CCSF that MID tail water is 37,000-ac-ft/yr. This amount needs to be accounted for in the model partly because he said the goal of selling fresh water was to pay for capture and reuse of this tail water. Tail water flow is enough that it needs node(s) separate from other accretions.	Return flows from District canal operations to the Tuolumne River are being incorporated into the development of the accretion estimates for the Operations Model. Such flows returning to the Stanislaus, Merced, and San Joaquin rivers are not being modeled in a river flow simulation model because those streams are outside of the scope of modeling. However, those return flows are included as a component of the operation of the Districts' canal systems, and will be described in the Operations Model Technical Memorandum (January 2013).
BH-06	**Specific**	No answer has come to my request in the above study plan: § 5.2 p 2 (electronic 246) Ground Water storage: I requested in October that this model add a node(s) for ground water storage to supplement irrigation supply during droughts, but the topic was not discussed in the Nov 22 filing. I ask again that this conjunctive use be added. A physical location of that storage need not be identified for these conceptual nodes. The idea would be to use what-ifs for some of the surplus releases in normal and higher runoff years when DP has spills that could be conveyed in MID and/or TID main canals in relatively small amounts to be injected into a nearby unidentified aquifer, to then be withdrawn via an output node into the respective district main canals during times of drought. A portion of this ground water bank capacity could be used to free up some surface water for anadromous fish release during these same drought periods. This concept was suggested in earlier comments by Spreck Rosekrans, then a water supply analyst at Environmental Defense Fund in San Francisco. Specifications outlining how this concept might be modeled were developed by Mark Williamson, PE, of GEI, consultants for the EDF. EDF created an extensive model	A "node" of groundwater will not be incorporated into the Operations Model, as it is unnecessary for development of analysis of FERC-ordered conditions for the relicensing of the Project. However, groundwater use within the Districts to meet water use demands is incorporated into the development of Districts canal operations, and will be described in the Modeling Report. Groundwater is assumed to offset the need for surface water diversions, and in the Base Case is explicitly defined. The sustainability of that groundwater assumption is not being confirmed by the Operations Model, as the Operations Model is not a groundwater model, but the assumption serves as a baseline for comparison of alternative scenarios of Project operations under groundwater use patterns similar to historical use. The results of alternative Project simulations will illustrate differences in Project operation parameters such as reservoir storage, river releases and canal diversions. In the case of differences in canal diversions, the effects of such differences require additional assumptions or a range of assumptions as to the impact upon economics, land use and/or groundwater use. The request to include use of groundwater as an alternative to alter or reduce the use of surface water for consumption use purposes was addressed by FERC in its Scoping Document 2 (see page 16). FERC indicates that such "alternative mitigation strategies that could not replace the Don Pedro hydroelectric project....do not satisfy the NEPA purpose and need for the proposed action and are not reasonable alternatives for the NEPA analysis."

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		(TREWSSIM) of CCSF water supply system for a large report in 2004 about re-operating the CCSF system that considered such a groundwater bank as suggested in this current request. The EDF TREWSSIM model has a detailed written logic and structure that might be available to the Districts and you.	
BH-07	**Specific**	Could you list the amount of water pumped into the MID and TID canals, most in drought years? I suspect all these pumps use Class 1 power purchased from CCSF, thus the volume pumped could be calculated for each well. The purpose is to show how ground water supplements surface flow.	Assumed groundwater use within the Districts' areas as it pertains to developing the Operations Model will be described in the Operations Model Technical Memorandum (January 2013).
BH-08	**Specific**	You and John Devine agreed at the April 9 meeting that the model will contain the generation at DP. I suggest that flow be listed and energy calculated by equation that would help to know the impact of "what-if' trials on generation. You probably will need another node for release and spill at DP separate from power generation. These releases often happen to meet flood reservation requirements in spring, e.g. 2011.	"Node" may not be the correct term used for identifying/disaggregating releases at Don Pedro Dam. The total release from Don Pedro Dam is the operative parameter in the Operations Model. This parameter will then be tested through additional logic as to power generation, through equations that relate generation potential (and constraint) to reservoir head. Releases that are in excess of computed generation capability are defined as bypass past generation. Each component of Don Pedro release will show in the results, releases through the power plant and releases bypassed. The power plant generation potential (MW) and the energy production (MWh) will also be provided in the results.
BH-09	**Specific**	You and John Devine agreed at the April meeting that the SFPC paper water bank would be shown and will show result of what-if trials.	Noted. See also response to CG-06.
BH-10	**Specific**	On your spreadsheet handout and in the CD, I see two nodes numbered "30", in Column W and Column AH.	Noted. The numbering contained in the cells of Row 17 of the worksheet should be revised to be sequential.
BH-11	**Specific**	I find your "Preliminary-Subject to Revision" map to be accurate. I suggest you add a note that there are MID and TID return flows and canal spills near the TR confluence and into the San Joaquin, Stanislaus, and Merced rivers if any.	Noted. The schematic and other illustrative tools will be refined as additional information is developed. Pertinent information will be identified.
BH-12	**Specific**	If you revise that map, I suggest you note the total number of riparian pumpers from the TR.	Noted. The schematic and other illustrative tools will be refined as additional information is developed. Pertinent information will be identified.
BH-13	**Specific**	I ask a node be provided for the TID gallery diversion at Geer Road of up to 100 cfs for domestic and/or agricultural use. This will be very useful for what-if tests on stream temperature from La Grange to this point and beyond. Likewise please show a diversion for this gallery on your Preliminary map downstream of "River Accretions". Including a river mile for its location would be helpful to RP.	Same as comment CG-02. The establishment of "nodes" in the Operations Model below La Grange Dam will occur as needed based on information gained from the field measurements of accretion, review of historical flow data, and practicable needs of the fishery/temperature assessments and investigations. The Operations Model should be easily adapted to accommodate additional nodes should required studies define such a need. Additional nodes can be established where measurable changes in hydrology occur.
BH-14	**Specific**	Could you list the measured temperature of DP release as a column in your spread sheet or as a footnote?	The results of the Operations Model will list reservoir parameters such as storage, elevation, releases, and inflow. These parameters will be provided as input to the reservoir temperature model that will separately model water temperature results such as the temperature of Don Pedro releases. That information will be provided from the reservoir temperature model rather than from the Operations Model. A composite summary information report will likely be developed to illustrate the several items of results.
BH-15	**Specific**	Could you calculate the flow and calculate and list temperature at TR confluence? This would be helpful to the fishery folks especially for what-if trials.	While the flow will be derived from the Operations Model, the temperature information is a parameter derived from the river temperature model. A composite summary information report will be developed to illustrate the results, including temperatures at the Tuolumne River confluence.

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BH-16	**Specific**	Remind us of the water year types that are the triggers for the present stream release schedules.	Water year types, and the determination of present stream release schedules, are defined by the current FERC license. Detail of the requirements are described in New Don Pedro Proceeding Settlement Agreement, 1995, available in the documents section of the Tuolumne River Technical Advisory Committee web-site http://tuolumnerivertac.com/documents.htm.
BH-17	**Specific**	Please provide for what-if trials to increase flood release below MOD gauge from 9,000 cfs to, say 15,000 cfs.	The Operations Model will allow users to adjust parameters that affect flood releases.
BH-18	**Specific**	Provide for the TID spillway data located upstream from Waterford that is used for flow from canal generators in good runoff years.	District operation assumptions necessary for development of District canal operations will be provided in the Operations Model Technical Memorandum (January 2013).
BH-19	**Specific**	Provide for what-if trials for release for anadromous fish to begin, say June 1 instead of Oct 1.	The Operation Model input and logic will allow for the designation of alternative stream flow requirements.
BH-20	**Specific**	Provide for what-if peak runoff to shift up to two months earlier due to climate changes. I don't see clearly how to vary the spring unimpaired daily flow as feed-back for what-ifs for climate change since inflow to CE, HH, South Fork, North Fork and Clavey River some of which are not data input points lumped in "local" flow. Perhaps hypothetical tributaries or distributaries could be added to make the shift evident.	"Runoff shifting" would require modification of the unimpaired flow components incorporated into the Operations Modeling, and is doable should studies require such assumptions. This form of data modification is typically "pre-process" analysis not requiring logic within the Operations Model.
BH-21	**Specific**	Page 10 of your Estimation paper, § 7.0 may refer incorrectly to W&AR-3, the temperature model.	The reference will be changed in the final report to state "W&AR-02" not "W&AR-03".

ATTACHMENT B

Final Meeting Notes – W&AR-2 Hydrology Workshop and Workshop Materials

Don Pedro Project Relicensing
Project Operations Model Study (W&AR-2)
Hydrology Workshop
Final Meeting Notes

Monday, April 9, 2012
10:00 a.m. – 2:00 p.m.

Attendees

Bill Johnston - Modesto Irrigation District (MID)	Donn Furman - CCSF
Art Godwin - Mason, Robbins, Browning and Godwin (MRBG)	Ellen Levin - CCSF
Joy Warren - MID	Carin Loy - HDR
Tim O'Laughlin - O'Laughlin & Paris LLP	John Devine - HDR
Greg Dias - MID	Dan Steiner - Consulting Engineer
Steve Boyd -Turlock Irrigation District (TID)	Jenna Borovansky - HDR
Bob Nees - TID	Jelica Arsenijevic - HDR
Bill Sears - City and County of San Francisco (CCSF)	Mike Maher - SWRCB
Chris Shutes - California Sportfishing Protection Alliance (CSPA)	John Buckley - Central Sierra Environmental Resources Center (CSERC)
Peter Barnes - State Water Resources Control Board (SWRCB)	Robert Hughes - CDFG
Patrick Koepele - Tuolumne River Trust (TRT)	Tim Finley - Hanson Bridgett/Bay Area Water Supply and Conservation Agency (BAWSCA)
Dale Stanton - California Department of Fish and Game (CDFG)	Ramon Martin - U.S. Fish and Wildlife Service (USFWS)
Steve Bowes - National Park Service (NPS) – *by phone*	Tom Fitzhugh - Bureau of Reclamation (Reclamation) – *by phone*
Allison Boucher - Friends of the Tuolumne (FOT)- *by phone*	Jim Alves - City of Modesto – *by phone*
Annie Manji - CDFG	Adam Mazurkiewicz - CCSF – *by phone*
Bob Hackamack - TRT	

Purpose of Meeting

The Hydrology Workshop was conducted in accordance with the Project Operations Model Study Plan as contained in the Revised Study Plan for the Don Pedro Project ("Project") prepared by Turlock Irrigation District and Modesto Irrigation District (collectively, the "Districts"), and approved by the Federal Energy Regulatory Commission ("FERC") in its

December 22, 2011 Study Plan Determination ("SPD"). Section 7.0, Schedule, of the study plan contained a task to conduct a Hydrology Workshop to present, discuss, and review the base hydrology for the Operations Model. The Hydrology Workshop followed FERC's directive related to ongoing consultation processes contained in Appendix B, page 1, of the FERC SPD. The Districts previously prepared proposed Consultation Workshop Procedures and Protocols, issued the procedures to Relicensing Participants ("RPs") and FERC on March 5, 2012, and held a meeting with RPs to discuss the procedures on March 20, 2012. No comments were provided by RPs on the procedures, and these have been formally adopted to apply to all Consultation Workshops (see Attachment 1). The overall purpose of the various Consultation Workshops is to provide opportunity to RPs and the Districts to share and discuss relevant data sources, methods of data use and development, and modeling parameters at key points in the execution of the relevant study plans.

The purpose of this Hydrology Workshop was to discuss the development of the unimpaired hydrology data set for inclusion into the Project Operations Model. The hydrology data set forms the foundation of the Operations Model; therefore, early review of the development of the hydrology will help to provide a common understanding of this fundamental component of the model.

Meeting Materials

The following handouts supported the hydrology workshop: (1) the agenda (Attachment 2), (2) a paper entitled "Estimation of Tuolumne River Unimpaired Flow and Other Flow Data" (Attachment 3), (3) an Excel workbook entitled "Don Pedro Unimpaired Flow and Other Flow Data Version 1.xlsx" (Attachment 4), (4) a sample print-out of the worksheet "Data" from the workbook (Attachment 5), and (5) a schematic entitled "Tuolumne River Measured or Computed Storage and Flow Locations" (Attachment 6). Attachments 2, 3, and 4 were distributed to the RPs via email one week prior to the workshop; Attachments 5 and 6 were provided at the meeting.

History of Water Use on the Tuolumne River

Dan Steiner, consultant to the Districts and the lead engineer for model development, briefly discussed the history of accounting for water use on the Tuolumne River for purposes needed by the Districts and the City and County of San Francisco ("CCSF"). Steiner referenced the combined use of the handout materials for the day's discussions.

The hydrologic record selected for the Operations Model is Water Year 1971 through 2009, which includes extreme hydrology (both wet and dry) and multi-year periods of challenging water supply conditions. Flow data has been developed on a mean daily basis. Data included in the worksheet comes from a combination of actual flow measurements and the records of actual reservoir operations. Additionally, data were included concerning estimated reservoir net losses

and gains from precipitation, evaporation, and seepage. All of these factors enter the computation of unimpaired flow.

RPs inquired why the 1971 to 2009 period of record was chosen for the model. Steiner explained that the record happens to coincide with the onset of operations for the new Don Pedro Project. Recordkeeping and measurements improved with the start of project operations in 1971, and this period of record provides a good representation for all water year types (e.g., wet, dry, average), and the period has a consistent method of preparing and reviewing the daily flows on a real-time basis.

The starting point for the operations model is "unimpaired flow." Unimpaired flow is the estimated flow that would be available without human development and use. The effects of canals, dams, and diversions are removed. Columns AE through AH of the worksheet show unimpaired flow for: (1) Hetch Hetchy Watershed, (2) Cherry and Eleanor Watershed, (3) Tuolumne River at La Grange, and (4) inflow to Don Pedro Reservoir from the unregulated contributing watershed.

The majority of data records were obtained from the U.S. Geological Survey (USGS), the Districts, and CCSF. These data, and earlier provisional forms of the data, are used by the Districts and CCSF for their own operations and planning. The data are heavily scrutinized to ensure that Tuolumne River water usage is consistent with the Raker Act and 4th Agreement between the Districts and CCSF. Steiner explained that unlike other watersheds, the methods and tools of accounting for the waters of the Tuolumne River have been in place for decades now as required to track water sharing between the Districts and CCSF.

Steiner emphasized that the following formula is key to computing unimpaired flow at a location. The equation is a form that recognizes that all flow entering and exiting a location must balance to maintain conservation of mass. Where reservoirs are involved, the equation accounts for change in storage and reservoir losses. ("t" in the equation below represents time period.)

$$\text{Inflow}_t = \text{outflow}_t + \text{storage}_t - \text{storage}_{t-1} + \text{reservoir evaporation}_t$$

The computation procedure for the four points of unimpaired flow were described by illustrating the hydrologic parameters (flows and storage) affecting each of the points. Several of the flow components are themselves computations made from two or more flow measurements.

RPs asked if either hydro station energy generation records or in-pipe acoustic velocity meter (AVM) measurements could provide a means to cross-check flows derived by other methods. Steiner answered that the present record is based on a consistent procedure. AVM technology was only introduced very recently and not consistently within the watershed or the period of record. Robert Hughes asked if cross-checking flow numbers might add more confidence to the hydrology database. Steiner responded that the derived flows have gone through a thorough

analysis by both CCSF and the Districts and each has a great deal of confidence in the flows so derived.

RPs inquired whether groundwater loss and gain are captured in the reservoir component of flow alterations. Steiner responded that groundwater interaction within a reservoir, if any, is being captured in either the net evaporation value or affects the record of reservoir storage.

RPs requested further explanation of the groundwater-surface water interactions and how the unimpaired flow accounts for the interaction. It was explained that an explicit amount of groundwater interaction (either within a stream or within a reservoir area) is not called out in the computation procedure. It is inherent to the gain or loss of flow upstream of a computation point. RPs would like to understand the components of the "reservoir evaporation" numbers better and how the monthly evaporation constants used were developed and calculated. Specifically, Hughes would like to understand the sensitivity of the computation results if using a varying evaporation rate as opposed to the "average" evaporation rate used for the presented record.

Action Item: Districts will provide a description of the source of the evaporation data in the model and an expanded explanation of its use in the model.

RPs requested that a description of how the CCSF system is operated be provided. RPs would like to understand the main features of the Hetch Hetchy system so that they can understand where and how water moves through the system. Ellen Levin and John Devine responded that a PowerPoint presentation, describing Hetch Hetchy operations, was given by Margaret Hannaford at a previous RP meeting (i.e., April 1, 2011). In addition, the CCSF also submitted information to FERC (available on FERC website).

RPs asked if there is a record of flow in the main stem of the Tuolumne River upstream of Don Pedro Reservoir. There were formerly gages on the Middle Fork and the South Fork that were operated through 2002, and then abandoned. Recently, a gage was reinstalled by Hetch Hetchy operations on the Middle Fork. There is no gage on the mainstem Tuolumne River below the confluence of Cherry Creek and Don Pedro.

Steiner described that the computation for Cherry and Eleanor watersheds is combined as one system. Bob Hackamack agreed with this approach. Steiner did say that the needs of the Operations Model may require disaggregation of the watershed and facilities, but that will not be known until later.

Steiner discussed the computation of unregulated flow into Don Pedro Reservoir; that is, the component of Don Pedro inflow that is not regulated by CCSF facilities. It was stated that Don Pedro Reservoir will have at least two inflow nodes, one representing this unregulated flow and the other representing regulated flow from CCSF. Interaction with the Reservoir Temperature model may require a greater number of nodes, but this has not yet been determined.

There was a general discussion about the occurrence of "negative flows" in the database. Steiner explained that this is common and inevitable in the development of daily unimpaired flows, especially when flows are small compared to reservoir size. Devine provided the example that if a daily reservoir reading were off by one-half inch, that could easily represent a difference of 500 to 600 acre-feet, which equates to a flow of 250 to 300 cubic feet per second, which is higher than many summer inflows. Steiner explained that computed negative inflows were inconsequential to the Operations Model because when the base case (and all operational scenarios) is modeled, the negative flows are overcome by the change in storage and revert back to positive outflows. John Buckley noted that having negative unimpaired flows makes comparisons difficult. Steiner and Devine both agreed with this observation.

In addition to data and computation procedures, Steiner illustrated the use of workbook graphing and tabling tools that are provided for looking at the data (provided in the Excel workbook). Some of the graphical tools described include:

- "YearofDaily" tab: Allows user to query a year of daily data for a single parameter. The data is graphed, and displayed in annual tables.
- "MonthTable" tab: Allows user to query the entire daily dataset of up to three parameters and provides a summation of flows on a monthly basis.
- "MultiGraph" tab: Displays several parameters of a year of daily data at one time on the same graph.

Steiner and Devine summarized the real time procedures used to calculate unimpaired flows in the watershed. The Districts and CCSF exchange relevant flow and storage information daily. The Districts also provide information daily to the California Department of Water Resources ("DWR") and other agencies. DWR uploads the data onto the California Data Exchange Center ("CDEC"). Steiner emphasized that CDEC does not typically go back and update data for corrections or change in rating tables and noted caution when using CDEC data as the Districts data is more reliable and up-to-date. Some of the USGS data also is provisional. For the period of record, the Districts have had the responsibility of calculating unimpaired flow, and that record has been submitted to DWR, both daily and subsequently after-the-fact as revisions and corrections occur.

Hackamack commented that he has interest in two additional data parameters being modeled. One is the CCSF's water bank. The other is generation at Don Pedro. Steiner explained that the water bank is a component of the Operations Model, and historical generation is not an item concerning unimpaired hydrology. Both the CCSF water bank and Don Pedro generation will be provided in the Operations Model base case and scenarios.

Lower river accretions measurements were discussed. There is a concern from RPs of incorporating and calculating accretion flows below La Grange Dam. RPs suggested that one or two nodes downstream of La Grange be included in the model, and possibly a node below the

Modesto gage. Devine summarized the Districts' plan for accretion measurements. Devine explained that since accretions are expected to be due to groundwater, they are expected to be fairly low compared to most river flows and difficult to identify given flow measurement accuracy limitations. However, with 2012 being a low-flow year, this may be a good time to take measurements. Four or five locations are likely (upstream and downstream of Turlock Lake/Modesto Reservoir, above Dry Creek, and near the confluence with the San Joaquin River). These measurements will be used by the Districts to develop accretion components to incorporate into the Operations Model. The first set of measurements will inform the need for additional measurements. It was stated that the Operations Model will be developed with the number of nodes to adequately depict river conditions; a node should represent a change in flow.

Action Item: The Districts will prepare a map showing proposed accretion flow measurement locations for RP review no later than May 15, 2012.

Hackamack identified the potential occurrence of return flows to the river. Steiner and Devine acknowledged the occurrence of intermittent return flows. During the measurement periods, additional attention will be provided to estimate and note any such flows.

Hackamack asked the Districts if the model is going to account for how far upstream the Dry Creek gage is. Steiner stated that the location of the Dry Creek gage will be accounted for in the model. He added that work is proceeding on developing a dataset for Dry Creek flows.

Devine discussed the schedule for the Operations Model. An Operations Model will be ready for illustration and use by RPs at the October 23 Workshop.

Ramon Martin wanted to know if flood control operations are shown in the workbook. The response was "not explicitly" because unimpaired flow is blind to operations. However, flood control operations will be built into the Operations Model. The flood control rules will be discussed at the October workshop.

Action Item: RPs will review the information provided via email and discussed at the workshop and provide comments within 30 days (May 10, 2012). RPs are encouraged to contact Steiner directly by email with questions; all substantive questions (i.e., those that go beyond technical assistance with the workbook) and responses will be shared with the RP email list.

Action Item: The Districts will post the Tuolumne River Measured or Computer Storage and Flow Locations schematic to the website. [Completed April 13, 2012]

Action Item: The Districts will draft and distribute meeting notes according to the consultation protocol. After a 30-day comment period, the Districts will file the notes and comments with FERC.

List of Attachments

All attachments are available on the Don Pedro Relicensing website (http://www.donpedro-relicensing.com) under Introduction /Announcements by workshop date and are appended to the final meeting note package.

Attachment 1 – Workshop Consultation Procedures and Protocols ***[Attached is the final Workshop Consultation Process document which was filed with FERC on May 18, 2012. It contains revisions to the draft Protocol provided at the April Workshop.]***

Attachment 2 – Agenda

Attachment 3 – Estimation of Tuolumne River Unimpaired Flow and Other Flow Data (Preliminary Review Draft) ***[Attachment 1 (Vicinity Map) to this document is "Attachment 6" noted below.]***

Attachment 4 – Don Pedro Unimpaired Flow and Other Flow Data Version 1. ***[This is a working spreadsheet data set for Relicensing Participant use and review. It is available electronically only on the Don Pedro relicensing website www.donpedro-relicensing.com attached to the meeting date (April 9) on the April Calendar.]***

Attachment 5 – Sample Print-out of Data from Worksheet

Attachment 6 – Tuolumne River Measured or Computed Storage and Flow Locations

WORKSHOP CONSULTATION PROCESS ON INTERIM STUDY PLAN DECISIONS

As part of certain studies to be undertaken in the Don Pedro Project relicensing, the Districts had proposed a series of workshops to share and discuss relevant data with Relicensing Participants (RPs). FERC has recommended that the Workshop Consultation process be formalized. In accordance with Appendix B of FERC's December 22, 2011 Study Plan Determination, the draft workshop consultation process outlined below has been developed to provide guidance for the decision-making process involved within the following study plans:

- W&AR-2 (Project Operations Model): Hydrology Workshop
- W&AR-5 (Salmonid Population Information Synthesis): Literature/Data Review Workshop and Conceptual Model Review Workshop
- W&AR-6 (Chinook Population Model): Conceptual Model Review Workshop and Modeling Approach Workshop
- W&AR-10 (*O. Mykiss* Population Model): Conceptual Model Review Workshop and Modeling Approach Workshop

The purpose of the workshops is to provide opportunity for RPs and the Districts to discuss relevant data sources, methods of data use and development, and modeling parameters at key points in the execution of these study plans. The goal of the workshops is for RPs and the Districts to reach agreement where possible after thorough discussion of data, methods, and parameters. Consensus on decisions dealing with data acceptability, or study approaches or methods, can only be achieved by the active and consistent in-person attendance and participation of interested Relicensing Participants. Additional workshops beyond those already specified above may be held as agreed to between the RPs and the Districts.

FERC has also directed the Districts to formalize the workshop process to define how interim decisions on model inputs and parameters will be made. To promote clear communication and informed participation, the Districts will make a good-faith effort to provide a workshop notice two (2) weeks before each workshop, in electronic format, along with information and presentation materials to be discussed at the workshops. For studies that involve resource modeling, presentation materials will be tailored to the audience at a level that assumes familiarity with the resource issues being addressed. To promote a common understanding of terms, a glossary of definitions will be prepared prior to each initial workshop, updated and expanded periodically, and included in the final study report. Prior to the initial workshops, the Districts will also prepare a logic diagram of the study steps from data selection through model development and numerical procedures to model scenario evaluation. This study "process diagram" will aid in promoting a common understanding of the step-wise approach being used in model development.

Following each workshop, draft meeting notes of the consultation workshop will be distributed to participants within approximately eight (8) working days. The notes will identify areas where participants reached agreement on data, methods, and/or parameters; areas where there is disagreement among participants; and action items for any future meetings. Following a 30-day comment period, the Districts will file with FERC a revised version of the consultation workshop notes describing areas of agreement, areas where agreement was not reached, copies of comments received, a discussion of how the Relicensing Participant comments and recommendations have been

considered by the Districts, as well as the rationale for the Districts not adopting any Relicensing Participants recommendations.

The proposed schedule for workshops and meetings is included below; all will be held at MID offices in Modesto.

March 2012
Mar 20 - 1:30 pm – 4:30 pm
Don Pedro Project Relicensing - Workshop on Consultation Process (as per Appendix B of FERC's Study Plan Determination)

April 2012
Apr 09 - 1:00 pm - 5:00 pm
Don Pedro Project Relicensing - Hydrology Workshop (W&AR-2)

Apr 10[1] - 10:30 am - 5:00 pm Don Pedro Project Relicensing - Salmonid Population Information Workshop (W&AR-5)

Apr 11[2] **-** 9:00 am – 12:00 pm Don Pedro Project Relicensing – Temperature Criteria Study Update Meeting (W&AR-14)

June 2012
Jun 26 - 9:00 am - 4:00 pm Don Pedro Project Relicensing - Salmonid Population Information Workshop (W&AR-5)

November 2012
Nov 15 - 9:00 am - 4:00 pm Don Pedro Project Relicensing - Chinook Population (W&AR-6) and *O. mykiss* Population (W&AR-10) Modeling Workshop

2013 (Dates to be determined)

March 2013 (preliminary) – 9:00 am to 4:00 pm Don Pedro Project Relicensing - 2nd Workshop Chinook Population (W&AR-6) and *O. mykiss* Population (W&AR-10) Modeling

[1] **NOTE:** From 8:30 am to 10:15 am, the Districts will conduct an introduction to the MIKE3 reservoir temperature model for use in W&AR-3. The goal is to introduce the model platform, computation methods, model development, and data sources. This is not considered a formal workshop. The Districts are also planning to conduct a discussion and presentation of the reservoir temperature model validation results at a Relicensing Participant Meeting on September 18, 2012 from 9 am to 4 pm at MID. Please add this meeting to your calendars.

[2] At the April 11, 2012 meeting, the Districts summarized their plan for continuing consultation related to W&AR-14. In accordance with the study plan as contained in the Revised Study Plan, the Districts will continue to meet with RPs every other month to keep them informed of the study progress. This study will not be conducted using the formal Workshop Consultation Process described in this document.

Don Pedro Relicensing

Hydrology Workshop (W&AR-2)

Monday, April 9, 2012
10:00 a.m. – 5:00 p.m.

Call-In Number 866-994-6437
Conference Code 5424697994

1. **Introductions**
2. **Purpose of Workshop**
3. **Summary of Districts' W&AR-2 Study Plan and Modifications Recommended by FERC Staff**
4. **History of Water Use on the Tuolumne River**
5. **Historical Flow Data**
6. **Sources of Flow Data on the Tuolumne River**
7. **Initial Development of Flow Data for the Operations Model**
8. **Discussion of How Inflow Dataset Will be Used**
9. **Action Items**

Turlock Irrigation District
Modesto Irrigation District

Don Pedro Project
FERC No. 2299

Estimation of Tuolumne River Unimpaired Flow
And
Other Flow Data

Study Plan W&AR-2
Project Operations/Water Balance Model Study Plan

Working Document
April 2, 2012

Estimation of Tuolumne River Unimpaired Flow
And
Other Flow Data
Study Plan W&AR-2
Project Operations/Water Balance Model Study Plan

1.0 Introduction

The Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) are developing a computerized Operations Model to assist in evaluating the relicensing of the Don Pedro Project (Project) (FERC Project 2299). As described in Study Plan W&AR-2 the objective of the Operations Model is to provide a tool to simulate current and potential future operations of the Project (MID & TID 2011).

Included in the model will be numerous model user-controlled parameters that will allow the simulation of alternative Project operations, such as the prescription of lower Tuolumne River minimum flow requirements. The Operations Model will perform a simulation of Project operations for a sequential period of years that covers a range of historical hydrologic conditions. The period of hydrologic record selected for the Operations Model is Water Year 1971 through Water Year 2009, which includes extreme years of hydrology (1977 dry and 1983 wet) and multi-year periods of challenging water supply conditions such as 1976-1977, 1987-1992, and 2001-2004.

Underlying Project operations and water supply in the Tuolumne River Basin is the unimpaired flow of the river and its tributaries. “Unimpaired flow” is surface water that is available for management and use. The California Department of Water Resources (DWR) provides a definition of unimpaired flow as “… runoff that would have occurred had water flow remained unaltered in rivers and streams instead of stored in reservoirs, imported, exported, or diverted. The data is a measure of the total water supply available for all uses after removing the impacts of most upstream alterations as they occurred over the years.” By computing the unimpaired flow one acquires the record of flow at a location, had no physical (e.g., dams and diversions) facilities been developed upstream of the location. At times, this record is fundamental to modeling the operations of a project as it provides a record of inflow to a facility. At other times, this record is needed to identify the total available water supply of the stream for purposes of division or allocation, which would not be known by simple measurement of the stream at a location that is below controlling facilities.

The unimpaired flow of the Tuolumne River has been computed for various locations for decades. From a water project development perspective, this information was important during project planning in understanding water availability within the basin. Today, it plays directly into Project and basin operations as a key factor in establishing annual water deliveries and the provision of flows to the lower Tuolumne River. The Districts and the City and County of San Francisco (CCSF) have used unimpaired flow computations to comply with Raker Act and

Fourth Agreement provisions, and for the operational and planning needs of their respective projects. Further, unimpaired flow data, along with other data is provided by the Districts to the DWR for incorporation into Statewide water management efforts.

The Operations Model requires several records of unimpaired flow. Three primary records are: 1) unimpaired flow (inflow) at Hetch Hetchy Reservoir, 2) unimpaired flow (inflow) at Lake Lloyd Reservoir and Eleanor Reservoirs, and 3) unimpaired flow at La Grange. Unimpaired flows at each of these locations must be calculated from flows measured from other locations. The Operations Model will possibly utilize a unique fourth component of unimpaired flow which depicts the runoff entering Don Pedro Reservoir that is not affected by upstream CCSF facilities. This runoff concerns runoff from tributaries and streams such as the South and North Forks of the Tuolumne River.

The purpose of this working document is to provide a narrative description of the computation of unimpaired flow for several components of flow needed by the Operations Model. This document accompanies a worksheet entitled " Don Pedro unimpaired and other flow data Version 1.xls" with the data used to compute these components. Following is a columnar description of the worksheet and the computation of unimpaired flow.

2.0 Columnar Description

Date Indices Columns A, B and C

The numeric and alphanumeric values identifying the date of applicable record. These values are also used for data assemblage purposes. All records reported by date represent either end-of-day status (e.g., storage ending at midnight, in acre-feet (ac-ft)) or average daily flow (e.g., average flow occurring throughout the day, in cubic feet per second (cfs)).

Reservoir Storage Columns D, G, J, and M

Reservoir storage reported by USGS.

- 11275500 Hetch Hetchy Reservoir at Hetch Hetchy, CA, Column D
- 11277200 Cherry Lake near Hetch Hetchy, CA, Column G
- 11277500 Lake Eleanor near Hetch Hetchy, CA, Column J
- 11287500 Don Pedro Reservoir near La Grange, CA, Column M

The record is reported in units of ac-ft.

Change in Storage Columns E, H, K, and N

The algebraic difference of the previous day storage record and the current day storage record. The value provides the storage change from the previous day, and is converted from ac-ft to cfs by multiplying by a conversion constant of 0.504167.

- Hetch Hetchy Reservoir, Column E
- Lake Lloyd Reservoir, Column H

- Lake Eleanor, Column K
- Don Pedro Reservoir, Column N

The record is reported in units of cfs.

Reservoir Evaporation Columns F, I, L, and O

Daily evaporation in a reservoir, estimated by determining the surface area of a reservoir from reservoir storage applied to area rating tables and multiplying the surface area by the evaporation factor (tables) for the month involved.

- Hetchy Hetchy Reservoir, Column F
- Lake Lloyd Reservoir, Column I
- Lake Eleanor, Column L
- Don Pedro Reservoir, Column O

For CCSF reservoirs an estimate of monthly net depth of evaporation is applied. These factors were developed from the mean of monthly observed depths of evaporation and precipitation readings taken at Lake Eleanor from 1909 to 1933. These factors are shown in the table below.

CCSF Reservoir Daily Evaporation Factors

Month	Daily Factor	Month	Daily Factor
January	-0.00325269	July	0.00975807
February	-0.00360119	August	0.00975807
March	0.00000000	September	0.00672222
April	0.00000000	October	0.00325269
May	0.00325269	November	0.00000000
June	0.00672222	December	0.00000000

The same daily reservoir evaporation value (CFS) for each of its reservoirs is used for the involved month based on the ending storage of the previous month. The factor shown in the table is multiplied by the area, with the result being in units of CFS.

For Don Pedro Reservoir, monthly evaporation factors were also derived from monthly averages from historical experience. These factors, converted to apply as a daily factor multiplied by the surface area of Don Pedro Reservoir are shown in the table below.

Don Pedro Reservoir Daily Evaporation Factors

Month	Daily Factor	Month	Daily Factor
January	-0.00088458	July	0.01397570
February	-0.00025777	August	0.01410893
March	0.00113491	September	0.01072018
April	0.00308124	October	0.00639480
May	0.00796822	November	0.00178105
June	0.01094715	December	-0.00013449

Don Pedro Reservoir evaporation is computed for every day, and results are in units of CFS.

The storage to surface area rating tables used for the estimated evaporation loss calculation are included in the worksheet within the tab labeled "Reservoir".

Measured Flow Columns P, Q, R, S, T, U, V, W, X, Y, Z, AA, AB, AC, and AD
Several measured flow components are needed to compute unimpaired flow at the three primary locations. To compute unimpaired flow at La Grange, the following measured flow records are needed:

- CCSF[1] San Joaquin Pipelines (SJPL), Column Z
- 11289000 Modesto Canal near La Grange, CA, Column AA
- 11289500 Turlock Canal near La Grange, CA, Column AB
- 11289650 Tuolumne River below La Grange Dam, near La Grange, CA, Column AC

The diversion to the SJPL, measured in million gallons per day (mgd) at the Oakdale Meters,is multiplied by a conversion constant of 1.547229 and reported by CCSF in units of cfs. The other three records are reported by USGS, also in units of cfs.

The other records of measured flow pertain to the computation of unimpaired flow at Hetch Hetchy Reservoir and Lake Lloyd Reservoir and Eleanor Lake. With little or no impairment upstream of these reservoirs, the computation of unimpaired inflow at these locations also represents the inflow to these reservoirs. The records provided are:

- 11276500 Tuolumne River near Hetch Hetchy, CA, Column P
- 11276600 Tuolumne River above Early Intake, near Mather, CA, Column Q
- 11276900 Tuolumne River below Early Intake, near Mather, CA, Column R
- 11278000 Eleanor Creek near Hetch Hetchy, CA, Column S
- 11277300 Cherry Creek below Cherry Valley Dam, near Hetch Hetchy, CA, Column T
- 11278300 Cherry Creek near Early Intake, CA, Column U
- 11278400 Cherry Creek below Dion R. Holm Powerplant, near Mather, CA, Column V
- CCSF[1] Lower Cherry Aqueduct, Column W
- CCSF[1] Mountain Tunnel, Column X
- CCSF[1] Holm Powerhouse, Column Y

The use of these records within computation procedures is described in the next section. Column AD "Total Release Don Pedro Dam" is for informational purposes and is the summation of Columns AA, AB and AC, in cfs.

Computed Unimpaired Flow Columns AE, AF, AG, and AH
As described earlier, unimpaired flow is computed by removing the effects that upstream storage and diversions have upon the flow in the stream. In a developed basin such as the

[1] CCSF gage locations are shown on Attachment 1.

Tuolumne River the procedures involve the recognition of the physical impairments that happen along the course of the stream.

There is no gage at the inflow to Hetch Hetch Reservoir. Hence, the computation of unimpaired flow into Hetch Hetchy Reservoir (Column AE), which is accepted as the inflow to Hetch Hetchy Reservoir, is calculated for a time period, *t*, using recorded historical storage, outflow and reservoir evaporation data using the following equation. The equation is of a form that recognizes all flow entering and exiting a reservoir must balance.

$$\text{Inflow}_t = \text{Ouflow}_t + \text{Storage}_t - \text{Storage}_{t-1} + \text{Reservoir Evaporation}_t$$

The storage and reservoir evaporation components of the equation have already been defined or computed for Hetch Hetchy Reservoir by Column D (Hetch Hetchy Reservoir storage) computed as a change in storage expressed as average daily flow (Column E), and Column F (reservoir evaporation) expressed as average daily flow. Outflow from Hetch Hetchy Reservoir is the summation of water released to the stream below O'Shaunessy Dam and to Canyon Power Tunnel.

Releases from Hetch Hetchy Reservoir to the stream below O'Shaunessy Dam are measured at the USGS gaging station below the dam (USGS gage 11276500; Column P). Releases to Canyon Power Tunnel are computed by accounting for the flow through Mountain Tunnel (Column X) and the flow that is released back to the Tuolumne River from Kirkwood Powerhouse. The release back to the Tuolumne River from Kirkwood Powerhouse is estimated by measuring the flow in the Tuolumne River upstream of the release (USGS gage 11276600; Column Q) and downstream of the release (USGS gage; 11276900; Column R), and adjusting the difference in flow by amount of flow that occurs to the reach from the Lower Cherry Aqueduct (Column W).

By substituting the recorded values into the equation, the following computation results. Results are shown in Column AE.

Unimpaired Flow (inflow) at Hetch Hetchy Reservoir

$$\text{Inflow}_t = \text{Column P}_t \text{ (flow below dam)} + \text{Column X}_t \text{ (Mountain Tunnel)} - \text{Column Q}_t \text{ (above Early Intake)} + \text{Column R}_t \text{ (below Early Intake)} - \text{Column W}_t \text{ (Lower Cherry Aqueduct)} + \text{Column E}_t \text{ (change in storage)} + \text{Column F}_t \text{ (reservoir evaporation)}$$

For the computation of unimpaired flow of Cherry Creek and Eleanor Creek into Lake Lloyd Reservoir and Lake Eleanor (combined) (Column AF) the same basic reservoir equation is used. The change in storage and reservoir evaporation components of the equation have already been computed for Lake Lloyd Reservoir and Lake Eleanor by Column H and Column K (Lake Lloyd Reservoir storage change and Lake Eleanor storage change) computed as a change in storage expressed as average daily flow, and Column I and Column L (reservoir evaporation, respectively for Lake Lloyd Reservoir and Lake Eleanor) expressed as average daily flow. Outflow from Lake Lloyd Reservoir and Lake Eleanor is the summation of water released to the streams below Cherry Valley Dam and Eleanor Dam, and to Cherry Power Tunnel.

Releases from Cherry Valley Dam and Eleanor Dam to the streams are measured at USGS gaging stations below the dams (USGS gage 11277300, Column T;, and USGS gage 11278000, Column S). Flow diverted to Cherry Power Tunnel from Lake Lloyd Reservoir and released back to Cherry Creek is estimated by measuring the flow in Cherry Creek above Holm Powerhouse (USGS gage 11278300, Column U) and below Holm Powerhouse (USGS gage 11278400, Column V), and computing the difference between measurements.

By substituting the recorded values into the equation, the following computation results. Results are shown in Column AF.

Unimpaired Flow (inflow) at Lake Lloyd Reservoir and Lake Eleanor (combined)

Inflow $_t$ = Column T $_t$ (flow below Cherry Valley Dam) + Column S $_t$ (flow below Eleanor Dam) + Column V $_t$ (flow below Holm Powerhouse) - Column U $_t$ (flow above Holm Powerhouse) + Column H $_t$ (change in Lake Lloyd Reservoir storage) + Column K $_t$ (change in Lake Eleanor storage) + Column I $_t$ (Lake Lloyd Reservoir evaporation) + Column L $_t$ (Lake Eleanor evaporation)

For the computation of unimpaired flow at La Grange, the basic inflow equation again applies, only in this instance the combined effects of both CCSF and District diversions and storage (above La Grange) are incorporated. For this computation the storage effects of Don Pedro Reservoir, Hetch Hetchy Reservoir, Lake Lloyd Reservoir and Lake Eleanor affect flow in the Tuolumne River. Regarding diversions from the river above La Grange that affect the computation, CCSF's SJPL diversion and the Districts' two canal diversions at La Grange Dam are incorporated. The other diversions described previously for CCSF operations remain within the basin and are assumed to be diverted and returned to the river instantaneously. The regulated release to the Tuolumne River below La Grange Dam is treated as an outflow in the equation.

By substituting the recorded values into the equation below, the following computation results. Results are shown in Column AF.

Unimpaired Flow at La Grange

Unimpaired Flow $_t$ = Column AC $_t$ (flow at La Grange) + Column Z $_t$ (CCSF SJPL) + Column AA $_t$ (MID Canal) + Column AB $_t$ (TID Canal) + Column N $_t$ (change in Don Pedro Reservoir storage) + Column E $_t$ (change in Hetch Hetchy Reservoir storage) + Column H $_t$ (change in Lake Lloyd Reservoir storage) + Column K $_t$ (change in Lake Eleanor storage) + Column O $_t$ (Don Pedro Reservoir evaporation) + Column F $_t$ (Hetch Hetchy Reservoir evaporation) + Column I $_t$ (Lake Lloyd Reservoir evaporation) + Column L $_t$ (Lake Eleanor evaporation)

The Operations Model will likely consider two components of inflow to Don Pedro Reservoir, a component of regulated inflow from CCSF facilities and a component of unimpaired inflow not affected by CCSF facilities. This second component of inflow was described previously and concerns runoff from tributaries and streams such as the South and North Forks of the Tuolumne River. A computation of this component of flow is provided in Column AH and is the algebraic difference between the total unimpaired flow computed at La Grange (UGSG gage

11289650, Column AG) and the two components of unimpaired flow (inflow) to Hetchy Hetchy Reservoir (Column AE, calculated above) and Lake Lloyd Reservoir and Lake Eleanor (combined) (Column AF, calculated above).

3.0 Additional Flow Components/Data Provided in Worksheet

Additional flow data is needed for construction of the Operations Model. These data include flows that are not technically "unimpaired" but are representative of flows that affect the depiction of flow within the lower Tuolumne River, and may contribute to conditions that affect Project operations. Such a flow component is the flow from Dry Creek which enters the Tuolumne River near Modesto. The flow from Dry Creek at times can influence flood control operations at Don Pedro Reservoir. The flow can also influence the temperature of flow in the Tuolumne River at and below the Dry Creek confluence.

Column AJ lists a preliminary placeholder for the assumed flow that enters the Tuolumne River from Dry Creek. The record currently reports the record of flow as measured by the DWR station Dry Creek near Modesto (Station BO4016), located upstream of the City of Modesto near Claus Road. Currently a synthesized daily flow estimate is being developed and will replace this record. The synthesized record will be representative of current circumstances that affect flow.

Also included in the worksheet are yet-to-be-developed flows representing accretions that will be assumed to occur throughout the lower Tuolumne River. These estimates are currently being developed, and will include information gained from upcoming physical flow measurements within the river.

The worksheet also lists a long-term record of computed unimpaired flow of the Tuolumne River at La Grange as reported by the DWR. The record is a mixture of values (1921 through 2003) published by DWR as planning estimates, and more recent records acquired through the DWR CDEC data system which are considered preliminary. The overlapping record of DWR's data and the detailed daily data provided by the Districts in the worksheet at times illustrate differences. To the best of the Districts knowledge, current DWR procedures accept the Districts' computation of unimpaired flow as being the record. Differences that exist might be explained as a change in DWR protocols for the record or the absence on the part of DWR of incorporating revised records. Nonetheless, the differences are small and the Districts will use its computation of unimpaired flow for the FERC analysis. The extended DWR record is provided to provide context of the 1971-2009 period of record used for the Operations Model within the perspective of the longer hydrologic record.

4.0 Data Review and Assemblage Tools

The referenced worksheet includes three separate tabs that provide graphic and tabular display of the daily flow and storage data. Any data item reported in the "Data" tab can be accessed by these graphic / tabular tools.

5.0 Vicinity Maps

Attachment 1 is a map illustrating the Tuolumne River watershed, adjacent areas, and the location of facilities and stream measurement and flow computation locations described in this working paper.

6.0 Accompanying Worksheet

Don Pedro Unimpaired and Other Flow Data Version 1.xlsx

7.0 References

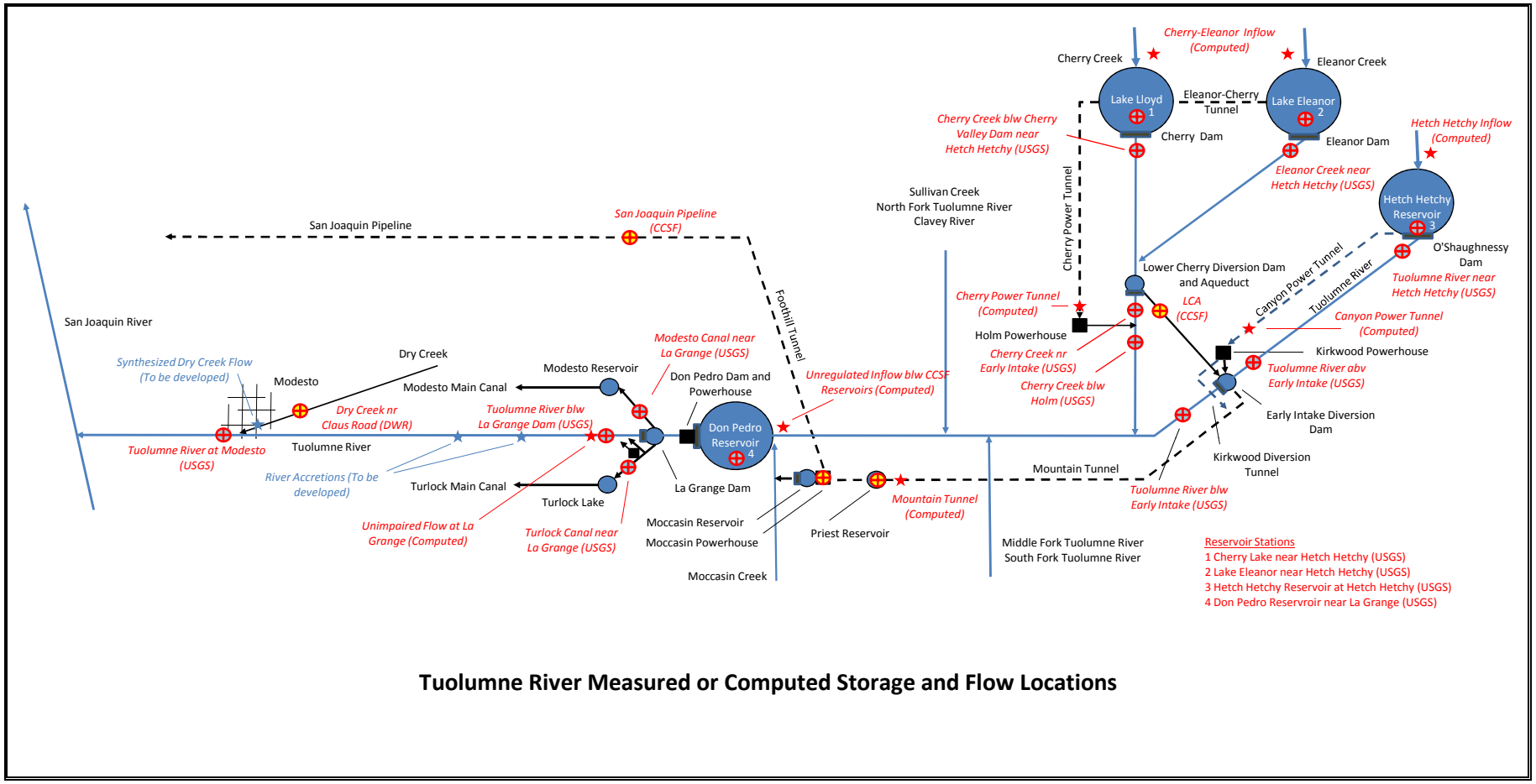
MID & TID. 2011. Revised Study Plan. W&AR-03 Operations Model

Attachment 1
Vicinity Map – Tuolumne River Watershed

To be provided at Workshop on April 9, 2012.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1		Blank	1																															
2		Unit	2	AF	CFS	CFS	AF	CFS	CFS	AF	CFS	CFS	AF	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	
3		Name	3	Hetch Hetchy	HH Change in	HH Evaporatic	Lake Lloyd Re:	LL Change in S	LL Evaporatio	Lake Eleanor S	LE Change in S	LE Evaporatio	Don Pedro Re:	Don Pedro Ch	Don Pedro Ev:	Tuolumne Riv:	Tuolumne Riv:	Tuolumne Riv:	Eleanor Creek	Cherry Creek I	Cherry Creek I	Cherry Creek I	Lower Cherry	Mountain Tun	Holm Powerh:	SJPL	MID Canal	TID Canal	Tuolumne Riv:	Total Don Ped	Hetch Hetchy	Cherry/Eleanc	Tuolumne River at La Grange	
4																																		
5																																		
6																																		
7																																		
8																																		
9																																		
10				HETCH HETCHY RESERVOIR			LAKE LLOYD RESERVOIR			LAKE ELEANOR			DON PEDRO RESERVOIR			MEASURED FLOW															COMPUTED UNIMPAIRED FLOW			
11																11276500	11276600	11276900	11278000	11277300	11278300	11278400					11289000	11289500	11289650					
12																TUOLUMNE RIVER			Eleanor	CHERRY CREEK			CCSF											
13				Storage	Change		Storage	Change		Storage	Change		Storage	Change			1/2 mile		Creek				Lower							Total				
14				USGS	In		USGS	In		USGS	In		USGS	In		Below	Above	Below	Below	Below	Near	Below	Cherry	Mount-	Holm	CCSF	MID	TID	Below	Release	Cherry	Tuolumne	Unregulated	
15				11,275,500	Storage	Evap	11277200	Storage	Evap	11277500	Storage	Evap	11287500	Storage	Evap	Hetchy	Early	Early	Eleanor	Cherry	Early	Power	Aque-	tain	power	SJPL	Modesto	Turlock	La	Don	and	River at	Inflow to	
16																	Intake	Intake	Dam	Dam	Intake	House	duct	Tunnel	house		Canal	Canal	Grange	Dam	Eleanor	La	Don Pedro	
17	Month			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	17	18	19	20	30	24	25	21	22	23	16	26	27	29	30	
18	Index	Date	Day	AF	CFS	CFS	AF	CFS	CFS	AF	CFS	CFS	AF	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	Watershed	Watershed	Grange	not Affected by CCSF
19		9/30/1970		250,500			172,900			11,600			111,000																				
20	1970.10	10/1/1970	T	249,200	-655	5	172,000	-454	5	11,300	-151	2	110,600	-202	12.1	34	40	64	15	18	20	666	11	682	648	349.0	576	661	11	1,248	79	81	159	-1
21	1970.10	10/2/1970	F	247,600	-807	5	171,100	-454	5	10,900	-202	2	110,300	-151	12.1	33	40	64	8	13	20	655	11	674	643	348.0	587	649	61	1,297	-82	7	55	130
22	1970.10	10/3/1970	S	246,200	-706	5	170,200	-454	5	10,500	-202	2	110,600	151	12.1	33	40	63	5	6	5	665	11	681	606	351.0	579	505	17	1,101	25	22	265	218
23	1970.10	10/4/1970	S	245,000	-605	5	169,200	-504	5	9,980	-262	2	110,100	-252	12.1	33	40	61	6	6	1	170	11	667	165	351.0	585	488	9	1,082	110	-578	-166	302
24	1970.10	10/5/1970	M	243,700	-655	5	169,100	-50	5	9,660	-161	2	109,300	-403	11.9	34	40	61	7	5	2	660	11	568	647	351.0	501	563	10	1,074	-38	466	180	-248
25	1970.10	10/6/1970	T	242,300	-706	5	168,100	-504	5	9,180	-242	2	109,500	101	12.1	33	40	57	6	6	2	660	11	671	648	349.0	356	704	10	1,070	9	-69	92	152
26	1970.10	10/7/1970	W	240,900	-706	5	167,000	-555	5	8,790	-197	2	109,700	101	12.1	33	39	56	7	5	1	660	11	683	648	350.0	319	803	11	1,133	21	-74	150	203
27	1970.10	10/8/1970	T	239,400	-756	5	166,100	-454	5	8,500	-146	2	109,700	0	12.1	33	39	56	7	5	1	660	11	683	648	350.0	319	803	13	1,135	-29	78	153	104
28	1970.10	10/9/1970	F	237,900	-756	5	165,200	-454	5	8,090	-207	2	109,900	101	12.1	33	39	61	6	5	2	660	11	679	647	350.0	310	766	12	1,088	-28	15	146	159
29	1970.10	10/10/1970	S	236,500	-706	5	164,300	-454	5	7,680	-207	2	109,900	0	12.1	33	39	64	6	5	1	608	11	684	625	353.0	310	767	12	1,089	30	-36	99	105
30	1970.10	10/11/1970	S	235,400	-555	5	163,500	-403	5	7,330	-176	2	111,000	555	12.1	33	39	62	6	5	2	165	11	681	158	353.0	247	245	3	495	176	-398	293	515
31	1970.10	10/12/1970	M	233,700	-857	5	162,950	-277	5	6,920	-207	2	110,100	-454	12.1	33	39	66	7	5	1	632	11	397	641	353.0	322	803	8	1,133	-406	166	-285	-45
32	1970.10	10/13/1970	T	232,300	-706	5	162,400	-277	5	6,580	-171	2	109,700	-202	12.1	33	39	65	7	5	2	628	8	864	640	350.0	326	984	7	1,317	214	197	335	-76
33	1970.10	10/14/1970	W	231,000	-655	5	161,200	-605	5	6,160	-212	2	109,300	-202	11.9	33	39	66	7	5	4	628	8	670	636	351.0	331	949	4	1,284	72	-174	-15	87
34	1970.10	10/15/1970	T	229,700	-655	5	160,300	-454	5	5,750	-207	2	109,900	303	12.1	33	39	63	6	5	5	628	8	680	635	346.0	214	558	6	778	79	-20	135	76
35	1970.10	10/16/1970	F	228,200	-756	5	159,400	-454	5	5,270	-242	2	112,400	1,260	12.3	33	39	61	7	5	6	632	5	674	635	346.0	17	13	2	32	-27	-51	210	288
36	1970.10	10/17/1970	S	226,700	-756	5	158,500	-454	5	4,870	-202	2	114,700	1,160	12.5	33	39	54	6	5	11	616	0	674	616	350.0	300	11	5	316	-29	-33	439	501
37	1970.10	10/18/1970	S	225,500	-605	5	157,800	-353	5	4,540	-166	2	116,900	1,109	12.7	33	39	52	7	4	11	173	0	695	129	350.0	37	1	9	47	141	-339	407	605
38	1970.10	10/19/1970	M	224,000	-756	5	157,600	-101	5	4,200	-171	2	118,200	655	13.0	33	39	55	6	5	11	640	0	567	634	350.0	0	1	17	18	-135	375	20	-220
39	1970.10	10/20/1970	T	222,500	-756	5	156,600	-504	5	3,800	-202	2	120,600	1,210	13.2	33	39	58	6	5	11	640	1	676	633	351.0	0	1	5	6	-24	-59	130	213
40	1970.10	10/21/1970	W	221,100	-706	5	155,300	-655	5	3,520	-141	2	123,000	1,210	13.4	33	40	58	6	5	10	648	2	689	636	349.0	0	1	2	3	37	-140	85	188
41	1970.10	10/22/1970	T	219,700	-706	5	154,400	-454	5	3,130	-197	2	125,700	1,361	13.8	33	41	67	6	5	11	665	2	670	638	352.0	0	1	2	3	26	21	385	338
42	1970.10	10/23/1970	F	218,300	-706	5	153,700	-353	5	2,798	-167	2	128,401	1,362	14.0	33	41	68	7	5	10	665	2	679	636	349.0	0	1	1	2	36	154	513	323
43	1970.10	10/24/1970	S	217,000	-655	5	152,800	-454	5	2,450	-175	2	130,700	1,159	14.3	33	42	61	7	6	11	648	3	681	623	358.0	0	1	1	2	80	28	261	153
44	1970.10	10/25/1970	S	215,700	-655	5	151,800	-504	5	2,210	-121	2	133,000	1,160	14.5	33	40	57	6	5	10	186	2	718	167	357.0	0	0	1	1	116	-431	265	580
45	1970.10	10/26/1970	M	214,000	-857	5	151,700	-50	5	2,010	-101	2	134,400	706	14.5	33	39	60	5	5	9	670	2	597	644	358.0	0	1	0	1	-203	527	84	-241
46	1970.10	10/27/1970	T	212,400	-807	5	151,000	-353	5	1,770	-121	2	136,700	1,160	14.7	33	39	61	1	5	9	666	2	674	644	358.0	0	1	0	1	-75	196	265	144
47	1970.10	10/28/1970	W	211,000	-706	5	150,300	-353	5	1,630	-71	2	139,100	1,210	14.9	33	39	61	6	6	6	660	2	696	638	351.0	0	1	1	2	48	249	460	163
48	1970.10	10/29/1970	T	209,500	-756	5	148,100	-1,109	5	1,480	-76	2	141,700	1,311	15.1	33	39	64	6	5	8	665	3	675	642	349.0	0	0	0	0	-21	-510	-254	277
49	1970.10	10/30/1970	F	207,200	-1,160	5	147,000	-555	5	1,330	-76	2	144,300	1,311	15.3	33	39	64	6	5	9	670	2	681	645	346.0	0	1	0	1	-418	48	-106	264
50	1970.10	10/31/1970	S	206,500	-353	5	145,800	-605	5	1,240	-45	2	146,500	1,109	15.4	33	39	59	6	6	9	652	2	685	622	351.0	0	0	0	0	388	12	484	84
51	1970.11	11/1/1970	S	205,200	-655	0	144,500	-655	0	1,140	-50	0	148,400	958	4.3	33	39	55	5	5	9	354	2	693	303	350.0	0	1	0	1	85	-350	-47	218
52	1970.11	11/2/1970	M	203,800	-706	0	143,700	-403	0	1,040	-50	0	152,500	2,067	4.4	32	39	62	6	6	9	690	2	604	665	350.0	0	0	0	0	-49	240	1,262	1,071
53	1970.11	11/3/1970	T	202,200	-807	0	143,050	-328	0	950	-45	0	158,200	2,874	4.5	32	39	71	6	5	9	690	2	691	662	354.0	0	0	0	0	-54	319	2,053	1,788
54	1970.11	11/4/1970	W	200,900	-655	0	142,400	-328	0	950	0	0	161,300	1,563	4.5	32	41	70	6	6	11	695	3	685	664	354.0	0	1	0	1	88	368	940	484
55	1970.11	11/5/1970	T	199,700	-605	0	140,800	-807	0	1,330	192	0	164,300	1,513	4.6	33	45	83	7	6	18	700	2	689	659	279.0	0	0	0	0	153	80	577	344
56	1970.11	11/6/1970	F	198,600	-555	0	142,400	807	0	1,870	272	0	168,500	2,118	4.6	33	46	79	7	6	20	705	3	687	670	258.0	0	0	1	1	195	1,777	2,906	934
57	1970.11	11/7/1970	S	197,500	-555	0	142,300	-50	0	2,110	121	0	172,100	1,815	4.6	33	47	68	6	5	20	690	2	691	662	258.0	0	1	11	12	188	752	1,606	666
58	1970.11	11/8/1970	S	196,400	-555	0	141,800	-252	0	2,160	25	0	174,200	1,059	4.7	33	40	57	6	6	12	354	3	666	313	257.0	0	1	0	1	158	127	540	255
59	1970.11	11/9/1970	M	195,300	-555	0	141,800	0	0	2,160	0	0	176,000	908	4.7	33	38	55	7	5	11	671	2	601	659	258.0	0	9	97	106	94	672	722	-44
60	1970.11	11/10/1970	T	194,000	-655	0	141,200	-303	0	2,160	0	0	178,700	1,361	4.7	33	38	59	6	6	11	666	3	664	657	257.0	0	7	220	227	60	364	892	468
61	1970.11	11/11/1970	W	192,700	-655	0	140,950	-126	0	2,060	-50	0	181,100	1,210	4.7	33	38	59	6	5	11	340	2	702	314	255.0	0	6	218	224	99	164	863	600
62	1970.11	11/12/1970	T	191,800	-454	0	140,700	-126	0	2,110	25	0	182,700	807	4.8	33	42	71	6	6	15	676	3	696	661	248.0	0	7	220	227	301	572	732	-141
63	1970.11	11/13/1970	F	190,400	-706	0	139,900	-403	0	2,010	-50	0	185,400	1,361	4.8	33	39	70	6	5	12	673	3	697	660	246.0	0	5	214	219	52	219	672	401
64	1970.11	11/14/1970	S	189,100	-655	0	139,400	-252	0	1,920	-45	0	187,800	1,210	4.8	33	38	61	7	6	11	631	2	699	609	252.0	0	6	213	219	98	336	734	300
65	1970.11	11/15/1970	S	188,100	-504	0	138,500	-454	0	1,770	-76	0	189,400	807	4.8	33	37	56	6	5	11	343	3	709	322	251.0	0	5	211	216	254	-187	245	178
66	1970.11	11/16/1970	M	187,000	-555	0	138,100	-202	0	1,670	-50	0	191,600	1,109	4.9	33	37	60	6	5	11	678	2	590	672	251.0	0	5	196	201	89	426	759	244
67	1970.11	11/17/1970	T	185,600	-706	0	137,200	-454	0	1,580	-45	0	193,800	1,109	4.9	33	37	66	6	6	11	669	3	711	661	258.0	0	5	198	203	64	171	370	135
68	1970.11	11/18/1970	W	184,000	-807	0	135,800	-706	0	1,430	-76	0	196,300	1,260	5.0	33	37	66	6	5	11	672	2	691	660	256.0	0	5	196	201	-56	-110	133	299
69	1970.11	11/19/1970	T	182,900	-555	0	134,700	-555	0	1,380	-25	0	198,600	1,160	5.0	33	37	73	5	5	11	678	3	699	665	256.0	0	6	198	204	210	97	490	183
70	1970.11	11/20/1970	F	181,500	-706	0	133,700	-504	0	1,290	-45	0	200,800	1,109	5.0	33	37	75	6	6	11	675	2	696	659	255.0	0	5	199	204	59	127	318	132
71	1970.11	11/21/1970	S	179,900	-807	0	132,500	-605	0	1,240	-25	0	203,400	1,311	5.0	33	37	61	6	5	11	638	3	705	624	254.0	0	6	199	205	-48	8	338	378
72	1970.11	11/22/1970	S	178,500	-706	0	131,500	-504	0	1,190	-25	0	205,400	1,008	5.1	33	37	55	6	5	10	336	2	701	318	255.0	0	5	199	204	44	-192	237	385
73	1970.11	11/23/1970	M	177,000	-756	0	130,800	-353	0	1,140	-25	0	207,100	857	5.1	33	37	65	4	5	10	678	3	605	667	255.0	0	5	199	204	-93	299	187	-19
74	1970.11	11/24/1970	T	175,900	-555	0	129,700	-555	0	1,090	-25	0	209,400	1,160	5.1	32	37	77	4	6	9	674	2	693	667	255.0	0	5	201	206	208	95	491	188
75	1970.11	11/25/1970	W	177,000	555	0	129,200	-252	0	3,800	1,366	0	212,900	1,765	5.2	38	65	111	9	9	43	722	3	700	667	254.0	0	6	201	207	1,336	1,811	3,900	753
76	1970.11	11/26/1970	T	179,300	1,160	0	132,150	1,487	0	4,710	459	0	220,500	3,832	5.3	41	175	241	8	8	91	435	3	701	317	254.0	0	5	201	206	1,965	2,306	7,403	3,132
77	1970.11	11/27/1970	F	179,900	303	0	135,100	1,487	0	4,480	-116	0	223,800	1,664	5.3	33	69	108	6	6	29	704	3	698	671	253.0	0	5	199	204	1,070	2,058	3,800	672
78	1970.11	11/28/1970	S	179,400	-252	0	135,500	202	0	4,090	-197	0	228,000	2,118	5.3	34	64	93	7	6	28	660	2	703	621	254.0	2	6	201	209	512	650	2,339	1,177

Preliminary - Subject to Revision
April 9, 2012



Tuolumne River Measured or Computed Storage and Flow Locations

ATTACHMENT C

Proposed and final accretion measurement methods and locations, as distributed to Relicensing Participants on June 6, 2012. (No comments received.)

HDR | ONE COMPANY *Many Solutions*℠

Memo

To:	Don Pedro Relicensing Participants		
From:	Turlock Irrigation District / Modesto Irrigation District	Project:	Don Pedro Hydroelectric Project
Date:	June 6, 2012		

RE: Study W&AR 2 Operations Model
Action Item from April 9, 2012, Hydrology Workshop
Proposed Lower Tuolumne Flow Accretion and Depletion Measurement Locations

In accordance with our Study Plan W&AR-2 (November 22, 2011), the FERC Study Plan Determination (December 22, 2011), and the most recent FERC Study Dispute Determination (May 24, 2012), we are planning to undertake between June 25 and 29, 2012, flow measurements along the lower Tuolumne River between La Grange Gage and the San Joaquin River confluence, as well as within Dry Creek, to develop estimates of flow accretions and/or depletions (Table 1 and Figure 1). Using accepted flow measurement methodologies, flows will be measured at permanent gage locations, established Instream Flow Incremental Methodology (IFIM) transect locations, and other sites where flow changes may be discernible. Fieldwork will consist of direct measurement of in-channel discharge at ten locations when flows of 100 cubic feet per second are scheduled, as well as opportunistic flow data acquisition at six additional irrigation canal outflow locations, if outflows are occurring. Discharge at each site will be measured using standard methods for collecting data in wadeable streams (Rantz 1982). Depths and mean column water velocities will be measured across each transect using the same methods as used in the co-occurring IFIM stream habitat assessment (Stillwater Sciences 2009). Where transects have a series of water depths greater than approximately 3.5 feet, depth and velocity may be measured using Acoustic Doppler Current Profiler methods (e.g., Simpson 2002). ***Please provide suggestions or comments on this plan to John Devine (john.devine@hdrinc.com) by Wednesday, June 20th.*** This data is targeted to be compiled, checked, and then shared with Relicensing Participants by the first week in August.

Table 1. Flow measurement and data acquisition June 2012.

River Mile	Location
51.5	Near La Grange Gage
49.1	Basso Pool
43.4	Bobcat Flat
39.5	Roberts Ferry Bridge
37.1	Santa Fe Aggregates
33	Waterford Main (MID)[1]
33	Hickman Spill (TID)[2]
31.5	Waterford
20	Faith Home Spill (TID)[2]
18	Lateral No. 1 (MID)[1]
17.2	Legion Park
16.4	Dry Creek Gage
16.2	Modesto Gage
11	Lateral 1 (TID)[2]
3.4	Shiloh Road
2	Lateral No. 5 (MID)[1]

[1]Opportunistic site. Flow data provided by MID if outflow is occurring during study period
[2]Opportunistic site. Flow data provided by TID if outflow is occurring during study period

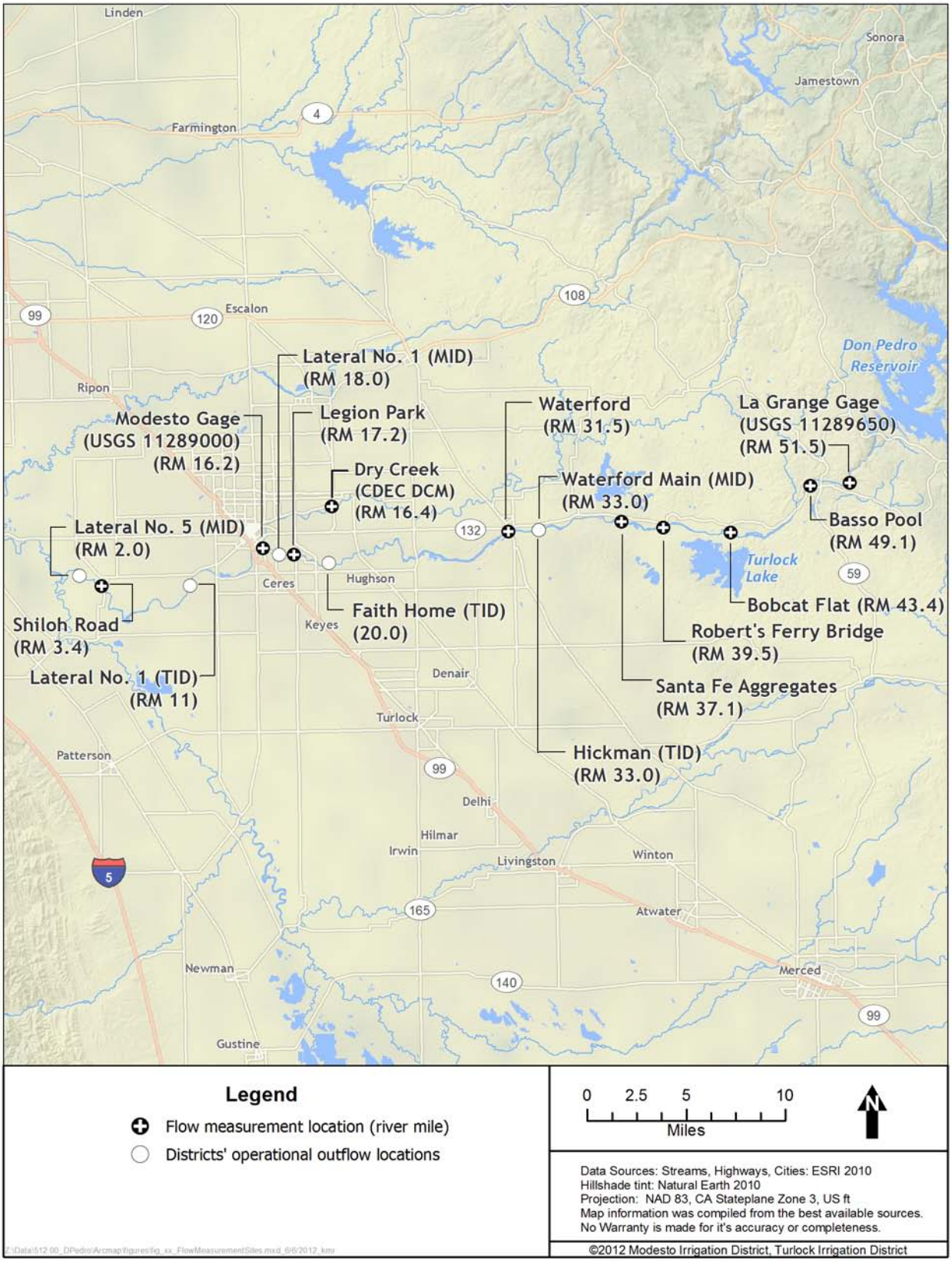


Figure 1. Flow measurement site locations along the lower Tuolumne River, June 2012.

References

Rantz, S.E. 1982. Measurement and computation of streamflow: volume 1. Measurements of stage and discharge. USGS Water Supply Paper 2175. U.S. Geological Survey.

Stillwater Sciences. 2009. Tuolumne River Instream Flow Studies. Final Study Plan. Prepared by Stillwater Sciences, Davis, California for Turlock Irrigation District and Modesto Irrigation Districts, California.

Simpson, M.R., 2002, Discharge measurements using a Broad-Band Acoustic Doppler Current Profiler: U.S. Geological Survey Open-File Report 01-01, 123 p.

ATTACHMENT D

Draft Meeting Notes – W&AR-2 Hydrology Workshop

Don Pedro Project Relicensing
Project Operations Model Study (W&AR-2)
Hydrology Workshop
Draft Meeting Notes – For Relicensing Participant Review

Monday, April 9, 2012
10:00 a.m. – 2:00 p.m.

Attendees

Bill Johnston - Modesto Irrigation District (MID)	Donn Furman - CCSF
Art Godwin - Mason, Robbins, Browning and Godwin (MRBG)	Ellen Levin - CCSF
Joy Warren - MID	Carin Loy - HDR
Tim O'Laughlin - O'Laughlin & Paris LLP	John Devine - HDR
Greg Dias - MID	Dan Steiner - Consulting Engineer
Steve Boyd -Turlock Irrigation District (TID)	Jenna Borovansky - HDR
Bob Nees - TID	Jelica Arsenijevic - HDR
Bill Sears - City and County of San Francisco (CCSF)	Mike Maher - SWRCB
Chris Shutes - California Sportfishing Protection Alliance (CSPA)	John Buckley - Central Sierra Environmental Resources Center (CSERC)
Peter Barnes - State Water Resources Control Board (SWRCB)	Robert Hughes - CDFG
Patrick Koepele - Tuolumne River Trust (TRT)	Tim Finley - Hanson Bridgett/Bay Area Water Supply and Conservation Agency (BAWSCA)
Dale Statton - California Department of Fish and Game (CDFG)	Ramon Martin - U.S. Fish and Wildlife Service (USFWS)
Steve Bowes - National Park Service (NPS) – *by phone*	Tom Fitzhugh - Bureau of Reclamation (Reclamation) – *by phone*
Allison Boucher - Friends of the Tuolumne (FOT)- *by phone*	Jim Alves - City of Modesto – *by phone*
Annie Manji - CDFG	Adam Mazurkiewicz - CCSF – *by phone*
Bob Hackamack - TRT	

Purpose of Meeting

The Hydrology Workshop was conducted in accordance with the Project Operations Model Study Plan as contained in the Revised Study Plan for the Don Pedro Project (Project) prepared by Turlock Irrigation District and Modesto Irrigation District (collectively, the Districts), and

approved by the Federal Energy Regulatory Commission (FERC) in its December 22, 2011 Study Plan Determination (SPD). Section 7.0, Schedule, of the study plan contained a task to conduct a Hydrology Workshop to present, discuss, and review the base hydrology for the Operations Model. The Hydrology Workshop followed FERC's directive related to ongoing consultation processes contained in Appendix B, page 1, of the FERC SPD. The Districts previously prepared proposed Consultation Workshop Procedures and Protocols, issued the procedures to Relicensing Participants (RPs) and FERC on March 5, 2012, and held a meeting with RPs to discuss the procedures on March 20. No comments were provided by RPs on the procedures, and these have been formally adopted to apply to all Consultation Workshops (see Attachment 1). The overall purpose of the various Consultation Workshops is to provide opportunity to RPs and the Districts to share and discuss relevant data sources, methods of data use and development, and modeling parameters at key points in the execution of the relevant study plans.

The purpose of this Hydrology Workshop was to discuss the development of the unimpaired hydrology data set for inclusion into the Project Operations Model. The hydrology data set forms the foundation of the Operations Model; therefore, early review of the development of the hydrology will help to provide a common understanding of this fundamental component of the model.

Meeting Materials

The following handouts supported the hydrology workshop: (1) the agenda (Attachment 2), (2) a paper entitled "Estimation of Tuolumne River Unimpaired Flow and Other Flow Data" (Attachment 3), (3) an Excel workbook entitled "Don Pedro Unimpaired Flow and Other Flow Data Version 1.xlsx" (Attachment 4), (4) a sample print-out of the worksheet "Data" from the workbook (Attachment 5), and (5) a schematic entitled "Tuolumne River Measured or Computed Storage and Flow Locations" (Attachment 6). Attachments 2, 3, and 4 were distributed to the RPs via email one week prior to the workshop; Attachments 5 and 6 were provided at the meeting.

History of Water Use on the Tuolumne River

Dan Steiner, consultant to the Districts and the lead engineer for model development, briefly discussed the history of accounting for water use on the Tuolumne River for purposes needed by the Districts and the City and County of San Francisco (CCSF). Steiner referenced the combined use of the handout materials for the day's discussions.

The hydrologic record selected for the Operations Model is Water Year 1971 through 2009, which includes extreme hydrology (both wet and dry) and multi-year periods of challenging water supply conditions. Flow data has been developed on a mean daily basis. Data included in the worksheet comes from a combination of actual flow measurements and the records of actual

reservoir operations. Additionally, data were included concerning estimated reservoir net losses and gains from precipitation, evaporation, and seepage. All of these factors enter the computation of unimpaired flow.

RPs inquired why the 1971 to 2009 period of record was chosen for the model. Steiner explained that the record happens to coincide with the onset of operations for the new Don Pedro Project. Recordkeeping and measurements improved with the start of project operations in 1971, and this period of record provides a good representation for all water year types (e.g., wet, dry, average), and the period has a consistent method of preparing and reviewing the daily flows on a real-time basis.

The starting point for the operations model is "unimpaired flow." Unimpaired flow is the estimated flow that would be available without human development and use. The effects of canals, dams, and diversions are removed. Columns AE through AH of the worksheet show unimpaired flow for: (1) Hetch Hetchy Watershed, (2) Cherry and Eleanor Watershed, (3) Tuolumne River at La Grange, and (4) inflow to Don Pedro Reservoir from the unregulated contributing watershed.

The majority of data records were obtained from the U.S. Geological Survey (USGS), the Districts, and CCSF. These data, and earlier provisional forms of the data, are used by the Districts and CCSF for their own operations and planning. The data are heavily scrutinized to ensure that Tuolumne River water usage is consistent with the Raker Act and 4th Agreement between the Districts and CCSF. Steiner explained that unlike other watersheds, the methods and tools of accounting for the waters of the Tuolumne River have been in place for decades now as required to track water sharing between the Districts and CCSF.

Steiner emphasized that the following formula is key to computing unimpaired flow at a location. The equation is a form that recognizes that all flow entering and exiting a location must balance to maintain conservation of mass. Where reservoirs are involved, the equation accounts for change in storage and reservoir losses. ("t" in the equation below represents time period.)

$$\text{Inflow}_t = \text{outflow}_t + \text{storage}_t - \text{storage}_{t-1} + \text{reservoir evaporation}_t$$

The computation procedure for the four points of unimpaired flow were described by illustrating the hydrologic parameters (flows and storage) affecting each of the points. Several of the flow components are themselves computations made from two or more flow measurements.

RPs asked if either hydro station energy generation records or in-pipe acoustic velocity meter (AVM) measurements could provide a means to cross-check flows derived by other methods. Steiner answered that the present record is based on a consistent procedure. AVM technology was only introduced very recently and not consistently within the watershed or the period of record. Robert Hughes asked if cross-checking flow numbers might add more confidence to the hydrology database. Steiner responded that the derived flows have gone through a thorough

analysis by both CCSF and the Districts and each has a great deal of confidence in the flows so derived.

RPs inquired whether groundwater loss and gain are captured in the reservoir component of flow alterations. Steiner responded that groundwater interaction within a reservoir, if any, is being captured in either the net evaporation value or affects the record of reservoir storage.

RPs requested further explanation of the groundwater-surface water interactions and how the unimpaired flow accounts for the interaction. It was explained that an explicit amount of groundwater interaction (either within a stream or within a reservoir area) is not called out in the computation procedure. It is inherent to the gain or loss of flow upstream of a computation point. RPs would like to understand the components of the "reservoir evaporation" numbers better and how the monthly evaporation constants used were developed and calculated. Specifically, Hughes would like to understand the sensitivity of the computation results if using a varying evaporation rate as opposed to the "average" evaporation rate used for the presented record.

Action Item: Districts will provide a description of the source of the evaporation data in the model and an expanded explanation of its use in the model.

RPs requested that a description of how the CCSF system is operated be provided. RPs would like to understand the main features of the Hetch Hetchy system so that they can understand where and how water moves through the system. Ellen Levin and John Devine responded that a PowerPoint presentation, describing Hetch Hetchy operations, was given by Margaret Hannaford at a previous RP meeting (i.e., April 1, 2011). In addition, the CCSF also submitted information to FERC (available on FERC website).

RPs asked if there is a record of flow in the main stem of the Tuolumne River upstream of Don Pedro Reservoir. There were formerly gages on the Middle Fork and the South Fork that were operated through 2002, and then abandoned. Recently, a gage was reinstalled by Hetch Hetchy operations on the Middle Fork. There is no gage on the mainstem Tuolumne River below the confluence of Cherry Creek and Don Pedro.

Steiner described that the computation for Cherry and Eleanor watersheds is combined as one system. Bob Hackamack agreed with this approach. Steiner did say that the needs of the Operations Model may require disaggregation of the watershed and facilities, but that will not be known until later.

Steiner discussed the computation of unregulated flow into Don Pedro Reservoir; that is, the component of Don Pedro inflow that is not regulated by CCSF facilities. It was stated that Don Pedro Reservoir will have at least two inflow nodes, one representing this unregulated flow and the other representing regulated flow from CCSF. Interaction with the Reservoir Temperature model may require a greater number of nodes, but this has not yet been determined.

There was a general discussion about the occurrence of "negative flows" in the database. Steiner explained that this is common and inevitable in the development of daily unimpaired flows, especially when flows are small compared to reservoir size. Devine provided the example that if a daily reservoir reading were off by one-half inch, that could easily represent a difference of 500 to 600 acre-feet, which equates to a flow of 250 to 300 cubic feet per second, which is higher than many summer inflows. Steiner explained that computed negative inflows were inconsequential to the Operations Model because when the base case (and all operational scenarios) is modeled, the negative flows are overcome by the change in storage and revert back to positive outflows. John Buckley noted that having negative unimpaired flows makes comparisons difficult. Steiner and Devine both agreed with this observation.

In addition to data and computation procedures, Steiner illustrated the use of workbook graphing and tabling tools that are provided for looking at the data (provided in the Excel workbook). Some of the graphical tools described include:

- "YearofDaily" tab: Allows user to query a year of daily data for a single parameter. The data is graphed, and displayed in annual tables.
- "MonthTable" tab: Allows user to query the entire daily dataset of up to three parameters and provides a summation of flows on a monthly basis.
- "MultiGraph" tab: Displays several parameters of a year of daily data at one time on the same graph.

Steiner and Devine summarized the real time procedures used to calculate unimpaired flows in the watershed. The Districts and CCSF exchange relevant flow and storage information daily. The Districts also provide information daily to the California Department of Water Resources (DWR) and other agencies. DWR uploads the data onto the California Data Exchange Center (CDEC). Steiner emphasized that CDEC does not typically go back and update data for corrections or change in rating tables and noted caution when using CDEC data as the Districts data is more reliable and up-to-date. Some of the USGS data also is provisional. For the period of record, the Districts have had the responsibility of calculating unimpaired flow, and that record has been submitted to DWR, both daily and subsequently after-the-fact as revisions and corrections occur.

Hackamack commented that he has interest in two additional data parameters being modeled. One is the CCSF's water bank. The other is generation at Don Pedro. Steiner explained that the water bank is a component of the Operations Model, and historical generation is not an item concerning unimpaired hydrology. Both the CCSF water bank and Don Pedro generation will be provided in the Operations Model base case and scenarios.

Lower river accretions measurements were discussed. There is a concern from RPs of incorporating and calculating accretion flows below La Grange Dam. RPs suggested that one or two nodes downstream of La Grange be included in the model, and possibly a node below the

Modesto gage. Devine summarized the Districts' plan for accretion measurements. Devine explained that since accretions are expected to be due to groundwater, they are expected to be fairly low compared to most river flows and difficult to identify given flow measurement accuracy limitations. However, with 2012 being a low-flow year, this may be a good time to take measurements. Four or five locations are likely (upstream and downstream of Turlock Lake/Modesto Reservoir, above Dry Creek, and near the confluence with the San Joaquin River). These measurements will be used by the Districts to develop accretion components to incorporate into the Operations Model. The first set of measurements will inform the need for additional measurements. It was stated that the Operations Model will be developed with the number of nodes to adequately depict river conditions; a node should represent a change in flow.

Action Item: The Districts will prepare a map showing proposed accretion flow measurement locations for RP review no later than May 15, 2012.

Hackamack identified the potential occurrence of return flows to the river. Steiner and Devine acknowledged the occurrence of intermittent return flows. During the measurement periods, additional attention will be provided to estimate and note any such flows.

Hackamack asked the Districts if the model is going to account for how far upstream the Dry Creek gage is. Steiner stated that the location of the Dry Creek gage will be accounted for in the model. He added that work is proceeding on developing a dataset for Dry Creek flows.

Devine discussed the schedule for the Operations Model. An Operations Model will be ready for illustration and use by RPs at the October 23 Workshop.

Ramon Martin wanted to know if flood control operations are shown in the workbook. The response was "not explicitly" because unimpaired flow is blind to operations. However, flood control operations will be built into the Operations Model. The flood control rules will be discussed at the October workshop.

Action Item: RPs will review the information provided via email and discussed at the workshop and provide comments within 30 days (May 10, 2012). RPs are encouraged to contact Steiner directly by email with questions; all substantive questions (i.e., those that go beyond technical assistance with the workbook) and responses will be shared with the RP email list.

Action Item: The Districts will post the Tuolumne River Measured or Computer Storage and Flow Locations schematic to the website. [Completed April 13, 2012]

Action Item: The Districts will draft and distribute meeting notes according to the consultation protocol. After a 30-day comment period, the Districts will file the notes and comments with FERC.

List of Attachments

All attachments are available on the Don Pedro Relicensing website (http://www.donpedro-relicensing.com) under Introduction /Announcements by workshop date.

Attachment 1 – Workshop Consultation Procedures and Protocols

Attachment 2 – Agenda

Attachment 3 – Estimation of Tuolumne River Unimpaired Flow and Other Flow Data

Attachment 4 – Don Pedro Unimpaired Flow and Other Flow Data Version 1

Attachment 5 – Sample Print-out of Data from Worksheet

Attachment 6 – Tuolumne River Measured or Computed Storage and Flow Locations

ATTACHMENT E

California Dept. of Fish and Game comments regarding the April 9, Hydrology Workshop

State of California -The Natural Resources Agency
DEPARTMENT OF FISH AND GAME
Central Region
1234 East Shaw Avenue
Fresno, California 93710
(559) 243-4005
http://www.dfg.ca.gov

EDMUND G. BROWN JR., Governor
CHARLTON H. BONHAM, Director

May 16, 2012

Robert Nees
Turlock Irrigation District
Post Office Box 949
Turlock, California 95381

Greg Dias
Modesto Irrigation District
Post Office Box 4060
Modesto, California 95352

Subject: Turlock and Modesto Irrigation District's April 9, 2012 Hydrology Workshop Don Pedro Hydroelectric Project (FERC Project No. 2299-075) Tuolumne River, California

Dear Messrs. Nees and Dias:

Representatives from the California Department of Fish and Game (Department) attended the subject workshop hosted by the Turlock and Modesto Irrigation Districts (Districts) as part of Water and Aquatic Resources Study Plan (W&AR-2) Project Operations/Water Balance Model, for the Don Pedro Hydroelectric Project, Federal Energy Regulatory Commission (FERC) Project No. 2299-075 (Project). The Department has also reviewed the associated draft meeting notes prepared and distributed by the Districts. The Department provides the following comments in response to the hydrology workshop and draft meeting notes.

General Consultation Workshop Comments

The Department appreciates the effort by the Districts to engage in a collaborative discussion of study plan development. As indicated in previous filings by the Department regarding this study plan, consensus on unimpaired hydrology within the Tuolumne River watershed is essential for subsequent confidence in the outputs of this and other study efforts. The unimpaired hydrology provides the foundation for not only the Operations and Water Balance model, but also the Reservoir and River Water Temperature models and aspects of the Reservoir Fish Population study.

As described in the Districts' March 2012 Workshop Consultation Process on Interim Study Plan Decisions document, the goal of this and subsequent workshops is:

> ". . . to reach agreement where possible after thorough discussion of data, methods and parameters. Consensus on decisions dealing with data acceptability, or study approaches or methods can only be achieved by the active and consistent in-person attendance and participation of interested Relicensing Participants" (page 1).

The absence of FERC and National Marine Fisheries Service (NMFS) representatives at the Hydrology Workshop (as well as the subsequent Salmonid Population Information Integration and Synthesis Study Plan (W&AR-5) Workshop on April 10, 2012), concerns the Department. When scheduling future workshops, we recommend the Districts consult with key agency personnel and other relicensing participants prior to selecting dates, times and locations to ensure the workshop audience is composed of representatives of the parties that requested (or in the case of FERC, required), the studies to be discussed at the respective workshops.

As another general comment, under the workshop consultation process, the Districts propose to distribute draft meeting notes within approximately eight working days of the workshop and, following a 30-day comment period, file a final summary of areas of agreement, disagreement and supporting rationales with FERC. Barring any formal response from FERC to the contrary, the Districts propose to proceed with study implementation at that time.

The Department has concerns about this passive role for FERC staff at key decision points in the consultation process. Review of FERC staff recommendations in the December 22, 2011 Study Plan Determination Appendix B reads in part:

> ". . . consult with interested parties as noted above and, if consensus is not reached, the Districts must file their proposal with the Commission *for approval*." [emphasis added] (page 1).

Given the absence of FERC staff at this first set of workshops, obtaining formal approval of next steps in the study plan, particularly steps involving disagreements, seems essential to satisfy the intent of the consultation. The Department recommends the Districts *not* proceed with implementing studies involving a pre-requisite consultation step, until such consultation is explicitly approved by FERC staff.

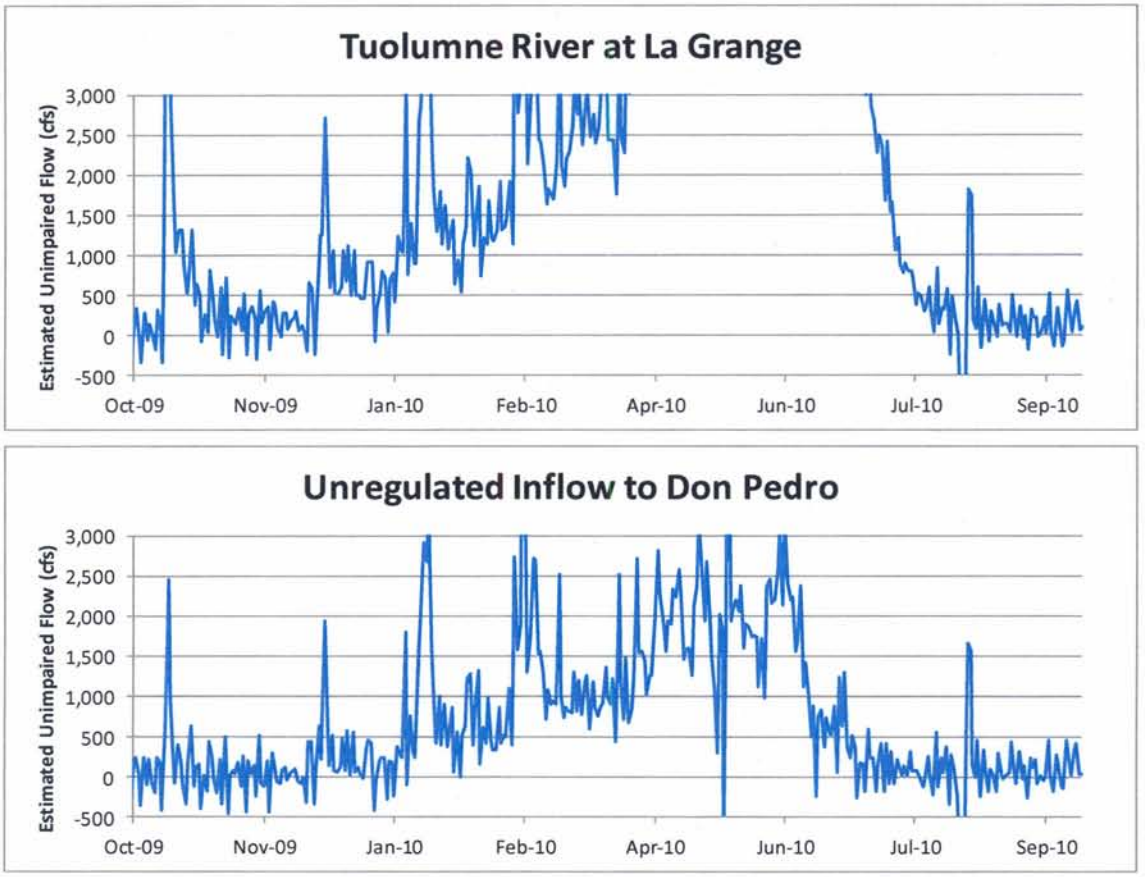
The Department also recommends future workshops be facilitated by a neutral party with real time documentation of major action items and decision points. Issues involving water use and aquatic resources in the Tuolumne watershed have a long and sometimes contentious history. A professional facilitator would encourage full and effective participation, while minimizing unproductive rhetoric. Recording action items and substantive decisions while all parties are assembled would assist in the compilation of meeting notes and, ideally, reduce the number of note edits.

Data Sources and Calculating the Unimpaired Hydrology

- The data sources rely on a combination of United States Geological Service (USGS) gages and stations maintained and monitored by the City and County of San Francisco (CCSF) and the Districts. The spreadsheet augments measured values with estimates utilizing historically derived factors affecting reservoir storage and flows, such as precipitation, evaporation and seepage. As an example the daily evaporation factors for the CCSF reservoirs were derived in the 1930s from measurements taken at Lake Eleanor. The date of the historical experience for developing the Don Pedro Reservoir evaporation factor is not specified, though it is assumed it is after the New Don Pedro Reservoir was constructed. Given the age of some of these relationships and intervening changes in climate and technology, the Department recommends a recalibration of key factors.

- It is our understanding the Districts applied a gage summation (a.k.a. mass balance) approach to estimating the daily unimpaired hydrology for the Hetch Hetchy and Cherry-Eleanor watersheds, the Tuolumne River at La Grange, and the unregulated inflow to Don Pedro Reservoir. Due to a number of factors, which likely include the challenges associated with measuring storage changes on a daily basis, the daily unimpaired flow estimates calculated by the Districts fluctuate wildly and often include negative flow estimates. The following charts highlight these issues for the Tuolumne River at La Grange and for the unregulated inflow to Don Pedro Reservoir for water year 2010.[1]

[1] The vertical scale has been set to allow the daily fluctuations and negative values to be easily identified.



- The importance of developing a credible unimpaired hydrology within hydropower relicensings cannot be overstated, with participants relying on it throughout the process. In this instance, that includes applying the unimpaired hydrology to the daily time-step operations model being developed pursuant to Study Plan W&AR-2. Given this pivotal role, the Department recommends applying a more sophisticated approach to developing unimpaired hydrology for the Project. Specifically, the Department recommends that the Districts apply a gage proration methodology similar to that used by Margaret Hannaford, P.E. in the Upper American River Project (FERC Project No. 2101)[2]. In general, this methodology involves adjusting the daily empirical data of one or more "nearby" USGS unimpaired streamflow

[2] Devine Tarbell & Associates, Inc. (DTA) and Margaret Hannaford. 2005. Hydrology Technical Report. Devine Tarbell & Associates, Inc., Sacramento, CA.

gages based on differences in watershed area and precipitation to generate a new synthesized unimpaired data set. This synthesized unimpaired data set is further adjusted based on a monthly gage summation (rather than a daily gage summation) as necessary to preserve the mass balance within each sub-basin.

- Various forms of the general methodology recommended above have been used in the development of unimpaired hydrology for the Middle Fork Project (FERC No. 2079), the Yuba-Bear Project (FERC No. 2266), and the Drum-Spaulding Project (FERC No. 2310), among others.

- In order to assist the Districts in the application of the gage proration methodology, the Department has identified the following USGS and California Data Exchange Center (CDEC) unimpaired flow records in the Tuolumne River Basin. These records are expected to be important in the application of the recommended methodology.

Gage & Description	Drainage Area/ Elevation	Period of Record	USGS Remarks[3]
USGS 11281000 SF Tuolumne R near Oakland Recreation Camp CDEC Station - STO[4]	87.0 sq mi. / El. 2,800 ft (NGVD29)	Apr 1, 1923 to Sep 30, 2002 (excluding water year 1997) Jan 26, 2009 to Present	"Records good. No storage or diversion above station."
USGS 11282000 M Tuolumne R at Oakland Recreation Camp CDEC Station – MTO[4]	73.5 sq mi. / El. 2,800 ft (NGVD29)	Oct 1, 1916 to Sep 30, 2002 (excluding water year 1997) Jan 26, 2009 to Present	"Records good. No regulation; small diversion above station for irrigation."

[3] United States Department of the Interior, Geological Survey (USGS). 1971. Water Resources Data for California, Part 1. Surface Water Records, Volume 2: Northern Great Basin and Central Valley. Menlo Park, CA.

[4] It is not known whether or not the City and County of San Francisco continued to collect unimpaired flow data at this station between Sep 30, 2002 and Jan 26, 2009.

Gage & Description	Drainage Area/ Elevation	Period of Record	USGS Remarks[3]
USGS 11283500 Clavey R near Buck Meadows CDEC Station – CBU	144 sq mi. / El. 2,374.08 ft (NGVD29)	Oct 1, 1959 to Jun 13, 1995 (excluding water years 1984, 1985, and 1986) Dec 7, 2009 to Present	"Records excellent. No storage or diversion above station."
USGS 11284700 NF Tuolumne R near Long Barn	23.1 sq mi. / El. 4,650 ft	Sep 1, 1962 to Sep 30, 1986	"Records good. No storage or diversion above station."

- While the development of an unimpaired data set extending through water year 2009 (or later) would be ideal, the Department believes that application of the recommended gage proration methodology will result in a more useful data set that will better serve the interests of the relicensing participants (including the Districts) – even if the period of record is constrained due to limitations in data availability.

- In addition to facilitating development of an Operations/Water Balance Model, the Department considers reasonable and fairly accurate inflows, along with inflow temperatures, to be necessary to produce meaningful scenario results with the MIKE Three Dimensional Flexible Mesh (MIKE3-FM) reservoir temperature model proposed by the Districts.

Model Nodes

- At the workshop, the Districts provided a preliminary schematic of Tuolumne River Storage and Flow Locations which included nodes where CCSF and Project inflows and diversions are currently computed as well as several general locations where accretion nodes might be developed in the future. The number and location of model nodes was also the subject of discussion at the April 16, 2012 Study Dispute Resolution Panel Technical Conference. Based on these sources of information, it is our understanding that additional Operations/Water Balance Model nodes are to be developed in conjunction with the workshop consultation process. These nodes should facilitate development of a model capable of analyzing potential impacts under different operational and meteorological scenarios. The Department provides the following recommendations regarding model node locations.

- As noted previously, the Districts are proposing to calculate the unregulated inflow to Don Pedro Reservoir, which is intended to represent "the runoff entering Don Pedro Reservoir that is not affected by upstream CCSF facilities." The Department recommends the Districts further disaggregate the unregulated inflow into Don Pedro and determine the unimpaired flow in the North Fork Tuolumne upstream from the main-stem Tuolumne River, the South Fork Tuolumne River upstream from the main-stem Tuolumne River, and the Clavey River upstream from the main-stem Tuolumne River. The Department believes this additional unimpaired flow information will be needed to help address various interests of the relicensing participants, including the recreational boating interests. The gage proration methodology recommended by the Department in the preceding section should accommodate this enhancement.

- The Department also recommends the Districts estimate the accretions and depletions in the reach between La Grange Dam and the confluence with the San Joaquin River. The accretion estimates should be calculated for each major inflow location, including Dry Creek and each agricultural return (i.e. Hickman spill, Faith Home spill, Rairden Gulch, etc.). The depletion estimates should include groundwater losses in Modesto Reservoir, Turlock Reservoir, Dawson Lake, and the entire Turlock Irrigation District and Modesto Irrigation District canal systems.

- The Department recommendation to expand the model node network downstream of La Grange Dam is consistent with the NMFS filing with FERC on April 16, 2012. In that filing, the NMFS noted model nodes are necessary in the lower Tuolumne River reaches heavily used for anadromous fish holding and spawning. The Department concurs with this reasoning and recommends that the presence of substantive agricultural diversions/returns in such reaches should also guide node location.

- It is our understanding based on an April 11, 2012 letter from FERC's Office of Energy Projects that once accretion and depletion measurements are taken by the Districts in the lower Tuolumne River, additional model nodes may be required by FERC. In response, the Department agrees with the NMFS recommendation ". . . several time periods of sampling are necessary to characterize accretion and depletion during the varying seasonal, climatic and diversion conditions that occur on an annual basis in the lower Tuolumne River."

Draft Meeting Notes

- Dale Stanton's last name is misspelled in the Attendee list.

- The Districts note there was a March 20, 2012 meeting to discuss the Consultation Workshop Procedures and Protocols and that "no comments were provided by RPs on the procedures." To clarify, the Department did provide verbal comments at the March 20, 2012 meeting but did not file formal written comments. Two such verbal comments reiterated here are: 1) it would be helpful to have real time notes of action items/next steps; and 2) the filing of the final meeting summary should include a specific request for comment by FERC staff, not just assume approval if no response is provided.

Conclusion

Thank you for the opportunity to provide comments on the hydrology workshop and development of the unimpaired hydrology for the subject Project. If you have questions regarding these comments, please contact Annie Manji, Staff Environmental Scientist, at (530) 225-2315, or Dean Marston, Environmental Program Manager, at (559) 243-4014, extension 241.

Sincerely,

Andrew G. Gordus, Ph.D

for Jeffrey R. Single, Ph.D.
Regional Manager
Central Region

cc: Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE., Room 1A
Washington, D.C. 20426

ATTACHMENT F

State Water Resources Control Board comments regarding the April 9, Hydrology Workshop

From: Peter Barnes [PBarnes@waterboards.ca.gov]

Sent: Friday, May 18, 2012 1:57 PM

To: Staples, Rose

Cc: Michael Maher

Subject: Comments: Hydrology Workshop and W-AR-5 Workshop

Rose,

Below you will find the comments from State Water Board staff regarding the draft meeting notes for Project Operations Model Study (W&AR-2) Hydrology Workshop and Salmonid Information Synthesis (W&AR-5) Workshop No. 1.

W&AR 2 Hydrology Workshop:

Many of the RPs inquired as to whether or not energy generation records or in-pipe acoustic velocity meter (AVM) measurements could be used to cross-check flows derived by other methods. The consultant for the Districts, Dan Steiner, responded that the derived flows have gone through a thorough analysis by CCSF and the Districts and that both have a great deal of confidence in the flows derived. Although CCSF and the Districts are confident in the current methods, many of the RPs would prefer extra assurance. Therefore, staff asks that CCSF and the Districts provide the RPs with any available energy generation records and AVM measurements and allow them to cross-check the derived flows. This would require very little additional work for the Districts.

It was requested that CCSF and the Districts provide the RPs with a description as to how the CCSF Hetch Hetchy system was operated. There was a request for a description of how the CCSF system is operated. CCSF and the Districts responded that a PowerPoint presentation regarding the operations of the Hetch Hetchy system was presented at an RP meeting in April, 2011. Over a year has passed since that meeting and many of the agencies and NGOs involved in the relicensing process are represented by different people. Staff ask that the Districts post this presentation to the Don Pedro Relicensing Website.

The Districts have agreed to prepare a map showing the proposed accretion flow measurement locations for RP review. In addition to the map, the Districts should also provide a write up describing the methods they propose to use in measuring accretion flows. The RPs should be given adequate time to review the methods and submit comments for the Districts' consideration.

W&AR 5 Workshop:

At this time, staff do not have any comments regarding the draft meeting notes for the Salmonid Information Synthesis (W&AR-5) Workshop No. 1.

Please let me know if you have any questions regarding this information.

Sincerely,
Peter Barnes
Engineering Geologist

State Water Resources Control Board
Division of Water Rights
Water Quality Certification Unit 1

ATTACHMENT G

Conservation Groups Comments regarding the regarding the April 9, Hydrology Workshop

May 18, 2012

Robert Nees
Turlock Irrigation District
PO Box 949
Turlock, CA 95381

Greg Dias
Modesto Irrigation District
PO Box 4060
Modesto, CA 95352

RE: Don Pedro Project (FERC Project P-2299) Comments Regarding Proposed Methodology for Developing the Unimpaired Hydrologic Dataset for the Tuolumne River System.

Dear Messrs. Nees and Dias:

American Rivers, American Whitewater, California Sportfishing Protection Alliance, California Trout, Inc., Central Sierra Environmental Resource Center, Friends of the River, Golden West Women Flyfishers, Northern California Council Federation of Fly Fishers, Merced Fly Fishing Club, Trout Unlimited, and Tuolumne River Trust (collectively, "Conservation Groups") submit these comments on the proposed methodology for developing the unimpaired hydrologic dataset for the Tuolumne River system.

Background

On April 9, 2012, the Turlock Irrigation District and Modesto Irrigation District (collectively the Districts) conducted a Hydrology Workshop. The Hydrology Workshop was conducted in accordance with the Project Operations Model Study Plan as contained in the Revised Study Plan for the Don Pedro Project (Project) prepared by the Districts, and approved by the Federal Energy Regulatory Commission (FERC) in its December 22, 2011 Study Plan Determination (SPD). Section 7.0, Schedule, of the study plan contained a task to conduct a Hydrology Workshop to present, discuss, and review the base hydrology for the Operations Model. The Hydrology Workshop followed FERC's directive related to ongoing consultation processes contained in Appendix B, page 1, of the FERC SPD.

The purpose of this Hydrology Workshop was to discuss the development of the unimpaired hydrology data set for inclusion into the Project Operations Model. The hydrology data set forms the foundation of the Operations Model; therefore, early review of the development of the hydrology will help to provide a common understanding of this fundamental component of the model.

Comments

Conservation Groups have reviewed the meeting notes and other related materials and have the following comments regarding the proposed approach to developing the hydrology data set.

Conservation Groups believe that the model would be significantly enhanced with the addition of several nodes and components:

1. During the workshop there was a discussion about the reservoir evaporation component of the mass balance equations. It is not clear if the evaporation component implicitly includes a groundwater depletion component or not. Conservation Groups urge the districts to include a separate component within the mass balance equations that will define groundwater losses at the reservoirs, including Don Pedro Reservoir, La Grange Reservoir, Modesto Reservoir, Turlock Reservoir, Dawson Lake. Further, groundwater losses and leaks should be defined for the entire canal system.

2. For many years the Turlock Irrigation District (TID) has been working with the Cities of Ceres, Hughson, Modesto, and Turlock to develop a Regional Surface Water Supply Project (RSWSP) that would pump water from the Tuolumne River at Geer Road, located at approximately River Mile 26, treat it to drinking water standards, and then distribute the treated water to the four cities. As part of the SRP-9 Project, TID installed an "Infiltration Gallery" at this location that could later be connected to a pump and water treatment facility and then distributed to customers. As part of this work, TID has also completed an Environmental Impact Report. Presently, the Cities of Ceres, Modesto, and Turlock are actively pursuing this project to provide treated surface water for their customers south of the Tuolumne River. Conservation Groups believe that a node or nodes should be added to the Operations Model that will help us understand the impacts of withdrawing water at the Geer Rd facility, should that project ever come on line. Presumably, that project could potentially add up to 100 cfs of additional flow from La Grange to Geer Rd, at which point the water would be withdrawn from the river for drinking water and other uses.

3. The Modesto Irrigation District has a number of "spills" from its canal system that either return to the Tuolumne, the Stanislaus, or the San Joaquin River, or simply collect at terminal locations and wetlands, such as the San Joaquin River National Wildlife Refuge. The Turlock Irrigation District has the Hickman and Faith Home spills, along with a number of terminal canal spills into the San Joaquin and Merced Rivers. Conservation Groups believe that nodes should be added to better define the water that is spilled through each of these locations.

4. The Oakdale Irrigation District spills tailwater into the MID canal system. A spill should be added that captures this water in the model.

5. Currently, the Districts are required to release a minimum flow to the lower Tuolumne River for the benefit of the environment, per the 1995 Settlement Agreement and 1996 FERC Order amending Article 37 of the Don Pedro Project License. In many years, the Districts release additional water, particularly in winter and spring, above the minimum flow releases for flood

management and other purposes. Conservation Groups request that these two different releases (Article 37 minimum flows and flood release flows) be defined within the hydrology dataset with two separate nodes. This will enable relicensing participants to manipulate flood flow releases separately from minimum flow releases to better understand the role of flood management within Project Operations.

6. Similarly, for the Don Pedro Reservoir storage node, the flood storage pool within the reservoir and the City and County of San Francisco water bank should each be represented as a separate node distinct from other water stored in the reservoir.

7. Within the watershed above the Don Pedro Reservoir, Conservation Groups request that the Districts develop and include for the Groveland Community Services District water withdrawals from the Mountain Tunnel. We also request the Districts develop and include nodes for the Clavey River, the North Fork of the Tuolumne River, and the South Fork of the Tuolumne River (including Middle Fork), separate from the other smaller tributaries.

Additional Comments

Conservation Groups were concerned at the workshop by the appearance of negative daily values for inflow to reservoirs. Conservation Groups support the recommendation by the California Department of Fish and Game (DFG) in a letter dated May 16, 2012. Specifically, Conservation Groups support the recommendation to bolster the hydrology dataset by using a watershed pro-ration approach to supplement the mass balance approach presented by the Districts' consultant at the workshop. We also support DFG's recommendation to secure Federal Energy Regulatory Commission approval on any decisions they have made but to which there was no consensus reached.

The Study Dispute Panel's report (eLibrary 20120504-5163, pp. 13-15) recommends that the Districts use the workshop approach to sort out issues relating to accretions and depletions in the hydrology dataset. Conservation Groups recommend that it would be efficient and productive to schedule an additional hydrology workshop before the end of June (which could be held as a Webex conference call) to discuss the need for more than one measurement of accretions and depletions. An additional workshop held before summer would avoid potential delays that could arise if, when the Water Balance Model is presented as planned at a workshop in October, relicensing participants were not comfortable with the accretion and depletion calculations as presented. The Districts suggested during the Study Dispute technical meeting that measurements were best taken during the summer period.

We request that the Districts respond to these specific requests in their filing with FERC on revised meeting notes.

The Conservation Groups appreciate the Districts' consideration of our comments. If there are any questions, they can be directed to Patrick Koepele, Tuolumne River Trust, 209-588-8636 or patrick@tuolumne.org.

Sincerely,

Eric Wesselman
Executive Director
Tuolumne River Trust
111 New Montgomery Street
San Francisco, CA 94105
eric@tuolumne.org
415-882-7252

Tuolumne River Trust

Chris Shutes
FERC Projects Director
California Sportfishing Protection Alliance
1608 Francisco St.
Berkeley, CA 94703
blancapaloma@msn.com
(510) 421-2405

Ronald Stork
Senior Policy Advocate
Friends of the River
1418 20th St., Suite 100
Sacramento, CA 95814
rstork@friendsoftheriver.org
916 442-3155 x220

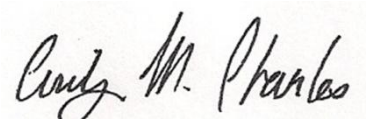
FRIENDS OF THE RIVER

Brian J. Johnson
California Director
Trout Unlimited California
1808 B 5th Street
Berkeley, CA 94710
bjohnson@tu.org
(510) 528-4772

Northern Sierra Regional Program Manager
California Trout
870 Emerald Bay Rd., Suite #303, Box #7
South Lake Tahoe, Ca 96150
jhatch@caltrout.org
530-541-3495

Michael Martin, Ph.D.
Conservation Director
Merced Fly Fishing Club
PO Box 2216
Mariposa, CA 95338
mmartin@sti.net
(209) 966-6406

John Buckley
Director
Central Sierra Environmental Resource Center
P.O. Box 396
Twain Harte, CA 95383
johnb@cserc.org
209-586-7440



Cindy Charles
Conservation Committee, Golden West Women Flyfishers
Board Member, Northern California Council Federation of Flyfishers
1940 Sacramento St. #6
San Francisco CA 94109
cindy@ccharles.net
415-345-8527

Dave Steindorf
Stewardship Director
American Whitewater
4 Baroni Drive
Chico, CA 95928
dave@americanwhitewater.org
530-343-1871

Steve Rothert
Director, California Field Office
American Rivers
432 Broad Street
Nevada City, CA 95959
srothert@americanrivers.org
530-478-0206

ATTACHMENT H

Mr. Bob Hackamack's Comments regarding the regarding the April 9, Hydrology Workshop

From: Bob Hackamack [BHackamack@frontier.com]
Sent: Wednesday, May 09, 2012 2:40 PM
To: Dan Steiner
Cc: 'Devine, John'
Subject: DP Questions and Suggestions for Dan Steiner
Attachments: TR DP, Questions for Dan Steiner, 4-2012.doc

Dan: I have attached my lingering questions and suggestions left from studying your write-up, handout and CD from the April 9 meeting related to the Water Balance and Operations Plan you are building for the Tuolumne River. I look forward to your operations rollout of your work on October 23. Bob H

Comments related to the Don Pedro Water Balance and Operations, W&AR-2, May 9, 2012

Dan: Here are my lingering questions about the TR Water Balance and Operations Plan you are building:

1. Concerning the negative results for calculated inflow to HH Res and other reservoirs, I suggest one additional explanation that has not been discussed. One reason for some of the negative daily results may come from the use of the monthly evaporation/precipitation factors which were derived from monthly tests, whereas inflow calculations are made on every individual day. I'm sure some days are sunny, above average temperature for that subject month, windy and have no precipitation that leads to higher evaporation than is calculated using the average historical monthly factor, possibly leading to the calculated inflow higher than actual flow was. The warm and windy day case showing higher calculated inflow would go unnoticed by relicensing participants (RP). Conversely, other days are cloudy, below that month's average temperature, calm and may have precipitation leading to lower evaporation than calculated using the monthly factor, leading to a calculated inflow lower than actual. That cool, calm case with lower calculated inflow than actual could show negative inflow on low inflow days. RP would notice only the negative anomaly. The monthly total calculated inflow would come out fine by smoothing out the above and below extreme weather days embodied in the monthly factor because monthly factors presume every month has the same average daily weather as the month(s) when pan tests were made.

As a way of reducing worry about the negative inflow days, it would be interesting to see if negative inflow days correlate among the three upper reservoirs. A more ambitious job would be to correlate negative days with weather data, say average daily temp, wind velocity, daily precipitation and insolation.

Another interesting correlation in low inflow months would be the relation of calculated inflow at HH Res with the recently installed real-time inflow gauge there, in use ca four years, USGS 11274790, "TUOLUMNE R A GRAND CANYON AB HETCH HETCHY", remembering that this main stem gauge will show the largest amount, but not the total inflow.

2. You say in your Estimation of Tuolumne River Unimpaired Flow… paper on p 6, "the Operations Model will likely consider two components of inflow to Don Pedro Reservoir…" Explain why unimpaired flow at La Grange doesn't include calculated inflows shown in the three Columns AE, HH calculated inflow; and AF, Cherry & Eleanor calculated inflow? Perhaps AH, calculated DP "local" inflow should not be included since DP outflow and CCSF diversion are already counted. I've come to this conclusion after careful study of your equation for Column AG. Also, tell us whether the Districts and SFPUC count AE, AF and/or AH in their unimpaired flow at La Grange.

3. You said at the 2011 W&AR-2 meeting that you would show a test of the accuracy of your water balance, but this April you seemed cool to including any test. One way you could test the accuracy and completeness of your model is to list your unimpaired flow at La Grange beside the same result reached by the Districts and SFPUC and show the long term difference and average difference and/or percent difference. You and all RP users would know that you are in agreement with the methods the District's and SFPUC are using, or why your model is more complete.

4. While you are figuring out the accretions from Turlock Lake Reservoir and Modesto Reservoir, also look into the riparian users along the river. In about 1970 the state listed summer riparian users in the reach not far downstream from La Grange as withdrawing 6 cfs directly from the river while the release (leakage) at LaGrange Dam was listed as 3 cfs. There could be other riparian pumpers farther downstream as well. I have been told that some of the Dry Creek flow comes from pirating from Modesto Reservoir as well as I have seen unintended release flow from MID flood irrigators along Dry Creek (where I lived for 35 years) and from intentional spill from the MID main canal aqueduct at its crossing of Dry Creek.

5. W&AR-2 Project Operations/Water Balance Model in the 2011 Revised Study Plan beginning at electronic page 245 states in § 5.2 page 5 (electronic 246) ¶ 2 "There are no tributaries to the Tuolumne River downstream of [Modesto Gauge]." This is true, but nowhere is there provision for tail water entering the Tuolumne, Stanislaus, and possibly San Joaquin and Merced rivers from TID and MID canals. A few do enter upstream of the Modesto Gauge, but most do not. In October 2011 Allen Short, MID General Manager, said at a public meeting about selling MID water to CCSF that MID tail water is 37,000-ac-ft/yr. This amount needs to be accounted for in the model partly because he said the goal of selling fresh water was to pay for capture and reuse of this tail water. Tail water flow is enough that it needs node(s) separate from other accretions.

6. No answer has come to my request in the above study plan: § 5.2 p 2 (electronic 246) Ground Water storage: I requested in October that this model add a node(s) for ground water storage to supplement irrigation supply during droughts, but the topic was not discussed in the Nov 22 filing. I ask again that this conjunctive use be added. A physical location of that storage need not be identified for these conceptual nodes. The idea would be to use what-ifs for some of the surplus releases in normal and higher runoff years when DP has spills that could be conveyed in MID and/or TID main canals in relatively small amounts to be injected into a nearby unidentified aquifer, to then be withdrawn via an output node into the respective district main canals during times of drought. A portion of this ground water bank capacity could be used to free up some surface water for anadromous fish release during these same drought periods. This concept was suggested in earlier comments by Spreck Rosekrans, then a water supply analyst at Environmental Defense Fund in San Francisco. Specifications outlining how this concept might be modeled were developed by Mark Williamson, PE, of GEI, consultants for the EDF. EDF created an extensive model (TREWSSIM) of CCSF water supply system for a large report in 2004 about re-operating the CCSF system that considered such a groundwater bank as suggested in this current request. The EDF TREWSSIM model has a detailed written logic and structure that might be available to the Districts and you.

7. Could you list the amount of water pumped into the MID and TID canals, most in drought years? I suspect all these pumps use Class 1 power purchased from CCSF, thus the volume pumped could be calculated for each well. The purpose is to show how ground water supplements surface flow.

8. You and John Devine agreed at the April 9 meeting that the model will contain the generation at DP. I suggest that flow be listed and energy calculated by equation that would help to know the impact of "what-if' trials on generation. You probably will need another node for release and spill at DP separate from power generation. These releases often happen to meet flood reservation requirements in spring, e.g. 2011.

9. You and John Devine agreed at the April meeting that the SFPC paper water bank would be shown and will show result of what-if trials.

10. On your spreadsheet handout and in the CD I see two nodes numbered “30”, in Column W and Column AH.

11. I find your “Preliminary-Subject to Revision” map to be accurate. I suggest you add a note that there are MID and TID return flows and canal spills near the TR confluence and into the San Joaquin, Stanislaus and Merced rivers if any.

12. If you revise that map, I suggest you note the total number of riparian pumpers from the TR.

13. I ask a node be provided for the TID gallery diversion at Geer Road of up to 100 cfs for domestic and/or agricultural use. This will be very useful for what-if tests on stream temperature from La Grange to this point and beyond. Likewise please show a diversion for this gallery on your Preliminary map downstream of “River Accretions”. Including a river mile for its location would be helpful to RP.

14. Could you list the measured temperature of DP release as a column in your spread sheet or as a footnote?

15. Could you calculate the flow and calculate and list temperature at TR confluence? This would be helpful to the fishery folks especially for what-if trials.

16. Remind us of the water year types that are the triggers for the present stream release schedules.

17. Please provide for what-if trials to increase flood release below MOD gauge from 9,000 cfs to, say 15,000 cfs.

18. Provide for the TID spillway data located upstream from Waterford that is used for flow from canal generators in good runoff years.

19. Provide for what-if trials for release for anadromous fish to begin, say June 1 instead of Oct 1.

20. Provide for what-if peak runoff to shift up to two months earlier due to climate change. I don’t see clearly how to vary the spring unimpaired daily flow as feed-back for what-ifs for climate change since inflow to CE, HH, South Fork, North Fork and Clavey River some of which are not data input points lumped in “local” flow. Perhaps hypothetical tributaries or distributaries could be added to make the shift evident.

21. Page 10 of your Estimation paper, § 7.0 may refer incorrectly to W&AR-3, the temperature model.

Thank you for considering these requests and suggestions. Bob Hackamack, P.E.

Copy to John Devine,